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MEREDITH BRASELMAN: Ladies and gentlemen, welcome to the National Transmission Planning Study webinar. We are thrilled to have Secretary of Energy Jennifer Granholm joining us today and kicking off our event. Secretary Granholm, welcome. We are good, we are good.

JENNIFER GRANHOLM: OK, great. Thanks. Sorry about that. Thanks, Meredith. Thank you all for tuning in to hear about the National Transmission Planning Study. This really is our latest really important step toward modernizing and expanding obviously America's electrical grid, which is, in turn, an essential part of President Biden's ambitious climate and clean energy agenda.

As many of you know, this administration has set these goals of cutting emissions in half by 2030 and reaching 100% clean electricity by 2035 and then achieving net zero by 2050. Those goals, of course, all depend on bringing our grid into the 21st century, and that means expanding our transmission capacity. So, because we need more transmission to run on 100% clean energy, including wind and solar and hydro and nuclear and geothermal, and to handle all the buildings and the cars and the trucks that were working to electrify, we need more transmission to give more Americans access to these clean energy sources that are already cheaper and to lower their energy bills. And we need more transmission to protect more households from power failures during natural disasters or cyberattacks.

In other words, we need more transmission, period, to deliver this cleaner and cheaper and more reliable and resilient energy, and not to mention, to create more jobs. There's already a million Americans working on transmission. And if we want more transmission, we need more electricians and truckers, construction workers, line workers, you name it.

So fortunately, the bipartisan infrastructure law invests over $16 billion to upgrade the grid. And so, the question for us is, how can we best invest that money? So, a few weeks ago we had a discussion about what we envisioned for our project development process, and today we're going to talk about how this National Transmission Planning Study will help us plot out which projects we take on, what ones we let go.

What we're doing here now is new, so we need a strategy. We want to build out a cost-effective transmission network, we need to build out a network that provides access to a wide range of energy sources, both within and across the regions that it covers, and of course, one that offers enhanced reliability and resilience by allowing for greater power transfer between regions.

So, if we want to address the highest needs, if we want to generate the most positive impact, then we need to be deliberate and we need to be strategic in our planning. And we have to move with alacrity as well. But that's what this study is all about. It's going to be a national scale transmission planning analysis that will span 15 to 30 years.

And so, it's going to identify where we have the greatest opportunity to provide long-lasting benefits to consumers, and it's going to help us develop inter-regional and national clean energy deployment strategies that maximize emissions reductions while maintaining reliability. So, the study is going to go beyond the existing regional planning processes.

So, to be clear, this isn't a replacement for those either. It's just—it's going to be a complement, I'll say, and that's something that can inform existing processes. So, we want to know out there. We have to reach out and we want to know what you see. As with our entire transmission modernization effort, we think that stakeholder engagement, it just is essential to success.

So, along with walking you through our vision for this study, both the goals that we've set and how we intend to reach them, we've carved out time as well to answer questions. We'll have a lot more opportunities to hear directly from you, but I know we have a full agenda, so let me thank you all once again for joining us and for your partnership and your input. So, with that, I think I'm passing this to Pat Hoffman to get us started.

PAT HOFFMAN: So, thank you very much, Secretary Granholm. Thank you for all your time and your efforts and being an important champion to transmission as we know that we need to expand the transmission system and support of our clean energy goals. So, I really thank you. I also want to thank everybody for participating on this webinar today. It's very important for us to continue to have a dialogue. As the secretary has said, transmission is at the heart of the clean energy objective. We really need to advance the building and planning of our transmission system. It is very crucial for us to think about the reliability, the stability, the access of clean energy resources, but just also, support of consumers in the electric sector.

So, we want to have a holistic effort here. We really want to engage everybody across different levels of government, across the electric sector. We want to think about, how do we plan out our transmission system? We want to go beyond what the ISOs and the RTOs are doing and really think about climate evolution as we think about transmission planning.

And so, some of the things that we have looked at in the past and we want to continue to look at moving forward is really some scenarios and being able to think about different options so that decision-makers can understand the wealth and the proliferation of options that could be available to the community as we think about continuing to develop our transmission system.

But it is all about transmission planning, it is all about a dialogue and stakeholder engagement. So, we recognize that it is not only about new transmission projects, but it's upgrading the existing transmission system. So, two parts of this effort is, of course, the transmission planning study, which is what we are going to talk about today, that really will talk about transmission and new transmission moving forward. But it also be a complement to another piece of work that the Department of Energy has, which is a transmission needs study. And really, needs study is future-looking, but it is also really focused on areas that will leave congestion or look at constraints as we think about accessing renewables, as we think about our transportation infrastructure, and really think about capacity transfer across regions.

So, we do have two efforts that we generally are talking about. A larger effort that's really thinking about the transmission planning, and then also specific efforts around high-priority needs that will be identified as part of the transmission needs study. So, as we take a step back and we think about building a better grid, we have multiple avenues, opportunities, authorities at the department that we really want to take advantage of.

But before I get into some of those authorities and those activities, I really want to emphasize a couple of principles under which the Department of Energy is operating. The first principle is really take advantage of what we can do with the existing infrastructure. So, a couple of things that we want to think about from

that perspective is really, what can we do to upgrade the existing infrastructure with the existing rights of ways, whether it's higher voltages, increased capacity on existing rights of way?
The other thing is, what can we do with respect to grid-enhancing technologies? And is there an opportunity to allow for dynamic line ratings, power flow control, other opportunities that will increase the capacity on the system? And so, those are a couple of things that we want to actually maximize the use and utilization of the existing transmission system.
I would say, in addition to that in that same category is utilization and placement of energy storage on the transmission system to allow more flexibility, capacity, and capability of the transmission system. So, once again, the first philosophy is let's get as much out of the existing infrastructure as possible.
I didn't mention reconductoring, I apologize for that, that is another technology that we want to make sure that's part of the portfolio moving forward and looking at the existing transmission system. Then the second part of the philosophy is really to say, how do we take advantage of dig once and think about co-locating as we look at critical infrastructure projects?
How do we think about really taking advantage of the built out of the, say, EV infrastructure for heavy-duty vehicles as well as the co-location for needs from an HVDC point of view? So, looking at that from existing rights of ways or other infrastructure rights of ways so that we have minimal disruption. And so, those are some of the principles that we really want to think about as we move forward and talk about transmission needs going forward.
So, not only do we want to utilize the existing infrastructure, we really want to be very coordinated as we get into the next phase, which is really how do we look at new infrastructure. What are the capacity transfers we need across the United States? And how will that guide the building of transmission infrastructure moving forward?
And so, the two aspects and the two opportunities is, once again, the authorities under our Building the Better Grid initiative that talks about DOE's authorities in our portfolio of technology and capabilities. But the other is the opportunity that's available under the bipartisan infrastructure law.
And so, there are many avenues in which folks in the Department of Energy can provide support for building out the transmission system. And so just for an example, in the bipartisan infrastructure law, there are several different financing tools that are available. We have, of course, the Western Area Power Administration's Transmission Infrastructure Program. We have the DOE loan program that allows for opportunity for new transmission.
We also have a brand-new effort, which is a $2-and-a-half billion transmission facilitation program, which is a revolving fund program that can support the building of transmission lines through three areas. It can look at increasing capacity or buying capacity on a line, it can provide a loan, or we could directly engage in eligible projects.
But the other area is that we shouldn't lose track of as we think about infrastructure upgrades and resilience goes back to my first principle, which was get the most out of the existing system, is we do have opportunities from some of the resilience provisions for either grid-hardening or grid-enhancing technologies as we think about that and how that can aid the transmission system.
So, there is $5 billion for under 40101, which is a grid-hardening provision; there's $5 billion under an innovative demonstration approach to transmission storage and distribution, and that is 40103; and then of course, there is the control and communication, the Smart Grid Investment Grant Follow-On Program, which is a $3 billion program that really focuses on control and communications.

So, all these efforts in addition to the Department of Energy's existing programs as we think about transmission planning are really important as we take a holistic approach in what the Department of Energy is doing. The other thing that I want to really identify for you today is that the Department of Energy is in the midst of a realignment, and what we are really going after is the ability to concentrate and focus our efforts around deployment and infrastructure investment moving forward.

So, not only is it a technology development area in the department under the S4 or the Undersecretary for Science, there is going to be a new Undersecretary in the S3 that's going to be the Undersecretary for Infrastructure and Deployment. And that really goes after supporting the funding that will be available—or if it is available, excuse me, under the bipartisan infrastructure law but really focuses that on clean energy infrastructure and large demonstration of deployment activities.

And so, what we're hoping to do is actually leverage the activities for the Undersecretary of Science and Innovation that's going to advance technology and technology development and have that be infused into the Secretary for Infrastructure that's going to focus on grid deployment.

So, I'm excited that there is this opportunity in looking at how do we really co-locate, but also really capitalize on the leveraging opportunities that the infrastructure bill has to offer, and we will continue to focus on providing support for all the activities of the department, because we know we need to be very aggressive in the R&D stage of making sure that the U.S. has leadership in technology development and manufacturing and in jobs, and then we want to be able to be successful in getting those technologies deployed in the United States moving forward as we invest in our infrastructure and continue to provide the best-in-class services when it comes to electricity.

But also look at what the climate and the extreme weather impacts are doing and affecting our infrastructure so we can plan ahead and really start collaborating on the technologies and the support we will need to building out our infrastructure in the years to come. So, in closing, I really want to express my thank you to the organizers of this conference. I also want to thank everybody for participating today.

As the secretary said, it is very crucial to have a wide range of stakeholders engaged in the process as we think about needs and planning. We know we have to do things differently moving forward. We know we have to assess, as some of the ISOs and RTOs have done, different scenarios from an investment strategy point of view. We know we need to leverage the capabilities that the different modeling organizations out there have, and leverage that to really think about, how do we develop a comprehensive and collective strategy for transmission investments?

We know this all has to be part of a partnership, and to really capitalize on the efficiency and effectiveness of large-scale technology deployment. So, we look forward to hearing from you today with your priorities and your goals as we move forward. I really thank you for your time, your contributions is very valuable, and I look forward to the discussion. So, thank you. Meredith, back to you.

JULIET HOMER: Thank you, Pat. And actually, I'm taking over from here. Hi, everyone. I'm Julia Homer with the Pacific Northwest National Laboratory. And I'll be co-moderating this event today with Meredith Braselman from ICF. So, we are excited to be kicking off this National Transmission Planning Study, and we're really glad that you're joining us today.

So, our agenda is as follows. We heard these introductory remarks from the U.S. Secretary of Energy Jennifer Granholm, and we heard from Pat Hoffman, Acting Director of the Office of Grid Deployment. Following our housekeeping announcements, we'll have a plenary panel with four excellent speakers,

which will conclude with Q&A. Then we'll have an overview of the National Transmission Planning Study, including objectives, modeling approach, public engagement, and Q&A. Meredith?
MEREDITH BRASELMAN: Thank you so much, Juliet. So, I am Meredith Braselman with ICF, and thank you for all of you joining us today to kick off this important study. A few housekeeping items as we always have for our webinars. This Webex meeting is being recorded and may be used by the U.S. Department of Energy. If you do not wish to have your voice recorded, please do not speak during the call. If you do not wish to have your image recorded, please turn off your camera and participate by phone.
If you speak during the call or use a video connection, you are presumed consent to recording and use of your voice or image. All of our participants are in listen-only mode today. If you have any technical issues or questions, you may type them into the chat box and select to send to our host. We are taking questions today, and you may submit them throughout the event using the Q&A or the chat functions.
We'll have a Q&A session after the panel and then another after our study overview. If you can, please reference the speaker or topic when you submit your questions. If you need to view the live captioning, please see the link that is in the chat.
And finally, the most popular question we get is when you'll be able to see a copy of today's webinar. We will be posting the presentation on the National Transmission Planning Study webpage on Monday, and we will have those links for you shortly. The slides will also have contact information for our speakers in their teams. A recording of the webinar will be available in about two weeks so that we can ensure Section 508 compliance. Juliet, I'll turn it back over to you.
JULIET HOMER: OK. Thank you, Meredith. So, I would now like to introduce our speakers. We have four excellent speakers who will each share for about 10 minutes. First, we'll hear from Brett Carter from Xcel Energy. Second, we'll hear from Debbie Lew from Energy Systems Integration Group. Then, we'll hear from Lauren Azar from Azar Law. And finally, we'll hear from Johannes Pfeifenberger from Brattle.
So, we'll have a Q&A session at the end with the speakers. So please, at any time, enter your questions into the Q&A function here in Webex. So, please join me in welcoming our first speaker, Brett Carter. Brett is the Executive Vice President and Chief Customer and Innovation Officer at Xcel Energy. Brett, thank you so much for taking the time to talk with us today.
BRETT CARTER: Thank you so much; I appreciate the invitation. I do believe that this is a very critical topic. I'm extremely excited to sort of reframe the long-running national exploration of our transmission network in terms that I'm extremely passionate about, and that's because all of these transmission lines and their long-term viability is so that customers—and we often forget that those are customers, they want and need and deserve these major investments in place.
We have to keep the customers at the center of our discussion in order to deliver the renewable and sustainable energy that they want, and they want it at an affordable price. I think that Secretary Granholm nailed it when she said that she understands that we need to upgrade and complement our existing transmission with more transmission.
I think about our company. So, Xcel is a vertically organized energy company. We're the sixth largest transmission owner-operator in the country. We're also the nation's second largest generator of wind energy and one of the first to surpass 10,000 megawatts on our system. So, we serve territories that both hold some of the country's greatest renewable energy potential, and we're the transmission connector between the east and the west, so we do sit in a very critical spot.

All of this, coupled with being the first major utility to pledge to get 100% carbon-free by 2050. It makes the issues that we're discussing today particularly important to me and to our company and the utility industry as a whole, I mean, they've led the way in reducing carbon, and we can continue that march right into the transportation sector.

Some utilities are uniquely positioned to finance a tremendous amount of transmission, especially in our own backyards, but we can do it cost-effectively and expeditiously. So, while we plan for the long-term, some utilities like Xcel Energy are prepared to begin that march almost immediately, and what we're seeing is customers of all types, especially within the commercial industrial space, they're significantly increasing their expectations on renewable energy.

You'll see more and more ESG reports being created by major corporations today than ever before. And we're going to have to realize that these customers are the ones that are taking the carbon off the grid. I mean, we can produce the energy, but we need to connect that energy with the customers so that they can then use this greener energy across the country.

We have to take on the hard issues. The problems don't age well, we all know that, and this problem is not aging well. The only way to meet that customer demand that we're talking about is through a vibrant and connected transmission system. You might ask, what are the barriers in the transmission space currently that are hindering us from achieving customer expectations?

Well, currently there's a lot of red tape in this space. You heard Patricia talk about the ISOs and the RTOs and how we need to work around those systems. Well, we've got to come up with some new approaches to that, and that red tape is creating a backlog of projects. And general congestion is making it hard for all of the stakeholders to deliver.

Congestion especially is a real challenge. The best way to fight that is to decrease market barriers and enable us to move forward. The east and the west runs from Canada to Mexico, and it cuts America probably right down—almost right down the center with the electric system, and it's restricting the flow of energy, and that renewable energy especially across this seam we have access to.

Our territories align vertically along this seam, so unlocking this seam so that energy can flow between the regions will be paramount for us to unlock value and provide customers with the cheapest carbon-free resources possible. And we're sitting on this rich supply of renewable energy, which we believe is probably one of the richest supplies of renewable energy in the world, and with the developers to tap into it and the need to unlock that value for customers by opening the pipelines to get it to the region's poor in carbon-free energy.

So, I believe that this study, and I'm so glad that you've commissioned this study, we believe it's going to identify where and how to implement the unique impact of this federal investment that we have in front of us, and there is a huge job opportunity across the country associated with this. And those IEJ dollars should be focused on the long-haul interstate transmission.

Customers are asking for these resources now, and again, there are parties like utilities, like developers which are ready and well-positioned to develop regional transmission to connect developing renewable generation. The biggest gap to benefiting customers remains opening transmission capacity to ensure renewable energy can get to where it's needed, when it's needed.

And these resources cannot be developed for the benefit of customers without a plan for building inter-regional transmission that can deliver the power of population—the power to population centers, east to west and west to east, directly to the masses where our customers live and work.

So, without an innovative transmission system, customers are having to shoulder higher costs. This renewable energy has come down in cost significantly over the years, and that is actually a short-term solution—we can actually build out regional transmission in the short term, and in the long term, we're continuing to delay getting the customers what they want and need the longer we hold out on relieving the pressures that we're seeing in this space.

So, the marketplace is obviously shifting, and customer demand is going to drive this sector, no pun intended, like never before. But like Apple and other consumer-driven products, we have to listen to the customer and deliver on what the customer is asking for. We talk about load, but it's not just load. I just want to end on this. It's people and it's businesses. And it's also about energy independence and the security of our energy system.

With that in mind, I hope this study is going to consider, again, the customers are the ones taking the carbon off the grid, so let's move forward with unlocking that value for them, and we are just glad to be a part of this conversation.

JULIET HOMER: Thank you so much, Brett. Excellent. Thank you. All right, our next speaker will be Debbie Lew, Associate Director of the Energy Systems Integration Group. All right, you're on, Debbie.

DEBRA LEW: Thank you so much, Juliet. Thanks for inviting me, and I'm so honored to be with such an august group of speakers. Today, I'd like to talk about why we need transmission planning and what are the benefits that it can provide. So, in 2020, ESIG convened over 50 industry experts and technical leads for several clean energy studies to understand what's the role that transmission plays in achieving a clean energy future.

The bottom line of that was, we found if you want to meet the triple goals of reliable, affordable, and clean, we need a lot more transmission. We need to think about it differently than we have previously. Without transmission, we could find pathways to getting you to two of those goals, but if you want all three, we need significant national transmission expansion, given everything that we know about cost trends and maturity of technologies.

The first thing to note is that we need transformative action to meet ambitious goals, like 100% clean electricity by 2035 or 100% clean energy by 2050. So, in the last two decades, we have done a lot to progress clean energy. We have built about 200 gigawatts of wind and solar, but we need to be doing this several times faster now to reach these goals. So, we need really action on a transformative scale.

Now transmission provides several benefits. The first really big one is to deliver energy ancillary services to loads. So, we all know wind and solar are cheap. They're getting cheaper, but they can be far from load centers. So, if we want to get access to this wind in the middle of the country, the solar resources in the south, the offshore wind on the coast, this is going to require transmission to bring these resources to loads.

We also know electrification is going to increase demand. This could be doubling demand or more depending on how we electrify. So for example, if you want to get to 100% clean energy economy-wide by 2050—so let's say you're electrifying a lot of the energy usage in buildings, in transportation, in industry, and maybe also using green hydrogen as a carrier, this bottom-right shows vibrant clean energy zero by '50 scenarios, looking at 100% clean by 2050, showing that we might need 1,000 gigawatts of wind and 1,000 gigawatts of solar, plus a significant amount of storage to meet those kinds of targets.

Now, distributed energy resources are definitely going to contribute, but they're not going to be sufficient on their own. They can't do this with just distributed solar and storage. And industry knows this is an

issue. There's 700 gigawatts of zero-carbon resources sitting in interconnection queues across the country, and Brett just explained about the big barrier being accessed to transmission to deliver this to loads.

So, transmission to deliver resources is one reason. Another reason we need large-scale transmission is for resource adequacy and resilience. So, for example on the left, this is showing SPP. Now before they became an RTO, they had a planning reserve margin of about 17.6% in this region. So, that means they had to build 17.6% extra capacity in generators over and above peak demand to remain reliable.

Now when they became an RTO, this dropped to 13.6%, and when they built in significant transmission and connected a larger footprint that had geographic diversity across loads and resources, they were able to drop this further down to 12% in 2017. And this last drop, just from 13.6% to 12%, planning reserve margin, was able to save them $90 million annually, because they didn't have to build as much capacity and generators.

On the right, this is showing Winter Storm Uri in February 2021. This top map is showing transmission constraints at the PJM MISO interface that limited imports into MISO. So, during this time, MISO was importing about 13,000 megawatts and sending about half of that west to SPP and other regions. While ERCOT, as you know, was only able to import up to about 800 megawatts to SPP, and that was only when SPP wasn't having their own troubles.

As we have extreme weather that covers large geographic areas, transmission is no longer just about leaning on your neighbor, but now it's your neighbors neighbor and their neighbors as well. So, helping to connect larger regions is going to be important. And then third, we need transmission for a host of other reliability benefits.

And this was really shown well in MISO's Renewable Integration Impact Assessment Study that they released last year where they looked at increasing levels of wind and solar across the Eastern U.S. They examined every aspect of grid reliability and fixed whatever problems they found at each set—10%, 20%, 30%. They fixed them with the cheapest commercial solutions that were available.

So, at 10% wind and solar, there's not a whole lot to fix. You get up to 40%, up to 50%, and there become issues with delivering ancillary services or with thermal overloads. Weak grid issues because we've got high levels of inverter-based resources like wind, solar, and storage. The key enabler that they found to keep the system reliable was transmission.

And you can see that here in gray, these are the AC transmission upgrades they had to make and additions they had to make, and in orange, DC transmission infrastructure that had to be built to help keep that system reliable across the Eastern Interconnection, at 50% wind and solar. So, those are the reasons why we need transmission, but why national transmission planning? Why can't we just do what we do today?

So, this is best shown by Brown and Botterud at MIT, who looked at transmission expansion and operational coordination first at a state-by-state level, then a regional level, then inter-regional level, and then finally a national level. And they looked at how do you get to 100% clean electricity with those increasing sizes of geographic coordination of transmission?

And they found that “every state for itself” approach costs twice as much as the national approach to transmission for your delivered cost of electricity to meet that 100% clean electricity target. Again, this national approach means you don't have to overbuild generation and storage capacity. Instead, you're exploiting the geographic natural diversity that we have of resources and loads across this great country.

So, national transmission planning, it saves money. It turns out it saves even more money if you're trying to decarbonize. So, on this left, this is the End Rail Interconnection Seem Study. And in this study, NREL looked at this HVDC macro grid that connects the Eastern and Western Interconnections.

And they found that at a 50% renewables goal, the HVDC macro grid had benefits that were two-and-a-half times the costs. When the renewables goal went up to 85%, the benefits went up to almost three times the cost. So, they're finding that you save more money—save more money if you're trying to decarbonize when you use this national transmission planning approach.

On the right, this is Vibrant Clean Energy Zero by '50 Study. And in that study, they build this national HVDC transmission network. And the transmission, it's not cheap; it's $200 billion to reach 100% clean electricity. It's $350 billion to reach 100% clean energy. But they find that if you don't build this national transmission network, you'll pay a trillion dollars more to get to 100% clean energy by 2050.

Now I realize $200 billion, $350 billion, that may sound expensive to you, but it's important to realize that these costs are small compared to all the other costs that are needed in transforming our grid. So, the left-hand graphic, this is from that MIT study by Brown and Botterud showing that the delivered cost of zero-carbon electricity across all their different scenarios, and this blue is showing the wind, the orange is showing the PV, the green is showing the cost for the storage.

And a tiny bit on top, about half a cent per kilowatt-hour, that's the cost of the AC and the DC transmission across those different scenarios. The middle graphic here is from that NREL seam study. This is the 50% renewables case. And most of the cost here is in the fixed and the variable costs of generation, a little bit for emissions, and this tiny sliver here for transmission.

And then on the right, this is that Vibrant Clean Energy Zero by '50 Study where they look at 100% clean energy economy-wide by 2050. And in this scenario, they find that most of the costs again are fixed and variable generation costs. A tiny sliver for transmission. In this study, they also look at upgrading distribution systems, because they do massive electrification to reach 100% clean energy economy-wide, and so distribution is actually a significant cost as well.

But transmission across all of these different studies is a tiny fraction of the total cost of other resources, generation storage, and other infrastructure. So, from all of this, we recommended from these sessions that we pulled together in 2020, a path forward. And we suggested that we need ongoing national transmission planning. Not just a one-off study like we did about 10 to 15 years ago, when we did interconnection-wide transmission planning studies, but rather, ongoing national transmission planning that happens on a regular basis.

We also recommended that we need to proactively plan and build transmission to high-quality clean energy zones, to help unlock some of that queue, to proactively plan, and to save money through economies of scale by building bigger to anticipate a large growth of resources. And we also recommended that we need to design and evaluate performance of a national macro grid for reliability, for resilience, looking at operations, looking at operability, and looking at economics.

And I encourage you to look at our reports to see not only from the sessions that we did in 2020, but also a most recent report that we just published this month, looking at design study requirements for a U.S. macro grid. And with that, I just want to say thank you so much. We're really excited about what DOE is doing. I commend DOE leadership for taking on this very critical endeavor to help us reach, again, clean, affordable, and reliable energy. Thanks.

JULIET HOMER: Thank you very much, Debbie. Excellent. Next, we'll hear from Lauren Azar from Azar Law. Lauren, Thanks for being with us. Take it away.
LAUREN AZAR: Thanks very much, Juliet. The secretary started this off by saying we need a strategy to achieve zero carbon electricity. Any national grid goes through the states, and I would like to speak to the role of the states and expanding the national grid. I'm a former state regulatory commissioner, and I was legally responsible for ensuring the citizens of Wisconsin had a safe and reliable source of electricity at a reasonable cost.
And all state regulators have a similar kind of legal responsibility to the electricity customers in their state. When it was cheapest to transport fuel such as coal and natural gas, it made sense to build all needed generation within one's own state. Interstate transmission at that time was primarily used for the pooling of generation resources.
But the times, they're changing. First, the cheapest fuels right now are no longer transportable, namely wind and solar. And second, the frequency of extreme weather events are impacting large geographic areas as Pat Hoffman talked about. They are dramatically increasing. And third, due to the economics and public policy, carbon-emitting generators are retiring at a really fast pace.
So, state commissioners have no choice but one, to face this changing landscape; and number two, to evaluate the most cost-effective way to address that change. Next slide, please. Today, I'm going to address three different initiatives that have been occurring, two in MISO and one a joint venture of MISO and SPP. Next slide, please.
The first one was the multi-value projects. And in probably about 2008, the governors and utility regulators in the MISO states asked MISO to develop a grid that would allow them to collectively comply with their RPSs that are shown here on this slide. So, MISO developed a new process, and if you could flip to the next slide.
Essentially prior to the MVPs, the regional grid was being essentially planned by the interconnection queue process. As a new generation interconnection request came in, MISO, in a serial manner, was determining where to build up the transmission grid. And at the time, MISO indicated that it would have taken hundreds of years to actually go through the entire interconnection queue process sequentially to get all those requests complied with, given the RPSs.
So, what MISO did was they embarked on an unprecedented scenario planning process that looked 20 years out to build a regional grid that would enable the states to meet their RPSs. And this ultimately resulted in the multi-valued projects or MVPs. And what states did was, first they selected energy zones, and those are the blue circles you see on the map here, which, among other things, tapped the best wind zones in the MISO's footprint.
Then after that, MISO figured out how to deliver the electricity from those energy zones to the load centers and they identified seven different MVPs, and those are the red dotted lines. It's noteworthy that though the MVPs were designed to deliver renewable energy from energy zones to load during extreme weather events, the MVPs have been critical in maintaining regional reliability.
Debbie talked about Winter Event Uri, and we certainly could have conveyed more electricity from PJM through MISO into SPP, but the MVPs were critical in conveying what electricity MISO could to SPP. Normally the MVPs were essentially designed for assuming a west-to-east flow of electricity from the good wind zones over the load centers. During Winter Event Uri, those power flows changed, and they became and went from east to west.

Just as some context, the total estimated cost of the MVPs at the time was $5.2 billion, and state regulators—I actually led the process—worked together over 18 months to develop a way to help pay for those MVP lines, which resulted in a FERC-approved tariff. Next slide, please.

Under the MVP tariff, the portfolio of lines that you just saw—those 17 lines—had to at least pay for themselves. And what this slide shows is the benefit-to-cost ratios of the MVPs over three different calculation periods, the initial one in 2011, which is the gray bar, and then 2014 is the green bar, and then the 2017 is the blue bar. And that's essentially in those three years and triennial reports, MISO calculated the estimated benefits to the cost of the MVP lines.

And the lowest BC ratio and all of these bars is 1.5, and the highest is 5.8. And that means for every dollar spent for the MVPs, customers receive between $1.5 and $5.8. If the MVPs had not been built, customers would be paying more for electricity than they need to, and that's exactly what Brett was talking about.

This slide also demonstrates the benefits for large regional transmission lines change over time. This is not surprising given that the transmission topology and power flows change over time as well. So, for large regional lines, you can't decide a specific value for specific beneficiaries only once when the lines are approved and then expect those values to remain accurate over the life of a project that probably is going to last for 60 to 80 years.

So, that's why MISO's regulators and MISO's stakeholders agreed to broadly share in the cost of the regional MVPs based on the usage of those lines. Well, the MVP scenario planning process was visionary at the time. It's also noteworthy that the future scenarios used in 2011 woefully underestimated the speed of change.

For example, in developing the MVPs, MISO assumed that 3.2 gigawatts of renewables would be built by 2021 last year in five upper Midwestern states. However, a recent analysis showed that almost four times that amount of renewables were actually built by last year, with another 2.6 gigawatts under construction.

The takeaway: the MVPs were undersized because the future assumptions were not sufficiently bold. But MISO did endeavor to resolve that problem in their current process of long-range transmission planning. Next slide, please. The LRTP process is ongoing right now. In 2019, MISO embarked on this process with a new 20-year scenario process with more realistic future scenarios.

For the LRTP—so we had three—we have three futures and the LRTP process. Future 1 is the most conservative. It captures state utility and—state utility goals, specifically, 100% of binding standards and approved IRPs, plus 85% nonbinding goals. Interestingly, once those standards and goals are indeed captured in the modeling, it resulted in a 63% reduction in carbon. Next slide, please.

So, first of all, I want to say this map is not yet final. It was released on February 22, and it won't be finalized until later this year, but it is based—this is tranche 1. The LRTP process is going to have four tranches. This tranche 1 is essentially designed to respond to the needs identified in future 1, the most conservative future.

Nevertheless, this, I believe, is the largest portfolio of projects ever designed in the United States. And again, it's focused on allowing the states and utilities to meet their already-announced goals. The estimated cost right now, again, it's uncertain, but it's going to be over $10 billion. And I would just like to note that the cost allocation proposal for this is pending before FERC. As with the MVPs, MISO must demonstrate that these projects at the very least pay for themselves. In other words, that they have a one-to-one benefit-to-cost ratio.

And in the FERC filing, the state regulators did come together and support the tariff for these tranche 1 lines. So, compliments to the state regulators and MISO and coming together. Let's jump to the next slide. I'm going to briefly talk about the JTIQ, which is the Joint Targeted Interconnection Queue study, which is being conducted by MISO and SPP. These two RTOs, they became aware that the scene between the two RTOs was preventing the development of renewable generators in the area. In other words, the cost that were going to be assessed to interconnecting generators was so high that the generators were not being built.

So, SPP and MISO got together, and they said, “Look, we need to figure out some transmission solutions to resolve the constraints inhibiting those interconnections.” And two, they also endeavored to align the interconnection processes between SPP and MISO. And just want to complement MISO and SPP, two RTOs, to come together to come up with some inter-regional lines to address a very specific problem. Next slide, please.

So, just this month, they released a report identifying some lines for to solve the problems of interconnections. We still don't have a plan for how these are going to get built, because there's not a cost allocation yet that has been designed to pay for these lines. So, the lines have been identified; we're in a holding pattern right now until a cost allocation is designed. Next slide, please.

So, in conclusions, due to economic and policy factors, the generation portfolio is dramatically changing in the United States. New types, locations, and volumes of generation are being added, while legacy plants are retiring long before the end of their natural lives. Likewise, we're experiencing more frequent extreme weather events that can impact large geographic areas such as Winter Event Uri.

And regional and inter-regional transmission lines are the most cost-effective way to address, number one, the portfolio change, but also the bolster the reliability and resilience that we need in relation to not only the portfolio change but these extreme weather events. As Debbie noted, states taking a parochial approach will find that their customers are paying more for electricity that is less reliable and less resilient. In other words, they're going to end up paying for unjust and unreasonable rates if they go it alone.

So, let's work together to capture the opportunities before us, and I urge the states to help DoE move from a national transmission plan to actually getting inter-regional lines in the ground. Thank you very much.

JULIET HOMER: Excellent. Thank you very much, Lauren. A reminder to everyone, we'll have time for a few questions and answers, so feel free to put some questions into the Q&A panel. And our last panelist for today is Johannes Pfeifenberger from Brattle. And go ahead, Johannes. Yep.

JOHANNES PFEIFENBERGER: It's a pleasure to be here. I will get into some of the details of why transmission planning and why into inter-regional planning of lines and actually building these lines has been so difficult. So, we are facing a lot of complications, and my slides reflect some of that complexity. The good news is that we have been investing a lot in transmission. Over the last two decades, we increased annual transmission spending from about $2 billion in the late '90s to about $20 to $25 billion a year today. And we are investing that amount of transmission throughout the country in both the regional markets, but also the non-market.

So, we are investing quite a bit in transmission. The interesting piece of that is that 90% of it is solely justified, based on reliability standards. When Debbie and Lauren talked about the benefits that transmission can provide, Brett mentioned those too, that kind of planning does not look at benefits at all, it just looks at meeting reliability standards.

So, where do benefits then come in? This is what the current planning process looks like. The first set of boxes here accounts for probably 50% to 80% of all transmission that gets built. It either gets built based on local needs of individual utilities or it gets built in response to generation interconnection request or a request for long-term transmission service.

These are small incremental builds in response to individual requests for service. There is no bigger-picture planning, there is no multi-value consideration, there is no regional consideration in that. Then the second box you see, these are the regional reliability standards. So, when MISO or PJM or SPP or [INAUDIBLE] looks at what regional needs remain after these local projects and generation interconnection projects that are getting built, those are the regional projects.

And today, as I said, 50% to 80% of all transmission gets built with that first set of boxes in that chart, and maybe the other 10% to 30% get built with regional reliability projects. The last two boxes here are the regional economic and public policy planning. So, the example that Lauren mentioned with multi-value projects—so the LRTP and MISO, that is the third box that the regional public policy projects, multi-value projects. Those account for 5% to 10% of the spending over the last decade.

So, for most of these projects, the benefits of transmission are really only analyzed for a very small portion of what actually is getting built. And the last box that you have here is the inter-regional planning. It really hasn't been effective, because essentially no major transmission projects have been built between the big regions. It's just not working. There are a bunch of merchant projects that have been proposed, but it's very hard for them to get across the finish line, too, and many of these proposed merchant projects failed to get state permits.

The reason is that it's just very difficult. We did a survey of barriers to inter-regional planning. Most of these barriers also apply to the regional planning. And the three categories is leadership, alignment, and understanding barrier [INAUDIBLE]. So, a lack of leadership, a lack of alignment and understanding of why this is important.

Now, that doesn't mean that some people are really trying to show real leadership and this is one of those efforts, but you need that understanding and alignment at every level, including the state levels, not just the utility commissions, but also the permitting agencies. The planning process is so reliability-oriented that we really don't know how to quantify the cost savings that transmission can provide.

And as I said, the sequencing of first doing local projects and generation to connection projects, then doing the regional projects, then in the end doing inter-regional projects is really not getting you to a cost-effective outcome where you plan the best projects. Because by the time you have done all the local projects and all the regional projects, there is no need remaining for inter-regional projects, even if those inter-regional projects would be more cost-effective.

And then permitting is a real challenge. The states will often struggle with determining a need if it's not a reliability project or if the need is regional but not necessarily state-specific. The MISO planning effort, the MISO regional planning effort is really commendable, and it's a visionary way of doing transmission planning. The multi-valued projects that Lauren mentioned that were built in the last decade are an example of that, and hopefully the new planning effort will continue that trend.

But what the chart here shows is, if one region, MISO, is planning transmission and is doing so well, is this really the transmission system that we need as a nation? How would that plan differ if the neighboring regions were integrated into that planning effort? Maybe this effort, this national planning effort, will get us

there, but this just shows you that original planning effort, how well-designed it is just inherently not able to plan a inter-regionally efficient transmission system.

And the challenge, of course, with transmission planning is that the benefits of transmission are very hard to quantify. And with benefits, it sounds like, oh, if I spend a billion dollars in transmission, maybe I get some benefits. But the benefits are cost savings. You spend money on transmission to reduce the costs that customers face overall.

As Debbie mentioned, many of the studies that have been done found that you could spend a billion dollars on transmission and save customers $3 billion overall. Those kinds of cost savings will be very important to get to a cost-effective future grid. And if we don't know how to quantify these benefits or if most of the transmission planning does not even attempt to quantify benefits because it's just looking at meeting reliability criteria, we just won't be able to get there.

And this just shows that where planners do look at benefits, they usually only quantify what is called adjusted production cost savings. It's a fancy term for fuel cost savings. But transmission does a lot more than save fuel costs. It saves investment dollars, it increases reliability. There are some examples in the chart here where these benefits, the other benefits have been quantified, or at least some of these other benefits have been quantified.

And as you can see, the total benefits, once you quantify more than just fuel cost savings, are much larger, usually double the fuel cost savings alone. And most of these projects shown on this chart could not have been justified without knowing what those other benefits would be because fuel cost savings alone wouldn't be large enough.

Those are all planning efforts within the region. When it comes to inter-regional planning, there's a real danger that neighboring regions get together and they say, well, we only agree on how to quantify one out of the five benefits that we typically quantify, and then you end up with the least common denominator approach where for inter-regional planning, instead of quantifying all the benefits that the region is known to quantify, they only quantify the few benefits where they happen to quantify them the same way. And that's no way to justify—to be able to justify any inter-regional projects.

And we have lots of experience with how to quantify these benefits. These are just an example here. And it doesn't even include most of these qualifications where it did happen, and where that did happen, it only resulted in about 5% to 10% of transmission spending that we have seen over the last decade. It's successful, but it's not sufficient.

But things like Winter Storm Uri, which Debbie meant, are extremely high-cost events. So, the benefit is not, oh, we'll get a benefit when these winter storms happen. What we need to say is, what is the risk to each region of not having enough infrastructure? And what happened in Texas is a great example of the very high cost—not just utility rates, but the cost to the state of not having enough infrastructure. It's really risky to have inadequate transmission infrastructure. We know how to quantify it, and we can't just focus on existing reliability standards.

We here at Brattle have written quite extensively about the experience that exists in how to do better planning. But then we also know, as Debbie has mentioned, that many studies have been done—these are planning studies that says, how can the nation cost-effectively decarbonize the system? And all of these studies find that we could save a lot of costs of getting there by having a more robust infrastructure. The trick here is that it's sort of optional, because as Debbie mentioned this study by MIT, if you don't build transmission, you can still get there; it will just cost you twice as much. So, it feels like, well, I don't

know, maybe we want to wait till we know more about this—these national decarbonization standards aren't law yet, we can't spend so much money on goals that are not mandates.

And then each state and each region feels like, well, they want to build local renewables first, so why would New England import wind from the Midwest, for example, or pay for transmission to do that when the jobs would be in the Midwest, not in New England? So, the challenge is, we can get there, it seems, without a lot of inter-regional transmission, but it would be very expensive.

So, since we have this many studies, why is it that we can't actually build any inter-regional transmission? How many more planning studies do we need? And the challenge, of course, is that having a planning study doesn't mean anything in terms of getting a project built. You still need to connect the planning study with an actual need determination that is accepted by the permitting agencies, which is usually the states.

But the first thing you need is, you need the regional planners to accept the need. You might have these national studies, but then when, say, PJM looks at its system and said, well, we don't see that need, and then it's immediately irrelevant. Unless the regions agree with the need identified in these national studies, it won't go anywhere.

But even once the regions agree that there's a need, and they assign a transmission project to a transmission developer like one of the incumbent utilities, those transmission developers still need to convince the states within the regions that this need is applicable to them as well.

You might have a regional need, but if the states said, well, we don't have a need in the state for this, it just takes our land and doesn't really benefit us, you won't be able to get there. So, it's really challenging to connect these inter-regional study results to an actual determination of need.

And then the states, of course, they also have clean energy standards, they have clean job standards, they like to have the renewables built in their state to support the economy and not necessarily import those renewables from very distant places. And somebody has to pay for the transmission, and most of these national studies do not propose how the transmission would even be paid for, and the states who don't see a benefit, so they don't want to pay for it. So, you can see, it gets really complicated very quickly.

We did do a roadmap report in the fall where we sketched out what could be done to expand the inter-regional planning that exists between some of the regions into something that could actually be more proactive and more actionable in identifying projects that could get developed.

And this is a complicated chart, but I will just say there are—right now we only look at the processes that exist only on the very right here. It's the individual regional planning processes that work pretty well. The joint regional planning processes, the effort that Lauren mentioned between MISO and SPP is the first joint regional planning effort that actually yielded any significant inter-regional project candidates, but unless cost allocation can be figured out, that won't go anywhere.

And maybe that's why there have been calls for a federal planning authority, which would be the blue pathway here, and people after Winter Storm Uri even mentioned that there might be a federal requirement that each region needs to have enough transfer capability with the neighboring region. So, the easiest way to get inter-regional project build would be a reliability standard because the planners know how to address reliability standards. And if there was a reliability standard that said we need that much transfer capability between the regions, people would know how to plan for it.

If it's not reliability, then you're in this teal-colored box of having to consider the state policies, the federal policies, the economic benefits, the local reliability needs, and you would then have to do some sort of planning before you overbuild the system locally and regionally to figure out, are there inter-regional solutions that are more cost-effective than addressing the policy needs strictly on a regional or local basis?

Anyway, you see that even if you have a national planning study, getting the results of that planning studies integrated into the existing planning processes that can actually result in projects is quite complicated. But it also means that to make that work, we have to improve transmission planning overall. We have to go beyond just addressing reliability needs to really use some of the examples, like the MISO MVP project planning process that Lauren mentioned, use some of these proven practices but apply it to other regions and on a national scale. And that means we need to be proactively planning for future generation and load needs, not just relying on incremental generation interconnection requests.

We need to understand the full range of cost savings that transmission projects that a more robust infrastructure can provide, which means we have to use multi-value planning. We just can't plan for only reliability; we also need to look at the cost savings that transmission can be providing. And in doing so, we can't forget about—that the future is uncertain.

So, we need to test any planning for different futures to make sure we identify solutions that are robust across the futures, but that also avoid really high-cost outcomes where we are stuck in a reliability situation or in very high-cost outcomes because we don't have adequate infrastructure, and events like Winter Storm Uri are a good illustration on that.

But then we also have to realize that transmission is not one transmission line at a time; it's really the grid that makes it work. Like the National Highway System, if you had one leg of a transmission line that doesn't create a system, so you really need to work together as a portfolio and we need to do that inter-regionally. So, thank you, and happy to entertain questions.

JULIET HOMER: Thank you very much, Johannes, and thank you to all of our panelists today. We're actually going to just move right into the overview of the study, and then we'll have all the questions and answers at the end of the session. So, thank you so much to all the panelists, and we're going to go ahead and move on now to providing an overview of the National Transmission Planning Study.

So, the core team from the Office of Electricity for this study includes Adria Brooks, Hamody Hindi, and Carl Mas. Today we'll hear from Hamody Hindi and Carl Mas, and then they'll also be joined by David Hurlbut from the National Renewable Energy Laboratory. And as I mentioned, we'll do all the Q&A at the end of this session. So again, if you have questions, please keep them coming, please put them into the Q&A box here in WebEx, and we'll get to those. So, now over to Carl and Hamody.

CARL MAS: Great. Thank you, Juliet. It's a pleasure to be with you all, and I'll try to see if we can make up a little time through our slides. So again, I'm very pleased to join you all today with our colleagues from the Office of Electricity and our National Lab partners. As was discussed at the start, earlier in the year, DoE launched our Building a Better Grid Initiative, which includes this National Transmission Planning Study, among a number of other efforts to both modernize and expand our grid. Next slide, please.

So, for our talk today, we're going to introduce our project team. We'll review objectives and desired outcomes, some of which will [INAUDIBLE] like you heard from our first panel. My colleagues will discuss the project scope beginning with baseline analysis, which forms the foundation of our work, and then scenario analysis through which we'll explore different futures.

We've heard from earlier speakers the importance of looking at different scenarios, given the uncertainty of the next 20 years. And that obviously critical to success, it's been mentioned a number of times, for this project is public engagement. So, we'll spend some time reviewing our engagement plan. Next slide, please.

So, this multi-year study will be completed in partnership with NREL and PNNL, who will support analysis and our engagement with all of you. The labs will build from a number of past studies, a couple of them are shown here, and expand the capabilities of their tools to tackle these new challenging efforts. Next slide, please.

So, I'd like to take a couple of minutes, maybe less, to reinforce what the secretary said at the beginning of our meeting. We have a number of objectives for the study, including the development of specific modeling outputs, but equally important is the beginning of a process that we hope will serve to advance our energy system goals.

Three of our primary objectives are listed here. We will identify inter-regional and national strategies to accelerate cost-effective decarbonization while maintaining system reliability. We will inform regional and inter-regional transmission planning processes, particularly by engaging stakeholders in dialogue. And that's a really important part. This is as much about a process that we are kicking off as it is any specific outcome from specific tools.

And as was stated a number of times, this is not a replacement for existing regional planning processes. We hope it will help to reinforce and expand on the earlier examples that we heard today in the MISO and other regions, which are great first steps at looking at expanded regional and even inter-regional collaboration to help bridge our seams.

We'll identify viable and efficient transmission options that will provide broad scale-benefits to customers, and the importance of benefits for just mentioned by Johannes. We are looking for national transmission opportunities that are feasible, and as will be described later, we are developing an iterative approach so we all can learn together. Again, we're not looking to simply produce a new set of knowledge, but to have co-learning amongst our stakeholder community. And we'll have a finite study period, but the advancement of modeling tools and the dialogue that we create will continue into the future. Next slide.

So, just to wrap up, how will we use this? There's both, as I've said, short-term and some near-term opportunities, but then we see this as a long approach, a long-term approach to how we can move forward with new transmission builds. So, we anticipate the results of this work will be used a number of ways to help prioritize future DoE funding, that's been mentioned a couple of times earlier today; to help fill existing gaps within inter-regional transmission planning; and to help provide a framework for stakeholders to discuss desired grid outcomes and address barriers to achieving them. And we've heard about several of those barriers already today, which we hope to overcome.

So, moved kind of quickly through that, but hopefully that gave you all a sense of why we're doing the work, the gaps we hope it will fill. So, with that, I'll turn it over to my colleague to walk us through the baseline and scenario analysis.

HAMODY HINDI: All right. Thank you, Carl. So, I'm going to go through this study plan here, and there are really two pieces to the analysis in this National Transmission Planning Study. There's a baseline analysis, and then there'll be scenario analysis. Next slide. So, for the baseline analysis, there are really two pieces for it. Next slide.

So, basically, we're asking the question, for the currently planned 2030 transmission system, how close does that get us to the administration's 100% clean electricity goal? So, to figure that out, first we'll develop a database of large transmission projects that have a high likelihood of being energized by 2030. And similarly, we'll develop a database of both generation requirements and generation additions we expect to occur by 2030.

And then we'll perform power flow and production cost modeling analysis to see where that currently planned 2030 system [INAUDIBLE] how close did they get to our decarbonization goals. Next slide.

But the second piece of the baseline analysis, it's asking the question, for that currently planned 2030 transmission system, if we fully utilize that transmission, how much additional renewable generation can we fit on that system? And how much closer then would that additional generation get to our decarbonization goals?

So, the map on the right here shows capacity factors across the United States. So, the yellow areas have high solar capacity factors, and the blue areas are high wind capacity factor and the green [INAUDIBLE] both high wind and high solar capacity factors. So, those are really the two pieces of the baseline analysis. Next slide.

So, scenario analysis is really the heart of this National Transmission Planning Study, and it's where the bulk of the time will be spent in our analysis effort. Next slide. So, for the scenario analysis, we're asking the question, what are the different ways that our grid can evolve going into the future? And how well do those different grid futures perform when you compare them with each other?

So, one way to look at the different grid future scenarios is the capacity expansion model. For that piece, we're given a set of inputs and assumptions, we'll co-optimize transmission expansion and co-optimize generation expansion together to see what future grid would be produced.

And then as you vary those input assumptions and constraints, which I'll cover in a couple of slides, you'll end up with different future grids, different future grid scenarios, basically. So, another way to explore how the grid might evolve is through inter-regional renewable energy [INAUDIBLE] analysis.

And for that, it's taking some concepts from an earlier Texas CREZ process, the Texas Competitive Renewable Energy Zone process from about 10 years ago, taking some of those ideas and adopting them to a national scale analysis. So, those are other ways to see how the grid could potentially evolve going into the future.

And then as we look to the future scenarios, we'll do more detailed analyses to see how those different scenarios perform. That will include production cost modeling, power flow analysis including transmissibility, economic analysis, stress case testing, and resource adequacy analysis. So, let's go to the next slide here.

So, as I was saying, how the grid might evolve into the future, it depends on certain inputs and constraints going into the capacity expansion model. And so really, those different scenario characteristics are listed here, and you've got three different categories. You've got the transmission drivers, the main drivers, and generation drivers. I'll just quickly talk through these.

For transmission, some key constraints are how wide of an area are you going to constrain the transmission expansion to be. Is this going to be within a balancing area? Are you going to connect different regions within an interconnection but still constrain the transmission to be within each of our three interconnections? Or in the widest area of constraint, are you going to allow something like a macro grid overlay as Debbie was mentioning in her presentation?

Other transmission drivers, of course, the big one is the cost of transmission. And then as Pat mentioned at the very top of our program, things like transmission technology, dynamic line readings, flow control devices, and so on. So that second category of characteristics influencing grid evolution would be demand drivers there.

So again, building and vehicle [INAUDIBLE], high levels of that, medium or low, and what does high, medium, low even mean? That will all be a part of this study process. And similarly on the demand side for distributed energy grid sources, again, high, medium, and low penetration of DER and what does that mean?

Now, the last category of [INAUDIBLE] characteristic drivers here is generation. So, renewable energy siting, how difficult is it to site solar and wind in various places? And renewable energy costs and storage costs, is that high, medium, or low going into the future? That will impact how the grid evolves.

And last but not least, how has our thermal fleet been involved? And that includes looking at how our existing thermal fleet will be extended to look at new nuclear such as small modular nuclear reactors. And look at clean [INAUDIBLE] thermal capacity such as if we modified our existing gas plants that run on hydrogen gas.

And then of course, carbon capture and sequestration. We like to say that DOE is clean energy-agnostic. So again, the evolution of our thermal fleet is an important part of our scenario [INAUDIBLE]. Next slide.

OK. This is really my favorite slide, because what it shows for the study on this slide is how are different data and all of our different models that we have all come together for our scenario analysis.

So, on the input on the right—excuse me, on the left here, you've got your wind, your solar thermal data, the power system model data, transportation and building data. All of that is going to feed into capacity expansion modeling. And there's some submodels. The distributed generation model, the load forecasting model that also feeds into capacity expansion.

And then the most compelling future grid scenarios that come out of those models we'll grab and pull over to the green column here for a more detailed analysis, and again, that will be production cost modeling, reliability analysis, including the [INAUDIBLE] standards that the reliability planners know and love. But also include resilience analysis and resource adequacy analysis.

And then the last piece of the more detailed analysis we'll really get into [INAUDIBLE] identification, what types of expansion options perform well in a number of different future scenarios, and in that way, present an opportunity for near-term high-priority investments? That's really the scenario analysis. I think I've got one more slide here. Well, a couple more.

So, this is the workflow for the scenario analysis. The real takeaway from this slide and what I want for folks to see is throughout our entire scenario analysis workflow, there'll be multiple opportunities for external review. And there'll be also multiple opportunities for a bottom-up planning approach. So, starting in the upper left of the scenario, definitions, feeding into a capacity expansion model, then we'll have external review for what are the most compelling scenarios.

And then our data translation process, that's also going to require interaction to see how we fit bottom-up planning approaches into that, and so on and so forth through this entire cycle. The other item which—we'll get to schedule later, but we're going to iterate through this entire workflow cycle twice, once in 2022 and then the second time in 2023. So, we'll have a couple of bites at the apple here for external review and integrating [INAUDIBLE]. Next slide.

OK, great. This is my last slide before I'll pass it off to David. So, I just wanted to emphasize what the study will do and also what it will not do. Again, we're linking several different long-term and short-term models for a really comprehensive look at the pros and cons of different future grid scenarios. And we want to inform and not replace existing planning processes. And that's why that stakeholder dialogue and public engagement is so important throughout this process.

And we want to look at scenarios that would lie outside current transition planning. Again, evaluate a number of different indicators for a comprehensive analysis of [INAUDIBLE]. We're not going to be citing individual transmission lines. That's beyond the scope of the study, and similarly, not doing detailed environmental analysis or individual transmission targets.

And we're, of course, not going to have results that are as granular as planning done by utilities. Another reason why this dialogue is so important in this process and we're not developing detailed plans [INAUDIBLE]. And I think with that, I'll pass it over to David for more details on our public engagement.

DAVID HURLBUT: Thanks a lot, Hamody. As Secretary Granholm said at the beginning, we want this study to stimulate informed conversations that otherwise would not happen. And as Hamody explained, the technical chops of the National Laboratories and DOE are going to be here. But we also want to stimulate conversations between planners and processes that tend to right now work in regional silos. And as Brett mentioned, we want the conversations to be more inclusive of end use customers, the utilities who serve them, and the regulators who decide how transmission projects are permitted and paid for. So, that's the thinking that is guiding how we are approaching public engagement in this project.

And we plan to do this in a number of ways. Let's go to the next slide, please. We have a number of public webinars on the agenda like this one that will be held at key times to present major milestone results, and at these webinars, observers will have an opportunity to comment on the interim results. But what we really want is for observers to take what they hear in these webinars and take them into other discussions, because it's these other venues where new transmission ideas really find their genesis. We also plan to continue coordinating with planners and regulators in existing convening groups who are already working on the same puzzles that we are, and we'll coordinate efforts with them especially to that input data and modeling assumptions.

The deep dive into details will rely heavily on a technical review committee, which I'll talk about more in a moment. We also know that this study might be of particular interest to some tribes, including those that have their own clean energy aspirations, or those who want to ensure that future development does not disturb their culturally sensitive lands.

Each tribe is a sovereign entity, and the project is going to conduct special outreach so we can understand the interests in the context of what the NTP needs to accomplish. Finally, energy justice overall is a priority. Throughout this engagement, the labs and DoE will work closely with others to identify the sometimes-complicated nexus points between transmission planning and energy justice. And our goal is to do this right. But right now, we welcome your input and invite you to submit comments through the NTP project website, which we'll share at the end of this webinar. Next slide, please.

Now, the Technical Review Committee is where public engagement will really get into the details. TRC members will be experts who are sharing their knowledge, insights about state-of-the-art technologies, and the best methods for modeling them. The TRC members will be fully engaged in reviewing the status of the project. And they'll participate in regular public webinars, and some may be involved in special working groups that focus on issues that are particularly complicated in the modeling.

The TRC itself will comprise subcommittees that focus on specific areas. There will be a modeling subcommittee, which will provide feedback on the technical assumptions used in the analysis. These members will have up-to-date knowledge of power system electronics and understanding both the current systems and those that are emerging.

Members will have experience with power system modeling, especially as applied to transmission planning. There will also be a government subcommittee, which will include state regulators and other officials. The role of this subcommittee is similar to what state regulators did in MISO, which is to provide guidance on an especially difficult area of planning. How the modeling can account for public policies and priorities that are seldom the same from one state to another.

The Lab team will also look to this subcommittee to help with the critical question that is often overlooked in national transmission modeling, which is cost allocation. What modeling outcomes will help understand the distribution of benefits of all types? And how will that be distributed across those who will ultimately would be asked to pay for the transmission? Insights from these decision-makers will help us present those results in ways that are most useful for them.

Now while the project won't be making any siting recommendations, it will make every attempt to avoid assuming that something can be built where, in fact, it can't be. So, we'll have a special subcommittee on environmental exclusions and land use constraints that will help account for state, federal, and local laws that limit where development may or may not occur.

Now the National Labs will invite members to the TRC and its subcommittee based on expertise, interests, and availability. Individuals may nominate themselves or others. TRC membership entails a sustained commitment of time to process materials presented by the lab team and to provide thoughtful feedback.

Details on the TRC membership process will be posted on the project website. We'll also distribute it via email—via the email distribution list created by DoE for the Building a Better Grid Initiative, which includes everyone who was registered for this webinar. So, you'll be getting that update soon.

Most of the TRC's work will happen in public webinars. The Laboratory team will schedule the webinars, set the agendas, prepare project updates, and find subject matter experts as needed, and record the discussions among TRC members. The public will be able to observe these meetings and post questions in the webinar chat box and submit comments about any meeting via the project website. Next slide, please.

Now we anticipate the NTP study's public outreach component to last about a year and a half. Today's webinar will be followed by a workshop for the TRC later next month. When the Lab team—and at that meeting, the lab team will lay out our initial modeling assumptions. We'll also ask for preliminary feedback on how to select scenarios for modeling.

The team will use this feedback in our work over the subsequent months, and in the late summer will come back to the TRC with the first round of results. Soon after that TRC meeting, the lab team will refine its presentation for another public webinar. So, this is the cycle. We listen, we work, and then we report out.

And we expect repeat this cycle at least twice, with final results presented in the late summer of 2023. During these cycles, there will be parallel engagement tracks with existing convener groups and another parallel track for engagement with tribes. The TRC subcommittees and working groups will meet in between the full TRC meetings, as needed.

We believe this timeline will enable the Lab team to conduct the study in the most efficient way, and at the same time, we think the process will provide avenues for bringing in new information from outside experts and from the public.

So, as I said earlier, the goal of this outreach is to turn research into informed conversations. And for these conversations to lead to new transmission that otherwise would not happen. And for this new infrastructure to accelerate decarbonization at costs that are just and reasonable. And we want you all to participate in that informed conversation. Next slide, please.

You'll be able to get updates on the entity study from the web page, which is shown here. The URL is also going to be posted in the chat box for a quick copy and paste. There's also going to be an email distribution list for important news about this project and the rest of the Building a Better Grid Initiative. And I believe you all were added automatically when you register for the webinar.

The website also has a place where you can submit comments at any time. We encourage you to share your thoughts on anything mentioned in this webinar or on any other aspect of the project. And with that, I'll turn it over to Meredith and Juliet to wrap up.

MEREDITH BRASELMAN: Thank you so much to Hamody and Carl and David for all the information. We have a lot of questions to cover, but first, a reminder that we will be posting a copy of the presentations today on the National Transmission Planning Study webpage by Monday, and we will have a recording available within a couple of weeks.

So, now this brings us to our Q&A portion of the webinar. We do not think that we're going to be able to get to all of the questions today, but the Office of Electricity will review and post Q&A in the coming weeks. So, let's go ahead and get started here. The first question for Carl, can you tell us a little bit about how this study will impact the construction of new transmission?

CARL MAS: Sure. Thanks for the question, and again, thank you all for taking part in this process. I'd also like just to take one second to let everyone know that we have a couple of other folks joining our panel to help us with the Q&A. So, we have Josh Novacheck from the National Renewable Energy Lab and Michael Kintner-Meyer from PNNL. So, I want to thank them both for joining us, and they'll be helping get into some of the details around the questions.

And so, in terms of the actual question before us, how will we impact construction? We want to be clear that DoE does not build transmission. So, we're really here to facilitate and create a process that allows for all the regulators and the key stakeholders to engage in this process. We expect that by conducting the study with input from planners, as David mentioned, with input from regulators, other key stakeholders, and tribes, results will influence federal funding to support new transmission, so that's one key outcome.

And the findings will inform those same groups so that system planners and state regulators will be able to look at the results and engage in the process, in the iterative process that was outlined to help them prioritize new projects.

MEREDITH BRASELMAN: Yep. Hamody, this next question is for you. Won't the national transmission model miss details that are important to reliability and grid resilience?

HAMODY HINDI: OK. Yeah, thank you, Meredith, for that. So again, we want to say this study is not going to be as granular as studies done by utilities. And so, that's why a dialogue through this process is so important, both to incorporate the bottom-up approach we're [INAUDIBLE] this might not work here or we'll need to do more detailed follow-on studies.

And again, tying into what Carl said, we expect this to hopefully catalyze new additional more detailed study and help existing processes identify maybe new opportunities if you'd like more detailed studies. I think I'll leave it at that.

MEREDITH BRASELMAN: All right. Thank you. David, this next question is for you. The need for transmission has been demonstrated in numerous studies over a number of years, including those paid for, conducted under DoE funding. However, very little of this is result in new inter-regional transmission. How do you envision that this effort results—that this effort results in an outcome where inter-regional transmission is actually constructed?

DAVID HURLBUT: Yeah, great question. And what we want to do here is to expand the outreach so that we're including folks in the conversation who really have more of a stake in paying for the transmission, for getting ideas initiated and discussed through the traditional planning processes.

As Carl said, DOE doesn't build transmission, but we can stimulate conversations, we can bring folks together, and we can do analysis that is usually outside the short-term analysis that is done in most transmission planning venues. Like Johannes described earlier, a lot of those planning efforts are really necessarily focused on short-term outcomes.

Well, we plan to take a longer-term perspective in the options that we're going to be looking at. Once we have those options better studied, then we can take them to the stakeholders, the folks who are most directly affected and raise new types of issues, new questions, and new types of analysis to help them engage in the process more.

So, in a nutshell, we're trying to expand the discussion, as Secretary Granholm said earlier, and from that broader discussion, get it through the regulatory process better.

MEREDITH BRASELMAN: Thank you so much. Josh, this next question is for you. How will generation other than utility-scale solar and wind be incorporated in the study? For example, will distributed energy resources nuclear and Canadian hydropower imports be considered?

JOSH NOVACHECK: Yeah, Thanks for the question. And the short answer is yes, absolutely, we'll be considering all of these other drivers that would influence the amount of transmission that our modeling suggests would be cost-effective and valuable under a variety of scenarios.

You might remember, Hamody presented a slide that demonstrated some of the different categories that we're going to consider, and some of those were distributed energy resources, what level of deployment do we expect there, what's the level of electrification, what do we think the evolution of the thermal fleet or other technologies other than utility-scale wind and solar, what might that look like? And how will the storage cost be influenced—influence the need for transmission in the future?

So, we certainly want to take a broad look at all of the different trajectories the future system could take, and then help that whittle down and identify these least regrets projects for transmission that we think would be very valuable under a wide range of different possible futures.

JULIET HOMER: OK. This is for Hamody, but Josh, you might want to answer this one, too. Will the study provide benchmarks such as the amount of electrification or DER for regional planning entities to study?

HAMODY HINDI: I think that would be a great one to pass off to our Lab colleagues here.

JOSH NOVACHECK: Sure, yeah. We certainly intend to make many of these results for our different model—for results from our different simulations and different modeling domains available both for external stakeholders to use, but then also as an input into their planning processes. So, not only do we

want review on what those assumptions are to make sure that they're consistent with what others are using, but also provide a basis for others to use in the future for their studies.

MEREDITH BRASELMAN: Thank you. David, the next question is for you. How will the study consider land use constraints that impact both renewable and transmission development?

DAVID HURLBUT: Great question. A lot of these constraints are codified in various federal, state, and local laws. And over the past 10 years, the databases, you're compiling all of this information, have improved significantly. So, that's going to be our starting point. Looking at the existing laws, existing restrictions that are on the books, and putting them into a geospatial analysis, basically, to identify where development can and cannot go.

That is going to inform our assumptions about, for example, how much wind capacity can be developed in a particular state, taking out all of these exclusion areas to make sure that we're not assuming that something can be developed where it really can't be. The same with transmission.

The path from point A to point B, well, it may go through areas where we're siting is severely limited or where it's very costly. We'll be looking at the factors that affect the cost of building new transmission, going over flat terrain as opposed to going through hilly mountains or hilly forested mountains; the construction cost is a lot more.

So, we'll be pulling all of those into geospatial analysis that will help inform the analysis of the transfer capability of new transmission between regions. That's essentially how we'll be approaching it, but we'll also be looking for input from from county planners, from national associations whose members are engaged in this type of local planning to make sure that our assumptions are accurate in the model.

MEREDITH BRASELMAN: Thank you. Michael, this next question is for you. Will the study capture the reliability challenges of operating a system with significant generation from renewable energy sources?

MICHAEL KINTNER-MEYER: Yeah. Yes, we will look at them. This study will be for the first time a full complete analysis, from capacity expansion planning models to production cost modeling AC power flow and dynamic analyses. And particularly with renewables and inverter-based technologies, of interest are these reliability components there that address how these systems might function. They are dynamically—if there are any contingencies with these new technologies available.

So yes, we will be looking at this, we will be looking at it even in stressed scenarios where it's impacted due to either cyber events or some weather events such as heat loads and a potential deactivation of transmission.

MEREDITH BRASELMAN: Thank you, Michael. Josh, this next question is for you. In addition to the 2035 goal of zero greenhouse gas electricity, we have a 2050 goal of zero greenhouse gas total energy for the nation. Will you include consideration of the 2050 goal, and do you expect it to impact the study materially?

JOSH NOVACHECK: Yeah, great question. We certainly will consider the 2050 goal as well. There is going to be an extra focus on the nearer-term needs to achieve the 2035 targets. However, all of the scenarios will also be considering what it means to get beyond the 2035 and towards the 2050 goal.

We do expect the 2050 goal to have a large influence on how the system transforms, what level of electrification we expect, and the demand for new demands that we don't serve today because of the need to electrify as one of the decarbonization strategies for the economy and for the energy system at large.

So, we will be considering that; however, we'll definitely be focusing a little bit more on the 2035 system, but making sure some of those investments and projects are in line with that 2050 system that we identify as least regrets.

MEREDITH BRASELMAN: Thank you. David, the next one is for you. How will the study consider land use constraints that impact both renewable and transmission development?

DAVID HURLBUT: Right. So, as I said before, a lot of the constraints are codified in federal, state, and local law. So, we'll be taking those into consideration. We'll also be looking at land characteristics that affect the productivity and the cost of, for example, building new solar capacity. There are some types of terrains where it's more difficult than others or more costly than others. So, this will be folded in into the analysis as well.

Another part of the analysis that we'll be looking at is what sort of discount factors to apply. So, sometimes the laws may change or the regulations may change. When we did a similar exercise for the Western Governors Association, we didn't assume that everything that could be developed would be developed. We assume that there would be only some fraction that would be developed.

So, that mathematically takes into account all of the things that are not captured in the land-use analysis and the geospatial screening that we apply. So, there are a lot of aspects to that geospatial analysis that will account for limitations on both renewable energy development and transmission development, but really, for the purpose of more realistically estimating, for example, what the line distance might be, but without really assuming where the siting is going to take place. We just—we really need a realistic picture of what that distance is going to be and what the developable capability is going to be.

MEREDITH BRASELMAN: All right, thank you. Carl, this next one is for you. Can you clarify how or whether the planning study will inform investments under the bipartisan infrastructure law? Will certain investments be postponed until the study is complete?

CARL MAS: Yeah, thank you for the question. And there were actually a few questions along the lines of what the interaction would be with the infrastructure law funding. And so, as the secretary and Pat Hoffman mentioned, this study will be one of several analyses; it will not be the only one, that is relied upon to help guide application of the billions of dollars.

Pat Hoffman had mentioned the $2.5 billion program that will be stood up. It's new. There will be another $10 billion of resilience and hardening. To be clear, none of those activities will be slowed down by this study. What we see in the infrastructure law is that there are revolving loans that will be coming through the loan program, the facilitation program, we'll be able to invest that $2.5 billion and then reinvest it over time.

And so, we do think all those programs will proceed full steam ahead. Those that already exist will ramp up quickly. Those that are new will take a little more time to get stakeholder input. But the results of the study will be impacting them in the later years, again, as we're reinvesting some of those resources.

MEREDITH BRASELMAN: OK, very good. Josh, a question here as we get close to wrapping up. If the study will not be citing specific transmission routes, what will the transmission expansion options identified by the study look like?

JOSH NOVACHECK: Yeah. So as Hamody has suggested, one of the key outcomes—and I've mentioned a few times as well, is this idea of least regrets transmission options. So, through our modeling suites, we'll identify more aggregated paths and regions that we want—that we see being expanded

robustly across a wide variety of scenarios. So, that will be at a little bit higher resolution, more of a zonal-like approach to identifying transmission connections.

And then we'll downscale that into a more resolved system that will be connecting parts of the system when we do our detailed modeling. However, that's really to flesh out some of the additional benefits of that transmission. How is that transmission operated? What are some of the reliability benefits of these options?

Again, to kind of give us an understanding of general areas where we think more robust connection between regions would be valuable. And then also get us—inform our different options in terms of expanding the topology, whether that's a large-scale macro grid or whether that's more targeted inter-regional investments that will bring value. So, that's what we're really hope to inform with this study. Not specific transmission projects that have specific routes, but robust connections between regions and an exploration of different topology options of this expanded system.

MEREDITH BRASELMAN: All right. Thank you, Josh. So, this brings us to the end of our Q&A for today. We have covered a lot in a short amount of time, from bridging the gap between clean energy goals and transmission to why national planning is so important. We want to thank all of our speakers today for joining us. I'm going to turn this back over to Juliet to talk about next steps and to close us out. Juliet?

JULIET HOMER: OK. Thank you very much, Meredith. So, what's next for the National Transmission Planning Study? Well first of all, as David said, we really want to hear from you. We've set up the website with a comment form and we'd love to hear—we've got a lot of great questions and comments, and we'll take a look at those.

But please, go to the website if you're interested and provide some comments and suggestions there through the comment form, and the link should be provided there in the chat. And then also, we encourage anyone who's interested to sign up on the email list so that you can get updates on for the NTP study, and I think since you've registered for this webinar, you're already on that list, but if you're not, you can access that through the website as well.

So, the team will continue conducting the baseline analysis and the scenario analysis going forward. The Lab team will select the Technical Review Committee members. And then we'll hold the first TRC or Technical Review Committee meeting in April. And emails will be sent to the distribution list about that TRC meeting and all of the rest of the TRC meetings. And then the next public webinar will be in the fall of 2022, and we'll share some interim results at that point.

So again, please enter your comments on the website. If you have questions, you can reach out to us at this email here, electricitydelivery@hq.doe.gov. But really want to thank everybody for participating in the meeting today. Thank you to all of our speakers and presenters, and thank you to Meredith Braselman for helping to facilitate. Take care, everyone, and we'll see you next time.