

# Design Concepts of Future Electric Transmission

## U.S. Department of Energy Technical Conference

Washington, D.C.

March 4, 2009

1:00 p.m.-5:00 p.m. EST

### Transcript

John Schnagl:

Good afternoon. My name is John Schnagl, and I'm the director of Transmission Adequacy at the Department of Energy's Office of Electricity Delivery and Energy Reliability.

As everyone finds a seat, let me attend to a few housekeeping matters. To keep you informed of future conferences, we request that if you have not already signed in at the registration desk to please do so before you leave. This conference is being webcast and transcribed. Transcripts will be available in several weeks, as indicated on your agenda.

To capture all questions and responses, it is important that all speakers use microphones to identify themselves prior to speaking so that you may be heard both by those here in attendance and those participating in the webcast.

There will be three panels moderated by Larry Mansueti, director of State and Regional Assistance with DOE's Office of Electricity; Joe Eto, staff scientist with Lawrence Berkley National Laboratory; and David Meyer, senior policy advisor also with DOE's Office of Electricity.

These moderators will introduce their panel topic and their distinguished panelists.

Following the panel presentations, there will be opportunities for questions. The first questions will come from other panelists. If time remains, we will open it up to the audience and to the folks on the webcast.

Now it is my pleasure to introduce Patricia Hoffman, Acting Assistant Secretary, Office of Electricity Delivery and Energy Reliability. Pat.

(applause)

Patricia Hoffman:

I was going to stand down here until you said it was webcast. We don't get a roving mike, oh, okay. Thank you. Even though I think most of you can probably hear me, I'm a pretty loud person, I just wanted to say welcome, thank you all for coming. If you all don't realize, we've got some challenging times ahead. We've got some exciting times ahead. I hear that they're going to work on another energy legislation coming up. I think transmission and electricity is going to be a very hot topic in the future, and it's very

important for this conference because we need to understand where we want to go, where we want to head.

There's planning activities that are going on at the interconnection level. There is talk of a national overlay, there is talk of different generation resource assessments, and requirements as part of EISA and future legislation. There is talk of climate change. So we need to, as a community, start pulling all this stuff together, having the hard technical questions asked, and figure out where we should move forward. I don't think, as we move forward in the debates that we should stop some of the activities that are going on. I think the country will continue to evolve and grow with the generation resources and its demands, and we need to move along with it. So we need to have the capabilities, we need to do the analytics, and we need to come up with potential solutions. We need to do different scenario analysis to have the solutions ready to implement as we move forward.

It's a great opportunity time, because there are resources available to help with the analytics. Our organization is kinda going from dry to a lot of money. Our organization, on the average, deals with about \$130 million of annual appropriations. Under the American Recovery Investment Act, we have \$4.5 billion, which is a significant change for our organization, but part of that is looking at planning activities, or planning and -- analysis and support of planning activities, I'll say it that way. I've been trying to be very careful and saying that the Department of Energy is looking for analytical tools and means that we can support the industry in developing capabilities and developing the analytics that we can make decisions and move forward.

We are not going to make decisions, but we want to help the interconnections, we want to help the entities who do make the decisions to do the scenario analysis and to have the capabilities to do what's best for -- whether it's the utility and the interconnection or the ISO.

So I just want to say welcome, thank you, we have a lot planned for today. I appreciate everybody coming, and I will be around for a little bit listening to some of the sessions. If you have any questions, please come up and chat with me. But don't -- I've got plenty of offers on how to spend the \$4.5 billion. Thank you.

(applause)

Larry Mansueti:

Good afternoon. I'm Larry Mansueti, Office of Electricity, the Electricity Policy Division. I am here to help chair the first panel. Our first panelists, Rob Gramlich, Dave Andrejczak, Eric Lammers -- Eric, are you here? And Chris Hickman, okay, we're all here, good.

And the first panel is going to talk about the future role of electric transmission. The recognition of what our country needs to as well as different contributions from the demand side and others.

And I'm going to ask the panelists to talk about three things, and the first question is what are the fundamental issues and needs for transmission in the coming decades? What are the trends that we see? Some of them are very obvious, obviously, I think we should all know what they are, but let's hear from the panelists on what those trends are.

The second one is a fundamental question -- there have been many calls to build a national electricity transmission network, and overlay of actual high voltage, some people call it, what have you. Should that be done or should it not be done?

And the third question that I am posing here is how should we take into account or should we take into account technological change that may happen in the coming decades, particularly things that we have no control over, perhaps. Things like human behavior -- will people buy these plug-in hybrid vehicles in large quantities? On the ingenuity that will be driven by the massive and billions -- massive amounts and billions of capital going -- venture capital, going into clean technologies, particularly if there is a national climate legislation, the capital flows.

And as I mention here, I'll just -- on the energy efficiency side, the demand side, Smart Grid, and so forth, and one example I'd want to give is -- just one example -- what if PV prices, and this is something that we can't control, particularly in the utility industry -- what if those prices come way, way down, and people just start buying PV? You can come up with another example, too, like cell phones. That's something that utilities can't really incent or control. They have policies and so forth.

Here is a slide that shows currently with federal and state subsidies, the dark color is where PV is close or almost what's called "grid parity." Well, that's not too many places. That's not saying that all people there would actually do that, but let's say PV prices start coming down. Then you start seeing more and more people -- this is a forecast for 2015, we don't know if the forecasts are true or not because they haven't happened yet, and then let's say if it's very aggressive, all these areas of the red, these are where it could make economic sense to just pull off -- this is distribution PV -- just pull off the grid.

Well, what happens if -- would you plan your distribution network and policy and transmission network differently? Should you?

So those are the some of the questions that we'd like to ask. Let's go to their -- directly to our panelists and let's go to our first one, and let's have Rob Gramlich from the American Wind Energy Association Policy Director, where we'll get his views on all these topics. Rob?

Rob Gramlich:

Thanks, Larry. I'm going to go from notes for those on the webcast, although if you are online, there is a AWEA/SEIA, Solar Energy Industry Association, white paper on either of our websites, and Michael Goggin, here in the room, has some copies of a paper that provide much of what I am going to say today.

The wind industry's number one long-term barrier is transmission. There was a very good report from the Department of Energy last year on getting 20 percent of US electricity from wind by 2030. That would be going from, roughly, 25 gigawatts of wind installed in this country today to over 300 gigawatts then in two decades. So that's a lot, and the report outlines all of the carbon benefits and various other benefits of that scenario. It was really a feasibility study, but what it did say, carbon benefits and various other benefits of that scenario, it was really a feasibility study but what it did say, I think it was quite sober on the barriers including the transmission barrier and identified that was the number one barrier.

Both the infrastructure but also the grid operations side of the transmission system. In terms of the infrastructure side, the report went through some options but based on the massive economies of scale in transmission, i.e., where extra high-voltage facilities carry so much more power per dollar spent and consumed so much less land area than lower voltages. The scenario was based on an extra high voltage grid overlay -- 19,000 miles of 765 kV AC network was used in that.

And so that's our wind industry sort of framework and rallying cry and goal now is to deploy that much wind and keep going up from 2, 3 gigawatts a year to like last year's 8 gigawatts a year to get up to 12 and 15 gigawatts a year and to do that, of course, we're going to need a steady ramp-up of this transmission grid.

So we do support a high-voltage grid overlay for that reason. Again, largely based on the efficiencies, and we've been working with a number of environmental groups. There are various letters and statement floating around Washington these days where a number of the environmental, including the land-focused environmental organizations are on board with a significant increase in transmission development.

They recognized, you know, yes, there will be, there should be, a lot of efficiency and distributed resources as well, but that's not enough in the context of climate change, and I think they understand this land area issue very well, and they don't want to keep incrementalizing low- and medium-voltage lines all over the country. They realize that if we do it big and do it now with higher voltage lines and, again, we'll use a lot less land area and, you know, the western public lands will be -- you know, there will be less impact.

So that's really, I think, forming the basis for a pretty broad consensus here in Washington for some action to make that happen. Everybody realizes that you're not going to build a massive interstate network alliance without active federal involvement. Exactly what that federal involvement is and exactly how the states can participate in the design of that plan and other -- and make decisions on aspects of that plan is being ironed out. We will see bills introduced in Congress, I think, as soon as maybe tomorrow or this week. There were bills in the last Congress. I think we'll see proposals this time that relate to full interconnection-wide planning -- so one for the East, one for the West, and leaving Texas alone.

And interconnection-wide cost allocation to keep it simple. You know, we could alternatively go through two to five to 20 years of regulatory process to figure out exactly who benefits from which electron, but our proposal is let's just keep in simple and spread it across the region. Texas has done it well and did it right, and let's just do it that way.

And then federal siting -- AWEA and this SEIA white paper advocate for federal siting. There are various ways to, again, slice the federal and state roles, and I don't think it's the purpose of this meeting to get into that. But in terms of -- now -- that legislation may or may not pass. That framework, I think, is catching on, and whatever happens, policy-wise, it makes a whole lot of sense from our perspective for the Department of Energy to lead the effort in planning this grid, or doing the analysis in support of this planning effort.

So, for example, scenario planning -- you know, Larry mentioned a couple of alternative scenarios. We don't know what's going to happen with different technologies or costs, et cetera, and no one can predict all of that. However, let's take the examples of the good transmission planning efforts around the country. Take CapX -- in the upper Midwest, they looked at a variety of generation portfolios and found that, you know what? Under any of these scenarios it turns out it's about the same transmission grid you need for any of them.

So it's -- Dale Osborn has a term for this -- there is a "core," there is a stable core, or a robust core of facilities that are needed under a variety of scenarios, and I'm sure he'll talk about that more on the next panel.

But let's do that scenario planning, involve the states in it. The Department of Energy can support that, it sounds like they are willing to, that's encouraging. I hope they can do that. I know they have supported Western Governors' Association work, and WECC work in the past, and that framework could be very helpful, going forward. To replicate in the East, there is and has been some recent Eastern interconnection-wide transmission planning going on through the joint coordinated system plan and the Eastern Wind Integration Study that's associated with it. So let's continue to support those efforts.

Right now, again, regardless of what happens policy-wise, that seems like it's a very worthy effort to support.

So I guess I'll leave it there and look forward to the discussion.

Larry Mansueti:

Okay, what we're going to do -- next we have Dave Andrejcek, acting director of Division of Bulk Power Systems Analysis with Office of Electric Reliability at FERC to speak. What we'll do is we'll hold questions until the entire panel is over, and then we'll take questions, and we'll have a, hopefully, robust discussion. David?

David Andrejcek:

Thank you, Larry. Good afternoon. Thank you for the opportunity to speak at this technical conference. I am the acting director of the Division of Bulk Power System Analysis, which is part of FERC's Office of Electric Reliability.

I have to give the disclaimer that the comments I make are my own as FERC staff, which do not necessarily represent the view of the Commission.

I'd like to present a broad view of what the Office of Electric Reliability is responsible for and how it may play a role in the future of electric transmission design.

The Energy Policy Act of 2005 established Section 215 of the Federal Power Act, which authorized FERC to certify an electric reliability organization for the purpose of establishing and enforcing reliability standards for the bulk power system in the continental United States under the Commission's oversight. The North American Electric Reliability Corporation, or NERC, fulfills that role.

The Office of Electric Reliability was formed in late 2007 to help protect and improve the reliability and security of the nation's bulk power system through effective regulatory oversight that's established by Congress and the President in the Energy Policy Act of 2005.

The Office of Electric Reliability monitors and addresses issues involving the assessments of resource adequacy and reliability. In addition, the Office of Electric Reliability directs long-term strategic research programs to identify emerging reliability and security issues and their implications for the bulk power system planning, operations, and Commission regulation.

Our office is structured with five divisions that work closely together. Beginning with my division, the Division of Bulk Power System Analysis, we provide transmission planning expertise and 24/7 monitoring of the bulk power system to the Commission. The majority of our engineering resources, however, are dedicated to the oversight of the regional transmission planning processes across the three interconnections.

Generation and transmission projects are tracked to assess their compliance with established reliability standards. In addition, we also keep the Commission informed on technical matters such as demand response, Smart Grid, and variable generation.

The Division impacts -- interacts regularly with the Division of Compliance to better understand events and issues that may require a deeper review in what, if any, standards violations may have occurred, and we also work closely with the Division of Reliability Standards to help identify trends that may require a review of existing standards or development of new standards based on events, near misses, and best practices.

We provide input to our Division of Logistics and Security as well. They were responsible for the recent development of the cyber standards.

Our fifth division, the Division of Reliability and Engineering Services, works closely with us in other offices at FERC to ensure that reliability issues are properly addressed when rate filings are brought before the Commission.

The foundation to Electric Reliability is clear with enforceable reliability standards and providing incentives that promote new technologies to address the logistical technological and financial challenges that expansion of the bulk power system will bring.

Among these Electric Reliability Standards, the Commission has approved standards in the areas of planning, operations, performance, protection, cyber security, critical infrastructure, personnel training, and communications. The reliability standards set the bar at the planning, design, construction, and operation of the system needs to meet or exceed to maintain reliability. Without the reliability standards, one could not evaluate the various designs would benefit or possibly be detrimental to reliable operation of the system.

History has shown that the reliability standards and operating criteria are not effective without mandatory compliance. In today's environment, mandatory compliance raises awareness and focuses attention on the issues that have the highest risk and highest consequences of violations. This should provide incentive to design a system that would minimize the elements that pose the highest risk and highest reliability concerns to the system. A well-planned and well-maintained system must be able to withstand the loss of any single element for contingency planning or n-1 criteria.

As the nation's transmission grid expands to integrate and move the expected influx of new renewable energy sources, these mandatory reliability standards will ensure that the integrity of the system is maintained.

In planning the future system, the location of new energy resources, fuels, transmission plans, and demand-side resources such as Smart Grid, all need to be considered to build a reliable system. The challenge will be to design and create the system that will match the resources with the demands while maintaining a level of reliability demanded by the standards.

The standards will guide you on where and what types of improvements are necessary or where there are enough facilities to maintain an adequate level of reliability.

The Commission stands ready to evaluate various transmission projects, assist in the assessments of the reliability of the future electric system, provide guidance on the expansion of the bulk power system, and apply its authority in resolving siting issues.

In addition, we want to support the nation's goal to improve and protect its electric infrastructure, create jobs, and put Americans to work into the next century.

Thank you, and I look forward to productive dialogue on the electric reliability of the nation's bulk power system.

Larry Mansueti: Thank you, David, for that view from FERC. Now we're going to turn to Eric -- Eric Lammers, a principal of ArcLight Capital Projects for a view from the financial community on these important questions.

Eric Lammers: Thank you, Larry. I'm Eric Lammers from ArcLight Capital Partners. We are an investment manager based out of Boston that focuses solely on the energy and power industries, predominantly here in the United States. And I just want to give a few perspectives today about some of the challenges that we've seen on investing in areas around transmission and, in particular, around renewable energy as it ties into transmission.

Some of the investments that we've made that I have led in the past have included investing in the expansion and buildout of the 500 kV Path 15 interchange in California in the Central Valley there between Southern and Northern California. I did that back in 2002. We invested in a transmission services company in 2006, MYR Group out of Chicago, that builds and repairs high-voltage transmission lines. And we've invested across a number of power technologies but heavily in renewable energy with Caithness Energy, CPV, and, most recently, with Terra-Gen Power. And different generating technologies including wind, geothermal, solar, biomass, and waste energy.

Our job is to put money to work in the industry, to build out the infrastructure that we're talking about here today, and we aren't always seeking just the highest returns out there. It's really about getting a risk-adjusted return, getting something that you know you're going to get your money back on and getting a reasonable rate of return on it. And we continue to be very interested in putting money to work here, but there are significant challenges, from our perspective, in terms of making that investment.

And, really, what I'm here today to talk about is just some of those challenges and the goal of ultimately creating a long-term stable structure that can attract and incent not only capital but also people to the industry and to the challenges we see here.

First of all, maybe focusing on the renewable energy side, to lay a little bit of the base before we switch over to transmission. We are currently active in trying to build and develop rather large geothermal, wind, and solar projects, the largest of which is an up to 3,000 megawatt wind project in Tehachapi, California. That is going forward with the support of a large PPA with Southern California Edison, and transmission build from Southern California Edison.

This will be the largest wind development, so far, in the world, and it's not really a coincidence that this is in California -- a state that has taken leadership, in a lot of respects, along with a number of other states, in terms of creating a long-term incentive for renewable energy and understanding some of the infrastructure challenges that support that, particularly around transmission build and development.

This project is fortunate because it is in California. It does have access to transmission. We've got other projects that we've either invested in or are looking at, talk to other people, other developers about in Wyoming, Nevada, Montana, that don't have the same benefits. They have great resources, they are world-beating renewable resources, whether they be in geothermal, wind, solar. They just don't have access to market right now, and there comes the rub of the transmission challenge.

You know, it is true that we've got some of the best power resources in the world out there. In fact, my family is from Montana. Whenever I go out there and talk to them, you know, they just want to know when is more wind energy going to get built out there.

Kind of switching gears to transmission, which is key to getting that energy to market, getting it to customers, and part of the topic here is a high-voltage transmission grid across the country. We would be all for that -- that's obviously going to spur the development of additional renewable energy and help gets us where we want to go long term. But one of the things we don't want to lose sight of is other elements around that, really, in the interim before that's built out. That might be able to be done to support more renewable energy generation and help get that to the load that wants and needs it.

And some of those items are specific transmission line buildouts. The recent Zephyr example that FERC is supporting an anchor tenant construct is pretty valuable. It allows us to break the chicken-and-egg problem that we see in development of both transmission and power generation of needing to rely on each other to get something built and, historically, running through open seasons has been a process that's had a fair amount of risk in it. I think you could talk to Trans-Elect or some others about their history with open season processes.

Additionally, if there was more work done to aggregate and push forward queues of power projects, oftentimes the queue system becomes really just an interminable wait for building new resources, and if you had a more proactive, maybe even regional process for analyzing transmission interconnection applications and moving those forward, you know, again, on a regional basis, we might be able to get more transmission built, near term, that would support renewable energy projects that are ready to go.

Talking to our guys at Terra-Gen Power, they also think that a fair amount of progress could be made just by improving some of the seams between different control areas and allowing additional transmission capacity in between those control areas to broaden the market that we are looking at.

And that not only allows specific projects to get built, but it addresses some of the issues about keeping reliability in the grid when you're adding greater and greater wind and solar penetration.

And another item that it's probably worth noting, because we've looked at this somewhat, is high-voltage direct current is another option with high-voltage AC. You know, not a technical background, by any means, but I understand that there can be very valuable reactive and voltage support from direct current lines, and you also have reduced line losses. So if you're looking at taking remote power sources, thousands of miles to load, that can have a pretty important impact, and it has the results of offloading congestion off of the surrounding AC system.

I wanted to just give a couple of examples of why a long-term approach is important here, too. We'd seen, in transmission build, that we went through a period where this country was spending under \$3 billion a year in new transmission. We are now back up to a point where we're spending over \$8 billion a year, and we're finding some constraints in the system there. The teams and the crews have the companies doing this work, often in their 50s and 60s now. They have old and outdated equipment.

One of the reasons we bought and invested in MYR is we saw this swell coming. We invested capital in the company, and we took them public thinking that taking them

public was going to allow them even greater access to capital. However, in these current capital markets for public companies, it's no guarantee of continued access to capital there. However, I continue to believe that whether it be private equity sources like ourselves or public equity investors, that there will be capital available when there is a clear, long-term investment opportunity, and we just urge the folks here to continue to work on that and lay it out.

Larry Mansueti: That was very good timing. The clock here says 8 seconds, so very good, very good timing. Our last speaker will be Chris Hickman of ICE Energy, and he'll give his viewpoint on these important issues of the day. Chris?

Chris Hickman: Thank you, sir. Good afternoon. I've just got one question before I start -- are media event coordinators a green collar job? Somebody better define them as such, and you'll win all your metrics. I don't know in terms of what jobs are being created, but I know that we sure have our fair share of meetings. I think there's been 11 electricity meetings in D.C. alone this week, so far.

So -- there are a lot of conversations going on, and I think it's really fun, and I was talking with Mike a little bit before we started this. You know, Yogi Berra, "It's deja vu all over again," every time we all show up together at a conference and what we're going to talk about that day and try to figure out how we're going to make it interesting and different.

So I'm going to take a little bit of a different approach today and do some philosophical things rather than just all the technical to see if we can make it a little bit interesting to start the day.

This is a really interesting industry in the fact that I can sit down with each of you, and I can have a conversation about grid 2030. We can describe with great clarity what this grid and how this system is going to look like in 20 years from now. And then I can ask you the question about what it's going to look like in five years, and watch people fall all over themselves, okay?

It is a very strange thing for somebody to be able to talk about the future with such great clarity and have no idea how to transition to there. I was over at one of the other electric meetings today, the National Action Plan for -- no, I'm sorry, that's the DOE program -- the Alliance to Save Energy is having a meeting, and the NEMA guys were forceful in that nobody should be given any money until all the standards are done. Yeah, let's just wait around for that. So -- that sounds like a great idea.

So -- when you think about what we're doing, it seems like we're in the same mode again -- all the right people having all the wrong conversations. As we look out in our industry, we seem to be a product of our environment with the hazing effect of deregulation, reregulation, unregulation, whatever the heck you want to call it this week, and our political environment -- this whole red/blue thing. The whole thought process that you have to be an either/or, you can't be an "and" or somewhere in between. It's permeated our technical workforce of this country.

The thought process that I have to take a stance on something so vehemently that I can't listen to another point of view, and it's corrupted our technical thought process in this country to a point that we can't get a dang thing done. You know, we all go to D.C. about renewable energy, right, and we're fighting over definitions of renewable energy because -- I'll pick on Rob -- you know, if it doesn't produce green, then it can't be included in

RPS. Well, is it renewables-enabling? Well, yeah, we need things like storage to enable renewables. Yeah, we believe that but, no, you can't count it in an RPS.

This thing about this overall "I've got to be black or white, I cannot have a common sense approach" that's killing everything that we're trying to do in this industry because we refuse to listen to each other and come to some happy medium about what we can get done, and that permeates all the way to transmission siting.

Coming from a state, New Mexico, with over a decade of experience of trying to permit a single line across five sovereign Pueblo nations, BIA, BLM, and Forest Service, you know, at some point we have to exercise at least a little common sense in our country and drop this crap that we're continuing to pursue and not be able to come to a common consensus about what we need to do as a country. It's embarrassing.

And when we talk about technical people leading -- no offense to all the lawyers or economists in the room, it's about time that the people with the technical background step up to the plate and start talking. But, please, if you do it, and you're going to speak with some sense of authority about a particular topic, please get current on it. Please quit talking about the solar that existed 20 years ago as a reason not to do solar today. Please quit talking about the turbines of 25 years ago for reasons not to do wind today.

Our ability to stay current with today's information age and as fast as the technology moving is daunting. But if you're going to speak with great authority from a technical standpoint, please get current so that people that sit in panels and rooms like this have the opportunity to get correct information so they walk away with a thought process that potentially might be able to come to a resolution for a good conclusion for our country.

And when we talk about the facts, let's not do assumptions. I love talking to people about the cost of siting a gas turbine. You know, how many people believe that the utility industry is a next-quarter-driven business? Okay, if you're an IOU, you probably do because, right, everybody is talking about next quarter earnings. Is a utility a going concern business? Do we invest in assets that last 30 to 50 years? How ridiculous is it to focus on the next quarter earnings instead of focusing on enterprise for what we need to get done, right?

So when we start having these conversations about, "Well, the first cost is higher." "Well, what's the levelized cost?" "Well, what do you mean?" "Well, these are both 20-year assets. Perhaps we should look at both the O&M component and the capital component and do a real comparative of what the cost of the actual project is." "No, I need to look at first cost because that's what my investors need to talk about this week." "Good, I guarantee you'll make a really good decision with that approach."

So -- with all of these choices that we have to enable our grid today -- phenomenal technology for nominal communications infrastructures and architectures being deployed across our country, it's always really amazing to me when I ask a simple question, and I do almost in every presentation or every conversation I have with somebody -- "What's the goal. What are we trying to accomplish?" And if you can't tell me what the goal is, we're going to have a really hard time measuring whether or not we're successful in what we're trying to accomplish. And it's amazing to me when you sit down and have this conversation with people, they can't describe the goal.

What is the goal of creating this infrastructure -- the EHV infrastructure of our country? What is the overall goal of our industry to bring renewables onto the grid? Is it strictly carbon? Is it strictly customer empowerment? Is it strictly grid reliability? What is it?

What are the goals that we're trying to accomplish, and based on the priority of those goals, it will help us define the things that we need to do.

But on that premise, I would like to propose that we don't do business as usual. Did everybody see what Eric was doing during his presentation? He didn't walk up here like a dumb old utility guy, aka me, with paper. He walked up with an iPhone, and he was scrolling through his notes on an iPhone doing his presentation, okay? That's not business as usual, okay? Things have changed, technology has changed, and the utility industry has been very slow to adopt, aka NEMA. We need to be the standard studying group and until we define them all, don't do nothing.

You know, these are the kinds of things that guarantee our failure both as an industry and as a country. The economy of this United States is founded on the premise of electricity. Anybody remember the numbers from the blackout investigation for how much the Northeast cost? I know one person does. What's the number?

Alison Silverstein: Six to 10 billion.

Chris Hickman: \$6 billion to \$10 billion, okay? The thought process that we have allowed our infrastructure in this country, which is the lifeblood of what we do as a country, to be in the state that it's in is criminal, okay? We can blame regulators, we can blame legislators, we can blame each other, and the bottom line is we're all at fault, and we all need to come together to come to a consensus and a solution about what we need to do. So what is that solution and what is that consensus?

I would pose that the founding principle for what we need to do as an industry is system efficiency. We have a whole bunch of people running around talking about site efficiencies. It is awesome to talk about CFLs, it is awesome to talk about Energy Star. These are all great programs, and they're one of the founding reasons why we aren't blackout today. But the site efficiency is only one aspect of this. But why do we focus on it? Because at least we can try to figure out how to measure it.

It's really hard when we start talking about the efficiency of the entire system. It's a conversation that gets technical, it's a conversation that gets hard, and so we don't want to have it. It's not enough that we make the site efficient. We have to make our system efficient. When we talk about a load shape that 10 percent of the hours consume something like 30 percent of the generation fleet, give me a break. That is a terrible way to run a railroad.

Our load shape and our load duration curves of this country need to be fixed. We need to do things across the board. There is not a silver bullet to solve this equation. It is a system. It is the system that Neil Armstrong stepped up to the podium in the year 2000 and said it is the single biggest achievement of mankind for the last century. It is a system, it is man's biggest machine ever made, and one answer does not solve the problem. It is a host of things that solve that problem, and changing the load shape is one of the founding principles that we need to focus on to make our grid more efficient.

All of the solutions that come from that are adding transmission, adding things on the demand side, and adding things on the generation side. It is a mix of all of the above, and we have to focus on all of the above to make it better.

But the thing that we also should recognize as we approach these concepts and as we move forward is understanding the realistic timeline for any of those technologies. When you talk about energy efficiency, demand response, permanent load shifting or distributed

energy storage technologies, you're talking about things that can get done in months. Then you want to talk about things like central station storage or transmission and distribution infrastructure, you're moving into the one- to five-year timeframe in terms of the actual planning construction of the asset, and then generation goes, obviously, beyond that -- three to 20-plus years.

And so the goals that we have as a country and the things that we want to accomplish are founded upon a reality of timeframes not just the technical capabilities of the -- the technology that exists today.

So -- with that, thank you very much.

Larry Mansueti: Well, thank you, Chris, as usual, the panels I've been on with you, you are very provocative and, hopefully, there will be lots of discussion, robust, I hope, and I already see our first speaker. Please announce yourself for those on the Internet.

Alison Silverstein: I'm Alison Silverstein. I'm a consultant to the Department of Energy, and my job here is to make sure that you all actually get some stuff in the record for the department. It helps to answer the questions that have been framed here.

I'm going to start by reading to you the title of your panel, which was "The Future Role of Electric Transmission and Recognition of Contributions from Energy Efficiency, Other Demand Side Resources and Local Distributed Generation," and, sadly, most of you didn't actually address that topic.

I am therefore going to ask each of you a question that tries to bring this into slightly better focus, if I may. The first one is for Chris, and just, like, answer the question I'm asking you.

If we did a lot of Smart Grid energy efficiency, distributed generation, demand response, and distributed storage within the next 10 years, or 15, if you want, how much could that shave off current load forecasts? That's the first part of a two-part question. Just ballpark -- is it 10 percent, is it 15 percent, is it flat?

Chris Hickman: Oh, I'm sorry, I was waiting for the second part.

Alison Silverstein: The second part is if we did all of that, do we still need big EHV?

Chris Hickman: Okay.

Alison Silverstein: Now you can answer.

Chris Hickman: So -- the first part is over the next decade, I think that we can take as much as 3 percent -- 3 to 4 percent of the load duration curve and resolve that on demand side, with demand side technologies of differing varying forms. There is a host of different things that are going on out there today, and I think, from both a cost-effective standpoint as well as a deployment capability standpoint, that we can address a significant portion of that.

I think that, quite honestly, that the more distributed the technology it is, the better. Because we can deploy the capital in the most effective fashion for the remaining assets and infrastructure that do need to be built.

Alison Silverstein: That's load shape. What happens to load magnitude?

Chris Hickman: So the load magnitude for the peaking, is you obviously gets affected by that dramatically, right? Because when you talk about dealing with things on the demand side, this is something that a lot of people choose to gloss over. It's not just the load that you're affecting. It's the losses on the grid, it's the transfer capability during the period that is necessary, and it's also your requirements for spinning reserve at that particular moment in time.

Every 100 megawatts that you deploy in storage versus generation, reduces the spinning reserve requirement by 12 percent, right -- so -- instead of increasing it.

Alison Silverstein: Chris, I've got more questions.

Chris Hickman: Mm-hm?

Alison Silverstein: If you've moved down the load duration curve by, call it, 3 percent to 5 percent, that's the magnitude of the peak -- or, rather, that's a load shape issue. Are we talking by 2025, 2030? Are we talking moving total sort of maximum demand down by 10 percent, 15 percent, 20 percent? Give me a ballpark.

Chris Hickman: Peak demand?

Alison Silverstein: Yeah.

Chris Hickman: Yeah, peak demand, in the next 10 years, I think that we can affect by a minimum of 4 percent, and I think it may be as high as 6, but the things that we can affect on the demand side in that short term -- because you're talking about a terawatt grid, right?

Alison Silverstein: If we do that, do we still need EHV?

Chris Hickman: Absolutely.

Alison Silverstein: Okay.

Chris Hickman: Our grid infrastructure is required as part of the overall solution, and you can't do one thing and not do others.

Alison Silverstein: Okay. Eric, you are clearly willing to invest in a lot of big transmission. Are you also willing -- do you see money being available for demand response energy efficiency, distributed generation, or storage?

Eric Lammers: I think there is money available for each of them. I think the investment structure is going to be different for each of them. We are people that do large, discrete projects. It's what people -- a lot of investors can get their heads around is something that's large enough to be liquid, large enough to put enough capital to work that actually gains profitability. So the items you listed -- storage -- you know, that's something that you can have discrete, large enough projects on, and I think we will see more energy storage projects, whether it be like compressed air or hydropump storage or storage that's associated with existing or new generation plants, you know, what people are trying with solar projects. You know, who knows if molten salt is going to be the right answer, but things like that are out there, and I think those will happen, and those will be part of the solution.

When you go to demand-side management, that really feels to me more like it's got to be a utility investment situation. You really can't, I don't think, create an independent

investment structure around it even though we've talked to a number of people who try to do that, you know, really in industrial and business applications, residential -- really tough. But Smart Meters, energy efficiency, that has to be something that's driven through the utilities and something that kind of gets worked through in the regulatory compact, in my estimation.

Alison Silverstein: And do you see demand response and distributed generation and distributed storage and energy efficiency as a threat to the security of an investment in an EHV project -- as a risk?

Eric Lammers: I think the investment structure to get EHV built has to be predicated off of a belief that it's going to enhance the system -- you know, reliability reducing line losses, greater access to the most efficient resources, particularly in this day and age, the most efficient renewable energy resources, and that thus there is a recognition of a common good in getting that built and that the system is going to bear those costs rather than it be a situation where you try to measure particular usage on EHV.

Alison Silverstein: Was that a yes or a no?

Eric Lammers: No, I don't think it's a threat. I think once you make the investment it's not a threat.

Alison Silverstein: Rob, you clearly want EHV for renewable development. You didn't answer the questions -- two questions -- one of them, is there any reason, other than moving wind, why an EHV network would be a good idea?

Rob Gramlich: Okay, and these are good questions. I feel like I'm being cross-examined, but it's not the first time I've been cross-examined by Alison, or kept on task. So I think we've all been here before.

Yes, there are -- well, there are numerous other benefits; namely, reliability and reducing congestion from an EHV grid overlay. You could look at the recent joint-coordinated system plan that saves \$12 billion a year under the -- in the 20 percent wind scenario there. It costs \$80 billion in, I guess, 2024 dollars, but the savings would be paid back in seven years from that \$12 billion a year savings. So just for congestion reduction, it pays for itself. So the economics should be a no-brainer.

There are other renewables, and there are other low-carbon resources that could be connected by this grid, and I think all of this should fall out of the planning process and the efficiency, demand response, other types of scenarios, should be put in as scenarios in the planning process and, again, I think the framework should be let's see which transmission plan is robust to these various scenarios. And if there is one, and I'm willing to bet that an EHV network will be robust to those scenarios, then we should pursue it.

Alison Silverstein: Thank you. David, if demand is no longer exogenous because we can use distributed generation, because we can use energy efficiency and demand response and distributed storage to change the shape of the load curve, we can no longer plan transmission around sort of a monster that keeps on eating more and more every year. Given that, how do you, a FERC guy, rate resource adequacy and standards compliance?

David Andrejcek: I think you've got to continue to look at the diversity, what we've got out there. There is, of course, many different sources to help the problem. Demand response is one, the use of the DC lines intertying with the existing AC, a well-planned system, I think, can really address the concerns that you raised.

- Alison Silverstein: It can help address the concern, but when you get -- when push comes to shove, and you're looking at compliance in an appellate role, how do you, or NERC, say, "This is adequate resources or this is inadequate resources," if you no longer have a fixed point to measure against for demand?
- David Andrejczak: I think you've got to continue to look at it from a bigger-picture standpoint in that it obviously is going to take time. We realize that where some of the load growth is coming from, it's not going to be your typical straight line growth like we've had in prior years. We've got other things that are affecting the load growth now, plus we've got the potential of the storage issues.
- So there's really a lot of questions that we've got to address internally before we can really give a straight answer to that type of a question, I guess, is where I'm getting to.
- Alison Silverstein: Are you prepared to face discussions in 10 years? Supposing that all the stuff we are talking about is possible on the demand side happens -- Smart Grid, efficiency, demand response, et cetera, et cetera. Is FERC prepared to take a position in 10 years, say, about -- let's say we invest in all this EHV because it's a swell idea. Where would you stand on the question of potential transmission overbuild 10 years from now, 15 years from now? Knock on wood, we get all this done in 15 years, but --?
- David Andrejczak: A well-planned system at this point, I think, is still needed. You still integrate all the different things that we've been talking about. You've got to have that overall plan. We talk about Smart Grid, which offers so many potential things for us, and I think we all realize that at this point we probably don't understand all the benefits that Smart Grid presents at this point.
- We still also realize the fact that you've got to have the overlay. There is no distinguishing between a green electron and a brown electron. When we start integrating wind, and we start realizing the benefits of the Smart Grid to the system. I think it's a very much evolving situation that we want to stay on top of.
- Alison Silverstein: So understanding that you do not speak for the Commission, and you don't have votes behind you, you all are prepared to argue that prudence should be determined by good decisions rather than bad outcomes?
- David Andrejczak: Absolutely.
- Alison Silverstein: Thank you.
- Larry Mansueti: Okay, other questions from the audience? Okay, here comes one, and please identify yourself for those on the Web.
- Eric Hsieh: My name is Eric Hsieh; I'm with the National Electrical Manufacturers Association, or NEMA.
- (laughter)
- The question is for Chris.
- Chris Hickman: (inaudible)
- Eric Hsieh: EPCAct 2005 required the states to consider a uniform standard for small-scale interconnections, IEEE 1547, and, to date, 25 states have rejected that outright, less than

15 have adopted it fully. Do you think uniform adoption of a small scale interconnection standard would lower the cost of connecting distributed generation?

Chris Hickman: Yeah. A point of clarification on the standards -- obviously, there are certain things that are sacrosanct, and if you're going to produce electricity on the grid, there have to be rules to make sure that people don't die as a result, right? So you don't want a lineman out there working on a line with backfeed issues because we have poor interconnection standards. But that doesn't mean that we need to, as a country, identify all the communication protocols and settle on two that we must use, as an industry, to move things forward.

So -- I think that the level of common sense that, yes, I firmly believe that an interconnection standard across the board needs to go out so that people know what targets they're shooting at rather than one that's moving. And then once you have that target to find, then people have the opportunity to design to it to make it successful.

Eric Hsieh: Thank you.

Larry Mansueti: Any questions from the Internet? We have none or --? Okay, well, in the meantime, why don't we -- I'll go to the next person right here.

Kim Harriman: Sure. I was just wondering where cost to consumers fits into this whole notion of design? I didn't hear anybody talk about cost to consumers. I heard some benefits from a study that two of the ISOs that participated in that study pulled out of and don't support. So I'm just curious as to -- at what point do we stop and think about the overall cost to the consumer rather than saying, "We need a national grid. We need it now. We need renewables?"

Sure, Kim Harriman from the New York Department of Public Service.

Rob Gramlich: Obviously, I mean, the planning processes always do consider that and should, and, you know, one question here is the difference between an EHV network compared to what we've been building, which was, you know, the smaller, more incremental facilities, and I think it's clear from all of the studies that there are massive economies of scale in transmission, and that's one of the points we are really trying to get across is that if you want to save money, and then from the environmental and land use perspective, if you want to save land area impacted by transmission you should really look to high voltage, and we should look out into the future and plan for what we are going to be building.

And, of course, everybody has always said that in the past, but I think now we have a unique opportunity and need to do that for two reasons. Number one, in the context of climate change, we are all looking at 2050, you know, we're looking at -- we have to look at very long-term plans.

And, number two, the resources that we're talking about, at least some of them, wind and solar, in particular, are location constrained, and we know exactly where they are going to be, right? And so it's very different from transmission planning in the past where transmission planners were really reluctant to even do five years but certainly more than five -- to do 10 or 15 because gas generation, which is all anybody was building, could be moved just about anywhere and so who knew where the resources would be?

But, again, now we know, and I think a lot of state regulators around the country are looking at the risk -- and Alison's question is getting to this, too -- you know, how do we know we're not going to build a line to nowhere or something that's not going to be used

and useful or otherwise a useful line? And, again, it gets back to the location-constrained nature of the resources. We know where they are, we know where they're going to be for generations to come. Our kids and grandkids can benefit from the power from these wind and solar resources, and I think everybody agrees the cost of wind and solar generation will come down. People disagree on the pace of it, but it's pretty darn competitive now, and in a generation, these lines will be there for--you know, the rights-of-way will be there forever. The actual lines, you restring them every 50 years, and it's a great long-term investment.

So any consumer benefit study, as you know, gets into what's your discount rate and how long a time period over which you measure the benefits. And believe me, I've had a lot of background in cost-benefit analysis and all of that. But some of things are almost beyond the ability of those models to account for since, again, you know where the resources are, and you know the transmission access to those resources will benefit this country, certainly in an energy security and climate change context, for generations.

Eric Lammers:

Yes, maybe just to give an example here, when we invested in the build of the Path 15 expansion in California, one of the elements that went into that decision originally was a study on the future savings, really, by being able to access lower-cost generation at the other end of the interchange, predominantly for northern California, so that the study was done, you look at the PV costs of the reduced power supply stack--in that case, it was pretty easy, because we only had to just do the analysis on power flows from south to north and not even look at reliability benefits, and that paid for the line pretty clearly.

You know, I think it's going to, when you get into the discussion, you think about what should be the size of an EHV network, how extensive should it be? I think you're going to have to do a lot of that complex modeling, and you're probably looking at how much value to put on other factors, you know, kind of longer term, as Rob laid out. And in addition to the just lowering that cost of power to consumers.

Because right now, when I pay my electricity bill in Massachusetts, it's not transmission that's eating me alive. It's the generation piece. And if we can bring down that generation piece, even marginally, a huge investment of transmission's going to be well worth it.

And then a couple of the other things that I think should be thrown into the equation is reduction in the usage of depleting resources. Because if we can access more efficient renewable resources, whether it be wind, solar, geothermal, whatever, we're going to have our oil and gas for longer, which I think is a pretty important strategic issue for this country. And then also health benefits. You know, just improving air quality and how that ripples through health care costs.

Kim Harriman:

Just one quick follow-up--who makes the determination as to a geographic area the need to access renewable energy and for all of these other environmental benefits that are being touted by the project? And just to follow up, again, on your comment about your Massachusetts bill, right now your generation component of your bill may be higher, but if we go down this path of building high-voltage transmission, your transmission portion of your bill can end up being higher.

Eric Lammers:

I think I really would challenge that. I mean, I can't imagine--.

Chris Hickman:

I don't think we can build that much transmission.

Rob Gramlich:

Yes, I'd say we'd stop before we get there.

Chris Hickman: Two things, I think, from a--a good point is the fact that we abandoned the concept of integrated resource planning through the whole whatever phase you called that of deregulation, and said, "We'll let generators independently do their gig and transmission people to independently do their gig and distribution people," and obviously, that has gone out of vogue, and we're actually talking about solid integrated resource planning again as a community, and it's very necessary.

And the second piece is, from a consumer advocacy standpoint, I have, out of one constituency that I think is well represented in this country today, I think it's them. Because I think the regulators in this country take that very, very seriously, and they look at this in each and every proceeding and everything that goes on. I think that's always one of the foremost, if not the foremost, question in every proceeding that occurs.

Larry Mansueti: Okay, I'm going to go toward, for right now, to one of the two questions that we have from the Internet. And the first one is, "How's the market for tax credits? PTC tax credit bonds, et cetera, in today's economic climate?" And I would want to add to that, particularly since the passage, if one can even say, with effect, it's a couple of weeks after the passage of the stimulus bill which does have a fix to that, and the corollary to that would be, an extension of that, is financing a problem for transmission? Some people say it's not really, that it's other things. Other transmission companies say they could use loan guarantees and financing help from the federal government.

Eric Lammers: First of all, on the production tax credits, and really, probably expanding that to all of the tax incentives that are in the stimulus bill, whether they be bonus depreciation, investment tax credit or production tax credit, this is a serious issue. There were, there was a limited, but large market for tax-based financing up until 2008, but a lot of those players, a lot of them are banks and finance companies, you know, GE Capitals of the world, their income statement isn't what it used to be. So that's one of the things we're struggling with mightily right now, is even with the benefits that are in the stimulus bill for renewable energy, how the financing structure's going to coalesce around it.

The second part of the question, transmission financing, I think when you have transmission that ultimately can be financed through rate base, you know, maybe back to the dirty word in some people's minds, but by rate base, whether it be directly in cost of service or indirectly through a long-term PPA, that we will be able to get that financed. However, I think the capital going into the ground here in 2009, in particular, is going to be a little bit slower because utilities in particular are not doing the same capital raises that they did last year.

David Andrejczak: I'd like just to add quickly the renewable energy tax credit was fixed by the stimulus bill, or the Recovery Act, and so we're in great shape, and we thank the Administration and Congress for that. Of course, any capital investment relies on capital being there in the market for anything, and so I guess we're sort of in a position where there's still some uncertainty about that, whether there's any capital for anything. But to the extent there is, we think we're in good shape from the wind side or renewable generation side.

Larry Mansueti: Okay. I'm going to, I've got a question that they came in, and it sounds like perhaps a follow-on to one of the questions that Alison had. And that would be for, either from a reliability standpoint or looking at the location of constrained renewables, that they need access to transmission, does it matter what kind of grid, AC/DC, different voltages or configurations, or just wait until the planning process comes out and figure that out?

Robert Gramlich: Yes, and I meant to clarify that earlier. This is Rob from AWEA. In terms of the AWEA/SEIA paper, it was not trying to advocate any one particular technology or configuration. And really, it is the planning process that we expect will determine what's appropriate. The recent Joint Coordinated System Plan came up with a lot of DC lines that weren't in the earlier version and were open to whatever is appropriate.

Larry Mansueti: David?

David Andrejczak: Larry, what I would say is that DC versus AC, I mean, there's benefits for both. Moving the power long distances that it looks like it's going to need, definitely DC will have a lot of benefits to play in that role. I think we've all got the issues still to deal with as far as how do you get it from Point A to Point B, which is going to continue to be a struggle as far as who benefits from it, where does it get sited? There's no easy answers on that one, as you guys know as well as we do.

Larry Mansueti: Okay. Let's see. Well, let's go back to the audience.

Mark Lauby: Hi. Mark Lauby with NERC. Very interesting introduction, of course, and I also liked Alison's discussion. Planning needs to have an objective, and I think you know one thing perhaps that we all kind of came here to hear about, but we haven't really talked about, is really, what's the goal here? And if the goal's not to build a lot of transmission, the goal is not to do a lot of demand response, the goal is to reduce carbon, and how we're going to get there and what is really the key to get to the 20% or 30% reduction in carbon? Is it 385 parts per million by 2050 or whatever the IPCC has suggested? And, of course, all of these different tools that we have--transmission, energy efficiency, demand response and distributed generation--are all going to help us get there based on the planning processes that we put in place as planners. And it's exciting, by the way, not to be a dinosaur anymore and actually be a planner that looks at long-distance things, you know, the longer term than, let's say, two years ahead.

I'd like to get your perspective on your view on how you perhaps balance all of these different elements here as we start looking forward and saying, "Okay, we want, really, the goal here is to get to a reduced carbon constrained world," or, you know, dropping carbon by 20% or 30% from, let's say, 1990 levels, or whatever the level is. And you know, how we balance all that towards society's good. And then also how these perhaps can work well together.

I heard the talk about interconnection standards, for example, 1547. We have a concern at NERC about 1547 because of how it might interact with the grid, especially when you have a lot of distributed generators that are dropping off at the same time because of low voltage considerations. So clearly, interconnection procedures are going to be important when we start connecting these different technologies like plug-in hybrid, storage, et cetera.

But I'd like to get your perspective, anyway, on kind of the overall mix and any mention about resource planning and how this all gets us finally to the goal itself. So thank you.

Chris Hickman: There's a million ways when you look at this in terms of specific examples that we can all give about any particular technology and what goes on. And I think I would just come back with an answer that is we've got to quit operating in a silo when we look at certain things and start considering system efficiency. Producing and building assets that only operate a couple of hundred hours a year or capacity factors of less than 5% don't seem to be a good place to invest our money to me. I think that we need to fundamentally figure out how to change the shape of the load curve because when you do that, you reduce the

starts and stops on generation assets, which are dramatically, have dramatic consequences from an environmental standpoint with each start and stop. And as you look at the overall efficiency of the grid, what needs to be built and when is significantly impacted if we can change that load shape as an industry.

Larry Mansueti: Okay, Alison, do you have a question?

David Andrejczak: Mark, too, because I think Mark and I have had many conversations over the few years--short few years we've been working together here about resource adequacy and how things tie together. I think a lot of the things that Mark raised, especially as far as, I'll start off with the first comment about making it cool being a geeky planning engineer, kind of reminds me of a movie you probably may or may not have seen, "Napoleon Dynamite," when the rather boring character, Pedro, comes out says, "Vote for me and all of your wildest dreams will come true." Well, I think there's a certain leap of faith that we all are taking right now that the smart grid, the renewables, the DC, the overlays, there's a lot of technologies that are going to come to mesh together in a very short amount of time to make all this come true. But there's a lot of work that's got to go in behind it. It can't just be a blind leap of faith. It's got to be a measured response. We do need to take the steps to get there.

Some of the steps, unfortunately, require the standards, and I know that's a slow process. But if you look at, for example, the plug-in hybrids, you've got automobile standards to deal with, you've got communication standards to deal with. We've got to make sure the cyber standards are in there, because there are threats to the nation, which if you ignore that, you're going to put yourself in the position that we really don't want to be in. So Mark, we'll continue to have those conversations, I'm sure.

Mark Lauby: Okay. Well, I've got a follow-on, a question. Some of you have talked about the need for, there should be some kind of interconnection-wide planning. I think, Rob, you mentioned that. We heard about IRP. Well, in the old days of IRP, and I understand IRP's still being done in the West. You know, the utility in the West does the IRP where there's no RTO, and under some states in the East. So that's, what about, following the interconnection? Who would decide the scenarios that would go into the interconnection plan? The RTOs and the transmission providers themselves? Would it be the states? Would it be Congress?

Robert Gramlich: That's a great question, and it is currently being debated in Congress now. I mean, it is a policy call, and I think there is a, you know, the states have a very important role to play in terms of determining, for example, how much efficiency is there in their state that will be incorporated into the plan and other sorts of assumptions like that. I don't know how that's going to shake out. A lot of our companies, including transmission companies who work with the wind industry, want to maximize open stakeholder participation in the planning process to get everything aired at the front end, but at the back end, you know, at the time when they're going to be sinking major capital investments into these facilities--both the generation and the transmission--they want a clear decision at the end that, you know, the plan is the plan and it's not going to be challenged.

So one framework for--and again, this is a legislative question that's up to Congress now to debate, not so much DOE or FERC--but an interconnection-wide plan that has certain planning process requirements in terms of participation and clarifying the appropriate role of the states. And then at the back end, our preference would be for FERC to ultimately decide that the plan is the plan and that the assumptions that go into it and whatever, transmission lines and interconnected grid falls out of that process ultimately is

stuck with and is a determination of need, essentially, in that process, rather than having every state determine whether the benefits exceed the costs for that particular state.

Larry Mansueti: Okay, any other views? With that, I will turn it next to you, Alison, but I do want to note that I have five questions from the Web lined up, so I'm sure you'll give us short, concise...

Alison Silverstein: It will be semi-concise. I want to go back to the question of goals. I don't want to see--we're talking about 50- and 100-year assets being built. And although carbon--I certainly applaud the goal of low carbon future--I don't want to see assets being politically stranded or financially stranded. What are the appropriate sets of goals under which we should evaluate the desirability and value of EHV?

David Andrejczak: So you mean the planning criteria; in other words, what is a proposal judged by?

Alison Silverstein: One would hope that it is more than just low carbon. What are the other considerations? Thank you.

David Andrejczak: Well, I'm sure we could all throw out some, and I'm sure Mike Heyeck, who will be speaking later, has a legislative proposal with a number of criteria to discuss. But certainly, a number of states have implemented transmission, including yours in Texas, where there was a transmission policy in order to implement renewable electricity standards. And there are 30 states with those standards and transmission has moved forward in a lot of those states as sort of a partner to implement renewable electricity. So that should be one planning criterion.

And then the other obvious ones are reliability, to maximize reliability of the grid and reduce congestion. But I'm sure, I know I've seen a number of other criteria listed, but I would think the planning process should have a well defined set of criteria defined by policymakers so the planners know what to go off and plan. And I think Dale would say, and it looks like from the Joint Coordinated System Plan perspective, you know, you can get a few different grid configurations, depending on what the policy criteria are. So policymakers really do need to clarify what the criteria should be so the planners know what to plan for.

Eric Lammers: Just a couple things that I might throw out, you know, just in the conversation. You know, renewable energy is often mentioned as the goal, but maybe looking through that, you know, things that renewable energy provides are energy security, conservation of depleting resources, cleaner air, and I know carbon and the battle against carbon is in vogue now, but let's not forget particulate matter, SO<sub>x</sub> and NO<sub>x</sub>, mercury, some of the others out there that are, you know, significantly mitigated by greater use of renewable energy.

And then I don't want to forget the key element that people historically have focused on and was beaten across our head up here a few minutes ago of cheaper energy supply, all in energy cost. And what longer term, having more renewable energy in the stack can do to mitigate price shocks from the return of \$150 oil. Because all I know is that's coming back at some point in time. You know, it might not be this year or next year, but it's going to come back at some point.

Chris Hickman: I think the rest of the criteria, I'm sure Mike's going to have a lot to say about criteria and different things that goes on, but I think fundamentally the thing that we typically forget when we start talking about a significant overlay is the fact that it's going to have a dramatic effect on a lot of different plans. The personal project that I hated the worst

when I had the capital budget at PNM was the distribution feeder reconductor. You put up slightly bigger wire, you basically rebuild the entire feeder. It cost about the same as building a new one, and you get 1.5 NVA for your effort. Okay?

Our tools that we've been allotted historically in this industry consist of a planner pulling out steel and wood and shooting arrows at stuff. We know that technologically we have different options today, and I think that while fully we need an infrastructure to do that, we need to recognize, as we integrate that infrastructure, it's actually going to de-stress other portions of our grid. And if we focus on a continuum and actually do things with a storage demand side, we have the opportunity to ensure the grid that we build is actually utilized at a utilization factor above 53%, which is what our grid operates at today, and actually increase that number so we're actually efficiently using that grid.

Alison Silverstein: Thank you.

David Andrejack: Then just to add that I think one of your questions, just part of it was, what do we want when we're done? I think what we want is what we currently have now, and that's a reliable system. I think the standards are in place that really ensures that. I think the last thing we all want to lay in bed is to worry about whether the electricity's going to be on in the morning. We've got many more pressing issues. I know I worry about other things that are all in the news like everybody else does. But I think we've built the system fairly well at this point, but we've got to really make sure that the things that we do integrate into it don't degrade the reliability.

Alison Silverstein: Thank you.

Larry Mansueti: Okay. We've got about five or six minutes left before the next panel, and let's see if we can get through these remaining questions from the Internet. The first one is to the panel, "What's the appropriate horizon for performing this conceptual transmission planning?" Typically, you know, we do, what, 10 years or so, but should we be looking 20 or 40 years instead of the 10 years?

Chris Hickman: I think planning a super grid at any planning horizon less than 15 years is just silly.

Rob Gramlich: I'd say as long as possible, but you know, I'll settle for, oh, I don't know, I'll settle for 20. That seems good.

David Andrejack: I would just weigh in that I think whatever we do, step by step, as long as we are making conscious decisions. Each of those pieces as they go into it, if it fits into the overall system, probably five to 10 years.

Larry Mansueti: Okay. Well, that was quick. Okay. Now let's go to something that might take a little bit longer. Let's see. This question is again from the Internet. It's asking, "Some states tend to be favoring local renewables as opposed to importing them from far distances. How would that change some of the EHV proposals?" Well, for example, the person mentioned the JCSP that is out on the table right now. So what do you do about states that want to do local renewables?

Rob Gramlich: Well, that's another thing that should be evaluated in the planning process. There are a lot of those states that have renewable electricity standards, have some form of a local requirement to the extent they can get away with it with interstate commerce restrictions. But you know, there's, you know, Congress and the Administration, I think, have national objectives, and so those need to be taken into account as well. And I think the costs very often work out better from a consumer standpoint to achieve national objectives, at least

cost, it often makes sense to go to remote resources, and you've got to use transmission to do that.

Larry Mansueti:

Any other views?

Eric Lammers:

I would just add, I don't think a national approach or EHV system should remove local efforts that are going on out there. I think they can work together.

Larry Mansueti:

Okay. I think we have time for maybe one more question from the Internet before we get our next set of panels up there. And that has to do with, it's a policy question, "Does there need to be a funded federal incremental transmission capacity banking mechanism to address the cost and risk of capacity that is not used and useful short-term in non-ISO regions?"

Robert Gramlich:

AWEA supports, there was a letter from the Western Governors to, I forget to whom, to the Administration or Congress, saying there would be, it would make sense to have the federal government support the near-term financing gap that's created if you build the optimally sized line now and you don't have enough subscribers in the near term. And so if there is federal government support or funding available, the Western Governors supported that, and that would make a lot of sense to us. I think there is a fair amount of debate within the electric industry right now about exactly what form federal government financial support should take, and there's certainly a lot of private companies in the transmission business who want to keep the transmission business private, but I don't think those are necessarily incompatible approaches.

Larry Mansueti:

Okay. Any other views? Chris?

Chris Hickman:

Yes, again, this planning horizon and this thought process of stranded asset or did you build too much or what capacity, I would ask everybody to continue to understand that we're building 30- and 50-year assets, and so building something and looking at it two years later and going, "Wow! We've got extra capacity." I sure the hell hope so. Okay? I mean, it's called "planning" for a reason, and it is a 30- or 50-year asset. And so I just, be very careful about how we talk as an industry about what is the right size based on when.

Eric Lammers:

Yes, I guess looking at it from the investment side, a lot of the problem we've seen with both renewable energy investments and transmission investments, the problem really being a challenge is how they fit together and how you get the full return on investment on both pieces at the same time, so I hadn't really thought about a federal banking system, but that would surely be one solution that would allow both sides of the equation to go forward, and I think more rapidly.

Larry Mansueti:

Okay. All right, I think we're right about out of time. Oh, two-minute warning. I'll use the two-minute warning to ask everybody to give a good round of applause for our panelists. And our remaining 10 seconds to say, "Will the next panel please take their places?" Thank you.

Joe Eto:

All right, well, good afternoon. My name is Joe Eto. I'm a scientist at the Lawrence Berkley National Laboratory. I had the distinct pleasure last December of losing a great lab director and then finding out that he was still my boss. I manage transmission reliability research for the Department of Energy that's focused on trying to better utilize the existing transmission assets that are on the ground. I also support the Department of Energy in their transmission analysis and policy work. And it's in this context that I have been asked to moderate this panel.

On this panel, the topic turns from the questions about what would the needs of an EHV transmission system serve to some of the questions about how to go about planning such a system. I will still ask the question of the panelists of whether we need to build or design an EHV transmission system, but I also want to focus on the questions of how would such a planning activity relate to existing planning processes and to evaluate the pros and cons of undertaking such a thing as an EHV transmission overlay design and build process.

And so one of the questions will be specifically, how does this entire activity and the transmission that might result from it interface with our existing transmission systems?

We have a very, very distinguished panel today. I'm very pleased to moderate this group. These are the folks who build, plan, and operate some of the largest transmission systems in our country. These are the folks who will be deeply involved in whatever transition goes forward in our country, and I'm very interested in hearing their opinions about some of these topics.

So I'm just going to follow the order of the panelists. Let me start by introducing Dale Osborn. He is the Transmission Technical Director for the Midwest ISO, and his interests are stated as, "development of efficient long-range transmission plans, integration of large amounts of wind energy into the power system." He has a BSEE and an MSEE, both from the University of Nebraska at Lincoln. So with that, Dale?

Dale Osborn:

I'd like to start out by reminding people that there is only one transmission system. There aren't green ones and red ones and brown ones and yellow ones. It all comes in drab aluminum. The reliability planning that we do today does not address the energy needs of markets. The systems we have weren't designed to ship energy large distances across the country. They were designed to serve local loads with local generation.

And the JCSP, or Joint Coordinated System Plan, was a voluntary plan of, that was set up, and it's a process that determines conceptual transmission designs on the economics of energy delivery markets as a whole. What that means is we design the system that will deliver the energy at the lowest cost to customers on wholesale electric price and then pay for itself. Most transmission is a cost that will not pay for itself. This is economics. It's got to pay for itself.

So how much does it cost once it's built? It doesn't cost you anything, but it costs you a lot to build. And the solution for the whole is more efficient than an assemblage of individual plans. If you took all the individual plans of all the RTOs and put them together, you would not get a JCSP. It would come far short.

We only staged two scenarios at JCSP--a 5% wind, which is existing RPS mandates, and a 20% wind scenario. And the reason we did that is DOE and NREL gave us money. Most studies--well, we also cooperated with them on a few other nice things.

But most studies include multiple futures. A future is a whole set of assumptions that says that if this happens, then what would the consequences be? And our two futures are a 5% wind and 20% wind. Should there be others? Yes. There should probably be a nuclear future, there should be a sequestered coal future, there should be a carbon tax future, there should be all kinds of different futures. There should be a gas restriction future, there should be maybe a Prius or an all-electric car future. There should be different futures that you should look at. We only did two.

And most futures include multiple resources. They're mixed. They're not just one resource to supply the whole country. And the, so what we take is multiple futures and design a transmission system for every future. And we take all the transmission systems, find the core of common transmission, find the sets of, "If this happens, you'd have to do this," that you would add to the core, and that's what we design as a transmission system. There is not one design; there's a core and there's a whole bunch of options around it.

This illustrates that the core is the intersection of the different scenarios. If you got all the scenarios together, you'd find out many of the lines are there in every scenario. And all we do is determine what those are. And you can start to build the core today with very little risk because it's going to be needed no matter what you do.

This is what a 20% wind plan looks like. These are sited based on a coalition of interests. Some are located in the most efficient places at the highest capacity factors, and some are located locally as we realize people won't do everything logically. It will be based on other reasons. And then there's coal plants, gas plants in this, and there were nuclear plants set up in the base case. But this is what a 20% generation plan would look like all on the ground.

There's another study being done presently called the Eastern Wind Integration Transmission Study that is looking at data offshore. The reason we didn't have data offshore in this study is it didn't exist, so therefore, we didn't study it. It does now exist, and we are now studying it.

The other thing is people think that all transmission costs the same. That's not true. It's cheaper to build a 345 line than a 765 kV line. But if you can load a 765 kV line, it is a lot lower in cost than the 345 per megawatt-mile. The cost of a 765 is about one-third the cost to deliver a megawatt-mile of energy.

HVDC, over 600 miles in length, is more economical in 765. The JCSP uses both. We're AC/DC. We're not DC, we're not AC; we're both. We're all messed up. We have both systems operating where they've worked the best.

This is what the plan looks like. It puts all the power, basically, from the West to the East, and then it delivers it down into the Southeast from the Southwest power pool. It's hooked up with a 765 undercarriage and an 800 kV HVDC overbelt. It's self-contingent. If you lose one of those lines--

(technical difficulties with presentation)

Joe Eto:

I'll take this spare moment just to refresh us on the format. I'm going to ask each speaker to speak for 10 minutes. Then I will attempt to ask the questions that Alison would otherwise ask and give her a chance to follow me if I don't get it quite right. Then I'll ask our other distinguished panelists in the first couple of rows if they have specific additional questions they want to ask. And then I'll attempt to intermix both questions from the audience with questions that come in over the Web. We may run out of time, in which case what we've agreed to do is for questions that have been asked from the Internet that we were not able to ask, we'll just post those along with the information from the transcript from this meeting so that folks will at least know what people were thinking about, even if the panelists couldn't speak to all the questions in the time that we had available today. We'll restart the clock.

Dale Osborn:

Please reset the game clock to 3:09.

Joe Eto: Restore 10 seconds, please.

Dale Osborn: Everybody thinks that \$80 billion is a lot of money. When you look at it in perspective, that's 2% of the cost of, the future cost of electric energy in the year 2024. If you take the transmission annual capital costs and the generation capital costs and the production costs, transmission is just 2% of that. If you think \$80 billion's a lot, think what the fuel's going to cost for those things, and think what generation would cost.

This is a curve I threw in just to let people know that there's a limit to how much wind you can put on the system. Up to about 30% it's linear. With the amount of transmission after that, you can throw all the transmission you want at it, it doesn't work. And the reason is that it's the minimum generation restrictions on the system that limit the system and not the transmission system. We are studying up to 30% systems in the EWITS study.

And everybody wants to know, "Okay, here's this big system. What can it do?" Well, first of all, it could create an intelligent grid that could do a lot of things the present system can't. And my question to people is, "Why would you want to connect this intelligent grid to a dumb transmission system? Why don't you make a smart transmission system?" And then higher amounts of wind can be hooked onto the system with the system we have designed--up to four times as much in the MISO compared to MISO itself. So we can carry a lot more wind out of constrained areas because we can transmit the variability of the wind out on the DC lines. We don't have to add generation in the area to control the area.

And the other thing that is important is it lowers the price of wholesale energy. The cost of wholesale energy on the East Coast go down about 30% with the assumptions that were used in this report. And you've got to remember that, because some people don't like the assumptions that were used in this report.

And the operating contingency limit would increase from about 1,500 megawatts to 4,800 megawatts. And what does that mean? It means that we're three times as strong as we are today. And you could build nuclear plants up to 4,800 megawatts. You could build a wind plant to 4,800 megawatts, and you could survive the outage of that plant. I don't know why Texas is building at 345.

Okay. What else can it do? Frequency control and the ancillary services, there's--it appears that we could control the frequency of the country with ancillary services and get rid of all this frequency control by using generation for that. If you aggregate the country, you could add a unit on an off-ramp up and down, you can control the frequency. The DC set on a frequency control, you wouldn't see any frequency deviation across the country. And it will also give operators a lot more time to operate.

To decrease the impact of outages, if you have a big outage on the East Coast, it would be spread over 800,000 megawatts. You wouldn't even see more than a ripple.

And you could schedule power around storm areas and probably provide diversity of wind and other things. Thank you.

Joe Eto: Thanks, Dale. Thank you very much, Dale. Our next speaker is Michael Bahrman. He's been responsible for system analysis, design, project engineering, and project management for various ABB, HVDC, and FACTS projects. He is currently responsible for business development of HVDC and FACTS systems in North America. Prior to joining ABB, Mr. Bahrman was with Minnesota Power, where he held positions as

Transmission Planning Engineer, HVDC Control Engineer, and Manager of System Operations.

Mike Bahrman:

Thank you. Thank you, Joe. I'm going to touch upon several topics in this 10 minutes that we have, and one is transfer limitations. Looking at AC versus DC, a little bit about how you can enhance the transfer capability of AC with FACTS, particularly series compensation, which is commonly used in the Western Interconnect, where lines tend to be longer and transmission distances from remote resources.

Compare a little bit, in very simple terms, AC and DC, a little bit on the technology--a very little bit. And then do some comparisons on economics, efficiency, reliability, and one or two project examples before summing up and answering questions.

The top curve is showing transfer capability of different voltage transmission lines as a function of distance. You can see it diminishes with distance. This is not in any way, shape, or form due to losses. It has to do with voltage profile, stability limitations, and reliability concerns.

You don't have this reactive power distance effect with DC transmission. So you see the different voltages compared, and these are without compensation of any kind. These are without intermediate switching stations. So you could say that you can increase these by adding other devices--intermediate switching stations. But these are steady-state transfer limits. There are no reserve margins in these limits.

If we look at the bottom curve, this is the nice phenomenon called reactive power. If you look at lines loaded very lightly, they generate a lot of reactive power. They're big capacitors. They tend to increase the voltage. And so this has to be taken care of to keep the voltage within the tight band.

If we go higher, then we have to supply reactive power to these lines. So this means that when you build such a system, you need other elements other than just the wires and the circuit breakers that go along with them.

If you look at the variable loading, which is something you don't see so much with baseload generation, but you certainly see with wind and many other renewables, the reactive power variation, regardless of the type of transmission, whether it's AC or DC, is going to vary with loading, and but there's another effect with AC, and that also varies with distance, where with DC it does not.

Some simple diagrams trying to illustrate the distance effects. If you're going from Area 1 to Area 2, different path limits will exist. They could be thermal, they could be stability-limited of some sort, and you do a schedule from Area 1 to Area 2, and you build some enhancements. In AC transmission, you can increase the capacity by intermediate switching stations. You have to do that anyway. This is a good thing, because it provides places for capacity to access the transmission and to drop off load, and you could reduce the number of lines by adding, for instance, as shown here, those little symbols in the middle are series compensation devices which make the line look electrically shorter, increasing its transport capability.

So to the extent that you don't use the system up to its thermal limit, you can increase it by adding reactive power compensation.

If we look to the bottom, another way of increasing the capacity is by a DC transmission, which is controllable, so you do not have the parallel flow issues that you would have in

AC, so in a complementary role, you would never, of course, build a grid out of DC, but in the complementary role for longer distance bulk power transmission, it has merit.

This figure is intended to illustrate the controllability. In many cases, particularly where you have the desire to move large blocks of power--for instance, from nice wind resources in the Great Plains to remote load centers--some of that power is going to flow on the existing transmission. You're going to have California electrons during rush hour on the freeways around Salt Lake City. So if you show a schedule and the generation varies, you have the parallel flow issues. Some of that will flow on the new lines; some of that will flow on the existing grid and use up some of its capacity.

If you go with DC, Dale mentioned Smart Grid, this would be one example of a transmission asset that is controllable. Therefore, you could follow the generation with the controllability of the line, and therefore none of it would spill over onto the adjacent lines.

Those adjacent lines could be limiting. One could reach a thermal limit or a voltage limit, so you may have unused capacity in the new transmission that you added that is congested or curtailed because of congestion on parallel paths--could be two or three states away.

Tapping. It is more expensive with AC--I mean with DC than it is with AC. With AC, the top figure, you've got to transfer some breakers, some relays, some reactive power compensation. So from a distribution point of view, picking up and dropping off resources, this is a strength of AC transmission. If you do this with a DC system, you have the extra cost of that converter. You can still tap it. There are some restrictions on the nature of the network relative to the rating of the tap regardless, but that is certainly true with DC.

There are two types of DC technology, one based on conventional converters and one based on voltage source converters. We at ABB call it HVDC light. Others call it something else. But this removes many of the restrictions if you tap a conventional DC line with a voltage source converter. Initially, that was impossible, but today it is, and there are some systems being planned that will do just that.

Grid extenders. A lot of times if you have large blocks of power and you're bringing them into a physically congested area--lots of load, lots of freeways, lots of existing lines--it's very difficult to allocate that to the different load-serving substations in and around a metroplex. And one way of doing that is, of course, going to a lower voltage and following different corridors to different load stations. And oftentimes some of these lines will load up heavy, some will load up lightly because the power flow is not controlled. It's controlled by the length of the line.

Sometimes it's difficult to share rights-of-way for reliability standards, so these lines could be underground. And if they're underground and they're controllable, then you could direct, like our switching networks do in the telephone industry, could direct the traffic to where it's needed and balance the flows and not overload the cables. And also, some of these converters also have the attributes of being able to regulate and support the voltage, like a virtual generator.

So if you have an urban area with reliability must-run generation, you can do it with static VAR compensators or different devices, but you can also do it with this type of transmission.

So if you summarize the technologies, conventional DC, this is the workhorse for the long-distance, low-power transmission, that based on voltage source converters. It can be overhead, it can be underground. You also have inherent with it the fact that it can support voltage and it doesn't demand any reactive power whatsoever at the terminals or along the line. So it's a different technology that's available to planners. And if you look at where the technologies are today, conventional DC, over 6,000 megawatts on a single double circuit line. If we look at underground transmission on a pair of cables, we can get up to 1,200 megawatts underground. And there are different ratings in between.

Comparing the costs, you can see the different AC and DC transmission scenarios for moving, in this example, 6,000 megawatts. These are the costs of delivering the energy at 75% utilization, and you can see for the longer distances, the higher voltages went out, whether it's AC or DC, and series comp is used on the lower-voltage AC lines. It could also could be used on a 765. This allows you to transmit more power over a longer distance with fewer lines.

Losses, we see a similar trend. Higher voltage lowers the losses in all other things being equal. But when we look at higher voltages, whether AC or DC, we have more power on single line. The contingency is such that we lose more should that line fail. This is an attempt to look at -- if you have many lines, each carrying a small part of the power, you lose one, it's not as big a deal, but if you have more and more power on the lines, then you're going to have a bigger disturbance. So you either build extra lines, you put in margin, or you put in a remedial action scheme so that you may trip some generation associated with the loss of the line. And the question is -- is that something you would do with wind more readily than you would do with a nuclear power plant? I don't have the answers. It's a point of discussion.

So go back in history -- Pacific AC and DC interties -- here we have seasonal diversity, resource diversity. Going back to the '60s, there was a mix of private and public funding, and there was an AC interconnection and a DC interconnection. One does the end around, and one is the local backbone on which to different generation or resources could be picked up and dropped off. Each of those interconnections has been expanded over the course of time, and it certainly has had value to operation in the West.

Here is an example of a system in Brazil from remote hydroelectric resources -- half the capacity is delivered on three series compensated 765 kV lines, the other half on two bipolar DC lines. And you can see the capacities there. Each DC line is 70 percent of the AC line cost, and there are fewer of them, and you get more circuits because each pole can operate independently.

So here you have a nice hybrid situation similar to the DC -- Pacific DC and Pacific AC intertie, and so I think, in a complementary role this makes sense particularly for sparser networks in the West, and I would say that we shouldn't draw a line at the border because we have a lot of renewable resources available, and we're importing today from Canada as well.

So, in summary, AC lines for really long distance transmission, high power, higher voltage is better, fewer lines. You can reduce those lines with variable reactive support -- either shunt or series. With DC lines, you can reduce the number of lines as well, and if you go to higher voltage, either AC or DC, you can reduce the number of lines.

So there is a choice of transmission technology. AC/DC, in fact, are things that can be used in a complementary role to assist, and generally you reduce the number of lines, and the controllability of DC? How do you evaluate that? The one way is if you have

congestion on parallel paths that make the capacity less firm, it has definite value that you can quantify, so for really high power transmission, 2,000 megawatts and above, distance is over 250 megawatts, DC might win out in a complementary role.

And the other thing is that in finishing up, if you have DC transmission or AC transmission, how do you stage it? Do you stage it -- historically, transmission has followed generation, and you would like it to stand alone both financially and technically. So that concludes.

Joe Eto:

Thank you, Mike. Let me invite Masheed Saidi to the podium. Masheed is Executive Vice President and Chief Operating Officer of the U.S. Transmission business with responsibility for running National Grid's U.S. Transmission business. In our previous position as Vice President of Transmission Regulation and Policy at National Grid, her responsibilities included directing the transmission business through the regulatory process, RTO/ISO participation and coordination, and participating in U.S. policy debates on electric industry restructuring and market structure. Ms. Saidi attended Northeastern University as a transfer student; earned a Bachelor of Science degree in Power Systems Electrical Engineering. She also earned a Master's of Science degree in Electrical Engineering from MIT.

Masheed Saidi:

Good afternoon. One of those engineers at the last panel had so much fun with, but the engineer in me is very excited about this concept of EHV overlay. My business sense is encouraging me to be cautiously supportive. The approach -- to approach this concept, we have to also think about the underlying system. We can't just think about the overlay and ignore what's underneath it.

So my thoughts on this is we have to approach this from top down and bottom up and make sure they meet in between and, hopefully, that approach, Alison, would minimize potential for stranding any future EHV overlay.

I'll talk more about that, but the integrity of any planning process depends on the assumptions and the standards that you put into it, and I want to just spend a few minutes to talk about some of the standards, and although we should not wait for standards to do scenario analysis, having standards up front, I agree with David, but when there are standards and requirements, things actually happen, and I'll talk about some of those standards, if I could.

The first one that everyone is talking about is a federal RPS of standards and associated incentives for long-term contracts -- how would that sort out as opposed to regional RPSs and state-by-state RPS requirements?

Second, is generation connection standards -- when I talk about the underlying system, this is one of those issues that, at least in the Northeast, some of the Northeast regions, several years ago were ordered to change the generation connection standards to something that we describe as "minimum" standards -- it's plug-and-play. Connect it, you don't have to build infrastructure to deliver it to load centers, and as you get wind power in the remote areas, and you don't build the underlying system, well, it doesn't get delivered to load centers, and that's one of the areas we need to think about and look at. Is this time to change that standard; go to more of a deliverability style standard for connection of generation? And, if so, do we move to apply those to only new generation and only renewables? Or do we apply it across the board and go look backward, try to catch up with some of the backlog over the last 10 years that we didn't build to deliver generation to load centers?

And if we do that, there is significant renewable development potential in many regions in the country; that if they get connected to the local loads, they are a few hundred miles away from load centers. Perhaps it's cheaper, and I can't tell you until we look at the whole study of the whole to see if the underlying system, if we just upgrade the underlying system, they could deliver some of that, and then we overlay the grid on top of that to take advantage of inter-regional opportunities and perhaps Canada and then Western and Eastern interconnections as a whole.

Load growth and demand response -- the last panel talked about some of those issues. Should the study assume that at 10 percent demand response through energy efficiency and Smart Meters is achievable in the next 20 years -- 10 to 20 years? What -- is that too high? Is it too low? What are the energy efficiency standards? And if we had those standards perhaps some of the tension between Chris and Rob would disappear, because you do need them all, and basically the location and magnitude of potential wind and hydro resources would be an input into the analysis.

And my sense is that, as I said, if we get the underlying system to deliver the local generation closer to load, and then overlay the supergrid on top of it for inter-regional benefits, that would be an approach that I think you might get most of the regions in the country on board that would make sense for them to look into.

Is it HVDC, is it HVAC? The way I look at it is if you go with DC, the loss of -- and I don't think Mike covered -- maybe you did -- but the loss of a single -- the largest source contingency becomes the focus in a DC, depending on how big you make it, as opposed to -- and you don't have the short circuit issues that you would have with an AC. With the AC system you would have to look at are you overdoing breakers due to additional short circuit that's coming to the system? Where are the offramps? Power transformers need, and so forth? So all of those would have to be looked at, and my gut feeling is that it's not all one or the other, it's probably a combination of both depending on where you are looking and what the specific circumstances are.

And quickly, I don't see what the -- oh, yeah, there's the -- I've got plenty of time. The stakeholder involvement -- I think if initially you set up a process that every region is involved, they looked at the assumption, they buy into it, they look at the solutions, they buy into it. The process moves a lot more smoothly than a process where you come up with the completed study and two regions walk out and say they don't believe the assumptions.

So FERC -- NERC already has a nationwide stakeholder process that perhaps could be used. Frankly, it's FERC requirements in any planning process to have stakeholders' input, so some thoughts might be given to what forum can be used for stakeholder review.

The list goes on. But as I struggle between the engineer geeky side of me, it gets very excited about this, and a business sense of caution. I can't help imagine 70, 80 years ago after the last -- after the Great Depression -- probably in a room like this, a bunch of people like us talking about building the interstate highways. And can any of us live without it today? Thank you.

Joe Eto:

Thanks very much, Masheed. Our final panelist is Brian Silverstein. Brian is Vice President for Planning and Asset Management in the Transmission Organization of the Bonneville Power Administration in Vancouver, Washington. He's been with BPA for 29 years.

Brian Silverstein:

Thank you. I'd like to actually try and follow the directions, which is to talk about what planning is going on now and then what needs to be done in the future. Our biggest initiative in the Western interconnection today is the Western Renewable Energy Zone Study. It started out as a request from the Western Governors to the WECC, and the group sent me to conduct a study basically in four stages.

Stage 1 is near-term focused -- 10 years. It looks at the existing renewable portfolio standards, and the primary focus of Stage 1 is to locate the zones where the high-quality resources are.

And here is a map showing the known wind, solar, and geothermal resources in the Western interconnection. One thing that's an interesting observation -- about three-quarters of the load in the Western interconnection is located along the Interstate 5 corridor, in most cases, a long distance from the high quality renewable energy zones. Somebody ought to do a study on that -- why that turns out in the history of this country.

And here is the Western grid as it exists today -- very strong East to West connections on the top end and the bottom end; a hugely strong interconnection along the West side and the Interstate 5 corridor, and rather weak on the Eastern side of "the doughnut," as we refer to it.

Going back to the study plan, the next term will take it out further in time to add a carbon reduction scenario, 25 to 40 percent reduction in carbon. The next stage ups the ante even further to 33 percent renewable portfolio standards, so above what exists today in the state standards and greenhouse gas reduction up to 50 percent. Then the final step will be the overlay of the EHV grid.

If I can address what I think is the greatest weakness of the REZ study is, in fact, in defining the objectives. This clearly focused on identifying how do you deliver the renewable resources known today to the consumers with current technology? And I would suggest that that is not the basis for sound transmission planning. It's an important step along the way, but I think one of the challenges is it really needs to look at a variety of scenarios -- distributed generation, other approaches, resources that might come online one to two decades from now because, as many people pointed out, we are planning transmission assets with lives of 50 to 100 years.

So this slide is just to remind people in the audience that in the middle of every geek is a double E. So why do we go to higher voltage levels? Well, theoretically, with a surge impedance loading, you can get roughly four times the power on a line as you increase the voltage level. Remember, as you see in many television and magazine ads, your results may vary.

So the challenge we face as we look to placing a new overlay in any system is can we afford, can we survive, the loss of a new facility moving much larger blocks of power? In the Western interconnection we tend to be limited by voltage and transient stability levels and the loss of a single line, which are now required to meet Level D performance in the NERC criteria, is quite severe. And we are also limited to the maximum amount we can generate we can lose because the Western interconnection is about one-fourth the size of the Eastern interconnection. So we had losses somewhere around 2,700 megawatts, we're actually going to go into under-frequency load shedding in the interconnection.

The last item I would like to note is that in EHV or a higher-voltage overlay, only becomes usable when you have an interconnected system. We have examples in the East

where you have transformer-terminated lines at 765 kV, which, unfortunately, cannot deliver at their full potential.

So I'm going to describe a game plan. I think the obvious steps are, number one, extracting what you can from the investments we have today. Also remind people, I did check the ANSI definition -- 345 and 500 kV are EHV voltage levels. We do have an EHV grid today in the country.

I think the first step would be to squeeze what you can out of your existing assets with thyristor-controller series compensation so we can push up the levels even higher than we currently have in the Western interconnection. It turns out if you look at it, building out, adding a third line in parallel with the 500 kV system, can give you significant benefits because you've moved beyond the loss of two adjacent lines -- what we are required to do in the reliability criteria.

If you are considering an overlay, of course, the engineer's rule of thumb is to double the voltage level, and I think we need to check today whether that does make sense given our ability to survive the loss of that large new facility.

And a reminder that in the United States today we have AC and DC transmission existing side-by-side and amicably working together. We have huge proposals in the Western interconnection for both AC and DC transmission, and I think the likely buildout is going to accomplish both. And so I think what we clearly need is a robust, integrated plan that looks at a variety of scenarios and so remembering the question from the last panel, I'm prepared in advance, I'll lay out my five goals for expansion -- reduce carbon; energy security; make the grid smart -- one that I haven't heard, so far -- we need to use our valuable and limited rights-of-way as effectively as possible, as it's going to be near impossible to go back again and again to rebuild parallel lines. Of course, you want to minimize the cost to consumers including the risks, the uncertainties, and finally we need to provide flexibility for the unknowns and the things that, in fact, are not knowable today. Thank you.

Joe Eto: Thank you very much, Brian. Now, I'm going to take the prerogative of being the moderator to ask a couple of key questions that I know the Department is quite interested in, and the first one is the question of whether we have moved from the stage of whether to how? And so the question to the panels is it inevitable that we will have an EHV overlay or a significantly increased EHV system in this country? And so is the question before us, again, not whether we should start thinking about how to design this thing but how to actually go about doing it? And I'd like to invite each of the panelists to offer their perspectives on that.

Dale Osborn: This is Dale Osborn, MISO. In our area, we are already past whether. Our governors in that area just want to build wind and get it out of there. So we're definitely working on that. We are working on it on multiple levels. We have the reliability planned at the base. We have what we call a mid-range or a target study where we are actually designing the system for 22,000 megawatts of wind in the Western five states or region, which meets the RPS requirements to 2025, and then we're working on the JCSP, which would give us even further extensions.

Mike Bahrman: Mike Bahrman, ABB. I think if we look historically, exploitation, if you will, of remote resources, be they hydro, wind, mine mouth generation, transmission and generation have been joined, and it's been done on a project-by-project basis. No one has gone out and built up a bunch of transmission and then sat back and waited. And then as someone already mentioned in an earlier panel, there have been no large-scale generation

developments and associated transmission for a few decades now since the '80s because it's all been combined cycle relatively close. Even initial wind buildouts have been closer to the loads in Minnesota and California and Texas, and now we're seeing the reaching out for more efficient resources that are more remote.

I see the same thing developing in the West, particularly, and in Canada. Brian mentioned there are a number of large-scale AC and DC projects, and some of them are double-circuit 500 k AC lines with 70 percent compensation, 3,000 megawatt on a double circuit single structure, and there are a number of DC projects with the same capacity.

If you look into China and India, they are doing similar things -- both AC and DC, depending on the distance of the resource and the combination gives them the best thing.

One thing that they have been doing in these other countries, and we still have in the U.S. and Canada is that we have an interconnect-wide planning. There is not an overlay in this country. We have ERCOT, we have the Eastern Interconnect, the Western, in Quebec, we have the ERCOT of Canada, we have Hydro Quebec.

Market folks hate seams from a reliability point of view, the machine can get too big, and seams are a nice break point. So I see the development going that way, where the capital flows together with the resource and the utilization matches.

Joe Eto: So may I just ask again -- there is no conceivable reason not to begin thinking about this kind of a plan?

Mike Bahrman: No. It takes time.

Joe Eto: I just want to be clear.

Mike Bahrman: Especially with our stakeholder process, it takes a lot of time. A wind plant can come on quicker.

Joe Eto: I'm going to ask the question how, but I want to just make sure where we are with the "whether" question. So, Masheed, do you have an opinion on this topic?

Masheed Saidi: Maybe I'll answer the question from the last panel, what should be the time period for this? And in five to 10 years' time, we won't even be building anything, so I am looking at a 2050 and looking at what is the role of electric utility industry, electric business, as a whole, towards that reduction by 80 percent and where are the renewable resources? Cluster them up, when are the local deliveries? Deliver those with the underlying system? And, yes, there is a role for the overlay but, yes, you should approach it by a scenario analysis and looking at the longer term.

Joe Eto: Brian?

Brian Silverstein: So I think it's clear that the train has already left the station. We are building the next generation of transmission facilities to deliver renewables, and that the plan is absolutely critical. I think that challenge is the transition, because the plan really does need to be looking on the long-term basis, and one comment you hear at these -- in the hallways of these meetings or sometimes even into the microphone is "I'd be more than happy to participate in the plan just as long as you don't 'blank' with my transmission project that I'm already proposing."

- Joe Eto: So I think this really goes to the next question -- which is "I want to understand from your perspectives if it is inevitable that we should begin this type of a planning activity. How should we go about it?" I think you've spoken to the timeframe, Masheed, and Brian you've spoken to current projects that are on the books. What are some of your other thoughts, panelists, about the hows and the do's and the don't's?
- Masheed Saidi: It's too big a chunk right now. You can break it down by the NERC regions and do a region-by-region and then close the seams up. Or you can go by the markets and the structured ISOs that exist, but they are not everywhere, so I am not quite sure -- or maybe a hybrid of the two.
- Joe Eto: Okay. Other perspectives on the "how" question?
- Mike Bahrman: I think the comment was made --
- Joe Eto: And I'm sorry, excuse me, I am reminded, because they're going to transcribe this, when you -- Masheed, we know that you're the only female in our group, but the gentlemen and then also when we have questions from the audience, be sure and identify yourself before you speak into the microphone, thank you.
- Mike Bahrman: Mike Bahrman, ABB. I think when you're looking at a collector system, you are looking at the best resources. For instance, if you're looking at the Great Plains, those resources straddle the East/West interconnect -- so some can go to Chicago, some can go to the West Coast. One shouldn't lose sight of future generation technology trends that allow you to firm this up with something. One of the slides I had showed the cost of delivery of energy for 75 percent utilization. Of course, if you have reasonably good wind, and it's 38 percent, that cost doubles. So one should, in planning out, look at the close stuff first.
- In the Northeast, they're looking towards Canada and the Maritimes for renewables. I think that's good. And if you're looking to go further, look at other resources, be they solar, be they geothermal, and be they some new technology coal. I recall the Arriva executive saying some weeks ago there are many solutions other than nuclear, but there is no solution without nuclear, and so that's about as -- we're just technology providers. So whatever people want will be manufactured.
- Joe Eto: Okay, Dale?
- Dale Osborn: Dale Osborn, Midwest ISO. First of all, I think the overlay is a separate function. It supplies the energy from one energy market to the other market. It isn't supplying capacity as the underlying systems have done. I think it needs to be planned as a whole. I think it needs to be planned separately. It doesn't work to take the pieces and try to glue them together. We've been trying to do that.
- The overlay I showed you resolve 300 constraints with seven lines. If you went through and did 300 constraints, you'd never get through a study. So first of all, I don't think you can ever get there if you don't do it as an overlay for an interconnection-wide study.
- The other thing is there's \$35 billion in 2024 dollars of congestion per year. That's a lot of money. That should be able to drive a business model. And the third part is something that a lot of people -- I don't know why they don't -- but I learned it very early in my career. It's called "Rule of Three." If you build one line at a time, you always build the same voltage, because if you put a higher-voltage line over, you won't get enough loading out of it to make it economical. If you put in two lines of a higher

voltage, it will break even. And if you put in three lines, and you can load them, it will always become the most economical solution from there on.

So if you can't get to two lines, you can't get started. And if you look at all the state processes, how do they approve lines? One line at a time. Guess what they get? The same voltages that they have, and that is one thing. When you look in an overlay, this overlay I showed you has 229,000 megawatts of wind and 180,000 megawatts of conventional generation tied to it. That is enough to drive it to the three-line concept and get it started.

Joe Eto: So to summarize what I'm hearing, I'm hearing look very long range in terms of the timeframe, and that's one very clear distinction from the five to 10-year plan --

Dale Osborn: At least 16 years.

Joe Eto: I hear scenarios should be considered, and I hear different thoughts about the scope in terms of how the regions and how big a bite one takes to begin with. Are there other perspectives on the "how" question?

Brian Silverstein: So I would again support what Dale said about the need for the broad geographic scope, particularly if you look at the map of the Western interconnection and the distance of high quality renewable resources from the load centers. Single utility planning on its own is not going to come up with an effective solution, and even our alphabet soup of sub-regional planning organizations in the Western interconnection cannot do that without being locked together in a room to do a single plan.

The one thing I would ask, as we lay this out, is to make it time-limited so that the planning process actually has a clear deadline and, as several people have said, a clear set of objectives in coming to their final plan.

Joe Eto: You raise the geographic question. It's one of the two questions I still have remaining. Some people have talked about a national power grid, a power grid that interconnects East and West and ERCOT ultimately. How should we think about that prospect or that contention or that suggestion in the context of the types of planning activities that you would envision in terms of designing an EHV overlay? In any order.

Dale Osborn: Okay, I can take that first. Politically, tying the West to the East is like tying two cultures that don't match together. I mean, one has -- the West has a culture and the East has a culture. And --

Joe Eto: Not to mention Texas.

Dale Osborn: Yeah, I won't comment on that.

(laughter)

The other thing is if you did a study of the entire United States, you'd have to have some data. It doesn't exist. Wind data and the solar data across the U.S. does not exist. You would have to create it. It would probably take you a year or two and some money from NREL or DOE or somebody. Nobody's going to pay for that by themselves. And if you did connect the West to the East, it would take about 14-15,000 megawatts of transmission to hook them together, and you would have to hook California to the system I just showed you -- the DC, in my opinion.

Joe Eto: Anyone else? Mike Bahrman?

Mike Bahrman: Mike Bahrman, ABB. The East and the West and ERCOT and Quebec are all interconnected now by asynchronously, and now we have Mexico joining the fray as well. So this allows incremental market transactions. You don't need -- and as Dale mentioned, from the stability point of view, if you bite the bullet and interconnect them synchronously then you have to do it a lot up front, and it might take some -- and normally the networks are very weak at the periphery, so you would have to reinforce them. So you could tie the markets together for time diversity and resource diversity as maybe a second or tertiary step without having a synchronous overlay.

Joe Eto: Do you want to comment?

Masheed Saidi: I kind of agree with both gentlemen here. There is some truth about the cultural issues, but I do need to go back and clarify what we said to the last question as far as this is fragmented. The point I was driving at was we need to get the individual markets planning for us as these rights so that we can give the right input to the overlay study. Not to do an overlay study in fragmented format. Otherwise, it will become garbage in garbage out.

Joe Eto: So you are suggesting some more work at the sub-regional level --

Masheed Saidi: Correct.

Joe Eto: -- in order to adequately support a region, and I think that's where you were at, Brian, is that right?

Dale Osborn: One thing I'd suggest is that in MISO we use a stakeholder process. That's the best thing about MISO and the worst thing about MISO. But the stakeholders in this process are your RTOs and large utilities, it isn't your individual generators or you individual loads. So when you get to this level, you have to have a market aggregated up to get enough energy to load up these interconnections and to manage it. And I think it's a hierarchical type of organization, I think. The overlay sits on top, it's run and managed by a separate organization that is responsible for it.

If somebody is going to spend \$80 billion, they're going to want somebody to hang if it doesn't work, and they want somebody to make sure that the money stays where it's supposed to be put. And some of our experience lately shows that maybe there is even a greater need for that.

So I would say that you need a different organization structure than what you have currently, because the interests of the individual groups do not match. You have to get somebody that can take their collective interests, build a system that serves their collective interests and then take care of -- the stakeholders in that group are your large utilities and RTOs. You probably have governmental processes in there, you'll probably have policy people, and stakeholder groups like that, you probably have the people that are going to pay for it. And you can guarantee they'll be in there, and there's no reason why they can't sit in the same room and plan a system. And the generators should be able to come into the room, too, and the market participants. They should all have inputs into the process.

And will there be fights? Yes. But they settle down after three or four months. I mean, they finally get to the point where they decide they need to get something done, and if FERC puts a little push on them, they get done faster. So there are ways to get it done,

but the existing organizations, in my opinion, are not sufficient to independently put this together. You need an organization that's function is to make this work and to focus on it, and it doesn't conflict with their other goals.

Joe Eto: Brian, I want to give you a chance to speak to the issue.

Brian Silverstein: Right now we have very limited capability between the Western interconnection and the Eastern interconnection. Only about 1,600 megawatts sprinkled in six or eight small back-to-back DC types. And there may be value of increasing that capability. But, personally, I see that as somewhat of a distraction today. I think the important thing is delivering the high quality renewables available within the interconnections.

If you take a look at the map, you see two things. One, there is this sort of big gap in the transmission grid -- several hundred miles of transmission between the two and the question is, is there value in filling that in today? Data that's actually somewhat dated now, more than 15 years old, indicated that ignoring offshore wind or maybe it wasn't even evaluated at the time, about two-thirds of the available wind that's in the Eastern interconnection got a quarter, and the Western interconnection about 10 percent in Texas.

So I think that will carry us for long enough to understand what the next-best thing will be in energy resources, and we should focus our attention and our dollar resources on building what's need to deliver the known high-quality resource sites today, the interconnections.

On an incremental basis, if we see opportunities for greater exchanges between the interconnections, that's great. My personal bias would be towards direct current and not that back-to-back but actually building DC that reaches into the two interconnections to fill over that gap area. But I think that's the next step. I think the first step is deciding what we need to deliver in the next 10 to 20 years.

Joe Eto: Thank you, Brian. I do want to be respectful to the audience and the other questions, but I just have to ask one more question, and I'm going to ask it in a very precise way and hope for very succinct answers.

We've heard that it's a good idea to do this planning. We've heard some aspects about how and what not to focus on. If the federal government wants to support this activity, and I'm going to ask this very specifically, what should they not do to maximize the likelihood of a plan leading to a successful outcome in terms of the objectives that we have for designing this type of system?

I know, Brian, you may have a conflict, because you're part of the federal government, but let's just hear from the panelists, any parting shots about that topic? Anyone want to venture that at?

Dale Osborn: Well, I want to say before I answer that question, I'm not supposed to lobby. So this has nothing to do with my opinion being expressed, okay?

I think the one thing they shouldn't do is re-confer or construct a group that isn't linked to the present infrastructure. There is a lot of things that work well in the electric utility industry. Let's try to get the cooperation to get those to work together to help the process so we don't go off and build something on the side that doesn't tie in well with what we already have. We have the energy markets; they are working. Are they perfect? No, but they could be a little better, they will get better, but let's try to use the infrastructure to build on it.

The JCSP was a voluntary organization, let's try to build on it, make it larger, you know, make it more inclusive. We've tried, but we've reached our limit. They could encourage participation. But I think the best thing is try to find out where people are willing to go and encourage them to go in that direction.

The biggest problem getting this built is the risk. If you put \$80 billion out on the table to build this system, and then they pass a carbon tax, you probably don't need any transmission. And the reason is that when you go to gas-to-gas and nuke-to-nuke, there isn't going to be exchange between the areas. We've seen this in our simulations, and it raises the wholesale price considerably. A \$25 a ton carbon tax raises the Midwest ISO wholesale price by 55 percent. That's a lot. That would be a big impact on a lot of people.

If you put in 20 percent wind, the price per ton is \$6 per ton of carbon dioxide for the wind. The incremental cost compared to the reference. And so I think, you know, that you need to get the economics in there as well as just the policy -- what's this going to cost the people?

Joe Eto: Does anyone else want to speak to that question?

Mike Bahrman: Two things -- don't be too rigid with the rules. It was mentioned earlier that FERC had approved TransCanada's business case for Zephyr. There may be others, so that's one thing. Also, don't be too rigid with the reliability criteria. Now, don't shoot me, we have intermittent resources, we could have more probabilistic planning criteria at least for intermittent resources than we would for baseload instead of deterministic. Keep an open mind, not be too rigid.

Joe Eto: Okay, thank you.

Masheed Saidi: I'm wondering whether I should say what I'm about to say, but the federal government probably should not rely on states getting agreement among themselves.

(laughter)

I've had too many orders coming back at us from FERC that says "Go solve it in the region," and there are always state disagreements. Even the other stakeholders agree the states do not necessarily agree. This could go on for a long time.

Joe Eto: Okay, Brian?

Brian Silverstein: I agree, don't be too prescriptive.

Joe Eto: Thank you. We are very close to the end of time. Are there questions from the audience? Alison? Do you have some put away?

Alison Silverstein: Can I get one of you all to define an overlay, please? What's an EHV overlay?

Dale Osborn: Since I just designed one, I should be able to tell you what one is.

Alison Silverstein: I was hoping you could.

Dale Osborn: The overlay is a higher-voltage volt transmission system that will deliver -- in the case that we studied -- will deliver energy efficiently across an interconnection.

- Alison Silverstein: Why do you call it an overlay?
- Dale Osborn: Because it's not piecemeal tied in and integrated and power is flowing through the underlying systems. The underlying system work, as they were designed, and the overlay does a different function without upsetting the underlying system. They are tied together; they don't interact to the point where one is a detriment to the other.
- Alison Silverstein: Thank you.
- Alison Silverstein: Brian, you talked about some reasons why -- technical engineering reasons why maybe we don't want a full overlay of the HV across the West but just sort of targeted applications at the HV. Did I understand that correctly?
- Brian Silverstein: I'm not saying that there couldn't be a full overlay. We need to recognize how those lines perform has to be looked at from a system standpoint and not thinking of them in isolation.
- Alison Silverstein: Thank you. Given some of the sort of negatives that Brian outlined with respect to some of the reasons why you need to be careful about doing EHV in the West, are there any technical or engineering reasons to be cautious about doing EHV overlay in the East?
- Masheed Saidi: I would only look -- sorry -- I would only look at the AC option and, depending on where they terminate, whether it would increase short circuit to a degree that manufacturers are not providing. I mean, I'm really reaching for that, but that could be one.
- Alison Silverstein: Okay. And most of the current EHV talk is about moving bulk renewable generation or by extension bulk nuclear or bulk coal from one area to another. Are there other compelling grid design reasons or goals to build the HV overlays?
- Dale Osborn: Yes, I went through those in my presentation. There is lottery liability only of 10 minutes to tell you all the good stuff, but the system would be much stronger, to say it succinctly - - much stronger with the overlay as it was designed than it would be if you just piecemeal patched it together.
- Alison Silverstein: Thank you. It wasn't clear whether that explanation was specific to your renewable scenario or whether that was generic. My question is generic -- does that answer still apply?
- Dale Osborn: I haven't studied all the scenarios, but the two we studied, it's generic.
- Alison Silverstein: Thank you very much.
- Joe Eto: I don't see anyone walking up to a microphone, and I want to apologize for not getting to the two questions that came over the Internet. We will post those, but I would like to have you join me in thanking this panel for a very good discussion.
- David Meyer: Ladies and gentlemen, we want to get our next panel underway, so please take your seats, and we'll get this discussion started.
- Well, thank you, ladies and gentlemen. It's my pleasure to moderate the third panel here today. And I think the two preceding panels have teed up the issues for this last discussion very well. That is, if one says, "Yes, we do need an EHV system, an overlay, yes, we should get serious about designing it," then, to me, the next set of questions is,

"Okay, what are some of the fundamental choices that have to be made? That is, what, particularly choices that public policy people need to start becoming familiar with?" That is, what are the options, that if you're designing this system, what are some of the fundamental design choices you're going to have to make? And what are the implications of those choices? What are the ripple effects that you need to anticipate and understand before you actually make the decision?

So that's the kind of the focus that I'm going to ask our panelists to zero in on. And they are, I've asked them to speak in the order in which they're seated here. Mike Heyeck, we'll go from the general to the specific. That is, Mike Heyeck and Kiah Harris will discuss some of these questions in more general terms, and then Jerry Vaninetti and Jon Jipping will address some of these things in the context of some specific projects or specific geographic areas.

So the panelists, these four gentlemen are familiar, I expect, to most of you. Mike Heyeck is Vice President for Transmission of AEP, Jerry Vaninetti is a Vice President at Trans-Elect Development, but he's had particular experience lately with the Western Renewable Energy Zone work and can give us information about that. Kiah Harris is a Principal with Burns and McDonnell, and he's had experience with many major transmission projects and can draw upon that, look across a range of major projects and give us some insights from that experience. And finally, Jon Jipping will tell us about the, particularly about the recently announced Green Express Project from ITC.

So with that, I will turn to the panelists. Mike, would you take us through your presentation, please?

Michael Heyeck:

Good afternoon. Being the third and last panel, we have the opportunity to say what was wrong with the last two panels. Actually, the last two panels set the stage for us, leaving us some opportunity to get a little bit more focused in a few areas of designing what this electric future would be.

I love to read history. There's something to learn from history. When you think about it, it was in the Nineteenth Century where we decided to develop a continental rail system. It was the Twentieth Century where we decided to develop an interstate highway system. Will it be the Twenty-First Century when we finally figure it out for the electric transmission grid? We had a lot of discussions in the last two panels about what the carbon tax will be, what's demand response, what's distributed generation, what will load be, what will, what will, what will this be?

Well, let's look at some of the discontinuities that we may face. One is the transportation sector is going to be electrified. That is a discontinuity that is going to affect our growth. Another is greenhouse gas emissions will come. And industrial processes will likely be electrified, and it will be on the backs of the utility or the generator to deal with the greenhouse gas emissions. We are going to have a load discontinuity, so whether we look at distributed gen and demand response, we need to add to that electric vehicles, plug-in electric hybrids, and we need to add that, the last mile of industrial processes electrifying.

When President Eisenhower had his focus in 1956 in finally developing what we call today the interstate highway system, think about how long it took to develop that system. In the '30s, the first plans were being developed. In the '40s, a task force was put together. It was finally designed and improved in 1956. So it took almost 20 years to figure out what the interstate highway system will be.

And it wasn't just a bold vision. There was a plan to it as well. What was the objective? Interstate commerce, national defense, it had very broad criteria--a leap of faith, if you will. They didn't know where the Wal-Mart Distribution Center was going to be. They did not know where the queuing process of the next Target. That's the fundamental issue we have today with our electric grid, is that planning it is very much piecemeal. We need to develop a broad vision.

We do believe that East and West grids need to be planned in a singular fashion, each to their own. Connecting the two grids will be opportunistic and probably HVDC connecting the East and West grid. The regions developed very well--PJM, MISO are developing a New York ISO, ISO New England, and so on. They're developing--the planning authorities in the Eastern Interconnect are doing a very good job inside their own authority.

But they're not doing a very good job connecting to other regions. And that's where we need to draw the lines, if you will, across these seams. And how do you do that? Well, I agree with some of the other speakers. Let's gather the minds that are already here to help do that. But we've got to stop developing Plan Number 157. There's got to be a singular focus to come up with a plan.

I've listed here some of the criteria which we ought to look at, such as national security, grid reliability, integration of renewables; market efficiency; land use, as some mentioned; the uncertain future, as I mentioned some of the electrification that will come; and certainly consumer costs--very important.

But transmission today, on the average bill--which is about \$95 a month--transmission's about \$6.00 a month. If today instantly you added \$100 billion of facilities across the United States and socialized it with load use, that would add another \$4.50. We are not talking about extraordinary amounts of money on the bill, but we are talking about an extraordinary impact that we can have on our energy future--the choices we make of supply, renewables, and other new technologies.

We've done a study of, we sponsored a study done by CRA International for the grid overlay in SPP. I won't bore you with the details; it's on SPP.org. But the benefits here are \$600 million per year. So there are benefits of developing an overlay.

I'm going to put this slide up and talk from this one for the rest of the presentation. We proposed, Rob Gramlich asked us to help develop a concept of connecting 400 gigawatts of wind, and this is the concept we created. Yes, it is 765 kV, but it doesn't have to be 765 kV. Everyone knows that every element has its own place, and HVDC, 345 kV, and yes, 500 kV.

One thing I should mention, though, is that we developed 345 kV almost 60 years ago. We placed our first 765 kV line in service 40 years ago. We need to perfect these voltages. We need to make better use of rights-of-way. We need to use more power electronics. But we need to develop the criteria first and then plan the grid second. What we do recommend, again, is that the East and West grids have a singular plan.

I was joking with David prior to the event today, saying, "If you get six people in a room, six engineers, all you really need is one box of 64 Crayola crayons and a lot of white paper." Because we do know where the resources are. We do know that Chicago is not going to move. Okay? We know where New York City is. And for our New York friends, no, New York City is not the beneficiary of everything we build. You do spread it across the entire country.

So if the cities don't move, and we know where the resources are, maybe the integration of renewables will drive our energy future. And yes, nuclear will come and other new technologies will come as well. But let's start creating a grid, and we can renew the plans, much like the interstate highway system was renewed as time passed.

There are really three impediments to transmission. Private investment is not an impediment. Private investment can be attracted to transmission. We do not need federal dollars to build transmission. But the three impediments are who; what project, which refers to planning; who will pay, who pays--cost allocation; and third, whose backyard--siting. We need to streamline these processes, and then the investment will be attracted.

So let's review a few things. One is we need an interconnection-wide plan for both East and West. And yes, Texas actually is the model when they developed the competitive renewable energy zones and developed the plan to connect those zones. That is the model that we should be using for the entirety of the East and the entirety of the West. And yes, they socialize, or as Alison would say, they spread the costs as peanut butter according to loads served. So it takes away the "Who pays?" issue.

Siting in Texas is under a singular authority. Siting is not that difficult in Texas. And regardless to where siting is, siting is much more a property-owner-by-property-owner proposition, and the rest of it is politics, as we say.

I'm going to welcome any of your questions, and Brian, we could debate 765 and 500 kV, and Mike, we could debate HVDC versus AC, but we both know it's not either/or; it's both. Thank you.

David Meyer:

Thank you, Mike. Let's turn to Kiah.

Kiah Harris:

Thank you, David. My talk is primarily to really pull out the "ee" from the "geek" word. I'm involved in quite a few transmission planning studies for both utilities and independent power producers who want to move considerable amounts of energy from one point to another. Talking specifically to the IPP industry with the vast amounts of wind that want to be moved from the Midwest to the East, I've been involved in studies in Texas for some fairly high-profile IPPs down in that state, as well as from moving into the Kansas and Oklahoma area, moving energy to the East Coast.

One of the common attributes to these programs from the IPP industry is that they're very large. We're talking about projects in the 3,000 to 4,000 megawatt range. When we talk about moving that amount of capacity on a transmission grid, the other issue that we are dealing with is that they want to move it a long distance. I don't know how many of you have ever been out to western Kansas or western Oklahoma, but the one thing that you see out there is not very much, and there's a lot of wide-open space out there, and consequently, there's not much existing transmission infrastructure to use. And so what you're dealing with is when you put in these wind towers that are 1.5 to 2 megawatts each, you've got to collect a lot of them to get to 4,000 megawatts. And so what we're dealing with is creating the regional or local collection systems and tying them to a very long transmission line to get it to the East. So one of the things that you see is that you very quickly get moved into the 765 EHV level, or into the HVDC realm.

Now, one of the things that we've dealt with in a lot of these studies--and it's a very common thing, because with no loads or infrastructure in these high-wind areas, what you wind up with, essentially, is a radial transmission line from these wind regions into the markets in the East. And whenever you get into a discussion about the wind, you fall

into another interesting paradigm with the wind in that you're building a transmission system that essentially is utilized roughly 35% to 38% of the time.

So but within that 38%, it can go from 100% during some hours to essentially 0% to some hours. And so what you're involved with is, certainly in a DC realm, is the regulation of the flows on the line based on the wind output.

So one of the things that we immediately get into when we're talking about a transmission line that's extending in some cases, 500 to 600 miles, is that we're moving from essentially a dumb grid--we really kind of blow through the smart grid and want to get to a Mensa grid--because the opportunities that come into play with managing the load side as we're dealing with this wind variability is extremely critical.

And at some cases, we have to essentially shut down a line when the wind falls below a certain level of injection into the system. And so what we're dealing with is a massive control scheme as well as just the transmission line itself. So the system that we're dealing with is not just the transmission line, but it's all the control aspects that go along with it.

When we're talking about HVAC, one of the things that we're really dealing with is fairly high short-circuit levels going into the collection systems on the wind end. And so we're dealing with really massive injections into these wind areas where essentially there's no infrastructure right now, so we have to be careful about the short-circuit duty that we're imparting into that existing system.

Another thing that we're dealing with on the AC side is that all of these lines will be series compensated. When we get into series compensation, we immediately move into the subsynchronous resonance issue with the local generators that are out there. And so that's another consideration that we have to have with the AC side.

Some of these problems disappear when we go to the HVDC, but HVDC has its own set of issues associated with it. But we think that in the development of these large wind farms, we're going to be seeing that the 765 is used primarily on the northern side, and then that will be connected to the systems over to the Chicago area. When we're dealing in the southern area, we'll be dealing more with the HVDC.

I appreciate the opportunity.

David Meyer:

Great. Thank you. Jerry?

Jerry Vaninetti:

Thank you, David. I want to thank John and Larry for inviting me to make a presentation today. I'm largely going to restrict my comments to the Western REZ process that DOE has a major role in funding. In fact, I think they may fund the whole shooting match. I also am here representing Trans-Elect, of course, as well as the Wyoming Infrastructure Authority, and at the end of my presentation, I want to touch base on one of the projects that's probably pretty well suited for WAPA involvement.

As you well know, the West is blessed with substantial renewable resources, just like the Upper Midwest and the Eastern Interconnect is blessed with substantial renewable resources. In the case of wind, we've got fantastic resources quite a long way away from load, although Phoenix is close to some of our solar resources; Albuquerque, Denver, Salt Lake City, and some of the Rocky Mountain urban areas are closer to load. But most of the load is certainly on the West Coast. But we've got great wind resources in Wyoming

and scattered throughout Colorado and New Mexico, and then certainly up in Montana as well as up in BC.

Solar, I think we've seen some earlier maps showing the solar potential, but certainly the desert Southwest has phenomenal resources. We've got geothermal resources in Nevada and some other places, small hydro opportunities, small and large hydro opportunities up in British Columbia, and then biomass opportunities as well.

You've seen this slide before. This is a rendition of the Western Interconnect showing the different voltages that are in play, and Michael, you'll notice there's no 765 out here-- at least there isn't as yet. And that's one of the concerns that a lot of folks have in the West, that the utility stakeholders, there isn't any 765 here yet. So if there's certainly discussion about a 765 overlay in an area, that you'll get equal time. A 765 overlay over a system where there is none.

There's a lot of 230 and 345 in the Intermountain region. We have a smattering of 500 kV. It's kind of a half, or a backward C going up and down the West Coast and into Arizona and into Montana and certainly up into Canada. And so there are concerns about do we finish the build-out there? What is the optimum configuration or the optimum overbuild for the West? Certainly not a lot of talk about that.

This is some illustrations coming out of the model that's been developed for the WREZ modeling effort. We had a Transmission Segment Subgroup, it's noted at the bottom of the line here. Andy Leoni of Tri-State chaired that effort. And what he attempted to do with a bunch of additional transmission operators and utility planners is to try to illustrate the Western grid in a simplified form. But to simplify the Western grid, we still came up with 100 segments, and there's still some work to be done there. But this graphic shows our ability to identify individual segments that we might want to model to take renewable resources from the WREZ zones into the load pockets.

And this first diagram does come from the model, so it shows some resources up here in BC, where you would have injections, and this red line are all the segments that would be used to get it all the way down to El Paso. That's not to say we'd use any of the existing grid; it's just the assumption that the existing corridors would be utilized wherever possible to put some additional transmission lines in.

We have, I think, 60 different WREZs to consider, as well as 20 different load zones to connect up, but this is part of our model, to be able to model this.

We had another subgroup, Transmission Characteristics Subgroup, chaired by Bill Pascoe, formerly of Montana Power. He's now in the consulting business, but he got a group of people together to look at configurations, so he looked at single and double circuit configurations. We looked at a number of different voltages, all the way from 345 on up to 500 and 765 kV. Also looked at a couple of DC configurations.

And then their effort was directed at trying to come together with some WECC-wide agreement on what the capacities of those lines would be, what the installed costs or the capital costs for the lines, what the right-of-way costs would be, and that number varies, substation capital costs, line losses, and then O&M costs. And then all that information would be fed into the model so that one can model any configuration they want, any voltage they want. and see the advantages. The default configuration is a single-circuit, 500 kV line, so if you don't like that, you can input whatever you want to utilize.

These are some of the results that the group has put together, so you can see from this

diagram that you've got 230, both single and double circuit, and then you can read on down different configurations. The capacities are estimated. The capital costs for installation, I think Dale Osborn showed a slide or one of the other presenters did earlier, and this seems to match up insofar as the economics are concerned.

You've got different right-of-way involved in terms of width for the different configurations. The line losses are much higher for the lower voltages than the higher voltage systems. The O&M costs seem to be consistent across the board in terms of percentage of the installed capital costs, not dollars per megawatt. And then lastly, the substations are important to take into consideration, and they vary all the way from \$50 million for a single 230 kV substation all the way up to \$250 million for a DC converter station.

Some input on the spacing of the substations, and in the notes down here it talks about some of the variations. One I really want to pull out to you, pull your attention, is the variation on right-of-way costs. As you might expect, going from the sagebrush of eastern Montana and Colorado and Wyoming, we're probably much more down in the range of \$50,000 per line mile for transmission, whereas in urban areas of California and the West Coast, you may be as much as \$650,000 a line mile. So that's where a lot of the variations occur in the model. And again, the users can select that information.

This is a summary of pulling that information together for a 600-mile-long line where the right-of-way was \$10,000 per acre, and this, to some extent, duplicates the slide that we saw earlier. A 230 kV line is higher costs up here. You're looking at something approaching \$4,500 per megawatt-mile. As you go to the higher voltages, the numbers drop down. The capacities vary, and that's shown on the left side here, so the low voltage lines, 230 lines, have much lower thermal capacity than do the higher-voltage lines.

The things I want to draw to your attention on this slide are the cross-hatched areas, which indicate the first new voltage introduced into an area where there isn't an existing voltage of that level. So in a lot of places in the West, we don't have 500 kV lines, so you would put in a 500 kV line, but you would get rated, effectively, as a 345 line. So that runs those 500 kV costs up to, in this case, \$3,500 per megawatt-mile as opposed to the second line. Its costs are substantially lower--effectively half the cost.

And then the same issue applies going from a 500 kV line to a 765 kV line, and then adding additional number of 765s, your cost comes down even lower, and then lastly, the DC lines are the lowest-cost option.

One thing to be cautioned on DC configurations is the issues of the stakeholders in the intervening states. A lot of people don't like transmission lines going across their states if they can't pull any of the power off or put any of the power on. So that's one of the challenges that we have in looking at long-distance DC lines, notwithstanding the excellent economics.

This comes out of the model, and it's just a portion of the model, of the display, but it shows how a user can select different segments. These are an arbitrary, I think six or eight different segments that are looked at. One can toggle between the different voltages that you might want to assume to handle that. So in this case, the default would have been 500 kV, but we have toggled to a 230 kV number. Depending on the amount of renewable capacity, you want to put that line on the line, it derives a utilization factor for you. In this case, it was only 4.3%, not too high a utilization number. And as a consequence, that results in this case with a really high levelized transmission cost of \$205 per megawatt hour. And the losses are calculated.

This is only here to show you that you have the ability to toggle and select between different voltages. And you can use either the calculated utilization, or you can override that and put your own utilization levels in there if you feel that you can put some additional resources on there--solar and wind together, for instance--or some gas resources to go along to get some higher capacity ratings. But you've got these kind of capabilities, so you can pretty much model anything you want in the West, or at least that's the intent when we're done with the model.

This has been touched on a little bit. Through the WREZ process, four scenarios were recommended to the WECC transmission modeling folks as a reference case for meeting RPS requirements. There's another one to get up to a 33% renewable case, a CO2 reduction case, and then lastly, the transmission super-highway overlay case. So there will be a lot of work being done within WECC to consider all of these options.

With regard to the transmission super-highway overlay case, we had a meeting in Phoenix here about a month ago. Several of us attended and made presentations, laying the groundwork for the WECC transmission planning folks to get together and for them to decide, what does overlay mean for the West? And I think there will be a number of debates about, "Is there a DC component? Is there a 765 component? To what extent is there a 500 kV component?" I think those are the three things that are going to get debated, and we'll all have to wait and see what comes out of that assessment. I wanted to ask Brian a question about what, knowing that we're supposed to answer these questions yes or no, and I was going to ask him if 765 was the answer, but I think he dodged that bullet.

Next, there's an effort that has been made to reach out to the WECC resource planners so that they can tell us what they want to have modeled and so we can add those pieces together in the hope that we can realize the economies of scale and the benefits of adding a number of different resources together--solar and wind, biomass, et cetera--to justify building long-distance, multi-state transmission lines as opposed to the model we're generally stuck with, where you only build transmission lines within a state because you can get quick approvals within those states. And in a lot of cases you don't realize, necessarily, the best economics or the best economies of scale because you haven't reached out and tied multiple generation resources together and justified building a much higher voltage transmission line with more capacity.

A point to be made here that Doug Larson wanted me to make, and Doug is the Director of the Western Interstate Energy Board and very much the leader of this WREZ effort, is that transmission does not get built without the commitment of utilities. They either have to commit to build it themselves, or they have to make the commitments to people who want to contract for the capacity to go ahead and build it.

And then the other option is that it gets mandated by public policy. And we're seeing emerging evidence of that occurring, certainly in Texas that's been talked about a lot. That's occurring both in California with the REDI process and in Colorado with the SB 100 process. And now we've got this stimulus package, which portends to provide some additional public policy for socializing transmission costs and getting it built out in advance of individual commitments being made.

Renewable developers, particularly wind developers, are very interested in making commitments to get transmission built. I think Transcan is an example with their anchor tenant shippers is the first evidence of that. But having been in that business and gone through an open season, you get commitments, but those commitments have

contingencies, and those contingencies are being able to sell it to a utility. So there's a lot of chicken-and-egg going on, so none of this stuff is a slam dunk.

I guess lastly on the WREZ process, our intent is to provide the tools so that you can evaluate the economies of multi-state transmission lines to collect multiple WREZs and deliver them to one or more load zones. We want to have the ability to do economic comparisons of local versus regional generation, or regional renewable and transmission systems. That's key.

One of the fears that we had in doing this study, or the concerns that has been expressed, is that by doing local transmission and renewables, you've Balkanized the development of regional renewable markets. We don't have those--we don't have an RTO in the West other than California, so we have those kind of challenges.

We want to look at the merits of utility collaboration via higher voltage to get to multiple resources with multiple state lines, and then lastly, we want to look at the merits of super-sizing transmission lines to realize the economies of scale.

In closing here, I want to throw a quick promo slide in here on the Wyoming-Colorado Intertie that has recently had an open season where we subscribed 70% of the capacity to two wind developers, and we have contingent commitments for them to be able to sell it into the Colorado area. It's 180 miles long, it's poised for construction to start in 2011, which makes it ideally suited to the stimulus package involving the Western Area Power Administration.

Western is one of the three partners in the project. It's our Trans-Elect, Wyoming Structure Authority and Western Area Power Administration. And we've always assumed that they didn't have any money to put in the game, but we valued their input because they are the operator of all the transmission lines across this area, and we had a successful partnership with them in California on Path 15. And lo and behold, now they have stimulus package funding potentially available to them, and we think this is perfectly suited for some of that stimulus package money. Just a little scrape off the surface.

And with that, I'll close. Thank you.

David Meyer:

Thank you.

Jon Jipping:

Well, the last speaker on the last panel. I stand between you and a cold adult beverage, I think. Right? So first off, let me thank John for the invitation to come here today. He put this panel together in short order. A credit to you and the folks that helped you out. This was pulled together in short time, and no doubt it's difficult to do with everyone's schedules, and with everything that's going on, but very timely, I think, in terms of what's happening. I really appreciated the comments of the first person that spoke in terms of this is an exciting time in the industry, and we've got some really neat things to talk about.

You know, ITC in Iowa and Minnesota sit on the front lines of the problem that we've been talking about today. Every day, almost, I get some sort of message about the struggle in hooking up wind generators, getting them online so that they can produce and be financially viable. We're running at breakneck speed to try to keep up with these folks, and to the comment made about kind of the stodgy utility folks, wind developers aren't them. They're very fast, they're very fast-moving, and we run pretty fast to keep up with them.

And it's in that light that, really, about a year ago, we took on the task of saying that something's got to be done in the area where we have our ITC Midwest operating company out in Illinois, Iowa, and Minnesota. We can't keep hooking up these generators like this and the system to survive and expect to rebuild it in the time that they need.

So since early 2008, we've been studying how to effectively bring the large amount of wind that we see, also in consideration with the RPS in those states, and just the potential out there. As we talk to wind developers, there's tremendous potential, and I'll mention in a minute about this only really touching on some of that potential.

We've aligned--this project is aligned with the objectives of the Regional Generation Outlook study that we participate with and also the JCSP that Dale talked about. It includes approximately 3,000 miles of 765 kV transmission at a projected cost of about \$10 billion to \$12 billion.

Now, you can see on the map here where really this, it's not too hard to understand the collecting of the wind-rich areas and delivering it to load centers. Pretty basic map when you overlay the high-quality wind areas and looking at where we've laid out this project.

This, I think, has been--.

David Meyer:

Pick up the pace. We've got time problems.

Jon Jipping:

Okay. This has been about the fifth time I think you've seen this slide, so I won't spend too much time on it. 765 and a higher-voltage EHV delivers energy much more efficiently than the lower voltages. One 765 kV facility can carry as much power as six 345 kV lines.

This is an old map--a little bit old now in terms of looking at a conceptual illustration of optimized use of wind resources, considering the transmission availability at the time that this was produced. Clearly, you see the states of North Dakota, South Dakota, those wind-rich areas, not being fully developed, since there's more wind resources there than load, as we talked about in the other panels. Where is the load? Well, yes, it's Chicago, Detroit, Cleveland, points farther east of where the wind-rich areas are.

Let me talk a little bit about the benefits of the project that we've put out there. In addition to talk to moving 12,000 megawatts of renewable energy out of the Upper Midwest, it really does increase electric reliability in that narrowly constrained area in Minnesota and Iowa. We have reduced line losses, we have avoided system congestion, and more importantly, we reduce carbon emissions by up to 34 million metric tons, the equivalent of seven to nine large coal-fired power plants. And largely for us, as I started with, resolves many of the issues we see with the MISO generation interconnection queue for this region.

I know there's a couple EEs in the crowd and we're tight on time, but this slide really illustrates for you the difference in the current band-aid approach looking at different transfer scenarios and the number of facilities, the number of elements that are limiting for various transfer levels. And you see it with Green Power Express, up to 10,000 megawatts is where we see relatively few underlying system upgrades needed. Again, a true nature of an overlay where the power is carried on this system, as opposed to the existing underlying transmission.

The same is true in terms of losses. For those transfer scenarios, we see that the integrated Green Power Express is able to transfer these large blocks of energy we've talked about at much lower losses than the existing system.

This slide here from our modeling with the Brattle Group really shows the reduction in carbon emissions, the real purpose of our discussions around integrating renewables into the grid. We've modeled the project in 2020, and you see the tremendous uptick from reduced carbon emissions going out past 2030.

This slide here is also from our study with the Brattle Group, and it looks at some of the costs. You know, we hear a lot about well, the renewables and certainly PV is very expensive in comparison to the other fuels that can be used. When we put in Green Power Express and we look at the fuel prices in map, what we see is that the high quality, as theorized, higher quality wind becomes competitive with other fuels, and so there is not a need for any kind of offset to encourage those forms of generation to be put online. The simple limiting factor is that there's no transmission to bring them to market.

Why not 345 kV? We've talked about this as well. Simply that it's more of a local fix. It does not have the power-carrying capability of a higher-voltage system and really will not allow us to realize the goal of carrying 10 to 12 gigawatts of renewable energy out of this part of the Upper Midwest. DC, you know, I'm in good company here since we're all thinking about the same thing, good technology. We're seeing the project goal of the first step in as being AC. And as I mentioned, this is moving only 10 to 12 gigawatts of renewable energy out of the area. The capability is much more than that. There's much more wind to harvest, if you will, in that area. And so that would allow for the DC lines that have been talked about in previous panels to come out of this area. We believe we need to start, though, with the AC underlying network.

Just to summarize in the couple of minutes we have left, this really addresses the lack of transmission infrastructure that we need to integrate the large amount of renewable energy that is available in the Upper Midwest. It really supports our national energy vision and the work of the Upper Midwest Transmission Development Initiative. As I said, we're working very hard to connect those renewable resources right now, and as one of the previous panelists said, let's get started creating the grid, because if we don't get started on this soon, in that first one to five years, as Chris mentioned on his panel, we're not going to be realizing the vision of it 10, 15, and 20 years out. David?

David Meyer:

Great. Well, thank you to all of our panelists. And let me come back to the question that I started with--that is, the fundamental design issues here. Obviously, there's been a lot of attention in the discussion so far to what's the proper role of high-voltage, whether 500 or 765, or when to go to DC lines with some of the tradeoffs that are involved there.

There's another question that I think I saw embedded in the discussions here. That is, and I want to ask the panelists, would you agree that an essential, or a defining characteristic of an EHV overlay, then, is that it unloads the lower level lines? And so if you're thinking about what is this thing going to look like or what does it need to look like, what does it have to do in order, how does it have to be shaped, configured, in order to accomplish that role--to unload the lower system as well as move large amounts of power long distances?

Michael Heyeck:

I'd like to start that. The folks that are not supportive of the EHV overlay need to recognize that most of the underlying system was built in a time frame that mostly post-dates World War II. But some of those facilities were actually built in the '20s and '30s. Yes, refurbished, but they're still not what they need to be.

I'll give you the example of South Korea, who had the unfortunate opportunity to rebuild their system after the war. Their lowest voltage is 154 kV, and then they go to 345 and 765. They have three voltages, the lowest being 154 kV. We have at least 15 voltages in the United States, the lowest being 23 kV. Think about all the transformers in between. So if you build the EHV grid overlay, that will allow you the window of opportunity when the capacity is not being used to upgrade lower-voltage facilities and actually retire and reclaim some right-of-way of other lower-voltage facilities. Just think about Route 66, and that's the parallel.

Kiah Harris: I'd have to agree. I don't think that the massive amounts of transfer capacity that we need--you know, we hear numbers from 56 on up gigawatts of wind to get out of the Midwest. You're not going to be able to do that without a massive overlay system. It just won't work to just patch the existing 115, 138s, 230s, 345s, 500s together.

Jerry Vaninetti: I have nothing to add.

Jon Jipping: Yes, I'd just add that in our studies, the planners developed a concept of what they called "the wall." And the wall is where regardless of the amount of upgrades on that underlying system, regardless of the rebuilds and new equipment that's put in, it simply is not capable of transferring the massive amounts of renewable energy that is potentially in the Upper Midwest. So to realize the vision or the criteria, if you will, of substantial amounts of renewable energy, be it a state or potentially a national renewable portfolio standard, the grid as it is today is not capable of transferring that, and another system needs to be planned and developed and implemented.

David Meyer: I have one more question that I want to raise with the panel, and then we'll go to questions from the floor or from the Web. I think it's apparent that when we talk about the EHV overlay, this is a network. This isn't just a collection of individual lines. But I want to ask the panelists to explore a little further, what are the implications here? That is, what are the particular benefits that one can achieve only by thinking at the network level and thinking in terms of network design? I want to be sure that we--I guess what I'm concerned about is that people will kind of nod affirmatively to the notion of, "Yes, the whole is more than the sum of the parts," but then the discussion still goes back to the parts. And I just want to find ways to make sure we do get maximum value out of looking at this thing as a whole rather than just a collection of pieces.

Michael Heyeck: I'll give you a somewhat micro view. When AEP designed its 765 kV system, it didn't design it with an A to B. It designed a seven-state grid that would allow each of the states to compete to site, at that time, 1,300 megawatt pulverized coal units. And that's what we did. We created a vision of what the grid would look like with a network in parallels. Now, when you build Line 1, you have a problem. When you build Line 2, it's better. When you build Line 3, as Dale would say, it's best. And that's what we did. We planned it as a whole with a vision and then attacked it.

Kiah Harris: I think one of the issues that I see extremely difficult to work with is that when we look at these wind resources that are in the Midwest area, absent the MISO just converting to a large balancing authority, we're still dealing with small control areas in these Kansas and Oklahoma areas. And when we're dealing with these control areas, we're talking about control areas that have 300 to maybe 1,000 megawatts of load and generation.

When we start injecting 4,000 megawatts into these systems, it overwhelms them substantially. And so if we don't bring the holistic controls of this highly variable resource that we're talking about with the load in a, as I mentioned, an extremely smart

grid, we can't just string these things together without considering the variability of the resource we're talking about.

Jerry Vaninetti:

The West has been burdened by the absence of an RTO or any RTO-like features. Dale Osborn's talked about the great things that go on in MISO and the joint planning efforts that are done in the RTO areas where you can look at regional opportunities. What we have done in the West via this WREZ process is to take the first steps towards looking at the advantages of, again, multi-state lines and more integrated, higher-volume, higher-voltage system so that renewable economics and transmission economics can flow to customers. That's just the first step.

Part of this WREZ process is, again, this WECC TEPPC process, where they will look at this overlay process. So this is what we can do within the WECC region to do regional coordinator planning, and we're all looking forward to the results of the study that will play out over the next year, and we'll have some things to compare with the things that Dale has put together.

Jon Jipping:

Yes, Dave, I mean, it has to be a network. It's not a transmission line. If there's anything we can learn from the existing system as well and as it has performed in the last 100-some years, it is a network. And the overlay system, whether it's because of the work of the JCSP, those are networks. And take into consideration all of the standards and requirements that are still going to be necessary for that overlay, just like the existing systems today. I believe there was a question earlier about, "Well, how are you going to do this with the existing standards?" Well, it has to be designed to meet those standards today. And that dictates some type of network typology so that it can be done.

How it's built, yes, it's built line by line, but once we get three in, then we'll have a network.

David Meyer:

Okay. Let's go to questions from the audience. We have one.

Jim Cunningham:

My name is Jim Cunningham. I'm a private consultant. And as I listen, I'm not sure this is the panel to ask it of, but David Meyer, is there going to be an integrated national plan, and who's going to take the lead in putting it together, and what's the time frame?

David Meyer:

Here, let me invoke the standard line that all I can give you is my personal opinion as a senior civil servant from, a member of the civil service at DOE. We do have resources in that, that have been given to us in the stimulus legislation to do this work. The Administration, at very high levels, has said, "Yes, this planning effort needs to be done." So I have little doubt that it is going to occur; it will go forward.

The pace is, that's a little harder to predict, particularly because in the East there is no single Eastern Interconnection-wide organization. We do have organizations--an organization--in the West and also a Texas organization. But nonetheless, in the East I sense a very strong supportive interest in doing this work, so I'm very confident that yes, we've got the resources, the talent, we can do this.

And there's a lot--I don't want to kid you. There is a great deal of work to be done. Everyone, the people who have talked about this have said you have to run a lot of scenarios. You have to look at a lot of possibilities. You have to do a lot of networking. This has to be a collaborative exercise that involves a lot of input from a lot of stakeholders. So there's a great deal of work to be done, but I think it's also, there's some urgency about doing this. Yes, Alison?

- Alison Silverstein: Alison Silverstein. Since you all are the design panel, let me ask if you have any specific suggestions or guidelines for how you choose between different EHV technologies in designing this kind of overlay. Is this so situation-specific that you can't do guidelines, or is there some general guidance you all can offer us?
- Michael Heyeck: Alison, there's a, you know, in some areas where the distance between substations might be 50 miles. It may dictate some, one thing, and then with distances of 600 miles may dictate another. But what I would just piggyback on the last answer, please don't take three years. We urgently need this study, and I believe this study can attract learned people. We already have the learned people in the RTOs, such as Dale, to make sure that we come up with one plan, but each of the segments are going to be decided based on normal, let's call it good utility practice.
- Jerry Vaninetti: I would echo those comments. I don't think one size necessarily fits all. I would hate to see the debate about an overlay turn into an argument about what is the best technology, what is the best voltage. I think one of previous panelists talked about there's probably a place for each one of the technologies in different applications. But I'd leave it to the utility stakeholders and the transmission planners who know this stuff the best to decide what the best configurations and the best technologies seem to be.
- Alison Silverstein: Thank you. At some point, the Department is going to hear from the transmission-phobic, who are going to say, "Gee, the downside of building a tighter, bigger transmission system is that it will just increase the size of the interconnection that will collapse in a single big event." How do we answer that?
- Michael Heyeck: And the tighter the interconnection, the faster you can put it back together. Certainly, the smarter the grid, the more you're maybe apt for cyber attacks. I mean, actually, the benefit of a dumb grid is that cyber attacks are usually 60 pounds of dynamite. So it does come with a little edge to it, but I would not talk about the transmission-phobic.
- What we do need is reliability, a grid overlay. And just to piggyback on something Chris said before, I'll bring back the South Korea example. Their T&D losses are 4%. Our T&D losses are, at best, 8%. And there's a reason, and I mentioned one of the reasons. But their load factor is one of the highest in the world. We're about 60%; they're about 72% to 74%. You can create something like that if you have a transparent grid, no constraints--a transparent grid. Imagine what you can do from a demand perspective nationwide.
- Alison Silverstein: Then is your answer, Mike, that the benefits outweigh the increased risk?
- Michael Heyeck: Yes.
- Alison Silverstein: Okay. Thanks, then.
- Michael Heyeck: And just another--.
- Kiah Harris: I'd have to say yes as well.
- Jerry Vaninetti: I would just echo what he said before, is we have the NERC standards, and this grid would be designed as part of those standards. What maybe is underlying your question is that, are those standards good enough? And I would say that I think they are, and this grid would meet those standards.
- Alison Silverstein: Thank you. Third question--.

- David Meyer: I think one question that Alison was alluding to here, and that I'm little surprised that there hasn't been mention of it so far, is what I would call designing in an islanding potential. And so is that something that should be on the menu here for consideration?
- Alison Silverstein: We're getting ready for our next blackout if that's the case.
- Michael Heyeck: Well, if we actually graduate to one of your recommendations, Alison, in the blackout report, and that is the broad use of synchrophasors to be able to detect the issue before it occurs, and then be able to act with some of the smart devices we already have in addition to what we will employ, but the synchrophasors may also act to deliberately island. So we do need synchrophasors.
- Alison Silverstein: Let me--that's a perfect segue to my last question, which as Kiah referred to, we need not just a smart grid, but a Mensa grid. And my third question is, in fact, what are the complementary technologies that we need to operate big-wires systems better, and synchrophasors are one example of that. What are the others that we are going to need to do? In parallel with big wires, what do we need with big Mensa capabilities?
- Kiah Harris: I think if we're talking specifically about renewable resources, especially with concentration on wind, there has to be storage technologies that are out there that are complementary to the wind output. It's very difficult to move generation in a gas-fired, and certainly a steam mode, fast enough to react to the wind. And so we've got to bring the load into the equation in a significant way to balance the high variability of the wind output. And when we talk about reliability risks, if we don't really look at the, specifically the Eastern Interconnect, when we're talking about the wind coming out of the Dakotas and Kansas and Oklahoma, we've got to be operating this grid as a, pretty much a single control area. Because when we Balkanize these small control areas in the West, part of the Eastern Interconnect, it's very difficult for them to regulate with these massive amounts of wind that are being developed.
- Jerry Vaninetti: In follow-up to Kiah's comments, I think in addition to technology associated with transmission, I think generation might be part of the solution. Some of the work that we've done, certainly the work that PacifiCorp has done, is starting to suggest to us that there's a role for gas-fired generation co-located in the wind fields to stabilize the transmission systems.
- Michael Heyeck: I'd just like to, someone asked me what a smart grid means for transmission. Transmission is already smart, but it's locally smart. It's smart in the substations. It feels what's happening in the immediate proximity and acts. If you actually think about smart grid for transmission, it's knowing everything and anything about every component remotely and being able to act on something before it happens. And that is putting all the power of electronics that we talked about today, actually engaging the parallel electronics we already have in a fashion that allows a control center to be able to act in a human fashion and in a closed-loop fashion, where you're able to automate islanding or automate gating some electronics to deal with the inter-area oscillations that we would see.
- Alison Silverstein: Then in that case, is it possible for you all to go in a back room and draw the maps for the big wire without in parallel designing all of the communications and control analytics technologies that are needed to make all the big wires work? Do these have to be designed and installed in parallel?

- Kiah Harris: I'm not so sure it's a matter of making the wires work. I think it's a matter of being able to incorporate the generation onto the wires. You know, the wires pretty well take care of themselves. It's the input and the output problem that's the issue.
- Alison Silverstein: In terms of managing the grid that you build, do you have to design the management and control capabilities simultaneously and implement them--?
- Kiah Harris: Absolutely.
- Alison Silverstein: In parallel with the wires?
- Kiah Harris: Yes.
- Alison Silverstein: Thank you.
- David Meyer: Any other?
- Henry Bartholomew: Just kind of a quick follow-on that kinds of builds on it. It's Henry Bartholomew from EEI. How do you see the overlay grid, both the design planning and the interaction with existing facilities, how do you see the facilities and the planning process for the overlay interplaying with the existing grid and how it's been planned, how it will continue to be planned? And just a mechanical question--will all of the slides be posted on the DOE website?
- Michael Heyeck: I think the planning authorities we already have will probably do very well in not only dealing with the local grids, but also the integration of the EHV overlay into the local grids. So my opinion is, let's let the local planning authorities deal with the local issues, one being short circuit current. You'd have to rebuild some of the areas because of the short circuit current you introduce, for example.
- Kiah Harris: You know, I think when we look at the interconnects, there are some specific locations that are obviously better equipped to handle large injections of power than others. And so I think just in siting these transmission facilities, we're going to be picking the sites that are least impacted by trying to inject these large amounts of power.
- Jerry Vaninetti: I think these are all part of the detailed plan that would be involved. There are clearly, you saw from my slides, some underlying system fixes that are needed when an EHV overlay goes in place, and it has to be all done together, there's no doubt about that.
- David Meyer: We're nearing the end of the allotted time for this panel, but we have the luxury, as the last panel, to declare that the clock has stopped, essentially, and we can continue talking until the clock resumes magically, somehow. What I'm saying is as long as people have questions and want to talk, and as long as our panelists don't have to catch planes right away, we will keep the discussion open.
- I have some questions from the Web listeners. One of them is, "Why has there not been discussion so far of 1100 kV AC?" And I guess one answer is, well, you'd have to build three of them, maybe, two--but other than that?
- Michael Heyeck: Actually, we tested up to 2250 kV in the '70s and '80s at AEP, and I know some others have tested it, too, trying to go to 1500 kV. The Chinese have implemented 1100 kV operating at 1 million volts in January of this year. Some others have already had the design.

The issue, I think the answer, it's not all going to be 765, it's not all going to be HVDC. There may be a segment or two that may require this 1100 kV as well as 800 kV DC or 500 kV. I really think it's going to depend on the segment-by-segment view once the overlay is conceptualized.

Jon Jipping: I think from the standpoint of introducing a new voltage, at least in the United States, from our perspective, 765 is something that we have existing designs on. There's good worldwide experience with it. You know, Mike mentioned the Koreans throughout the 1980s and '90s, having developed significant manufacturing capability. So it's hard enough to get this overlay built. Introducing at 1100 or 1500 would just add an order of magnitude of research and the need to develop the facilities, to get vendors to build the equipment. Much of the equipment, although manufactured overseas, is available today. So again, we can get started building it now.

David Meyer: I have another question here that is, it's not strictly speaking a planning question, but I think it's still an interesting, useful question. That is, the question is, what R&D needs to be done in order to overcome barriers and obstacles to broader use of HVDC? So Mike, do you have--?

Michael Heyeck: Have you got about an hour? First of all, we don't spend enough on R&D. The issue with the United States is we're so fragmented with ownership of the grid that we, but we do have the opportunity to leverage EPRI, the DOE, and some of the other agencies we've been dealing with. But from a R&D perspective, certainly, let's leave the smart grid and efficiency issues aside, I think in R&D the HVDC lines are very efficient, but we need to make the stations to power electronics much more efficient. The FACTS devices themselves, as well.

What we need to also consider is we have three-phase transmission lines. There's really no rhyme or reason why we should triple the phases for a single-phase fault. So there are ways we can develop facilities that actually are almost outage-free. We need to develop facilities that have minimized no-load losses.

The last point I'll make is synchrophasors. The technology's there. It's \$15,000 in each of the stations. Really, the R&D's needed in the last mile to get the situational awareness to the point where I'm predicting the future and being able to act on it. And that's just a few samples of where R&D could help.

Kiah Harris: I think also R&D in the HVDC area, specifically about the ability to increase multi-terminal aspects of HVDC, is very important. You can think about an interstate highway that went 800 miles with no off ramps. I mean, that's essentially what you could wind up with, with DC, so we need to make sure we have multi-terminal capability.

Jerry Vaninetti: Notwithstanding the need for R&D, I don't think the absence of R&D has precluded the development of an overlay. I think it's your basic issues--it's cost allocation, who pays for it, and the need for regional planning. And I think we're having a good discussion about that finally now.

Jon Jipping: Dave, I think we've touched on it, but certainly in the areas that have been brought up in regards to wide area control, use of the data that's coming out of many parts of the transmission system that's already there--how do we make good use of it would be a good targeted area for R&D.

David Meyer: Okay. Let me ask the audience here. Any questions you want to raise here before we--we are going to--do you have a, Lauren, are there additional questions, Web questions?

So any questions from the floor? John? Okay. Well, with that, please--I'd like to give thanks to this panel.

John Schnagl:

A few comments as we wrap this up, I want to thank all the panelists, the moderators, and the guests for some very thought-provoking discussions this afternoon. So join with me in thanking all these folks. I also want to thank Energetics for making this all work and work well. All the electronics here are wonderful.

I have one last thing, just kind of a closing comment to think about as you walk out the door. Over the last several days, I've heard from many who would play a role in the planning, design, siting, permitting, and construction of the regional type of transmission necessary to bring renewable generation to consumers from coast to coast. The states say they can plan regional transmission in five years. Those involved with the NEPA process--the National Environmental Policy Act--say they can evaluate any regional transmission plans in three to four years. Permitting takes one to two years, and construction takes two to three years or more. Based on that sequential time line, it will take 11 to 14 years before we see any regional electric transmission energized. We've heard of some plans here today of ongoing projects, but keep that 11- to 14-year time line kind of in the back of your mind and see if that's an--if we can afford 11 to 14 years, if that's what it's going to take, to integrate the high-quality renewable generation.

Thank you much, and I appreciate you attending this technical conference, and this conference is adjourned. Thank you.