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Rapporteur's Summary*

Session One.
Forming Expectations for Price Formation

The technological transformation of the electricity system presents challenges for market design and price formation. Expanded intermittent resources, whether distributed or centralized, will steadily increase the importance of demand bidding, scarcity pricing, intertemporal price consistency, and overall system flexibility. The recent experience in ERCOT illustrates both the importance and the power of enhanced scarcity pricing with an operating reserve demand curve. Other Regional Transmission Organizations are moving in related directions. What have been the impacts and lessons? What are the next steps in developing more granular representations of scarcity impacts through locational extensions of the operating reserve co-optimization with energy dispatch? How can day-ahead markets accommodate? How will intertemporal products and prices be integrated in future pricing reforms? What are the greatest long-term challenges for price formation, and how does the evolutionary path compare with these objectives?

Moderator.
Good morning. This session is entitled "Forming Expectations for Price Formation." And in particular, in doing so in an ever expanding milieu of renewables and other intermittent resources. I've taken the Moderator's liberty to briefly introduce the magnitude of the potential problem using ERCOT as an example and the effects on price formation, if I'm doing this right. By the end of this year in ERCOT they expect to have over 25,000 megawatts of **land** installed.

Perhaps even more remarkable is the growth of the utilities-scale solar. In just four years it's grown from less than 300 megawatts, now to expect over 3,000 by the end of this year. And all of this space of estolic capacity, ERCOT still has under a 10% reserve margin. I think it went into this last summer with 8%, which led some observers to ask the question, "How can they possibly keep keeping the lights on and the air conditioners humming?" And this is a notorious quote that I picked up from this summer. The answer is scarcity pricing. Which will warm the hearts of some here. A good price formation, or rather, good price formation with scarcity pricing

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and that's how we will do it. And to explain that will be Speaker 1.

Our panel includes a great cross-section of views and experiences, including two of the ISO's that have among the most explosive penetration of intermittent renewables. That's Texas and California. Which also interestingly represents perhaps two of the most diametrically opposed approaches in the country.

In the order of speaking, we've got Speaker 1, who's been the independent market monitor of ERCOT since 2014. And Speaker 1 will explain how Texas has managed to keeping the lights on over the last two, last two summers. And also, will try to explain how we avoided the curse of rolling blackouts which many observers had been forecasting again, for years.

From Cal ISO, we have Speaker 2. He's Vice President of Market Quality in California, Regulatory at the ISO. Speaker 2 will lay out how California is dealing with the challenges that are posed by intermittent resources as it relates to price formation and resource mix.

Next will be Speaker 3, who is a Senior Advisor RAP, Regulatory Assistance Project, where he works on issues that are related to power market design. Speaker 3 will explain how some of the foreign power markets, other than ERCOT, are dealing with the issue of price formation in the face of intermittent resources and other challenges.

And then finally, but not least, is Speaker 4, who finally got a job in the private sector. [LAUGHTER] Speaker 4 is Vice President of Regulatory Affairs at NRG, which operates both resources and serves retail customers in many of the organized markets including ERCOT, Cal ISO, and the New England ISO. He'll give us his perspective on how various RTO's and ISO's are dealing with this issue and as a market participant in what is working and what is less successful and useful. And with that…

Speaker 1.
Good morning. I serve as the Director of the Independent Market Monitoring Unit for ERCOT. We talk about price and price formation in ERCOT. One of the key drivers and one of the parts of our price formation that have two sponsors and owners of this idea. The ERCOT's ORDC.

Now, what ERCOT calls ORDC, Operating Reserve Demand Curve, is an adder. It is a price adder that comes into play and is part of the real-time price. That price adder, the magnitude of which is determined and reflective of the value of declining or liability as reserves shrink. So, as it's basically at a function that is defined and then the picture up here is a depiction of the range of that function. As reserves drop, the adder increases and can increase all the way up to our value of loss load, which is deemed to be $9,000.

This was implemented in 2014. This was an idea brought to ERCOT market by Doctors Hogan and Hope as part of some marketing design work that was happening at the commission under the leadership of then-Commissioners Anderson and Nelson and was implemented as a quick and easier way to get to the effects of real-time co-optimization. This picture that I'm showing reflects the mechanics of the curve. There were 24 separate curves for time periods and months.

That mechanism was simplified earlier this year and now have a single curve that applies all year and the determination of the curved part of the curve was shifted somewhat. Increased, if you will. That as second shift is slated to be implemented March 2020. So that's a little bit of what it is. Overlay that with, as the Moderator mentioned, we entered this summer with very low

installed reserved margins. The lowest certainly that I've ever been aware of.

Why do we get worried about very low installed reserved margins? It's those installed reserves that provide us some sort of certainty or guarantee, or expectation that will have sufficient operating reserves in real time. And as those installed reserves shrink, the likelihood of having insufficient operating reserves increases and we get nervous about being able to maintain that and serve all of our load. ERCOT is a growing region and that continued, which is unique in some respects across North America. We continue to have significant load growth and that in and of itself then leads to shrinking installed reserves, coupled with some significant retirements that we've seen over the last few years has led to the tightness, if you will.

This summer we had record peak demand. I'm calling it the five days of August. We had a record peak demand on Monday, August 12th. We had what we would consider high prices that afternoon. The next day and on Thursday, Tuesday and Thursday we entered emergency operations. ERCOT entered emergency operations appropriately so during the duration of those operations we had prices at $9,000. That's what is expected under those situations. On the slide I show the duration of those times. In the periods, there are 15-minute periods. So, it's an hour to two hours of $9,000 pricing on each of those two days.

One of the other services that we'll talk about, this emergency response service is a demand-side product that also is deployed during EEA conditions and has a role in our price formation that I'll touch on here in a minute. You all are good enough, I'm going to fast forward to the end here. I'm showing a set of curves for the week of August 16th. I've condensed it down to just basically the afternoon hours. And if we look at just the dark blue lines, those are the load. That's utility load. And you see those dark blue lines, the highest one was that Monday. That was our new record peak demand. But the Tuesday and Thursday that little purple indicates price.

So, yes we had some high prices on that Monday, but our $9,000 pricing was on Tuesday and Thursday, and was not tied to the highest load. If you look at that green line, that green line reflects what we're calling net load which is customer demand minus wind generation, minus solar generation. And I see a pretty good correlation to those very high prices at the time of highest net load. So that's a changing dynamic and one that I know California's dealing with and our patterns are different and that leads to some challenges. I think California has bigger challenges than Texas in some respects. But that's the thumbnail sketch of what that week in August looked like from a pricing outcome and load outcomes.

I mentioned our ORDC adder. Our real-time prices have a component, a second adder component we call the reliability deployment price adder. So when ERCOT takes various reliability actions, their supplemental RUC commitments that tend to have a price suppressing outcome. ERCOT runs a pricing run calculating the impact of that action. Well, one of the reliability actions that was of note this week was the use of our Emergency Response Service, that ERS service. And so, that deployment is priced out. The price effect of that is determined and then added back in. I'll get into a little bit more detail here in a minute.

What you're looking at on this slide, and all I want you to take away is that you see three different colors. And the green is a noticeable color on Tuesday and Thursday. That's the point that I want you to get from this picture. That green reflects the contribution from that reliability deployment adder. The red is the

contribution from the ORDC adder, and the blue is just of wind. If we zoom in a little more closely on the Thursday afternoon, you see across that afternoon from noon to 6 p.m. basically, you see the large component, the large contribution not really from the ORDC adder, that's the red. It's the reliability adder in green. It's the pricing in notes the calculation of that price effect of deploying that ERS service that had significant impact to our price coordination that afternoon.

Just some summary. My introduction to this slide is, the older I get, the longer back in history I like to look and put things in context. What is this? About 18 year's history of annual energy prices and gas prices in ERCOT. The far right column is the energy price for eight months, the first eight months of this year. And you can see, we had the highest average energy price eight months higher. The last highest was the very extreme year we had in 2011. So significant contribution.

Here are a couple pictures of the contribution of each of these components to overall price's compared 2019 versus 2018. We start with the top left chart. On a monthly basis we're looking at prices. In 2018 we had some contribution from the ORDC adder, and then contrast and similar contributions if you will, for the months of June and July of 2019. It was only in August that you see the large contributions from ORDC and the liability deployment adder. The bottom right chart shows an eight-month summary of all of that and putting it in context.

So you see the system Lambdas last year to this year are about the same. That's of note because gas prices are probably 15% lower this year, so there is some net margin on the built-in, if you will, to the LMP price. But appropriately so and not surprisingly, with lower installed reserves we're getting a much larger contribution from the ORDC adder. Because of the shift I mentioned that went into play earlier this year, in March, the frequency of the adder being non-zero increased. So, what we're looking at here are three years of monthly counts of wind. ORDC adder was greater than zero. And at some point that's just rounding. It's greater than 0.0. Like I said the new mechanism went into place in March. And you see kind of a significant increase in the number hours in which it was non-zero. [LAUGHTER]

There's a lot of words on this slide because this slide was used for something else, but basically what this is saying is we did a calculation of what we thought the impact of the changes were to price. We had one kind of ORDC mechanism that was implemented in 2014 that was shifted earlier this year. What was the effect of that shift? And basically the effect of that shift is laid out here on a monthly basis. If I pick up on the August price, the shift to ORDC had the effect of increasing price somewhere in that $26-$32 a megawatt hour range. Again, over six months, because it went into effect in March, over a six month basis. That's a $78 or 12-14% effect on overall prices. We had done some simulations of what some changes might be and I'm happy to say that these are right in line with some of the simulation work that we had performed.

I stole these slides from ERCOT and they're attributed. They have their logo on them. One of the key aspects in how does all of this work and certainly from my belief, as prices rise if consumers now have a chance to select when they want to pay those prices. And wouldn't that be nice if we really had a real market where demand expressed their willingness to pay and supply their desire to be paid, and we actually intersected.

The first step to that is the ability for demand to actually take actions and avoid these high prices. These are ERCOTs very initial estimates of how much demand-side reduction they saw across this

week in August. And you can see maybe 3100 megawatts on that Tuesday, the actual peak day on Monday was about 2500 megawatts. Weather was different on Wednesday. Lower, much lower demand-side reductions were expected.

This is another ERCOT slide that talks a little bit about that ERS deployment. And there's a lot of lines on this chart. The key ones to look at are the bright green at the top, which is baseline load, if you will. Their estimate, ERCOTs estimate of that baseline load. The aqua blue right below that shows what load actually did during those periods of time. And when I say baseline load, these are the total consumption for the specific customers that are part of this ERS program. And so you can see that those vertical dash lines then indicate where they were specifically deployed and when they were recalled.

And of note is the significant level of pre-deployment if you will, of folks providing this ERS program, or see the ERS product. And that's OK. That is allowed and some would say enabled as part of this program. But the aspect of our pricing outcome has to do with the assumptions that were made about how long those ERS loads were not consuming. You can see from this chart they were deployed for less than an hour.

But our assumptions built into the pricing run are that we would assume that it takes them 10 hours to recall and so that's why you saw such a significant and lengthy, high contribution from that reliability deployment adder. I would describe that as an inaccurate reflection of that behavior and overstates the impact of that. I would imagine that we'll see some changes, some alterations to that going forward. So, in terms of do we have it right? In a lot of ways, yes. In this very specific way there's absolutely some room for improvement. So with that I think I've more than used up enough of my time and I'll pause.

Moderator: Are there any clarifying questions?

Question: I'm sorry, because I'm not as familiar with the ERS program. And I think you said that that was really the significant cause of the price spikes even much more than the ORDC. Could you just explain, how is the ERS priced for those of us who don't know?

Speaker 1: So, ERS is a program. Let me back up and say that it's loads that have elected, if they're part of this program they are compensated. There's a bucket of money they get paid ahead of time. And for being paid that bucket of money ahead of time, they are obligated to, in emergency conditions they are the first ones to be offline. Because I can say this in this room, back in the old days you had interruptible rates and that was a way to sort of get some money to particular customers and for that money they agreed they were interruptible. As we move to our wholesale market we lost some of that ability to point to somebody who would go first. And that's what ERS is. Its loads going first.

Questioner: It sounds, I hate to say this, it sounds a little bit like a capacity payment with a strike price that is setting the—

Speaker 1: No. The strike is determined by when we are in emergency conditions.

Questioner: OK.

Speaker 1: Now, it's likely that the price, it's likely the price would be very high and with the pre-deployment, if you will, it's likely that many of those loads chose to get out of the way. And you hit right on some of the issues. So a very good question.

Moderator: Next.

Question: Just to clarify, the reliability adder

happens when ERS is deployed? That's the connection?

Speaker 1: Yes. ERS deployment is one of the conditions in which the reliability adder would be effective.

Questioner: In the 10 hours that you described that some presumption about, if I'm interrupted it takes me 10 hours to get my process back online.

Speaker 1: Yes.

Questioner: That's the justification.

Speaker 1: Yes.

Moderator: Next.

Question: My apologies. Just in terms of determining the reserve margin in ERCOT, how do you account for intermittent resources like wind and solar? What percentage or do you use more effective load carrying capability?

Speaker 1: It's an effective load carrying capability that translate to a percentage. And if I were to tell you the number I would be wrong because it changes and they just issued a CDR that broke out some of that in more detail. It's, yeah, I'm not going to quote it. Others are in the room may have that on the tip of their tongue. I don't have it.

Questioner: Can you give me an approximation at least?

Speaker 1: I think the teens, 14%. Anybody got that off the top of their head?

Moderator: Can anyone answer the question?

Comment: Yes. So there's a kind of historic lookback, and wind in particular is broken now into four areas. At the lowest, wind gets about a 10% capacity factor. For coastal wind it's almost 60%. 54, 56, something like that. And solar, we don't have as much a solar penetration right now so that gets I think close to 100 right now.

Speaker 1: Aren't we up to 100? At one point it was 80ish.

Commenter: But the formula is to look back at the—

Speaker 1: 20 highest?

Commenter: —20 highest hours across peak and see how the resources perform.

Question: I'm just trying desperately to understand this liability adder. So, I actually thought the ERS triggered it, but in answering you said there are other things that may trigger it. And how is that, is there a set price when it's triggered? That's what I'm trying to understand.

Speaker 1: So a more common triggering of the reliability adder would be a reliability in a commitment action. And what that looks like is ERCOT RUCs 100 megawatt unit that has a 50 megawatt minimum run. And so, if we didn't do anything that 50 megawatts of injected capacity and energy would have an effective suppressing price. The process effectively removes that and price is in that contribution.

Moderator: Yes.

Question: Just so other folks have a sense of it, how's the ERS capacity price set?

Speaker 1: It, interestingly, it's a bucket of money that the Commission has basically directed ERCOT to spend $50 million over the course of the year on this kind of product. And so ERCOT goes through a process and it gets

broken down into various categories, but in my glib way of referring to it, it's a $50 million program. Proposals are gathered, or accepted for the different time periods and ERCOT tries to maximize the impact and minimize the amount of money spent.

Questioner: In the simplest terms, ERCOT takes proposals for the least-cost resources that might be willing to deliver during those four different timeframes and chooses the least-cost mix of resource that can maximize the bucket of money?

Speaker 1: Yes.

Moderator: Next.

Question: If this isn't a clarifying question I'll just hold it until later, but I'm wondering early on, looking at the coincident peak charges being the thing that drove response, how does this work with the coincidence peak?

Speaker 1: I'm happy to dive into that, as well. One of the significant demand-side actions we will see is transmission-level customers choosing not to consume on days in which it is likely that the calculation or the determination of their contributions hang for transmission is calculated.

Let me back up and explain that a little bit better. Because of single jurisdiction, all transmission costs in Texas are paid for by all loads. The allocation for that is based on what we call the four CP. The four coincidence peaks, June, July, August and September. So the highest 15-minute interval in each of those four months. So, if I'm a transmission-level customer, certainly that is going to be exposed to transmission-level allocation based on my consumption during each of those periods. I am highly motivated to not be consuming during four CP times. Or times that I think might be for coincident peak times.

And ERCOT historically has seen lots of demand- side action to avoid four CP. Less on an issue like this past year where load and prices were high and it made sense for people to avoid. Certainly in years past, when it was a four CP day and wholesale prices were $50, we'd see 1500, 2000 megawatts of load not being there. And I can't believe that they're avoiding wholesale pricing. They're avoiding the transmission cost allocation. So the four CP and that's why you see that on this chart. That four CP, that four coincident peak allocation is a significant driver for loads. So, thank you for that clarification. It's a big part of this.

Moderator: Did you have a clarifying question?

Question: [NOT SPEAKING INTO MICROPHONE]

Speaker 1: That's a good question. I don't personally don't have tremendous insight. And so, in my glib way of describing it, choosing not to consume versus turning on my diesel gen set or something is sort of equivalent at the wholesale level. I imagine that there are many, many of these customers that have alternative power supply issues, but I don't have personal insight.

Moderator: Any other clarifying questions?

Question: [NOT SPEAKING INTO MICROPHONE]

Speaker 1: Where's the 50 million come from? Where did that value come from? I don't know. Commissioner, where did that come from?

Comment: It was very scientifically [LAUGHTER] arrived at.

Speaker 1: Yeah. And well, interestingly, the ERS program is a very hot button issue in ERCOT. If you're being paid by it, you love it.

Many people hate it just on principle. And it's hard to have a nuanced conversation around it. I tend to have kind of a nuanced approach to this program. I think there is value there. Now would I say there's $50 million of value? I'm not sure I could go that far. There's—

Comment: [NOT SPEAKING INTO MICROPHONE]

Speaker 1: I don't know, 10 billion something. Is that right?

Commenter: It's 50.

Speaker 1: 50 billion. 350 terawatts times, call it 35, yeah. That's about 10 billion. 10 billion. Yeah. Yeah.

Commenter: What is interesting here I think, though, is that they were curtailing themselves well before they were instructed.

Speaker 1: Which is acceptable and under the performance requirements of this program, basically you just have to show that you are off during the period. There's no expectation that you're on beforehand. You just have to be off during that period.

Commenter: They also stayed off at a time when prices were high. So that, what I think is happening is there's a lot of behind-the-meter backup generation and not just on the transmission system. There's a lot on the distribution system, big box stores and that sort of thing.

Moderator: Any other clarifying questions? Let's move on.

Speaker 2.
All right. Thank you for the opportunity for discussion. I know price formation has been a topic for quite a while and I think you'll see from California's perspective what we're doing is partially a product of where we came from and a product of how things are changing in the system. So, I'll just provide some trends in terms of what's happening and then some of the enhancements that we're planning to develop or have developed to improve, if not price formation, value for services associated with the entire capacity and energy products.

So, this is a slide that's intended to illustrate the transformation, what's happening, whereas we're moving from a time when energy prices really captured all the services in capacity and energy. What we're seeing, at least in California, is energy prices decline as the marginal resources shift from being fuel based to renewable resources and then obviously lower natural gas prices.

And as those decline, what we're seeing is still the need for capability and services including flexibility, which we think will increase in value, especially with the amount of variable renewable resources and the increased uncertainty around load and supply. Load partially because of that influx of behind-the-meter supply and the uncertainty around it. But also supply on the grid side being more variable and uncertain. Underlying capacity value and that's really just the tightening of the capacity itself with coal, gas retirements.

In California, and I'll get into this more, as we have a resource adequacy program that obligates and requires certain entities to have sufficient capacity to meet a 15% planning reserve margin every month. And thirdly, the new products, some of the value of the environmental attributes in California, we've got a cap-and-trade program in which case the economic dispatch does incorporate the cost of compliance associated with carbon compliance onto the California air

resource support. Those types of mechanisms in terms of environmental attributes, whether it be reqs or cap and trade, some are developing in other states across the West.

And then, lastly, we've got this bucket of additional services, really kind of reliability services to ensure that one, we can maintain the frequency, have sufficient inertia, spending mass in the system, black-start capability and again, this is a separate kind of value proposition in terms of those services that we think can be decomposed from the single energy price.

This graph is something from our department of market monitoring. For the last several years we've had excess capacity margins and stalled capacity margins probably in the range of 25% capacity margins. And what you're seeing here is that in the energy market the contribution of net revenues from the energy market are only a portion of what is, in this case a hypothetical combustion determines annualized fixed cost. And so, the bottom line is the missing money piece, the energy market as is, is not sufficient to cover the annualized fixed cost.

And in part, that's why you've got a resource adequacy and resource adequacy payments can supplement or meet some of those missing money costs. The red line is what's called our soft offer cap of capacity. In other words, if the load entities do not get sufficient capacity, we have a backstop mechanism that can procure capacity, CPM and that is basically at a $6.31 dollars-per kilowatt month, or about $78 a kilowatt-year mechanism.

Now, some will say, "Well, that becomes kind of a cap to the resource adequacy because why would you contract that above that soft offer cap?" But I think we'll talk about that when we get to Speaker 3, when we see what's actually happening when we see the tightening conditions in terms of capacity.

This kind of speaks to the tightening of conditions. We're coming again off of the situation where we've got excess capacity, but if we look forward now out a few years, several things are happening. One is you've got about 4,000 megawatts of OTC. One through resource capacity that is due for retirement. That's that orange line in the middle and those are gas resources that we'll retire. Second thing is, with the increased amount of solar resources, basically the mid-day peak is now being met in larger amounts by behind-the-meter resources.

So what that looks like then is the peak later is occurring later in the day and as that pushes out that later peak, the contribution or the effective load carrying capability of those solar resources becomes lessened. And what we've seen in the CPUC's resource-adequacy assessment, they do the effective load carrying capability assessment and in the less cycle it was about 34% in September for solar. And that, in one year in the next cycle of how does the effective load capability look for solar, that moved to about 14%.

Just to give you a sense of scale of that we've got about 12,000 megawatts of grid-side solar and another 6,000 megawatts of behind-the-meter solar, and a reduction of about 20 effective load carrying capability is somewhere between probably about three to 4,000 megawatts of loss capability in just one cycle of assessment of that effective load capability. So that's a significant change in one year.

The third component that causes us concern is that prior resource-adequacy assessments assume that our import capability, which is about 11,000 megawatts, would be fully filled up with energy. And what we started experiencing in 2017, 2018, is that when we see the highest load period in

California, and those coincide with high temperatures, high loads across the west. The energy behind that, what is import capacity, doesn't exist. It dries up.

The other thing that we observed is that under the resource adequacy program, you can contract for imports. And only about half of that import capability is actually contracted with capacity or import energy, or capacity to support that. So I think it's a fallacy to assume that you're going to, when you're looking at resource adequacy, fill up that full 11,000 megawatts. So, those three drivers, imports, the effective load carrying capability of solar and then you throw on what was known, it was a known that the OTC's were going to retire, but if you throw it on top of those other moving things, what that then shows is that we start to see this shortfall of capacity start to rise 2020, but more dominantly in 2021.

And that red line is that one- and two-system requirement which includes a 15% plan and reserve margin. That grey in 2021, at the top, is the 5,000 megawatts of uncontracted import capability. The dark orange is the import capability that is contracted. So, the bottom line is that red line riding above the orange line is an indicator that we are short, that we are seeing shortages potentially arise. And the second thing is that it's not happening at traditional peak, gross peak hours. If you look at the gross peak hour, we're probably maybe see shortfalls of about 2,000 megawatts. It's happening two to three hours later when the solar production basically goes to zero, not even the 14% and you still have relatively high loads occurring.

This is operationally when we see those tight conditions arise, prices rise. But the concern here is that if we don't have that energy production capability and we may not be able to meet and serve the load in those hours. And that should translate into both higher prices, but also higher capacity prices and even though we don't have a scarcity energy demand curve to set the price, the prices will rise currently to about $1,000. We have demand response that kicks in at about $950 that will set that price. And then with FERC Order 831 that will eventually move to a $2,000 price cap level. So that's kind of a trend of what's happening and as a result of that capacity values are increasing.

The other side of price formation that usually gets discussed is well, what's your uplift look like? We have three-part bids, minimum loads, startup costs and energy, marginal energy costs incremental to the minimum load, to the extent the marginal prices is not sufficient over a 24-hour period. We do pay bid cost recovery uplifts to recover those unrecovered costs. Generally speaking, this uplift payment has been running about less than 1% of the total market cost which is about $9-10 billion market. But we do see periods of time where that increases.

A couple interesting things here, one is the Q3 there. We see that had some high gas price events in southern California in 2018 that increased the amount of bid cost recovery associated with those startups and minimal load costs. But the other thing that's interesting here is the majority of those uplift costs are occurring in real time, not so much day-ahead. Which is an indicator to me, that there's things that are going on in real time that were not captured in day-ahead, or in the real time. And some of those may be driven by operator actions having two position resources, preposition resources in a ramping range and those costs are incorporated into this cost recovery.

And I say that because I think it leads to some of the solutions that we're looking at and that is, to the extent the operators are taking actions, to address uncertainty or positioning resources. We think those are some of the products that are

missing and what we're trying to value are those products associated with that uncertainty, or the capacity that supports that uncertainty or capacity that supports ramping or positioning.

The rest of these slides are going to go through some of the products that we're trying to develop. I can quickly go through these just to make a point, and then we can get to the rest of the discussion and I can answer any of these in the Q&A.

For the resource adequacy in California, as I said, is responsibility on the load serving entity. You have both enough system capacity to meet 115% planning reserve margin. Local capacity, because a certain amount, about 40% of the capacity is in localized areas where you are transmission constrained and you need those resources to maintain the reliability in those local areas. And the third component that we've advocated for in the capacity resource adequacy is a flexibility.

That ensures that there is a certain portion of the capacity coming to the market is dispatchable and responsive to dispatch instructions. And that flexible capacity is about now, about 13,000 megawatts of three-hour ramp. Our resource adequacy program is a one-year program. So you contract with these one year out and it has monthly granularity. It's a program that is, at least for the jurisdictional entities to the California Public Utility Commission, responsibility on those load serving entities. Those who are not jurisdictional to California Public Utility Commission, it's up to the local regulatory authority and then if there's no program, the ISO is a backstop mechanism, or a default responsibility.

The bottom line is load-serving entities' contract with suppliers. Those suppliers then have the responsibility to offer their supply through bids to the ISO market that we then optimize on a day ahead in real-time basis. That's the resource adequacy program. Flexible ramping, as I indicated, with the amount of variable resources and you all know our duck curve. We talked about it before. We had that three-hour ramp in the evening. That's increasing and will continue to increase and we need that flexible capacity. This is currently a product on that we manage and procure in real time. It provides the stability to get about 1,000-2,000 megawatts of position, rampable speed that can provide upward- and downward-movement capability in real time to cover those planned and uncertain changes that happen from one 15-minute to the next and then within the five-minute.

The effective way we pay this is that to the extent we hold a fast resource back from earning the energy price. That marginal opportunity cost effectively sets the price and we settle all resources providing this flexible capacity at that price. There's some other additional constraints that we're trying to build into the system to recognize things like remedial acts and schemes and generation contingency. These are additional constraints that we will incorporate into the security constrained economics dispatch.

By adding those constraints we can get prices out of the shadow prices of those constraints. GCARM or the generator contingency is one of those mechanisms and it recognizes both remedial active schemes and the potential loss of a resource and it will value the replacement capacity of that generation contingency. I'm not going to go through the details. I don't want to bore you with all those. I saw your slide. [LAUGHTER] Very cute. This is the roller coaster. OK. So, the, I'm going to back up here.

The corrective capacity is actually a more defined 30-minute responsive. This is a post-contingency event. This is where not only you have to survive the outage and not overload anything, but you

have to get back to normal loading within 30 minutes. And this corrective capacity is a recognition of that 30-minute capacity and we are preparing to add additional constraints there to reflect that and compensate for that corrective capacity as well. These are all operational time frame matters. And this point here is that if we're holding back again a 30-minute capacity, we will pay that capacity that is being held back, in case of a contingency, not because the contingency happened, but in preparation for the contingency and it creates this opportunity cost, marginal opportunity cost associated with that corrective capacity.

The one that we are adding, and I think it's more important and I think it's more relevant to this value of this uncertainty, is that we are preparing through our day-ahead market enhancements to look at additional uncertainty products, or imbalanced reserved products that really get at that, what I described earlier as that money that's missing or the bid cost recovery money that's occurring in real time. We think that's driven by largely uncertainty.

Through the day-ahead market enhancement products, we're proposing to, one, integrate our integrated forward market with our residually inter commitment so that we are co-optimizing both the bid in energy clearing, but also this reliability-based amount to cover our forecast. That forecast does not cover uncertainty. So, in addition to that forecast, what we are preparing to do is we know that there's uncertainty around that forecast up and down, and we would basically add an additional product, sort of like our real-time reserve product, flexibility reserve product, but it's basically procured a day ahead to cover that uncertainty that can arise, which can be 2,000-5,000 megawatts of uncertainty between the day ahead and the real time. And that would be additional capacity that we would settle on a marginal basis.

So, there would be upward and downward capacity and that capacity, once procured in the day-ahead, would then have an obligation to make itself available in real time that when it would be re-optimized in the real-time market for the actual conditions and, if that uncertainty's realized, it would be converted to energy. If it's not realized, then that capacity would still be compensated, but it would be available at least to real time.

In summary, we're trying again, I guess the difference is we're not against scarcity pricing and we think we would be continuing to look at scarcity pricing, but what we're viewing is that we need a variety of products and capabilities and we are trying to optimize the market, recognizing those different products that are needed to operate the system in the new transformed market with variable resources. I won't go into this. It's the same thing practically about the uncertainty around the predictive point and what those distributions are.

The last thing I'll say is that, as we do this price formation discussion, probably the place it will start having more relevance is as we consider the extension of the energy and balance market which is a real-time optimized market over a wider footprint across the west, covering about 50% of the western footprint now. We're considering extending that to the day-ahead market. We could then make decisions about day-ahead commitment, optimized flows between areas and, as we take up that topic, one of the topics that we are going to grapple with is, do we need to extend day-ahead concept of things like fast-start pricing?

This would allow a resource that can start in real time. Its minimum load cost to start to set the marginal price. And then the last thing is we will consider again whether we need to enhance

scarcity pricing.

And on the scarcity pricing front, some of the things that we're grappling with is this notion between, what is scarcity and what is market power and market power being exercised? And there's not a clear distinction there, but I'm just telling you that in California that gray area is a point of contention. Some will say well let the prices go. And that is fine. You'll get outcomes like you do in Texas. But on the other hand, if you let those prices go to those high levels and there really is market power being exercised is that then being an abuse against all demands element? It's a challenge to get that straight, but I think that's the discussion that has to happen. All right.

Moderator: Oh, any clarifying questions?

Question: Ancillary services have always been directly allocated to load or to retailers. I think you said that your ramping product is allocated to the causer, which would presumably be a combination of grid-scale solar and behind-the-meter solar. Are you literally charging this to the grid-scale solar?

Speaker 2: Correct. When we get to the flexibility products, unlike the ancillary service products, we're attempting to allocate those to the drivers of that variability.

Questioner: So, are those guys arguing that spinning should be charged to big generators?

Speaker 2: They made that argument.

Questioner: OK.

Moderator: Next question.

Question: Full disclosure, I also consult for California ISO. So this is for both Speaker 1 and Speaker 2. It sounds like they're very different systems in terms of scarcity.

Moderator: Is this a clarifying question or is it a—

Questioner: Pardon me.

Moderator: Is this a clarifying question?

Questioner: This is. I was going to ask Speaker 2 to clarify. Do you think it's just a matter of degree rather than of kind, the difference between what California does in ERCOT and that we have $1,000 and soon to be $2,000 penalty prices that drive, for example, the demand curve for flexible ramping product? And that if we had $9,000 for the big cap then essentially it would be the same as what we see in ERCOT. So is it a difference of kind, or is it really a difference of degree between what happens in California and ERCOT?

Speaker 2: I think it's more than just the difference in degree. I think it's also a difference of design. When you look, in part, where we came from in California, from the crisis and capacity. The need for recognition and need for that capacity and load serving and just having an obligation.

I guess the other thing, and this is maybe getting into the discussion, is about when you have these scarcity prices and you hold those scarcity prices up, when maybe the response has exhausted or the need for that response is exhausted. I think one of the challenges that we have in our observation is that if you do that then you have a challenge of having resources follow dispatch instructions. Because you're sending one signal with the high price, but then you're sending another signal what that marginal price really is and what the system conditions are actually feeling. So that's something that I think as we

consider scarcity pricing is, how do you hold it up and how do you still incentivize correct response to your actual system conditions?

Moderator: More questions.

Question: You mentioned that your resource adequacy has three different categories of capacity. Is that currently mandated, the mix of that or is that something—

Speaker 2: Yeah. That's the design of the resource adequacy program. It's been refined over the years, but I think there's three components of that have been there for at least the last four years.

Question: Two things. One on your last point about this alignment between pricing and system aid. I'll refer you back to a presentation I made at HEPG in Florida about a year and a half, two years ago. Where we spoke about exactly that issue and needing to make sure they don't get separated by very much. The clarifying question I have is, you talk about attempting to price the uncertainty from day-ahead into real time. I want to understand how you're thinking about quantifying that uncertainty. Is it an uncertainty of timing? Is it an uncertainty of volume? Is it both?

Speaker 2: It's basically the uncertainty that we observe between what our forecast looks like day-ahead and what we actually experience in real time. And so, and we can do that either on a load basis, or a net load basis in which is probably more relevant at this point to capture both the load and variable supply uncertainty.

What we can do basically as an hourly basis, when we get down to 15-minute granularity there's two components to it. One is the granularity itself. So if you go from hourly schedules to the day-ahead, to 15-minute schedules, you have a difference just because the granularity difference. But then there's the actual forecast uncertainty difference. That's in addition to that. That's the quantity that we're trying to—

Questioner: So both timing and quantity.

Speaker 2: Timing and quantity. Yeah. Shaping it, if you want to say.

Moderator: Next.

Question: Just as clarification, did that flexibility reserve product that you're developing, that's going to be a biddable product as I understand it?

Speaker 2: Yeah, a good question. So, just to differentiate. The realttime flexibility product today is driven by the energy bid itself. So, it's the marginal opportunity cost. There's not a capacity adder, or component to it. As we're looking forward and looking at designing the imbalanced reserve product, which is that kind of equivalent real-time flex, or day-ahead flexibility product. We are contemplating that there will be an explicit capacity bid on that product.

Questioner: And have you thought about how that would interact with the current flexible capacity market that, as you mentioned, is not biddable?

Speaker 2: We think they're separate, but I think that's still part of the design phase of how they will interact. And there's other components that play into that and that is as you add that capacity component a day ahead, what, if anything do you. I know you're going to hate this. What if anything you need to do in terms of is there also mitigation of that, or does there need to be kind of some kind of recognition that there's a limit to that, or what's the appropriate level? And is it resource-specific or is it based on the technology

that's providing it?

Moderator: All righty.

Question: First of all, are imports for capacity based on a portfolio or a unit basis? And can the imports, since they seem so critical, can they participate in your real-time flexibility program and will they be as a contemplation that they can participate in the day-ahead? If you can give a little color around the imports which seem so critical to the system.

Speaker 2: OK. So the import capacity right now that can be RA can be either portfolio- or resource-specific. This is a topic of discussion. There's been concerns about the ones that are not resource-specific. The portfolio ones, is there really anything backing that capacity? And there's been a recent decision in the CPUC to say, well, if you're not resource-specific or you're not dynamically scheduled, which is effectively backed by a physical resource and you can see it, that capacity will have to be self-scheduled. In other words, schedules become a price taker.

This is a controversial issue. I'm not going to get into the details of that, but that was getting at the concern about strategic bidding of non-resource specific imports. Imports today cannot participate and provide flexible ramping, real time. Except for, correct me if I'm wrong, if they're dynamic because dynamics are five-minute, dispatchable. They can be responsive. But if they're not dynamic imports, no they cannot.

As we look forward we contemplate that we will be able to support a 15-minute dispatchable scheduled import that can be responsive on a 15-minute basis, can provide flexibility in the future. In the day ahead, we're contemplating that, yes, imports can provide flexibility. But again, if they can provide ultimately real time, 15-minute responsiveness. Sorry.

Moderator: All right.

Speaker 3.
OK. Good morning. I'll run through this as quickly as I can because I think we want to get to Speaker 4. I can't compete with Speaker 4 on raw entertainment values. [LAUGHTER]

I'm going to bring a little bit of international perspective to bear. So we know this discussion isn't taking place just inside the U.S. or the U.S. and Canadian markets. Cut right to the chase, the expectations for price formation, this is an analysis that was done for Orsted a couple years ago, the large Danish generator. But other analyses have come to similar sort of conclusions.

I've looked at a forecast of the price duration curve in northern Europe in 2050 with a system with 70% renewables, let's say a little more than half of those would be variable. Intermittent renewables. You look at the black line which is the actual 2015 price duration curve in that market. And they looked at a system where prices are truly marginal cost reflective. Where the surplus capacity is not needed to meet the customer's expectation of liability is actually retired from the market. And where there's an increase in the ability of consumers to respond to market conditions. And of course there's a $C0_2$ price there, this being Europe. There are a number of different lines there, they ran a number of different scenarios. They were trying to make a certain viewpoints with this. The bottom line being though that our expectations should be that wholesale energy prices, if they're formed correctly and if the market is adjust as it should to supply and demand conditions, there's no reason that wholesale energy prices cannot support the stable remunerative environment for investment.

And that's exactly as it should be. And it's not

only possible, it's probably more important than ever because of the role that robust energy pricing can play. In creating a business case for a broad range of alternatives that in some cases almost certainly will not be able to participate in the sort of the productization that approach that some markets are taking and Speaker 2 described some of that.

So with that as my expectation for what we should be targeting in terms of energy price formation, I wanted to take a look at a couple of international cases that might suggest some areas where we're succeeding, some areas where we're not succeeding and actions that are important going forward.

Let's look at the NEM in Australia. And I've skipped over the title slide, but the subtitle is that it's possible to have too little intervention. So, if we look at the NEM market in Australia, it is as some of you know, probably as close to a pure energy-only market as we're likely to see in most places. There's no capacity market, not reserve shortage pricing, no day-ahead market. They do co-optimize energy and reserves. And they allow offers to clear up to the price cap of $14,500 Aussie per megawatt hour. And through a period of quite a bit of churn, in terms of a large amount of entry of new OCGT and renewable, primarily solar investment over the past seven to 10 years, followed by a significant exit of mostly coal fire generation.

The reserve margins on a system basis have held up pretty well. One could argue that the market seems to be delivering what it needs to deliver in terms of capacity investment. But the natives are restless. And there are some issues. The prices are very high. Wholesale prices are very high on an absolute basis and relative to global prices elsewhere. And the politics around that has become very charged. And we'll take a look at what has actually happened in wholesale spot prices, but as you can see and certainly concentrated in that, around the federal election this year, where the electricity market outcomes became a political issue.

So let's look at this from Paul Simshauser at Griffith University. It looks at what's happened in the NEM over the past 20 years. And as you can recall that period where I put up the installed capacity, there was a period of a large amount of entry. You can see the predictable merit order effect. The transient merit order effect as a result of that. Steep declines in spot prices which subsequently drove a large number of exits, mostly coal plants.

Prices have rebounded steeply, as one could argue they should, to more or less reflect the marginal new entrant in the Australian market. And if we overlay domestic natural gas prices in Australia on that chart, you can see a pretty remarkable degree of correlation between the movements at wholesale spot prices, spot electricity prices and the movements in the Australian domestic natural gas prices. Which I suppose shouldn't be surprising. And some will note that that's extremely different from the experience we've had here in the U.S.

That can be attributed largely I think to the fact that Australia has targeted LNG export markets for its gas production rather than using their considerable natural gas resources to stimulate domestic production activity. So the net back effect in terms of Australian domestic gas prices has been fairly dramatic. So, the bottom line is there's an argument to be made that actually the NEM is working reasonably well. I mean it's doing what it should do.

But of course these are difficult things to explain in newspaper headlines. And the political pressure's mounting, as you can see. These are quite high spot prices. Political pressure is

mounting and I think the NEM suffers from what I would say are two fundamental and very closely related problems. The first is a failure to be seen to detect and mitigate market power. And the second and obviously related one is a significant lack of trust, indeed anger at market outcomes. And so the pressure is mounting to do something, which is always a dangerous situation to be in.

Audrey Zibelman, who many of you know, who's the head of the Australian Energy Market Operator, mentioned recently at this event that Ross and I were at in Sydney. That she's not willing or her bosses are not willing anymore to allow the market to continue to guess at it in terms of what's needed, and what the market outcome should be. So there's a perception basically that there's an abdication on the part of the market authorities to exercise some sort of administrative control over how the market is functioning, rightly or wrongly.

Let's look at the UK market, which is maybe the other end of the spectrum. The best of intentions thwarted by intervention. So November 2015, the UK in their GB Market, the Great Britain Market, introduced something that will be very familiar to many of you, very similar to what Speaker 1 described. They refer to it as their "cash out reforms," one part of which was an ORDC-type instrument. It came out in 2015 with a £3,000 per megawatt hour cap that's been gradually raised until November of last year. It was raised to £6,000 per megawatt hour which is pretty darn close to $9,000.

So, a robust mechanism. They've repriced in real time to the extent that the single imbalanced price used less than what would be expected from the demand curve. And some of you will also know that the UK and Europe is a decentralized self-dispatched, self-scheduled market, so they don't have a day-ahead market. So all of this has to happen in the balancing market. So, what they do is they forecast the de-rated reserve margin, noonday ahead and then at eight hours, then four hours, two hours and one hour for real time. And one hour before real time is gate closure. Which is when they lock in the loss of load probability. And that has worked reasonably well. They have seen as they expected to do forward prices in the energy market, the Apex or the Apex Energy Market. Converge as you approach real time towards the expected balancing market price, set the imbalanced price.

The other features were designed to make imbalanced prices more marginal. They reduced the minimum size bid required to set marginal price and they went from a two price imbalance system to a single imbalanced price. It had immediate insignificant impacts. November of 2015 it was introduced and immediately you saw a rise in the incidence of scarcity pricing at relatively modest levels. The orange line is the percentage of settlement periods which prices above £100 a megawatt hour. The black line is the percent of offer volume.

Immediate impact was working as expected, more or less. There were even a very small handful of more extreme incidents of scarcity pricing. A small handful, four or five events. Over the last couple of years we saw scarcity pricing move up more closer to the cap. The problem is that at more less the same time that they introduced the cash out reforms, they also introduced a capacity market. And nothing necessarily wrong with that I suppose, but all of the usual sort of nonsense comes rolling into it as well.

So you start with the usual resource adequacy double standard which in Europe is no different than the U.S. This is the way things work. This is a, this graph, this chart shows the SAIDI, the System Average Interruption Duration Index on the west European system across I think 15

countries unplanned and planned. Unplanned plus planned and unplanned interruptions, and it's per customer per year.

On the right hand side you see a typical European resource adequacy standard, which is expressed in three hours per year loss of load expectation. Applied and practiced, and then converted to the same metric and it's per customer per year, and apply in practice you need to keep in mind that it's very similar to what happens in the U.S. Three hours per year was initially designed to be an average annual loss of load expectation.

But in practice, and if you talk to any European system operator they'll tell you the same thing, that's not the way it's treated. It's treated as an annual maximum, not an annual average. And so if you go through all that and convert it to minutes per customer per year, resource adequacy standard at the end of the day has absolutely no relationship to customers' load experience with the liability. And so that plays into of course the way the gas fuel market is administered and you see the familiar result.

This is dated from National Grid and you see the plant margins rising over the past few years to four times the target required to satisfy the reliability standard and the loss of load expectation declining to effectively zero. Is that a bad thing? Of course it's not a bad thing necessarily, but does it cost a lot of money? Well, you could argue in the grand scheme of things it doesn't cost a lot of money. The money that you spend on it though is almost by definition wasted. It's wasted consumer's money because they get no net value from their respective, from spending it. And so, as a result, all this wonderful work that went into designing the cash out reforms is producing very little in the way of scarcity pricing because scarcity is structurally driven out of a market.

And the costs of doing so are socialized across all consumers in a nontransparent and non-inclusive mechanism in which whole range of potential alternatives that could lower the cost and bring reliability are simply unable to participate and a whole range of innovations that could come into the market will have no business case because they don't have access to those revenues.

So, in conclusion, I guess I would say that I'm not pandering to Bill here, but I would describe the lived experience in several markets, not just in the U.S. but around in different parts of the world, is that the introduction to the administrative reserve shortage pricing is kind of the Goldilocks notion, I think. It goes far enough, or I think the experience has been it can go far enough to address many of the concerns associated with allowing scarcity pricing.

A lot of those concerns really center on market power mitigation and public acceptance. Now, Australia has another issue, which is the business of the net back pricing in the domestic natural gas market. I'm not sure what you do about that. Whether to wrap up production and stop issuing LNG export licenses. But I think the experience in ERCOT is so far, touch wood, instructive in this respect.

Obviously, market power mitigation's not perfect, but the fact that you can actually do it is the key point. Australia, they're constrained because the Australian market relies on market participants exercising market power to express scarcity pricing. And that is a major contributor to the lack of public acceptance around price formation in the Australian market.

And finally, if I think the ERCOT market has demonstrated that economically a rational level, in terms of the value that customers actually place on service interruption, can be achieved by introducing effective shortage pricing without an

out-of-market capacity intervention. But even in places like the U.K., PJM, Speaker 4 is going to talk about PJM, introducing more effective administrative shortage pricing alongside a capacity market, is not necessarily usually problematic as long as the other issues associated with capacity markets can be resolved.

That is primarily the whole issue of the way in which they just structurally drive over capacity and any incentives or any role that the energy market can and should play in shaping investment. In terms of where we need to be headed, Speaker 2 talked a lot about this. If you look at the NEM, as I said earlier, I think it's hard to argue at the moment that the NEM has a capacity problem. What they do have is a services problem, a flexibility or reliability services problem. And you can see the deterioration and system frequency over the past 14 years. And that's symptomatic.

If you look at what happened in the U.K. the night of August, you would draw a similar conclusion that the problem, and again as I put up earlier, there's certainly not a problem with installed capacity in the U.K. And yet on August 9th, a relatively mild day in terms of demand for supply, they ended up shedding about 3% of system load for about 45 minutes. And between, if you look at the Australian example, if you look at the most recent system black event in the Northern Territories in Australia, all of them point to the issue that the problem here is not driving investment and stalled capacity.

The problem is, put simply, system operators, regulators and government ministries not keeping pace with the change in resource mix in terms of specifying and implementing both increases in the supply of existing ancillary services or reliability services, for instance, operating reserve in the U.K. is one of the issues identified there. And also adding new critical services like inertia replacement and very fast frequency reserves.

So the focus really does need to be not on missing money for investment and capacity. I think it's quite clear that an energy market with administrative reserve shortage pricing is perfectly capable of meeting what a customer would expect from reliability. What is missing is the real demand for existing and new ancillary services and the assurance that the demand for those services is going to continue to be a reflective information of energy prices. So, with that I'll conclude and turn it over to the next speaker.

Speaker 4.
Well thank you very much trying to tie all of this together and mainly my remarks will focus on ERCOT and ISO with a couple of divergences otherwise. The slide deck up here, maybe. There we are. You missed the self-title I gave myself which is Regulatory Majordomo. That's how you know you're getting a slide deck that has not been cleared by corporate coms. When I give myself such a deck, the typical safe harbor thing, but please not if you invest in NRG, you're taking a risk based on our projections. If you don't like that you should invest in a regulatory, regulated utility so you can socialize the risk of those projections, but you know, anything I say don't hold it against us, et cetera.

We're big. We're big in Texas. We've got about one sixth of the load that you heard about being served in Texas. And some ERCOT takeaways. First, holy moly, this actually seems to work. After many years of people questioning the ERCOT market model, including NRG itself which was actively advocating for a capacity market for a number of years in ERCOT, I think we can now conclude that we don't feel that way any longer. That prices came through and supply faces really an incredibly strong incentive to be

available when it's most needed.

This is sort of a restatement of some of the data you saw earlier from Speaker 1 that 44% of real-time energy market revenue out of a six-month period became in a single five-day stretch. And I can just tell you having come onboard NRG shortly after that period, it was basically a topic of conversation: How do you make sure all of our plants online, that every single person up and down in the company had? That's the type of incentivization that exists when you have scarcity pricing, is to make extra sure that everything is actually working to capture those revenues.

Similarly, load faces a strong incentive to cover its position through self-supply or some other third-party commercial arrangement. So in Speaker 1's appendix there was a slide that said that 10-20% of the load was unhedged to the real-time price, so exposed to that. That doesn't quite tell the whole story for retailers like ourselves. We allow some of our load in real time to be unhedged, a calculated risk to periodically expose ourselves to the real-time price in certain regards.

So, actually the right number we think, once you consider retail activity, is even lower than that. And that's obviously something that most people, maybe not those in this room, but most, say, state regulators often miss is they hear high volatile prices and they think, "Well, how can consumers possibly manage?" Well, retail consumers are not typically paying those volatile prices. Except some who decided to sign up for a retailer. There's a couple of retailers in Texas that do offer real-time prices. And they link their account to your bank account and they just take money out of your bank account as you continue to use electricity.

It turns out that's pretty costly in the month of August 2019. And those companies lost a lot of customers. They had been growing in their market share, but they lost it. We gained a lot of customers off those types of deals. The regulators got a few calls and they said, "Well, has there been deceptive marketing practices?" That's the thing that's ongoing.

But that market share tends to be relatively low. Most retail customers are hedged from the volatile wholesale prices in Texas and it turns out that customers have a mind of their own. Since the Arizona regulators are out of the room, I don't risk any *ex parte* by saying it's an instructive comparison to look at that versus, say, the Arizona marketplace where APS has been offering this sort of bonanza of product offerings in the form of rate plans to its consumers. It turns out that the rate tool they were using, accidently I think, guides customers towards rate plans that are more lucrative for the regulated utility and not that are for the customer.

So a shopping tool that ends up driving people to essentially making the wrong choices and the Arizona commission had to spend seven hours putting the screws to APS's new CEO just yesterday on this thing. So, very vivid depiction of what happens when you try to simulate choice through a monopoly environment which is always going to be fakery versus Texas where people can actually just fire their retailer and do when their retailer doesn't do a good job.

Looking ahead, what do we see? We do see a lot of retailers trying to tap into more demand and flexibility in the system. 1.2 million customers, mostly this is sort of commercial and retail I'm talking about in the second bullet point or on price responsive products, time of use or demand response. You've seen on the part of retailers a huge uptick in purchases from our company to Google for buying Google Hub, or Nest, because we're interested in giving those products away to our customers and occasionally taping into their demand as another type of hedging product.

That's something you see emerging from the Texas marketplace. And then of course you see the larger, more sophisticated CNI customers making their own decisions about whether to select index pricing. You're also seeing new supply entry in, as the summer was progressing and prices were being revealed to us. We signed 1400 megawatts of solar on 10-year PPAs based on both tradeable forward prices as well as our estimates beyond the point when those trades become relatively liquid.

So you are seeing people willing to sign on the dotted line and I'm speaking from the perspective of a retailer as far as that goes, but from the perspective of generators who might be in the business of building those wind and solar farms, it also means that you will eventually see the emergence of something like a merchant fleet of renewable generators because once that 10-year PPA rolls off, they too will be exposed to the wholesale price. And that's something that's really been missing that I'll talk about in just a little while though.

The fact that so many renewable generators are not in the same lot in life with many conventional generators in terms of being exposed to markets turn. The latest CDR report from Texas shows the big uptick in projected solar and wind. Again, rolling up numbers from ourselves and others. And you know, take a bow you all. The authors of a certain White Paper deserve some credit here. Now this is pandering, Speaker 3. [LAUGHTER] I've got to sing for my supper.

Bill Hogan, Susan Pope did an excellent job making sure these proposals got before regulators. Regulators themselves deserve some credit for letting it ride in spite of the administrations of those of us who would have just pulled the plug on it years ago. And I think when you look at the ERCOT market it really stands as a major accomplishment for those who'd want to see competitive markets survive and thrive, I should say. So thank you Bill. Not so secret admirers of reserve pricing reforms. PJM, I won't say much about this other than to say, it works on many of the same bases. There's a great number of details under dispute. I always love seeing the PJM for immediate release which makes it sound like action is imminent on the proposal that it makes to FERC. We're still waiting for a rule—

Comment: [UNINTELLIGIBLE]

Speaker 4.
Exactly. That's right. But needless to say you've heard from the international marketplaces that have done this even before Texas and now two from domestic markets, an increasing desire to focus on the ORDC as an avenue to price reserve shortfalls. This is just a more granular picture that CDR data, to show the point that we're probably going to have another clutching of pearls summer next year. We think it should perform like it did roughly this coming year, but even if one takes out some certain projections of renewables that are perhaps over optimistic, in our view by 2021 commercial operation dates, reserved margins will see an uptick.

Obviously, in a market like this, a lot depends on when you get things built and whether people go forward or not with building things. So, a few nits to pick with ERCOT. It's mostly sunshine and happiness, but all is not entirely perfect in the kingdom. The first, this is an issue that is controversial that we're working through. Environmental law versus scarcity. So, periodically over the last summer, Texas's state environmental regulator issued notices of enforcement discretion. ERCOT gave a projection of scarcity to the environmental regulator and then the environmental regulator issued this, which basically says it's a blanket, it's

sort of a plenary indulgence of sorts where they're telling thermal units, "Hey, you know, if a pipe goes out on your scrubber and you have to violate MATS for a little while, do it. Just keep the lights on."

And Texas CQ is putatively saying don't worry about these short lived environmental violations because we will not fine you and we will not go to Federal Court to enforce the Clean Air Act. Well the reality is the Clean Air Act is not only enforceable by state regulatory authorities, it's enforceable by private actions. People like the Sierra Club.

It worries us that we're expected to operate our units out of environmental compliance, at a risk not only to us as a corporation, but to our individual plant operators. We can't realistically expect them to do that. It is also the case that this can't be permanent. You can't make the market work if one of the design features is you're consistently violating environmental laws of the United States. I think we can all agree on that.

So, some greater thinking needs to happen in terms of how to get us right with that. Again, not all sunshine and happiness, but mostly. This is, and I don't want to overstate the importance of this. Let's not get a phone call from Houston. Now that I'm corporate, I do have to make that type of thing. So, transmission rate making, you've already heard this alluded to as well that 4CP isn't when the scarcity actually exists on an energy basis. It seems bizarre that you would have loads falling off the system in order to avoid the kind of regulatory rate-making prices of the transmission system. It would be much better if you're going to keep a 4CP type transmission rate-making methodology to tie it to that peak connect load which is more correlated to actual periods of energy scarcity.

This might be the one really nice thing I say about California. I'm sorry. I'll say some more nice things, but California actually just has a load ratio share transmission cost-allocation methodology. And then the transmission system like Texas's, where a lot of transmission investment exists to open up new energy resources where to serve major industrial loads that are in load pockets that are constrained, might actually just make sense and be more fair to have a transmission rate making methodology that's based on load ratio share rather than on some formulation of peak. The CDR projections verses reality.

This is something that every commercial participant needs to look at, whether the CDR projections are going to become true or not. On the one hand, we've seen occasionally that I think in previous rounds of HEPG, this has been called the theory that there's a lot of dumb money out there. And people come and I think that's a Ken Anderson term perhaps. But people come in and make these investments in generation even if they don't end up panning out and that's on them.

We do see, however, as I alluded to in the economic case for new entry in this market, we have relative confidence in the CDR projections which show a relatively robust reserve margin in 2021 and beyond. And then finally we'll need another kind of socialized buildout of electric transmission in a system that has so many incremental entry of renewables on the system. And that's another big question and that's kind of a political one.

I mean, we are talking obviously about a highly competitive market for generation, but Texas's market for transmission, like so many others, remains fundamentally planned and socialized. So it's a great slogan that ERCOT has. Reliability through markets. This is a cup that sits on my desk at work, but actually, ha ha, it's actually the California ISO. This is an artifact that I found thanks to my predecessor, Abe

Silverman, in my desk, literally this used to be from the California ISO's reliability through markets.

So, how to have a discussion with your kids about California energy markets. Well, it helps, I think, to begin with the question that Speaker 1 asked later in her slides, maybe in the appendix, "Did market participants effectively manage their price exposure in relation to ERCOT's summer?" And the beauty of ERCOT is that people who care the most about the answer to that question are market participants. And because they care so much about the answer to that question, state public policy makers—well, there's a lot of meetings, a lot of calls—can afford to either worry less, or understand that their incentives are well aligned with the market participants in ERCOT.

In California, by contrast, government still very clearly owns that question as well as the answer to it. Thus, the extravaganza of different types of capacity that Speaker 2 was talking to you about before. We got the system capacity and the flex capacity, and the local capacity like you wouldn't believe. There's lots of different ways to slice and dice it because California is fundamentally living in that planned model. California doesn't have a full competitive retail market to pass off the business and risk of hedging, too.

I think it's sometimes understated what an essential element retail competition in Texas is in making the Texas wholesale market work the way it does. Second, California has IOUs that because of regulation are largely financially indifferent as to whether they're making good or bad bets on energy supply. That denotes just a pass through for them and those costs are seldom disallowed or challenged, in any way. And then finally to the degree that you have anyone trying to rationalize that market, it tends to be local government-sponsored community choice aggregators that are making bets again with other people's money, not really shareholders, but really with an eye towards beating the IOU price to compare and not really on achieving medium- to long-term hedging practices.

Again, they're trying to, in their startup phase, first be able to start up at a lower price than the IOU they're peeling off from. And then, number two, when they periodically send mailers to their customers notifying them of the price to compare, preventing those customers from opting out back through the IOU. They have a clear desire to keep the price low. They don't necessarily have a strong incentive to effectively hedge, however. Someone else's problem.

So this is a depiction of what the California energy market looks like. I thought about photoshopping Speaker 2's face onto it [LAUGHTER], but I thought this bedraggled-looking hipster was more evocative of the California experience personally. So this is just a coy comment on the complexity of the California marketplaces design at the moment. I, in full disclosure, before I became a market participant, I was on the energy and balance market governing body and each time you thought you understood the design of the California marketplace there was a "But, wait, there's more" moment with some other aspect, some other mechanism to discover about it.

And, you know, life's complicated and resource adequacy, which in some sense isn't even a wholesale market product, it is a wholesale market product really subject in some way to primarily the design of the CPUC with ISO sort of checking the math and tripping it occasionally. But resource adequacy is sort of on the rise in California. And this CAM and CAM-like resources, this is cost allocation mechanism of resources are growing in volume. I mean you can see that there are essentially more capacity contracts executed on a system allocated basis

than there ever have been before in the state of California.

When you do that to resource, they start to be unmoved by energy price signals. I mean this is fundamentally a missing-money type of market design. RA price is also rising in California. So it's risen 61% year on year in just two years. So, it's actually quite good to be a capacity resource in the California market right now. I can tell you they're not public, but just looking at the broker quotes these prices are even higher still. It seems we're in a period of sort of price discover through broker quotes.

And as sort of flex capacity, in addition to the system capacity, comes online, you're probably going to look at a higher and higher RA prices until California's supply projection meet. And if you've already seen the slide in a different form from Speaker 2, those projections are a shortfall for the time being. But this is your brain on RA. Rather than if you kind of seed the field on trying to drive investments through energy prices that reflect scarce intervals, you instead have to make sure that your planned product for the future delivery or capability to deliver energy is well tuned. And there is a lot of fine tuning, as I say, going on in California.

Some of the difficulties. First, parties have different changing views of what RA is and so, Speaker 2 noted this, when you started using the effective load carrying capability methodology, departing from an ascendance methodology to measure the resource of the capacity value contributions of renewables. The bottom fell out essentially of the estimations of capacity that was available to the system. Some other states, however, most other states in the west I should say, continue to use a more simple ascendance methodology to study their calculation of renewable value.

So one of the questions I think for regionalization is when two people are using methodologies that are maybe not fundamentally at odds, but very, very different to ascertain resource adequacy value and different premise of the conversation is that you need this sort of Rube Goldberg machine of resource adequacy to politically achieve a regional market. How are those things going to line up? And it's not clear to me how they necessarily will.

That kind of goes to the third point that even without a regional RTO, or an EDAM, parties still engage in a lot of trade in the western interconnection. You've heard the conversation already about inner imports. But they usually don't calculate RA as a function of the value of resources in relation to the regional interconnection and where it stands in terms of periods of system stress or scarcity. They usually just evaluate themselves as a standalone firm and then try to impute RA against their position.

Again, they're trying to have one foot in one regionally integrated in trading world, while they have one footprint in a more classic sort of vertically integrated construct. We've seen the sort of reemergence you could say of more ad hoc resourced decision-making as people begin in the west to get scared about what's going to happen in a future where capacity looks short. It's California's ridden to the rescue of these once through cooling plants, about 3,000 megawatts. You've heard mention of rules on RA imports. I mean California, just to put a finer point on it, about four non-resource specific RA imports California is essentially requiring energy self-scheduling which will have a dampening effect on energy prices in the ISO.

If that decision is allowed to stand, CCAs and, perhaps unsurprisingly on this low, low price RA from a non-resource specific imports in order to make their price look attractive to, compared with

IUs so I was kind of hoping in fantasy land that you would see the CCAs go to FERC to try to pre-empt the California PUC which would be a delightful spectacle. I don't think we'll see it for political purposes. But they definitely think that the CPUC is invading the kind of design of the wholesale energy market.

And then finally you see a raft of coal plant closures throughout the western United States. When you look at the analysis that undergirds it, it's not clear how capacity is being incorporated into those analyses at all. And then finally you heard from Speaker 2 sort of a focus on more productization rather than a strict focus on energy to try to better define the value of what capacity type resources are in the future.

Finally, a little bit, not a digression, but sort of a, let's end on a cynical note, shall we? What's the point of price formation if you live in a world where 100% of consumer demand is going to be met by clean energy state mandate? And if the implementation policy to get there isn't entry through energy prices shelling on the market, but is instead just a bunch of government-led procurements? Because that's what we're seeing right now in 100% clean energy jurisdictions. You continue to see long-term contracts, multi-decade old contracts that prevent the market from really showing any churn. They're priced substantially above prevailing, or forward wholesale market price expectations. And they're the result of processes that aren't really all that competitive. And they finally have counter parties, state agencies, or incumbent TND utilities that are financially in default.

So one example of what I'm talking about is New Jersey's bonanza of offshore wind. The way this is being purchased is essentially through the development of a revenue requirement for those offshore wind facilities that petition the New Jersey Board of Public Utilities for approval. Basically a wind farm comes to them and says, "Well, we hear your governor wants a lot of wind. This is what my wind farm will cost." And the New Jersey BPU says, "Well, it looks like it's in the ballpark, so we'll pay you this price per megawatt hour, credit to us all of your energy and capacity revenues in the future and we'll create some phony baloney price for an offshore renewable energy credit that makes up the difference."

But it's really just revenue. If it sounds like utility regulation, it's because it is. It's revenue requirement regulation, but it's worse because it has none of the transparency of open books and records that was a hallmark of utility regulation in the past. And I've provided the most amazing screen shot to demonstrate to you exactly what I mean.

This is a photograph on the bottom right of an affidavit that was filed in support of the application to the New Jersey regulator. You'll note, needless to say, all of the numbers are redacted so no one can actually tell what anything costs in this application. But there was one more interesting redaction which was the name of the affiant so, literally, the New Jersey BPU took essentially secret testimony in furtherance of its public policy goals. You know, bring on the spectral evidence. We can go back to draw on the East Coast roots of jurisprudence to make our administrative regulatory decisions. So, no way to run a railroad.

If we do think instead that price formation around clean energy goals is a function of the products that clean energy laws give rise to, which are renewable energy credits or clean energy credits, we can look to our existing practice of how those reqs are priced for some instruction about how price formation is working in that market and it ain't good. I drive my poor kiddo, who's newborn but had to have some dental issues done,

to a place in Hyattsville from my place in D.C., 20-minute drive or thereabouts. And I noticed that there's solar panels on the roof in Maryland at this dentist office. Well, they're getting paid, you can't see it, but $60 per rack for their production, meanwhile I, as a district rate payer, pay more than $400 for racks. Even though solar on the rooftop of Georgetown is going to be abating the same amount of emissions, producing at the same time as rooftop solar on my dentist's office.

So, if this is actually the future of energy supply resources, kind of ad hoc entry through government contracting, price formation ends up being kind of dead letter. And our Chief has endorsed a proposal that we were informed by attendance at HEPG for a forward clean energy market which would essentially use an auction-like process to separately clear a demand in clean energy credits. I'm happy to talk about that more in some other time and context. But it deserves to be said again, that if state RPS's and CS's aren't rationalized, then this nuance of price formation is going to be a footnote in the flood of state-contracting activity.

And finally, just to re-emphasize a major and overlooked component of anything to do with market design, and this really goes to the ERCOT case, is that buyers need to care about cost. And regulated utilities, default suppliers, state entities don't. Or, at least they don't as much as they ought to. Thank you.

Moderator: I think now we take a break. What, 15 minutes, 10 minutes. 10 minutes, so be back here at 11:15. [LAUGHTER]

[BREAK]

Discussion. (Partial)

Question #1: —I observed one that I'm glad Speaker 4 admitted it in his last slide because about halfway through the presentation, I whispered that this is about retail completion work and not about wholesale markets working. And I would submit to you, coming from a private equity, we just put together some slides on this very issue and if you look at ERCOT, I have a fabulous slide that shows the cost of financing in ERCOT versus PJM.

And basically you're looking at in ERCOT a combined cycle coming on. It's about a 12.7%, 7.5% way to cost of capital. In PJM it's 9.7%. And what's really interesting, as I said to my guys, this is dated material. The way to capital that we were using for ERCOT was 2012. Guess what? No gas combined cycle's been financed in ERCOT since then. So, let's take a step back. With all this intermittent penetration, we need gas flexible gas units. I mean also—

Respondent 1: I disagree.

Questioner: Wait, one more. I had the ERCOT interconnection queue, and if you look at it there's about 13,000 megawatts of intermittent that is sort of processed through the real stage of interconnection and there's about 600 megawatts of gas that has processed and a couple thousand that are waiting until the revenues are higher to actually go through. So, I want to say that from a financing perspective, capacity markets actually deliver a cheaper product at the end of the day because if our financing is cheaper we can obviously afford to be more competitive.

I agree there's a problem of oversupply. Nothing like stupid money in PJM. As you all know there's a lot of negative interest rates. That's whose building the next wave of power plants that we're seeing these investments and we all know they're all going to go bankrupt at some point. So anyway, I just wanted to make that

point.

Session Two.
Coherence or Confusion: What is the Environmental Agenda for the Power Sector?

Is the environmental agenda for the power sector clear or confused? Do multiple, often contradictory, directions by multiple advocates representing specific interests produce positive results or just costs? While there are some shared objectives, most notably reduction of greenhouse gas and other emissions, the means of achieving those objectives are hardly consensus matters in the environmental community. Some of the competing, if not conflicting, points-of-view include: Is the responsibility for emission reduction being disproportionately imposed on the power sector, as opposed to reductions to be obtained from other sectors, such as transportation? Beyond simply extracting emission reductions, are sector-specific policy focuses reconcilable with a society-wide focus? Is it better to promote specific zero or low emission technologies than to price carbon appropriately through a tax or cap and trade regime? Should electricity pricing be used to promote specific technologies? Are these two approaches inherently conflicting or can they be reconciled? Are there contradictions between advocates of air quality vs. advocates for land and water quality (e.g. views on siting transmission lines and role of natural gas/fracking)? Which is preferable, when applied to reducing emissions, command and control or market-based approaches?

Moderator.
Good afternoon. This afternoon we are going to have a lively discussion about the role of the environmental advocates in the power sector from several perspectives.

I was an Illinois State Utility Regulator. My background includes working for the private sector, nonprofits and environmental groups, so I come at this with a variety of perspectives. And I just have to acknowledge the backdrop as we're here today. In past years, twice I've been at the UN Climate Conference. This is the second week. They're meeting in Madrid. And I was part of a state delegation organized by the Climate Registry where I was recently the part-time Executive Director. We had 11 states, bipartisan, in Bonn a couple years ago. This year they have eight states. There's also about seven Canadian provinces represented. And next year they expect a lot of governors and premiers to attend.

And while I was with the Climate Registry, we worked a lot with the U.S. Climate Alliance, which sprung up when the president announced he was withdrawing from the Paris Agreement and now has 25 Governors. And if you haven't checked out their website recently, they've increased their staff. They have a lot of initiatives and resources for these states that are involved in that effort.

Our panelists today include a Senior Energy Reporter for *Energywire*, a chair of Environmental Management, an attorney, consultant, educator and clean energy law and policy expert, and a sustainability advocate. So, we're going to start with the first and move down the line.

Speaker 1.
Thanks for this opportunity. I am a reporter for E&E News. We have about 75 reporters and editors, very closely covering climate, energy, the environment. Mostly in Washington, but in nine other cities around the U.S., and Tokyo. And I

gave a lot of thought to what a journalist could say to a group of experts like this. Some of you, I've quoted in the past and so, I'll make a blanket apology right up front for any damages done. They were unintentional.

But I did ask myself what can I say that's of value to a group like this and so, I'll give you a journalist's perspective on it and I got my starting point from a really deeply troubling documentary movie. It's now at the National Gallery of Art in Washington, in the East Wing and it's called *Incoming*. And it's a series of photographs by a photographer named Richard Mosse of refugees. And you can find it, you can get it on YouTube.

Watching this very troubling film was to me a reminder of what the point is about all of this discussion about clean energy. And that is the future that's coming towards all of us, and how in the world with our fractured political processes and imperfect means we can do something about it. So, again, I don't have to tell this group at all about the fact that we're losing ground.

Here is the *Washington Post*'s Kaiser Family Foundation survey of U.S. adults. And we see that three-quarters of the people that they surveyed agree that the climate change is either a crisis or a major problem. So, that looks good, right? There's a majority of the country that sees this as the real issue for what we know it is. We're heading into an election where it's possible that for the first time, climate change could be a central figure in the debate.

Here we see Speaker Pelosi saying, they're going to put out an agenda and see how Congress responds to it and make that an issue. And so, now there's a question whether, at least in the House, is the Republican Party heading toward a tipping point in climate? And so you have the contrast of President Trump's embrace of the opportunity to lampoon the Green New Deal and Minority Leader Kevin McCarthy's recent statement back in October that at least in the House side they've got to start looking at this because, otherwise they may be on the wrong side of history.

And here's the dilemma. We do have serious discussions to have about timelines. Is it 2050, is it 2040, is it 2030? How do you finance it? These are going to be issues. But I think all these are workable and they're not as divided as they were the last time. And so, we'll see. But these are profound, as challenges to confronting policy. And here's the Green New Deal. There. Thank you. Senator Warren. So, she says by 2028 we don't have any more new building that has any carbon footprint. By 2030, we do the same thing on vehicles, on our cars and light duty trucks. By 2035, an electrical generation.

To me, while it's crucial to have aggressive and challenging goals, goals without a discussion of ways and means are at best half-baked. And the problem with the Green New Deal advocates have is that they've got to start talking about how we actually do this. Here's a quote from Jodie Van Horn of the Sierra Club: "We sent people to the moon. We can transition our aging electric grid to run on 100% renewable energy if we put the right policies in place and commit to making that a reality."

Well, that's true in an abstract way. But the challenges of doing it, of course, are right in front of us all the time. Back to the *Post* Kaiser survey. How much have you heard or read about the Green New Deal? A great deal, 7%. A good amount, 15%. So, at this standpoint a quarter of Americans have heard something about the Green New Deal. This next one is interesting. Would you support or oppose the Green New Deal if you heard it would set a goal for 100 percent of U.S. power coming from zero emissions energy within 10 years? 69% said they supported it. Would you oppose or support the Green New Deal if you heard it would increase Federal spending by trillions of dollars? 30% support.

That tells me that the public is a long way from kind of understanding what the scope of the

challenge is. And I think the fact is that we are deeply divided as a country on a red state, blue state basis about the climate issue and the response to it. So, this is a familiar chart. These are the states in green that set a renewable portfolio standards and the gold ones have goals. This was as of January 2012.

Most of these standards were put in place before President Obama's inauguration, which to me was kind of the line of demarcation when climate really became politicized. We ran a chart after the Obama Administration introduced their Clean Power Plan of states that were suing to block the Power Plan, 26 states. And the states that were supporting it, 16 states. When I saw this chart it looked immediately like another one that you'll recognize. The one on the right is of course the 2016 election. And of course we're in a volatile run up to the 2020 election and who knows how that's going to play out. I don't. But some of the polling indicates that it's going to come down to six or seven swing states. And you're still going to have a very large block of, at least in the Senate, opposition to some kind of a broad climate response like a tax on carbon.

Here's another piece from that poll that suggests that the perception of the climate threat has a Republican and Democrat split. The poll asked, "Do you think climate change is a major factor in contributing to these conditions where you live?" In the southwest and California, they asked about droughts and water shortages. 20% of the Republicans and 63% of the Democrats. "Do you think that climate change is a major factor in wildfires?" Less than 20% of Republicans. Almost 60% of Democrats. And in the upper mountain midwest, "Do you think that climate is a major factor in flooding?" 7% of Republicans. Almost 50% of Democrats.

So, here we see this partisan division, even on the understanding of what the problem is. This is a chart that reminds us that 160 mayors have decided to honor the Paris Climate Agreement, despite the fact that President Trump has decided to take the U.S. out of it. That's an example to me of a very widespread interest and concern about climate, but something way, way short of a national consensus to move.

And I included this chart because this to me gets at part of the problem. When the prevailing public attitude is skepticism that a national climate policy is possible, then the groups that are fighting for a single issue, or special interest parts of the solution, become even more entrenched. And so we see a country that's divided over whether to ban or restrict fracking operations. And there we are. Why don't I put that in there I wonder?

So, I think that coming back to a starting point, it's really imperative that people that are concerned about and active on climate, not only talk about aspirational goals, but get real about the challenges of getting there and start to have this conversation with the American people. This is Ernie Moniz. He's coming out with a challenge to the Green New Deal he calls the Green Real Deal. And he focused part of that on the California challenge.

Here's a timeline of what California is trying to do and it's familiar to you, but here you see the 2030 goal of economy wide greenhouse gas emissions, 40% below 1990 levels, and 5,000,000 electric vehicles on the road. I was part of a team at E&E News that drove a series of electric vehicles 8,000 miles around the U.S. in September, October. We started in Houston. We took it into the southeast, up in the midwest. I had a Chevy Bolt and a Kia Niro. I drove from Detroit, Chicago, Davenport, Minneapolis and I came off and I picked it up in Billings, Montana and took it through Montana, down to the Pacific Northwest, and then over to Seattle.

It was at a very good grassroots exposure to what the potential and the interest in battery electric cars is, and how far the infrastructure has to go. I just show these quickly. I don't have time to go into them, but this again is from Moniz's look at

the California challenge. And he divides the issue up into two segments. The things that can be done to really move forward on greenhouse gas productions by 2030 with existing technology. And then, there needs to be a tripling of federal research on advanced technologies that are going to be needed to get from 2030 to 2050, and then a much deeper carbon reduction, much of which, according to Moniz, we just don't know how to do.

Here he's pointing out that something that came up earlier today and that is the ramping challenge that California faces and the fact that they can't get there, in his view, without natural gas. And here he points out that it's not just electricity and electric vehicles. The major challenge is to decarbonize for industry buildings and agriculture. Interestingly, the biggest payoff in the short run on transportation is tougher CAFE standards and that policy now is going in the opposite direction from Washington.

This is an interesting commentary by Wood Mackenzie. Building a 100% renewable energy power grid in the U.S. by 2030 or 2040 would require an investment of $4.5 trillion in new wind and solar power transmission lines and storage. The price tag would cost U.S. households nearly 2,000 per year through 2040, according to the study. How do you make that into a political platform? Then he goes on to say that in areas of the country that have decent wind and solar potential, you can get to 50% renewables without struggle. Above 50% the challenge takes off. The scale of the challenge is unprecedented, requiring an upending of fossil fuel industries and the complete redesign of the power system.

I want to just put a quick note in here about another challenge that's not about climate. It's about the threat of the cyber. And I don't know how many of you tuned into the *Worldwide Threat Assessment* that Daniel Coats gave in January. Just take a second to look at those two assessments and the people that prepare this document say that assessments in here are reviewed and scrubbed very hard. China has the ability to launch cyberattacks that cause localized temporary disruptions such as disruption on a natural gas pipeline for days to weeks in the United States.

Imagine what the loss of the southwest gas supply to California would be, or the loss of gas supply into New England would be in the middle of a polar vortex. Russia has the ability to execute cyberattacks on the United States that cause localized temporary disruptive effects on critical infrastructure. The concern about where cyber is going, it's not just ransomware and attacks that cause an inconvenience for electric power utilities, but attacks that are designed to go in and break things.

So, what can the president do? What could a president do in 2020 to try to focus the American people back on the climate challenge and the need for a more resilient grid? And I just had the idea that what we need here is some way of trying to engage the American people to think more about the problem and the challenge of redesign of the grid. Here was the northeast blackout. Those are the good folks trying to get home from New York. As you know, that led to the Energy Policy Act of 2005, and the idea of national energy strategic orders in which the federal government, at least as Congress meant the act to say, would have the power to overrule state objections and site transmission policies in these corridors when it was required for congestion reasons.

By a three-to-two decision in 2007, the 4th Circuit said no. Do we only have that authority in the event that a state commission doesn't act? If the state commission affirmatively rejects the power align, that's it. I've been thinking about that in the context of a report that the National Renewable Energy Lab produced called the *Seam Study*. And this is just one of several illustrations from it, but the idea is to build a network of high-voltage, direct-current lines that cross the country and connect the interconnections so that we can use time zones and the fact that the sun is still

shining in the southwest when it's getting dark in Chicago to our advantage.

This would be a monumental undertaking. You could run lots of it down federal land. So, you could run parts of it along interstate highway, freeways. The study that NREL did said that it would pay for itself three times over. Maybe this is the kind of large challenge that would engage more of the public to see the connection that they have with doing something about climate change and getting out of the mud that we're stuck in. Thanks.

Moderator: Thanks, Speaker 1. And now Speaker 2.

Speaker 2.
OK. Thank you, and thanks for inviting me to this gorgeous location. Why aren't we soaking up some solar energy out there? But I'm not tempted to cancel class. But there won't be a test. You can relax.

I'm going to talk a little bit about big picture and small picture things, some lessons that I think I've learned over the last 20 years being on the Market Surveillance Committee of the California ISO and for the last 30 years being involved in environmental policy design. First, I'm going to do what Speaker 1 this morning did and what she said was, "The older I get, the further I look back." So, I'm going to give a little history quiz. You can try to answer these questions. Just to prime us a little bit.

Then I have four points and one is that if we want one of the big transitions that Speaker 1 just talked about, by 2050, we're going to have to have a systemic price throughout the economy of carbon. We can't afford to do otherwise. It will be impossible to reach these goals otherwise. Second, we know the technology mandates can promote learning and there are some benefits, but there are an awful lot of costs. And if they get locked in place, we're going to waste a lot of money. And I'll show some numerical simulations I've done for both Europe and the western United States that illustrate what these costs are. Third, what's going on in the states. I serve on the Maryland Climate Change Commission, a mitigation working group and we just went through an exercise of evaluating, and this a big number, of possible policies and individual measures to help Maryland become, if not carbon neutral, at least close to that.

The big point I'm going to make here is that the best thing that Maryland can do, and Maryland recognizes this, get RGGI to more states and to more sectors. And we need that sort of leadership. Finally, I'll give some examples of where the details of policy matter are that we can waste an awful lot of money if we tweak things the wrong way. And I'll show a couple of examples of that.

So, we want to look at the long-term goal of complete carbon neutrality by midcentury, but on the way there let's avoid wasting tons of money. But we need to pay attention to details of policy to do that. OK, so the history quiz. Ella Grasso is running for a first term as governor. What was the major issue in that gubernatorial election? Does anybody? Not yet. That was the year after, so that was the year after the Arab oil embargo. So, it was actually the ugliness all over headlines. Transmission distribution lines. Citing new transmission lines was the environmental issue and arguably the issue period. And the industry saw it that way too.

A lot of things have happened since then. From folks talking about the possibility of global cooling to where we are today. OK. How did Senator Mitchell of Maine propose to solve the acid rain problem when he was talking in the mid-'80s, when he was the Senate Majority Leader. What was his solution? No. He had an acid rain bill and what was in the bill? Hint, he was an attorney. Yes. And, in particular, name the 50 dirtiest power plants and force them all to put on scrubbers? That's the solution. Classic economist solution. Well as we know, in that

decade, EPA did some experiments with, for example, lead trading and that led to George Bush and the Environment Defense Fund, and Congress and the industry getting together and passing Title IV of the 1990 Clean Air Act Amendments.

OK. So, how much more expensive in reality did sulfur trading turn out to be than what was anticipated? Senator Mitchell's Bill was going to cost $10-20 billion per year. What did people think $S0_2$ trading would cost? And what did it actually cost? How much more expensive did it turn out to be? Right. It was about half as expensive as people thought. People thought something in the order of $2-3 billion a year. It was actually $1-2 billion. Because lots of things happened that people didn't expect. Things like the Staggers Act and fuel switching instead of building scrubbers. OK. How many pages was Waxman marketing?

Comment: 1,215. [LAUGHTER]

Speaker 2: I saw 1200, so that's just rounding up. Yep. OK. How many pages was the Title IV program? 1990. So, it was about 15, including lists of all the power plants and the amount of allowances they would get.

Comment: [NOT SPEAKING INTO MICROPHONE]

Spesker 2: Indeed. So, carbon was a heck of a lot more difficult. We were on a roll. We thought look at the success of Title IV. And now we'll do it with carbon. Europe was doing it with the Emissions Trading System and instead it collapsed of its own weight of those 1215 pages. And now here we are today with the states and the cities taking the lead.

I won't give you the answer now, but how many different programs, rules, initiatives did we consider in the Maryland Climate Change Commission and ultimately put into the plan this year? What order of magnitude? So, 10 is a guess. I'll show you later. OK. And what fraction of Maryland's emissions decreases by 2040? We're not heading towards neutrality, but we're hoping to get 60% of the way there. What fraction of those emission reductions are going to be coming from the power sector according to the plan?

Comment: 40.

Speaker 2: We'll see that later, too. OK. So, I'm going to make these four points. I think Speaker 1 put it very well. Previously, we're looking at incremental little programs. We didn't think AB32 was little, but compared to what folks are talking about now, some of you may be disappointed that I'm not going to show Page 3 of the *Sun*. I will not do that. But at any rate, even Boris Johnson wants the UK to be carbon neutral by 2050. But of course he's not going to be in government then.

So, a much bigger challenge, and there's no way that we can get anywhere close to that unless we're a lot more efficient than we are now. Unless we send a signal throughout the entire economy. So, I was sitting at a meeting with environmental regulators, a regulator from New Jersey, assistant commissioner says, "You know what? I think we ought to go after the conductor sizes of transmission distribution lines and have the environmental regulators regulate those, because there's too many losses and that causes carbon emissions to go up."

Imagine doing that in every sector of the economy. Every industry. Everywhere that, for example, power is lost. It's inconceivable that you'd have anything close to rationality. The law of one price. Thank you, Paul. Paul Sotkiewicz is not here, but if for any sort of efficiency, you have to have the marginal costs of emission reductions to be roughly comparable in different sectors. There's no way you'll come within even orders of magnitude if you try to do it by rules in that way. It will be completely, it will be like the Soviet Union, pre-1989.

Right now we're wasting hundreds of millions and we can afford that because we're not being terribly ambitious now. But if we similarly double the cost, or triple the cost compared to where we could be of remission reductions, it will simply collapse of its own weight. There's no way we can do that. And so, here's an article from a rival outlet of Speaker 1's. Just saying that New York state recognizes that they didn't even dare say what the price tag would be of the carbon reductions. But trading might really help. And by the way, it's not just filthy lucrative. So, what if we waste some money? The important thing is the environment. Wasting money means we're wasting the resources that could be used to get even more environmental improvement.

Let's talk a little bit about the complexity of what we're facing at the state. So, this is a breakdown of Maryland's emissions in 2014 and all the various sectors. And there are measures for each of these. So, there are many more than 10. In fact, we considered something of the order of 10 to 2. About 100 or so, in which 50 programs got recommended to get us, and I wish I had a laser pointer, but it would have to be three-headed or something to do it. We have in law targets of 25% reductions by 2020 and 40% in 2030. And there are various packages of things that might be able to get us there.

This is where we wound up with the draft plan. And now you can see that it's the power sector and mainly a handful of coal plants that's going to make the big difference. So, the power sector is going to be reduced emissions by 80% and that's going to provide over two thirds of the emissions reductions, they think, by 2040. So, we have 50 programs of which basically somehow figure out how to shut down the coal plants. That's going to make this big difference. And of course this is a long way from the carbon neutrality that a lot of people would like to see.

Some more comments on that. I strongly feel that the best thing that Maryland can do is to get New Jersey back into the RGGI fold, bring onboard Virginia, which is happening, and Pennsylvania, which has a good chance of happening. And also, start to look at transportation. And to make sure that the price of allowances stays solid rather than undermining the price of emission allowances by for example, requiring the coal plants to shut down. You just do that then that's going to tank the price of allowances and perhaps it's a more expensive way of meeting our goals than otherwise. But there's very little stakeholder interest in that. Maryland Department of Environment got beat up by stakeholders saying, "You're not saying precisely what you're going to do in 2037". I don't think it should be carbon capture. I think it should be something else. And MDE's saying, "We have no idea what the technologies are going to be then in 20 or 30 years."

So, nobody really wants to talk about pricing and extending carbon pricing. And so, I'm reminded of a famous statement by LBJ which, since we're under Chatham House Rules, I can say this and nobody's going to blame me. You may remember what LBJ said about giving talks about the economy that it's like, excuse me, urinating down your leg. It feels hot to you, but not to anybody else. That's basically the way I

Speaker 1: The only requirement you have to be wearing a pair of blue surge pants. [LAUGHTER]

Speaker 2: So, that's sort of the way I felt talking about pricing. But to their credit—

MAN: [NOT SPEAKING INTO MICROPHONE]

Speaker 2: That's right. And I'll never be invited back. OK. So, the excitement is over concrete things that they can do, and that's been pointed out over and over again about legislation. People want to see offshore wind carbons. People want to see power walls in houses and so forth. And then they think we're really making progress.

I just reminded the stakeholders of a lesson of the Committee on Nuclear and Alternative Energy Systems Report, 1978. Back then, what did they say was the most promising renewable energies? Does anybody know? I bet Bill might, maybe not. It's after you left Washington. So, they said they thought that wind had very little promise and it's going to be all geothermal. The answers are going to surprise us. That's the only thing we can count on. And to make sure that we get surprising answers that are good news, cheap things, we need the systemic price. And luckily the state administration sees this, so they're being a leader in trying to expand RGGI.

OK. The inefficiency of present electricity policies where we're paying two bucks to get 25¢ or 50¢ worth of benefits. So, as an example, are 60% RPS. The problem with mainly leaning on the RPS and the CRPS that's driving things in California much more so than the carbon price, is that it really is not successful in shutting down coal capacity elsewhere in the West. Navajo is gone. Coal plants are going away, but it's not because of California's RPS. California's policy of limiting trading renewable energy credits with other states. It's really a local employment policy. We've got these negative midday prices which my snotty-nose kid, living in LA, doesn't see. He sees 30¢ a kilowatt hour, so of course he put 30KW on his roof. Which of course is just going to make this a lot worse. And this 30KW cost twice as much as grid-scale solar.

But I'm not the only one to say that RPS, of course, is an inefficient way to get these goals. There's this article about ERCOT that came out recently. I'll show another example for Europe. And I've just mentioned, and I think this is consistent with Speaker 4's statement this morning. The law of one price, you want a price power consistently up and down in both retail and bulk, so you don't have the recent power forcing consumers to do one thing while the grid scale powers 4¢ and sending people in another direction. Someone mentioned energy storage and distributed energy resources initiative of the California ISO, which is in Stage 4 right now. Stage 4 sounds fatal. Let's put it a different way. So, there is, with good intentions, a desire to have energy storage in the home have access to variations of prices in the bulk power market. But of course what that doesn't, you have to separately meter the battery. What that misses of course is that thermal storage, just precooling your house, is like one-tenth the cost of storage, but there's no incentive to do that under that sort of rate. You have to have not only time-of-day pricing, but responsive pricing. We have a lot of partial measures that help out, maybe help out Elon Musk's stock price, but at any rate, that's going to have to change in the long run.

Let's look at some particular results. This is the western United States. This is a model that we run for the Western Interconnection. And this is an example of the sort of thing that you see, even with an efficient RPS, WECC-wide which we certainly don't have. Where California has its high number, Wyoming has nothing. The cost of carbon reductions are twice what you would get for WECC-wide carbon pricing. This is looking at the year 2034. In terms of operating gas plants instead of coal plants and spurring investments of different sorts. Renewables are a big part of the equation, but not everything. Obviously when you get to 100% you got to have that. But carbon pricing is going to save a lot of money in the near term which could be used for more reductions if you wanted.

Let's look at the Netherlands. And so this is another model that I ran with the Environmental Assessment Agency for the Netherlands asking basically the same question. And what we found out, you're not interested in the details of this thing, but we have 1200 hours per year so we capture variability, storage and so forth. Using the emissions trading system that Europe put in place, if you leaned on that primarily the cost of obtaining 470 million tons per year, the incremental cost would be half of using an RPS. Even an RPS that's sufficient across Europe. And

what happens is that with renewable subsidies you use a lot less gas and you see a lot more coal. And the implicit cost per ton is £30, if you do it the efficient way. It's more than £60 if you do it just with renewables, even in efficient renewable policy.

Third of four points, and I know I need to wrap up so we can go on. As I made this point already, there's no substitute for geographic expansion. I think credible estimates say that, of the emissions reductions in the RGGI region, half of that is leaked out and since has been compensated for by increased capacity factors in Pennsylvania and other miscreants outside of RGGI, who then import in. And that's inevitable with our regional scheme. You can't avoid that. There are partial fixes to this leakage problem, border cost adjustments, so what California tries to do in terms of attributing carbon to imports, what New York state is going to do soon. You might put an allowance price floor on, but if the UK winds up generating access allowances and selling them up wind to Poland, that doesn't help very much. That's oh, oops. That's down wind. And Russia's up wind to Poland. So, that's OK by the Polish.

Here's another tweak, the Maryland Clean Renewable Energy Standard which will give payments also to nukes and to CHP, but it won't lower RGGI admissions. So, you're just shuffling emissions around without lowering cost. You think you're doing something, but you're not accomplishing anything. That's a waste. I don't want to see that happen. So, finally do tales of policy matter? So, req trades are difficult in Europe. They're very difficult in the U.S. and they vastly increase the cost of meeting RPS targets.

So, let's look at this. This shows as we tighten the European RPS, we raise it up to 60 or 65%, what the cost is, if you build it efficiently, the least cost renewables. That's the blue line. The red dot is if you just go with the so called NSE, sustainable transition, which has country-by-country targets. A lot of offshore which is much more expensive. The incremental cost is eight times as high to obtain that target. So, instead of renewable possibly being twice as expensive to achieve a carbon target, it's going to be 16 times. If you allow trading with the green X, if you allow trading between countries, but still assume the same mix as the regulators want, it's only going to be four times as expensive. And finding the least cost way is going to be a lot of onshore wind and a lot of solar in different places than you see elsewhere. So, maybe we can afford spending eight billion a year now versus one billion which is what this shows. But if we're wringing all the carbon out of the economy we can't afford an eight-fold inefficiency.

Final substantive slide, this is our analysis of the west. If the western U.S., North America did things efficiently you'd be that green dot. You'd move from the green dot to the blue dot, charge about nine bucks a ton. That's not a huge decrease. That's 13 million tons, but it's more than you're getting with AB32. With AB32, you're spending a lot more. About 10 times as much, and you're getting fewer emission reductions. The blue is what you get with $20 per ton. The orange is 40 for California price. And the different X's are different rules to try to control this leakage problem. What emissions you deem that imports have. And some rule they make a little bit of difference. They make things a little efficient, a little bit more, a little less cost, a little less emissions. But this is not getting us anywhere close to 100% reductions, or 50% reductions.

Here's an example of a tweak. If you have technology-specific deemed rates, you force, in a sense, electrons to be traced. Under mild carbon restrictions you get a lot of contract shuffling, but at some point you do see some difference. But that's costing you $80 or $150 a ton to get those reductions. Now, I like New York's proposal. New York is going to rebate emissions cost to exporters from New York state. And that actually results in pretty big efficiencies. Essentially it

would double the carbon reductions from AB32, but California's allow that and it kind of sounds bad that you say, "Oh, you're polluting in our state, but you're sending the power out of state? That's OK. You're not going to have to be charged for carbon."

You can imagine that's politically popular, but it turns out, it makes the policies much more efficient. Once we're at 100% renewables it may not matter, but in the transition, spending money and not getting anything for it is really a bad idea. So, my conclusions are you need a systemic price if we're going to have any hope of ringing carbon out of the economy. Technology carve-outs, whether they're for Elon Musk's batteries, or for particular types of renewables, generally increase cost, although you might get learning, if there's technology you might push further along. We need to expand state initiatives at least until we see a change in the federal government. And finally, details in the policies really, really matter. Thank you.

Moderator: Thanks. I've got, I'd like to hold clarifying questions until after everyone's done because we're running a little over. We move on.

Speaker 3: Well, I was going to stand up, (a), because I have to somehow follow the Professor, and (b), because I thoroughly enjoyed the buffet. [LAUGHTER] All right so, hello. I wanted to say thank you so much to the Harvard Electricity Policy Group for having me. Thank all of you for being here.

I know that folks are interested in engaging on this topic and a lot of folks here care as much about the environment and tackling climate change as I do or anyone else who's up here, so. So, I'm a clean energy advocate and I focused a lot in recent years on the issues related to energy justice. And I like to have this slide that has all these logos because I really have had in terms of thinking about what's going on with the environmental movement, what's going on, what can you expect? I was trained as a utility lawyer. My first job outside, after doing above, was at the Environmental Defense Fund. I went to NRDC. I moved to Hawaii for three years. And now that I'm back, I'm with the New York Renews Coalition, which is a coalition of 200 environmental and climate justice organizations.

I figured I would like to at least share my perspective, the advocate's perspective, on some of these issues. And that's basically all I'm promising you today. So, we're talking about what is the environmental agenda for the power sector? What can you guys think of or expect from the advocates? And I thought one way of looking at this because I could leave history to the Professor and I know Speaker 4 will talk also about other initiatives, was just to share some perspective and where I'm going to take us back is, yes, back to around 2010 and 2011.

This, of course we know, we had unified controlled government in Democratic hands, and it looked like a federal cap-and-trade policy was within reach. Now as we know, that didn't happen. It's led to the environment that we have now. So, really, and this was what I was part of at EDF and I think it's fair to characterize what happened is a lot of the energy advocates looked at the regulatory environment and realized we have to pivot away from federal initiatives and take a look at state-by-state advocacy. And when I say pivot, I mean pivot in two ways. Pivot turn, but also turn to the idea of tipping-point strategies.

So, what does a tipping point strategy mean? It really meant regional approaches. Regional approaches to the power sector. So, the idea was can we go into friendly jurisdictions, mostly restructured jurisdictions, advocate for local and regional policies and, hopefully, if we do that we can push that advocacy and push those policies further out throughout the country. That sort of the one idea of sort of a tipping-point strategy. So, what do we have? We had the Clean Power Plan. And, also, tipping point in states also still looking at what can the executive do, obviously.

So, when you look at this list and it's something thatother presenters have talked about, some of these initiatives are carbon-reduction strategies and some of them are not really top-down carbon-reduction strategies. So, we have the Clean Power Plan, which was probably in the robust bucket of what's an actual way to reduce carbon emissions. And, yes, at NRDC we were going state by state to try and enlarge these policies and get more folks to get interested in these regional plans where we thought it could happen. RPS advocacy is something that really took off. Problematic, visionary, yes. But that's something that we could do, not just we could do, but that's something that folks could feel empowered to do on state by state on a municipal level.

Then this is something I know you guys are very familiar with. These regulatory campaigns that were also state-based about grid modernization, renewables integration, evaluation of DER, business model reform. I represented NRDC in the Reforming the Energy Vision proceeding. There was a lot going on in Hawaii in terms of business model reform.

Again, were these efforts carbon reduction plans? Not in their entirety, necessarily. And then I do think there's also some very important regional approaches and some federal advocacy happening in the creases and I will definitely allow Speaker 4 to talk more about that angle. Also, I believe it's fair to say, as has been mentioned here, really the rise of grassroots natural gas advocacy. And again, and we'll talk a little bit more about that, but to me it's not a surprise, right, that those advocates were most powerful in a state like New York, another sort of friendly restructured jurisdiction. And so, we'll talk a bit more about that. But there's sort of these regional breakdowns I think are really important.

So, yes, this is my excuse to show a picture of a rad picture of the Banzai Pipeline on the North shore of Oahu. But it is also my graphic to show really what happened in 2018 was huge in the environmental advocacy world. The wave that reacted to Trump and ushered new folks into power, I think it's very fair to say, completely changed the landscape of environmental advocacy. And I think so much so. And it's not only there are a lot of things about that wave's intergenerational issues in terms of the youth movement. But I think it's fair to say that the agenda has been not appropriated, but if it was sort of a handful of large green environmental groups, many of whom I love closely and dearly and have worked for, were sort of in charge of this agenda. I would say that is no longer the case.

So, what does this mean? Well, any advocate worth their salt is thinking now, if this administration changes what are we going to be able to get out of the executive? So, no matter what side of this coin you're on, anyone with a pulse is thinking about, Is there a post-Trump landscape and how can I influence that? Yes, every candidate in the Democratic field, if they want to go anywhere, and this is amazing what has happened. Since I came back from Hawaii, I've done a little bit of advising on Green New Deal plans: the Inslee campaign, some with new consensus which is the AOC shop. I've met these folks from the Sunrise Movement. What these young advocates are doing is unbelievable and they can't be dismissed.

Every candidate has a robust Green New Deal plan. They've got flaws. We talked about that, so I'm sure we'll talk about it some more. It has had national impact. New York's climate law which New York Renews helped advocate for, has major justice climate and environmental justice provisions, which I really think could not have had steam if not for Green New Deal initiatives. So, we're going to see that.

And another thing that is fascinating, five years ago the idea that we're going to nationalize the power sector in America, I think was a laughable conversation. It's still a slightly terrifying one, but it is alive. It's alive in every Green New Deal

proposal and it's alive in California. Right. So, this is alive. There are a lot of changes. But what can you expect? You can expect this regional advocacy to continue and to expand.

I wanted to respond to this idea of incoherence with an example about gas. Incoherence from the environmental agenda. We all know that natural gas is killing coal. It's crazy to want to end natural gas, if ending coal is your desire. I think there's smart regional advocacy going on, which is my point here. What is happening right now in New York State, the fracktivists in New York state are so powerful, I'm afraid to say "Let's frack" in New York. They are powerful. They have shut down a lot of natural gas activity in New York State. So, when National Grid went to have a very large pipeline approved and was denied, just about the next day they imposed a gas moratorium.

New York state's response from Governor Cuomo was, "We're not having that. We're going to take away your permit and we're going to fine you, what was it? $26 million. You're going to figure out how to do this without getting your pipeline." And that's the way it's going to be. And Con Edison is also put on notice. This happened just a couple of weeks ago. This was in the news and I thought it was really interesting. This was Dominion Energy put out a big RFP for peak capacity in Virginia. S&P came out with the report saying, "You know what? These guys are inflating demand because they want a billion dollars in natural gas peakers." So they withdrew the RFP.

I'm saying that advocates do have their eye on the natural gas sector and it's not a silly thing. Heading towards the end of my presentation, I think something that's really important, there is no monolith in terms of the environment movement. I mean this is just a bunch of logos. It's only a pinch of all the groups that are out there. You've got people who are focused on carbon reduction, people who are focused on waste, land, water, wildlife, oceans. What I think is really important is to think about concepts of energy justice.

I think what you've got since 2018 is not incoherence, but volume. You've got people activated, more people activated who were before and they want to be involved and we need to think about how can our processes be more inclusive to productively engage these voices. And I'm going to cue a video in just one moment. But if you're in this beautiful location then I'm sure you've been on a junket to Hawaii to talk to the regulators. Anyone been out to Hawaii? All right. You don't have to raise your hand, that's all right. I know I was. That's how I ended up moving there.

Hawaii is one of those states where they were very aggressively pursuing utility reform and the first state in the nation to do 100% renewable energy RPS. A lot has gone on, but a lot has gone wrong. And you have, what is happening, I just came back from this, and you'll see me in this clip. But there is a community that is protesting some windfarms that the AES Company is trying to erect. The AES Company also owns the coal company in Hawaii. This I think is a warning as many things in Hawaii are of what happens when you don't have a more inclusive process. So, I'll cue video. It's only one minute.

[VIDEO]

Speaker 3: I can imagine if you would say, "Where is this explosion going to happen in the entire United States?" I think Hawaii would be the last place you would think something like this would happen. I was there. We had a very peaceful and silent attendance of a PUC hearing in Hawaii. In Hawaii, this doesn't happen. This is the PUC, basically the PUC's looking at whether or not they should consider some of the power purchase agreement approval issues. I won't go into it. But the community showed up and rallied at the actual PUC. Nobody wants this in their jurisdiction. So, anyway please, buy my book. I joke. It's an academic book. You don't

have to buy the book, but feel free to contact—

MAN: [NOT SPEAKING INTO MICROPHONE]

Speaker 3: I know. I have gotten I think, $75 for this entire book effort. But anyway, I will stop. Thank you very much and yes, feel free to contact me. Thank you.

Moderator: Next speaker.

Speaker 4.
Thanks very much. I think that you could say on the substance I agree with most of what Speaker 2 said personally. He said we could just end the presentation right now and move on. And I think I speak for some of us in the environmental community who feel the same way. Unfortunately, no one is letting perfection get in the way of something that's somewhere between poor and good, I guess.

In the meantime, I'm the Director of the Sustainable FERC Project at Natural Resources Defense Council. And I think some of you at least know that NRDC and the Sustainable FERC Project is a coalition of, give or take, 30 or so national and regional environmental groups that we started just about 25 years ago, co-extant with the beginning of open access through Order 888, FERC Order 2000 and PURPA, for that matter, implementing some of the PURPA provisions where it became clear that the bulk power system and wholesale power markets both through bilateral and then in organized markets would be in increasingly significant influence on the environmental quality and clean energy drive and progress that our country needs to make.

We were created to provide more input into FERC governance and decision making and RTO governance, I should say, in decision-making and to really illuminate the broader FERC public interest considerations in its decision-making and the review process. But I'm not really here specifically to talk about the FERC project or say what we heard in Panel One. I'm here to talk about more of the broader environmental movement concerns and priorities. And to maybe reflect on some of what we've already heard. I'm going to do it in 12 minutes I think. Is that right? OK.

There was just a little bit of a focus maybe in the first couple of slides on NRDC, because I know a little bit about that and its formation and foundation. And I think how NRDC has changed over the years, from the early '70s at its founding to now, is very informative and I think a major part of it relates to Speaker 3's bottom line about the need for consideration of environmental and energy justice. And maybe we'll just have a little bit of a peek inside how the green groups work.

This is a long slide. I'm sorry, but I thought it was important to put down NRDC's purpose and mission because it reflects the mission statements of a lot of national and local and regional environmental groups. It's very ambitious. But this is what drives most of the advocates around the country. Solving our humanity's most pressing environmental challenges. Restoring the integrity of the elements that sustain us. Stopping the disproportionate burdens born by people of color and others who face social and economic inequities. And making sure everyone has a right to have a voice in decisions that affect their environment. We've iterated on this over the last few years, but this is something that just came out that we raised it a couple of years ago.

Here's something else that I think is also illustrative. When NRDC was formed in the early '70s, the very first clients that NRDC took on was the Hudson River Keepers Association. Or, the Hudson Fisherman Association. It was one of the predecessors to the River Keepers. And NRDC was hired by the Association to fight a Consolidated Edison large, pump-hydro storage plant on Storm King Mountain in New York on the scenic, majestic Hudson River. I don't think this was an environmental justice issue *per se*. I think that it was a different time and it's ironic, of

course, because this was a zero carbon resource that NRDC was opposing, but it was opposing it because of the pristine environmental and other qualities that would have been ruined by carving off the top of the mountain on the left hand side and putting a large pump hydro storage plant there. I can't remember which zone that would be in, in ISO now.

Flash forward to 2018, 2019 where NRDC and a collection, I think about 60 different local and regional primarily local communities and citizens, filed an amicus brief in the DC Circuit, arguing that FERC had not properly considered the environmental and energy justice impacts of the Atlantic coast pipeline compressor station that was being built in middle south Virginia. So, again, just a reflection of the changing perspectives of NRDC and I think this is true for many of the other environmental groups as well, as they've considered energy issues over time.

This has got to be the dullest slide in the presentation of any of us, I'm just going to skip it. Somebody asked, I think it was asked, what our vision is for the future of the power sector. That's, after all, the topic of the panel. And in NRDCs view, and then I think this is true for a lot of the others as well, it's this: it's an energy power system that integrates a lot of the economy, that cuts carbon emissions for the transportation and building sectors. Because those are the two sectors that are most connected to the power grid and system today. Agriculture and aviation obviously are not so much directly connected. And on the wholesale market front, at least in the near term, we have been doing battle around supporting wholesale market policies that facilitate and not frustrate some of these state policies that we just heard about. PJM as being a good example of that and see what the order FERC will come out with soon addresses on that situation.

So the trends, Speaker 3 probably touched on a few of these that we've seen, that I think where we're having more of an alignment between economics and environmental policy. Which is something that's happened over time. Obviously, renewables are less expensive than coal and on par with gas. Why is that that economics have changed? Obviously economies of scale, technologies have made a big difference. And also reflect, I think, the important value of environmental policy as sort of a pinchers on the environmental externalities of fossil emissions. Fossil power.

Rules like the Mercury and Air Toxic Rule, for example, I think helped move out some of the coal in both regulated and restructured states. So, it's really a two-fer and it's a little out of order, but I think when we looked at the Clean Power Plan and more recently when we thought about what FERC's role is in setting carbon policy for the country, I think most groups, most environmental groups would say the responsibility is primarily on the federal government and states acting through their environmental authorities and mandates rather than FERC. Which is primarily an economic regulator to tackle carbon. And of course there's a preemption concern that what FERC might do would impede state action.

And I think there's also general distrust of FERC over any period of time from a lot of the environmental groups. It's one of the reasons the FERC Project exists, to help represent groups inside FERC and inside this primarily economic regulator environment. And we get to actually talk about Beyond Extreme Energy, for example, versus the FERC Project and their approaches to advocacy, which is important. Really an important piece is that utilities, we haven't talked too much about this, but utilities have really stepped up in response to customers, all the way from corporate to residential customers, to make commitments to reduce greenhouse gas emissions.

It's really quite stunning when you look at the whole list. We compiled a lot of the commitments around the country and they're not

enough to get us where we want to go. And I think a lot of the commitments are based on 2005 emission levels. And so you look at between 2005 and 2030, which are the near-term commitments and my assessment is that a lot of these utilities are not going to have a heck of a lot of difficulty meeting the 2030 commitments.

It's really the post-2030 commitments where the challenges really occur. And of course most of those commitments are voluntary and so, green groups are working through state IRPs, Certificate of Need and other regulatory state legislative processes to help bake more of those commitments into law. And I don't have a map to show this, but I think there's probably some, not complete, alignment between the level of those commitments and some of the red/blue state imagery that Speaker 1 showed. I think there's something to be said there for that. I made a note on my slide here that the Green New Deal, I think it caught some of the large green groups a little bit off guard, some of them. But we were, and I speak for the green groups and not just the FERC Project, just amazed as Speaker 3 said how quickly that shifted the conversation among more moderate groups and more middle of the road quote unquote entities, organizations, a lot of companies feeling pressure.

And this is basic politics, right? I mean you got pressure to move the center in a different direction and I think the Green New Deal is a set of principles. There are things in it that I think some of the traditional green groups, the large national groups, had trouble with getting their heads around. But the fact is that it did move the conversation in a different direction. And I think it was probably aligned a little bit with what already was happening on the ground. It does emphasize though, going back to what Speaker 2 said that we do some sort of a national policy to make sense of this.

I worked for seven or eight years at Akin Gump in Washington, D.C. representing clients in hazardous waste regulation. And, believe me, I struggled mightily with managing compliance for companies across a number of different states that they existed. There was a time when I really wanted some uniform federal policy that would make it easier for companies to comply. Now, having said that, I think when it comes to energy now, we're seeing a need for states to take more action because we haven't had any federal action on this for decades, if ever, in a really meaningful way.

And we talk about the Energy Policy Act of 2005. That's coming up on 15 years now and I'm not too optimistic about the next couple of years. So, in wrapping up in the next couple minutes, I want to say number one, that, to Speaker 3's slide about all the organizations involved in the environmental movement, there is agreement, I think across the board, that we are in a climate crisis and I think we have agreement as said with people in general that we are in a climate crisis and we need to act quickly. And that at least in the short term, renewables and energy efficiency and storage are the most promising currently available and expandable resources for decarbonizing the economy.

How we get there is the challenge of our times. We've already talked a little bit about the states and cities acting to reduce carbon emissions on their own. And, I think globally, act locally in play. All politics is local. Whatever you want to say. People want to feel like they're contributing, doing something themselves. Locally, I think this goes to Speaker 2's comments about what's happening in Maryland to some extent. One of the most frustrating pieces and part of my work, just stepping back a second, or narrowing in on the FERC Project, is the challenges around building new transmission. Building large, new regional transmission lines that we believe we need.

Look at what happened to the Clean Line company, which really implemented a business plan around what was in the SEAM study and other studies before that. That was a complete

failure. It's very hard to motivate that in the Midwest and the Great Plains where we need a lot more transmission. Because each state believes largely that they're still their own island. I think they know a robust transmission system coupled with the right markets and everything, really a new conversation about the role of transmissions this morning, market design. But they really play very well together and I think that's also an area which is very challenging and it's also an area where energy and environmental justice come into play.

My first experience I think directly with energy, or environmental justice was when we supported the use of eminent domain in the Plains, I think it was the Plains in Eastern transmission line project. And we got a lot of blowback from local communities and groups in Arkansas and elsewhere about our support for that line. And, of course, eminent domain raises a really sensitive issue because it comes up on the gas pipeline side, as well, where NRDC and others are fighting vigorously on that point.

And just finally, I often hear comments about, "Well why do we need to do so much about the power sector itself? Because the power sector's share of greenhouse gas emissions is declining." My response is usually that that's why we're talking about the broader transportation and vehicle sectors, as well, and building sector. We need to tackle as much as we can and web together with, now I just lost my thought, what I was trying to say. Another objection is, "Well, other nations are worse. China, India. The Paris Accord, why should we put out ourselves and take these commitments?" Well, we need to exercise national leadership. We need to export the right technologies, the right energy resources. LNGs, while less than coal, still emit carbon, still emit carbon and the big problem with LNG is the lifecycle and upstream and down, upstream emissions, the methane releases and leaks that Environmental Defense Fund and others have done a wonderful job in really quantifying more. So, that's a real challenge, and do you want to lock in a lot of those long-term contracts? I think just finally to close for me, what worries me a lot and I think other environmental organizations need to think about it, as well. We already heard a little bit about it maybe from Speaker 1, is what happens in every decade? What happens between 2020 and 2030? The grid's not ready right now in a lot of places. There's thousands and thousands of megawatts of wind and solar projects are just falling off the queue in MISO because there's simply no more transmission and capacity available in the network itself. Forget about the interconnections. What worries me is the distribution system. Is the distribution system really going to be capable?

What do we need to do, to bulk up distribution system to handle all of the electric vehicles we want to plug into it and then send power back to the grid? For these and other reasons I'm on the boards of the Grid Lab Organization, which advises public interest advocates and others on a lot of the engineering and reliability aspects of power systems operation. I also participate very actively in the Environmental Systems Integration Group, which is really a fantastic utility-focused collaborative that helps to tackle some of the questions that worry me. Maybe after the break we can talk a little bit about where nuclear power is with advocates. Maybe a little more on transmission. I think it's probably a good time to wrap up and take a break and see where we want to go from there. So, thank you very much.

Moderator: How long a break? So, 2:45? See everyone back here. Thank you.

[BREAK]

Discussion.

Question #1: I'll start off with a question and then we can have audience members as well. I want each of you to just think about or give your thoughts on what are the kind of short- and long-term impacts of the absence of strong federal

policy on climate and the environment. And, in the meantime, we're seeing a lot of state and local action. We have a patchwork of state and local initiatives.

Respondent #1: Well, just very briefly the Justice Brandeis quote is true, "States are laboratories where they can try things out without hurting too many people." That was his phrase, I think. And I think that's very important. I just don't think that we're terrific as a nation in buying other people's solutions. So, the fact that State A does something, or City A does something and they do it really well, doesn't mean that the commission and State B, or the mayor in State C are going to say, "Well, that works. Let's do it." We're all from Missouri and so, I just wish—

Comment: Show me you're from Missouri.

Respondent 1: Well, that's right. You got to show me. So, I don't know how we get people to pay more attention to successful projects and pilots around the country. I really think that there has to be White House leadership on this whole issue, every aspect of it and find some way to kind of blast through all of the confining scar tissue here and then try to get more Americans to really think about this thing. But it is good to have the experiments. It's just that they don't get picked up.

Questioner: Any additional comments on that?

Respondent 2: Such a depressing topic to think about, how the judiciary's being changed, now the rule's being reversed and when states try to do something like California with its own CAFE or working with Quebec, it's not only being ignored that you have to push back on, sometimes when I'm optimistic I think that this is encouraging localities and states to take more initiative and that will be good and whole. That's in the long run, OK that's a glass half full. We are going to be paying for these four, hopefully just four years, for a long time.

Respondent 3: I'll briefly say, I spoke a bit about the state and regional action. It is terrible and it is terrible that we don't have federal leadership. It's hard to see us addressing this crisis without federal leadership and international cooperation. So, it's disastrous out there. You know, it's disastrous. As much as we try to do good work, we have to do better.

Respondent 4: The Moderator should close her ears when I say this, but I'll never forget about eight or 10 years ago, I was in a meeting with a senior Illinois Commerce Commission staffer who referred to Wisconsin as a foreign state when we referenced some good attributes of the Wisconsin Renewable Energy Standard. And the response was essentially, "Why should we care, Wisconsin's a foreign state?" And it just was an early lesson for me and the challenges of working regionally, applying those lessons.

I think it's something that a lot of organizations in my sector work on every day, trying, writing the reports, educating policy-makers on some of the best practices of other states. Because they are the incubators in a lot of ways, especially I think, just in the very narrow confines of the hierarchy and distribution grid proceedings. That's where we really want to see a lot of the new grid stuff happen. And so, it's not national policy, but it is a little bit of a glass half full piece.

Respondent 3: I will add though, as much as folks like saying in Hawaii, "We don't want to hear what's going on in New York and California," but as soon as a door closes and you have to write the legislation of the policy, "What are they doing now in California and Hawaii?" So, people do need what's going on in other states.

Moderator: OK, I've noted about eight, 10 cards. I'm going to start.

Question #2: Thank you. So, my question relates to the issue of the border adjustment mechanism that Speaker 2 mentioned in the first years of its cap-and-trade program. California decided to

adopt this default emission factor through unspecified sources of power. That seems to have created some perverse incentives, one of them is laundering. And there is some evidence that contract reshuffling may be taking place.

So, in the absence of a WEC-wide cap and trade program, but at the same time at a moment where there's more trading between the California ISO and neighboring balancing authorities in WEC, I was wondering if California's given more thought as to what would be a more effective way of implementing border adjustment mechanism? And if they haven't, what would be, in your view, a more effective way of possibly doing this to mitigate concerns of leakage?

Respondent 1: So, I'm looking at Don Tretheway. Don and, well, the ISO staff and he's looking as if, hoping people won't notice him. But there was a period of a couple of years when CARB had proposed something that Bill quite rightly pointed out was completely nonsensical to try to make things carbon neutral on an hour-by-hour basis. Who cares about hourly CO_2 emissions? And this incredible recalculation of the dispatch, as if California didn't exist. And the ISO quietly dropped this. So, the worst ideas have been quietly dropped.

And now we have this deemed rights, if you don't say where the source is, or if you do say what the source is, our simulations seem to show that some rates are better than others. There's slight improvements in efficiency lower costs. Lower costs to the west as a whole and lower emissions, but it turns out the deem rates that have lower costs for the west as a whole have higher costs in the State of California.

But these are all very marginal things compared to what it is that we need to be doing in the future. We're talking about California's 40 or 50 million tons out of the west, 350 and a handful million of tons. It really doesn't make much of a difference. But so, I don't think there's anything going on now. I think CARB has just quietly moved on to other things. Is that right, Don? And there are indeed bigger fish to fry. I think our eyes are on New York, about their new system, which is different. I have no opinion about whether it's going to be better or worse, but I think that's where experimentation analysis is probably going focus. Anybody, I'm surprised Bill you don't have an issue pay, or something of the HEPG website about your view of New York's water cost adjustment, but. Is there anybody here who's been thinking about that?

Commenter: [UNINTELLIGIBLE]

Respondent 1: Oh great. All right.

Moderator: Next up.

Question #3: [NOT SPEAKING INTO MICROPHONE] —hear your response to the scenario that I see unfolding. We're going to talk more about this tomorrow with offshore wind. My observation with offshore wind which I understand is regional-specific, so I apologize to those in the middle part of the country, is happening in the reverse order, in that we have significant mandates for offshore wind that are not necessarily tied to RPS's. They're not necessarily, they might be in part driven by gold or reduced emissions, but they seem to be managed in a separate way in that the states of Massachusetts and New Jersey, and Maine and New Hampshire, and now Virginia are saying we're going to build X number of gigawatts. I think the total currently stands at 26, that might be, I forget if that includes a New Jersey number. And I'll talk more about that tomorrow of offshore wind.

And the push for that has been driven by both, I think, voices in economic development, jobs, manufacturing and then second, largely the experience in Europe and those companies coming to the U.S. and making the case that it's really good economic development and energy. I don't want to say policy, because there's not necessarily policies around it *per se*. It's that

we're going to construct these facilities and invest this much money, billions and billions of dollars. I'm curious from your perspective, that my observation has been that it's not really driven by environmental advocacy and, in fact, for the most part environmental advocates have been quiet about it. There's a lot of issues around marine and fisheries and things, trying to resolve those. But it almost seems to be the reverse of how other renewables were developed, on shore wind and solar. So, your observations would be appreciated.

Respondent 1: I think there have been environmental issues. In the U.K., at least in England, if not Scotland, and Maryland and other places, it's very difficult or impossible to have shore wind now, just the permitting. I think we've seen the last big project in Maryland so it's the only way that you're going to do it, even though it's twice whatever the cost is per kilowatt hour. I think there's some environmental concern, but it's very definitely when you see restrictions on WEC trading and so forth.

And the way these policies are pitched, it is about economic development. Whether in fact, there are more jobs because now we're going to pay more for power and that takes money out of people's pockets or makes things more difficult for industry to compete. I think that's actually a hard argument to make with a straight face that spending a lot more money on power than you need to is somehow going to create more jobs, enough for the economy. But that is indeed the pitch that, well that's what the Governor O'Malley was trying to ride to the presidency. It didn't quite work out for him too well, but it's definitely economical as the argument. I love the quote, by the way, that was shown earlier with the blacked out names for the advocates. I don't know whether Massachusetts, New Hampshire, Maine are quite as messy with their acquisition processes as New Jersey was.

Questioner: Yeah, I guess I'm just curious, are environment advocates supportive or not supportive? Maybe to put it more in a black and white way.

Respondent 2: Just to answer, I think many of us are supportive of and have been on the record of being supportive of wind. A good early example, I think some environmental organizations are very involved in the BLM lease process around that. And wanting to do it right from the start as much as possible.

There's definitely been some, I don't know, there's been some split, but a number of the large groups I know and local groups, too, are supportive of the development. Especially a lot of the big stuff is happening farther offshore and avoiding some of the immediate visual impacts that kind of can spur people on. Funny. I used to run a video like Speaker 3's, except mine was also an offshore wind. It was at first Cape Wind Project and Jon Stewart, *The Daily Show*, had a really funny clip about it, but it was really the Kennedys' opposition to the Cape Wind project and it was like the elite folks opposing and now it's completely changed. In some cases it's not just the elite opposing these projects, but it's changed. A lot has changed since then I think, so there is some support for it for sure.

Respondent 3: Yeah, I know when I was with NRDC in New York, were very supportive of it and, this kind of goes without saying, but I think some of it is that the sort of the process is so extended and long in terms of getting these things going. And there are some technology hurdles. This is not my on-point area, but I also witnessed when the Bureau of Ocean Management was looking to do offshore wind in Hawaii and, just, it's a long time table of creeping forward.

Respondent 4: If the objective is a decades-long battle to get carbon out of the economy, then some of these projects could have value as kind of loss leaders to prove to people, provided they're done well, that you can do it. That it works. It's like driving your first electric vehicle. If you haven't had that experience, it's a kind of

"gee whiz" moment. "Gee, these things actually go." So, I could see and they go very fast. I could see a value in these things as examples that may change public perspectives, even though they're a very expensive way to get at that.

Respondent 2: It wasn't a great example, perhaps a failure of federal policy, again around transmission, because developers are going out and working on building it themselves, probably inefficient. RTOs have challenges with that. And so we don't have a national transmission policy that addresses a regional network.

Question #4: Thanks. After hearing everything in this presentation and after talking to Ashley I keep coming back to a quote from the late satirist Kurt Vonnegut from *Cat's Cradle* and I'll paraphrase. Given the past 500 years of man destroying the environment, what do we have to hope for? Nothing. Absolutely nothing after hearing these presentations today. Not just cynical. We have it within our power obviously, we know what to do, but we can't seem to get around it. We have Balkanized policies that raise cost. We have reversed beggar thy neighbor policies where, for economic development purposes, we want to keep a few jobs here, charge more to the rest of the rate-payers in one state and cross-subsidize consumption in other states which just leads to more emissions to keep nuclear plants open, or wind being built, et cetera.

And now, we have border adjustments. So, Speaker 2, this is a question for you following up on another question. Let's be careful what we ask for. What about border adjustments to protect those states that are nonbelievers in climate change? From those states, such as the RGGI States in PJM and New England who have a price on CO_2. They want their own border adjustment to be protected from these liberal policies. And doesn't that lead toward more increased Balkanization?

Respondent 1: There is this thing called the Commerce Clause, but I'm not a constitutional attorney, so I don't quite understand what the legality is of present things and why nobody's challenging them. But certainly the legalities thing that you're talking about would be challenging. But this is not in my wheelhouse. Do we have a constitutional lawyer here?

Questioner: No, this is a very real problem. This is actually a serious problem. They're having discussions in PJM currently where some states are saying, if you want a border adjustment to charge for emissions from West Virginia and Ohio and Indiana, and Kentucky, well damn it, I want a border adjustment to protect me from the higher prices in your states setting price in my state. This is actually on the table, being discussed currently in the PJM stakeholder process. This is not theoretical.

Respondent 1: And that would be applied to exports from West Virginia, that they would tax exports going to, or what would they do?

Questioner: Border adjustment would be similar to either what New York is trying to propose currently.

Respondent 1: So, imports and exports.

Questioner: Or, that California is currently, something along those lines, for net exports from the coal States into the eastern part of PJM. By the same token, when gas is on the margin and those resources are subject to the RGGI price, the coal states don't want to be subject to that RGGI price in setting their prices. And they want to be protected from that. Border adjustments work both ways.

Respondent 1: OK, there's so much room for mischief. There's got to be some case law about when things can pass muster by the Commerce Clause and when they can't. And I just don't know that at all, but this amazes me. And one could go down that path and those sorts of things are held up. This is only just the start. But at least West Virginia won't be subsidizing offshore.

Moderator: And we saw some of these dynamics at work at the OPSI Annual Meeting end of October. Next up .

Question #5: Thank you. This is a very interesting panel and I want to focus a question for Speaker 2 and the carbon price, and why it's you're articulating the story about why we need a carbon price and a significant carbon price because of all different things that have to be given the right incentives and all of that sort of thing. And I agree with that.

But I want to ask you a different question, related to that. It's not exactly the same thing, but it uses the same analytical framework as Marty Weitzman's famous paper on price and quantities. And so, if we go to the globe and we talk about the price quantity combination, you know it would be appropriate. We could apply Marty's paper to that study and we could have a debate about whether setting the target or setting the prices is the right thing to do. I think that's a little bit more complicated. If we go to a country which is a subset of the globe, the uncertainty around the price and story and the aggregate demand for that doesn't change. But the uncertainty around the quantity and how much they should actually be doing in that country changes a lot and that's a lot more uncertain. And if you go down to the state, the uncertainty around the price doesn't change and it's the same argument, but the uncertainty around the state's quantities that would be consistent with that price is massively larger than it was if we started with the whole globe.

What I get out of that story is that if you're trying to address the global problem and you're trying to do it by quantity targets for low, small scale entities like states, that it's going to be incredibly more inefficient than you ever thought because you haven't looked at the fact that there's no reason to think that the percentage reductions in California should be the same as the percentage reduction in Tennessee. But there is a reason to think that the price of carbon should be the same in California as the price in Tennessee. What do you think about that?

Respondent 1: So, in a nutshell, aligning prices might be more rational, or more efficient than trying to figure out quantities by state. And, of course, this goes back to LBJ's comment. I think people get more excited about quantities, seeing something concrete and that's of course, it goes back to Title IV where we cut SO_2 emissions in half. That's the right number because if really focusing on the quantity and getting something as opposed to Proxmire's proposal. Remember Senator Proxmire proposed a price on SO_2.

So, somehow quantities, you think you're really going to get something for that, but as you rightly point out, quantity within a state that's within an open economy that has a lot of trading with other states, might not as much. So, let's see. Why have we tended to have quantity instruments? One is, of course, the feeling that you're really going to get something concrete. The other is for Title IV, this is really important and for the ETS, this is really important. You can give away allowances. And so actually the industry profits might go up.

That was very important in getting them onboard. You know this is the dog that didn't bark in the night. Why didn't industry, why didn't the utility industry object to the Emissions Trading System? Because their profits would actually go up. It would help them restrict supply and raise prices and they get the allowances for free. So, they've been political dynamics, I think, that have been pushing for quantity-based measures in the past. But perhaps for, and this is something that you discussed before the last presidential election. I think you're talking about Dale Jorgenson's proposal for taxes that this could be something that Republicans support because it would help out with fiscal problems and the deficit, though nobody seems to care about that these days.

Maybe, though, for those reasons we'll see more

interest on taxes in the future. But at least in Maryland we're talking mainly about quantity-based things. Either shutting down the coal plants *per se*, or having a cap. We're not talking about prices. But I think your proposal's something that should be looked at. There may, and perhaps that would be more efficient as it plays out among 50 states and each has their own policies, that maybe priced-based policies would result in less inefficiencies than quantity-based ones. Unless you can trade the credits across states, which, if you could do that, then it shouldn't make much of a difference, at least in a certain world.

Moderator: Next.

Question #6: Sorry. I didn't think it was a question until I looked it up. And the genesis of this question is I talked to a lot of very smart people who are my friends who I think are honest and sincere. And they either don't believe in climate change, or they don't believe in carbon as a cause of climate change. So, I've done a little research on the internet and I've been able to find things like the Kaiser Family Foundation poll. They can't find, and that goes to is there climate change? And people believe there is climate change. A lot of my friends believe there's solar storms or something like that. The 35-year cycle. But anyway I'm not finding anything, [MICROPHONE TURNS OFF] [LAUGHTER] I don't have elixir in my house. [LAUGHTER] Anyway the question is whether there's any data on people believing [MICROPHONE OFF] is actually the cause of the climate change by some sort of [MICROPHONE OFF]. I haven't looked into that. I don't think it's in this particular poll. But I'm sure there are attempts to get at them. But I can't see anything on it.

Respondent 1: Yeah. I wish I had a definitive, I think somebody in our organization has the answer to that. It seems pretty basic, fundamental to it. And I just don't know.

Moderator: OK.

Commenter: But I do think it goes to the point of new political leadership to take this issue to the public in terms that they can understand and that would be an argument for talking about quantity, not price.

Respondent 1: [MICROPHONE OFF] — consensus to do something. I would think you would have to say what are we doing, something about that being carbon rather than climate change if you want to limit carbon emissions.

Respondent 2: Anyhow, I think that, in the environmental community, the community shifted away from referring to carbon years ago and went to climate change because they felt that some of the languaging that people got a better sense of it as, when you call it climate change, global warming, whatever. Carbon itself seemed like a difficult concept for a lot of people to get to so, I don't know if that's one of the reasons, because just the general dialogue is around climate change and not carbon as the understood cause of it, or not. But I know that no environmental advocate wants to say carbon because they just think it's confusing to people. It's another abstraction.

Commenter: If I might offer, I think most of the polling on this question has been around human activity is causing climate change rather than whether it's carbon specifically.

Respondent 3: On our road trip with the electric vehicles on the 8,000 miles, we had an interview with the head of electric vehicles at Ford and they're coming out with a sort of a Mustang-themed battery electric SUV. And they're not talking about carbon at all. They're talking about torque.

Moderator: All right.

Question #7: I have a partial converse to the comment about paying attention to success. And it relates to another comment that criticized what I would characterize as a self-indulgent expensive

greenery of California. I'll add that it's also happening in Australia and a bunch of other places. And I know various people have highlighted the U.S. challenges, but my question really goes to whether what's going on in California or Australia is influencing the places that are going to be the real problem?

As was mentioned, these are China and India, and let me add to that, all of the newly industrialized in countries within 20° of the Equator who are all going to want air conditioning in the next 15 years. Are all of them learning the wrong lessons from California and Australia too? Is it those points of darkness destroying our opportunities globally to do the right thing? Not to be more pessimistic.

Respondent 1: Right, exactly. So, I think that, I guess maybe back to the glass half full because it's such a challenge to get the global agreement on carbon reduction. So, what we're left with is I do think we're not going to see this linear reduction with what's happening in China and India. We're not going to see a linear reduction. Even China says it's going to go up and then down. So, I don't think California's an unmitigated disaster. I understand why it's happening. We don't think it's an unmitigated disaster at all in Australia nor in the absence, again, of the fundamental need to act federally and internationally.

Yeah, it's hard, but I think they're going to be experiencing the same issues in those countries. They're working through that too and it really sucks. I agree. But it's better than doing nothing. It's a pat answer, unfortunately. It gets back to that everything is so much is local politically. I don't have the most satisfying answer beyond that because we're strong advocates for aggressive international treaties around this.

Moderator: Next.

Question #8: I'd like to ask about the issue of environmental justice. I represent the electric cooperatives. We serve a lot of very low-income rural communities, many of which are going to be harmed economically by this shift to lower-carbon resources. It may be mining communities. They may be communities where the best employers are the coal power plants. I haven't heard those communities discussed much when the issue of environmental justice, economic justice comes up. The other issue I've heard discussed is we serve a lot of the areas where the wind turbines are put in, the power's exported. If we move to something like a carbon tax, are all of the benefits of that also going to be exported? How much of the benefits versus the cost of the transition to a lower-carbon economy are going to be borne or exported by low-income rural communities?

Respondent 1: I think those are excellent questions. I cannot speak for the New York Renews Coalition in a formal way. But I can say that in conversations with the coalitions with the national climate and climate justice and environmental justice movement, there isn't anybody. It's a plank on the platform that transitions security should be a priority for affected communities. I think that in some ways when you talk about say environmental justice and rural communities, some of these movements have emanated from places like New York, like California and of course the foundations of environmental and climate justice comes from Black and brown communities.

So, I think we want to increase and broaden those conversations. And again, I don't know. Folks are 100% onboard with transition security, but there's going to be winners and losers in this transition. And that folks need to thrive. I think that's a real plank of the climate and energy and environmental justice platform. I'll let someone else address the rural community issue, but the situation in Hawaii is interesting for the rest of the country is, where are the large scale wind and solar plants going? They're going into the lower-income, marginalized communities. That's exactly where they're going to power the other

centers. I mean it's a thing.

Questioner: Are you seeing specific proposals that would turn the plank of transition security into reality?

Respondent 1: I want to say yes in some of these Green New Deal plans. I'll let other folks speak to it, because when you're also you're talking to the climate justice and environmental justice movement, this is an emerging power that's been sort of asserting itself, not been in the driver's seat.

Respondent 2: One, a couple of specific examples are around securitization of assets, accelerated depreciation and allowing utilities to reinvest proceeds from the early sale of plants into communities and those kinds of bond rules have passed in several states now, specifically to address this issue. I don't know if it's passed yet in Colorado, but that's been a big legislative push from environmental and community justice advocates in Colorado. It's happened, I think in two or three or four other states so, that's a specific policy solution.

And then thinking about the flipside of the impacts of communities of plants leaving is, not the flipside, because look at Four Corners for example where you have community activists who do want the plant shutdown and want relief from the decades of problems that the plant has caused from the environmental perspective, right. And it's also true in Kentucky and West Virginia. It's not monolithic. There are people who are concerned about the mining waste, the long decades of water and air and other pollutions.

So, it's a mix. It's a more nuanced story, I think and there is a lot of conversation about this. I should invite you down to the office where you can hear about it from some of our colleagues who work full-time on this. And then, I don't know if I'm responding to your second part of your question when I say that, of course, supply chain development, economic development is a big piece of the answer, too, the economic answer.

Questioner: I understand that Denmark has dealt with a lot of opposition to local facilities by careful tax policy and sharing of the benefits, not just the Shoreham Nuclear Plant in Long Island not giving all the tax benefits to one little town that immediately builds a high school with 16 tennis courts. And then the plant never runs. But, yeah, there are lessons to be gained there, but I don't know if there's enough surplus or value in new transmission lines and new wind facilities to make everybody feel like they're better off because of it. But supposedly there are success stories and more successful approaches than we've used. I don't know. It'd be good to look at those lessons.

Respondent 4: OK. I wished we'd known each other 15 years ago when I was working on Farm Bill Energy Policy and the NRPs and we used to struggle so much with some of the farm groups around the RPS issue. They were making a lot of money on the ethanol sales of corn for ethanol and the overall higher price for corn. But it was always a struggle then on the RPS where they would be getting $5,000-a-year payments for wind turbines for 20 years, which is a pretty great deal along with tax increases in local communities from those turbines and it was a struggle. And I was a little off-point, but it was a real education for me on some orural America politics at the time.

Moderator: Yes.

Question #9: Yeah, thanks. My question deals with some confusion that I perceive in the environmental agenda with regard to the ultimate outcome. [PHONE RINGING] [LAUGHTER]

Comment: Another friend calling. [LAUGHTER]

Questioner: So, on the one hand, Speaker 2, you've made a very compelling argument that if

you wanted to get to this efficiently, you'd put a price on carbon. And the efficiency gains are huge. William Nordhaus gets the Nobel Prize in 2018 and he did all the research. He said, "Look, the right price on carbon would be about $50 a ton." And there's a lot of uncertainty there. Maybe $50, maybe $60, but let's say people tried to balance the cost and benefits of carbon reduction and you implement that and in 2050 the result is we're not at net zero.

So, my question to the panel then is, is that a good outcome? Do we want to live with that, or do you want to continue to intervene and push carbon prices up and up until you get to net zero? Which is the desirable outcome?

Respondent 1: I don't know that zero is the right number. Maybe negative is the right number. Or, maybe positive is the right number. I've not looked in an integrated way they way that Bill Nordhaus has on all of the impacts and tried to put a value on that. I suspect that $50 number is good within +/-100, it could be, look at the Stern report. I think he was looking at something perhaps five to 10 times as large. It all depends on so many assumptions. It's all whether it's 2%, 3% or 5%.

Questioner: But just assume that people come to some determination of what they think is balancing cost and benefits, and it gets imposed. We get the nice efficient result you're talking about, but it doesn't get us to net zero, which you had mentioned that being an objective. Other people have talked about the Green New Deal having a net zero objective. How do we reconcile an efficient solution that possibly is significantly different from net zero?

Respondent 2: OK. Well, I would just say from some of the environmental groups' perspective, the goal is net zero. Whether or not it's 50, another number, or it's a range of other ways to get there. I think that's the goal, an international trajectory, as well. So, I think that's the group's goal essentially.

Respondent 1: I'm afraid I'm pessimistic we're going to probably blow through our targets and it's going to have to be some sort of geoengineering to save this place that we live on.

Questioner: Some of us have been looking a lot a direct air capture. I know that's so far off. I mean CCS even seems reasonable compared to the achievability of direct air capture in the next 30 years. I don't know if this is an area of R&D that cries out for government investment. That's where the responsibility should be and there could be big payoffs, but—

Respondent 1: I definitely don't think a $50 price would get us direct air capture. I can't remember what the number is, but it's so much higher.

Respondent 3: There'll be a political argument if you start out rebating to consumers the carbon tax. As the carbon tax takes hold then, and the carbon goes down you're getting less and less money from that, right? But you're paying higher and higher energy prices and so people that don't want a climate change policy are going to tell people you're getting taxed up to your eyeballs.

Questioner: My question really was if it was successful, if we successfully implemented an appropriate price on CO_2 and it doesn't get us to net zero, is your preference to live with that or not?

Respondent 2: I'm sorry. How do you define success?

Questioner: Success is an economy-wide or global implementation of an appropriate CO_2 charge. And you live with the result.

Respondent 2: Right. I guess I would say that does not compute in a way. It just doesn't.

Questioner: Well, in the power sector we're talking about in the U.S., you institute a policy where you implement a price on carbon and you

get rid of all the distorting things of command and control mandates and subsidies, and we say we're trying to get an efficient result on the demand and the supply side.

Respondent 1: Right. And I'm not going to prejudice the future by saying that's not possible, but it's highly unlikely that we'll have that to the exclusion of everything else. We look at this right now in the context of RGGI, a weak RGGI price plus a PJM carbon price. It's inefficient, but it's kind of what we're working with, much less efficient than what you're talking about. So, again, I think that's a vision of perfection that's pretty darn hard to achieve.

Respondent 2: The efficiency I was addressing is pretty narrow, so there's several sorts of efficiency. One, the very broad allocated efficiency of how, what is the right concentration of CO_2 or what are the right amount of emissions in terms of balancing the benefits of cost? And I don't really have anything smart or dumb to say about that.

What I'm addressing is a narrower problem of production efficiency. Given that you want to, say, lower emissions by 50% or 90%, how can you do it with some efficiency so you're not paying $2,000 a ton to reduce it here and ignoring opportunities at $2 a ton over here to do it? That's going to cripple your efforts in the long run. So, I'm looking at a narrower definition of efficiency than perhaps you're addressing, which is the right level. Is zero the right level or not? And I actually don't know. I suspect that maybe we'll look at it carefully and think negative is the right level to bring it back down. Aspirational.

Moderator: Another question.

Question #10: I had three sets of questions to go to this.

Respondent 1: Three sets? Bailiff. [LAUGHTER]

Questioner: [NOT SPEAKING INTO MICROPHONE]

Respondent 1: It may not be fair, but it's efficient.

Questioner: [NOT SPEAKING INTO MICROPHONE] —different environmental groups have conflicting agendas. Those concerned with air quality want to build more transmission to enable more wind energy to get to load centers. Other groups, more concerned with land and water, oppose transmission and believe that generators should be close to load. How do you negotiate something where environmentalists are on conflicting sides?

Respondent 2: The one thing I would say is, I'll try to answer all three in one sentence, but even if you have a national goal, or an international goal, how you solve it inevitably is going to be regional. Just as, in one region you might need the transmission, in another region you don't. I think the point about the rooftop solar is yeah, a lot of it is moving towards commercialization. In a lot of ways that's good, not good, but it's the reality as you said that happens in other sectors too, and business generally, so.

Questioner: [NOT SPEAKING INTO MICROPHONE]

Respondent 2: What about getting both winds together, right. At least you're getting environmental carbon reductions and other reductions at least to a point until you start curtailing the heck out of everything. So, and I guess second, that's no different than a lot of other industries. It's not a justification for it, not at all. Right.

There's no purity in a lot of this because there's no national planning around it, so you're left with Brower's comment about so much of it being local. Otherwise, though, I really want to stress my view that a lot of this is very regionally focused and that there are different solutions in

different regions. So, you need transmission in the Midwest and the Great Plains. There's a lot of land, not a lot of people and so if you can build it, that's where it's going to be. You don't need that in other parts of the country. It's not going to happen.

Respondent 3: I'll say that I agree that putting the supports for this nascent technology in some ways has driven us to points of inequality, in particular with rooftop solar. I think that's right. But as you specifically taught me there're other objectives to decentralizing systems and also liberalizing markets, other than propping up say a particular technology. I mean that's what the Reforming the Energy Vision proceeding was about.

And, look, I think your point is made extremely loud and clear. I mean I think it is an entitlement. People think they're doing God's work because they're building solar plants in a native Hawaiian community's back yard, right next to their high school and they don't want it. And I think that's a serious issue. But I still am somebody who thinks there's a place for the private market in these systems and for more legalization maybe.

Respondent 2: I thought you were going to mention PURPA too. You could have just as easily.

Respondent 1: I'll just address the third point. I think the ecological approach to transmission as we had it perhaps 10, 15 years ago, there wasn't a transmission line proposal that they didn't like. And they wanted to see a lot more, but they just knew it was good. Don't show me the numbers.

And then when the State of California ISO does some careful analysis and they say, "You know, that line's going to give you back 30¢ for every dollar you invest, it really doesn't make sense." And FERC didn't want to hear that. I'm not in favor of just stringing lines across the landscape because we know that's going to be good in the long run. I think infrastructure, as much as I favor markets and letting pricing drive things, infrastructure has to be planned carefully in an accountable, open process that's honest.

Just down slope from here we have the Central Arizona Project, a very large canal that thanks to the Bureau of Reclamation and federal dollars, we had something that was built that probably gave 10¢ of benefits for every dollar and that's because of politics. Jimmy Carter, to his sorrow, tried to kill all that. Remember, what was it? What list was it? Enemies list. That was a different President. He had the hit list.

And the Corp of Engineers and Bureau of Reclamation are a lot better than they used to be. In part, because the water resources planning standards and, similarly in transmission infrastructure, we need careful planning. And that's what Order 1000 was trying to do. So, the answer as to whether it should be transmission lines from California to Wyoming to bring in Wyoming wind, or whether it should be local development, I think that's where entities like the ISO, WEC and others need good analysis that's accountable and reviewable so we don't get more Central Arizona Projects.

Respondent 3: Also, and it's something we did at EDF and also somewhat less at NRDC, but the idea of resilience and thinking about that we're living in this, we're living in climate change now and the cybersecurity piece has to be looked at more. I mean it may be insane to invest in that type of transmission project.

I'm not saying that I'm pro let's continue to prop up the solar industry, but this has been my maddening thing about Hawaii, which is probably one of the most unstable places in terms of waiting for a natural disaster, certainly in America. And even the highest levels of solar penetration where solar rooftop PV and the policy being that basically nobody can island when the storm comes and the power goes out. So, having a conversation about decentralization that thinks about resilience I think is unbelievably important.

And that's what we're doing at EDF. When Con Edison wanted to spend eight billion dollars after Hurricane Sandy and we're there saying, "Please, you have to think about this project in terms of sea level rise, where that equipment is going to be. Is that equipment going to be able to handle the increased temperatures?" And these things are still not standard thinking.

Respondent 4: I don't think we want to say that long-distance transmission and resources closed to load center are either/or choices. They ought to all be considered. And I do recommend you try to take a look at the same study. It's not that easy because the Energy Department, even though the study is finished, decided it needed two more years of work, so they pulled it back. But it was previewed over a year ago at a conference in Ames, Iowa. So it's on the web and you can take a look at the amount of work that NREL put into it. I'll just say on the cyber side of it, the cyber threat is present on long-distance transmission. It's present in hooking up the Internet. Cyber's not a bigger problem for one option than the other, I would say.

Respondent 2: I absolutely agree with that and I think the two support each other. It's not either/or. In fact, you need a lot of the local resources to complement the larger resources that are needed for flexibility across the region. So, yeah, same study, very good. And it's just not one or the other.

Moderator: Yes. Next.

Question #11: I saw as the Presidential campaign was getting underway, I saw a headline recently that said, "Monopoly's Worse Nightmare, Elizabeth Warren." And I was like, "Oh, my God, it's really happening." It's really happening and then you read it and it's about Big Tech. And it's become a popular cause in the progressive Left to advocate breaking up Amazon, Apple, Google. Quote Senator Warren, either they run the platform or they play in the store.

And yet much of what we see in terms of Democratic law-making on energy policy continues to use the monopoly balance sheet as a kind of way to achieve clean energy policies. There's an obvious disconnect between what you see in terms of progressive Left on Big Tech versus on energy. And I wonder if the resident progressives on the panel and others, too, if you want to chime in, if you'd like to explain the discrepancy for people like myself who don't understand how one can believe one thing in one sector and one thing in another, when you just have to change a couple words, like App Store, in what Senator Warren is talking about.

Respondent 1: The radical Left is having a real conversation about nationalization. It's really happening and it's amazing to me, because, again, five years ago I don't think that would have been on offer. But, then, I think there are a lot of people who do think about the sector in terms of market structure and monopoly power and wanting to do liberalization. And, I'll say, this has been something that's been frustrating to me because people who put these policies out, the idea of energy democracy and we need to stop these monopolies and the idea of nationalization are incongruent in several ways.

Respondent 2: I don't know if I agree with that. I don't know if this is a complete answer, but I think what I observe is that people don't talk to each other necessarily on issues like that and I think the clean energy wings of a lot of large groups are focused on looking at the biggest possible targets for the reductions. So, that's why they gravitate to Google, to Walmart, to Amazon and to other entities like that without maybe thinking about some of the other implications from an environmental justice perspective. And it may not be the complete holistic perspective. I'm not saying that one is better than the other.

Questioner: I didn't mean that the clean energy advocates would go out of their way to demonize Facebook or whatever for their clean energy

targets. I'm not that. For the first time in a couple of generations you have a sort of progressivism that finds a home in talking about breaking apart things that frankly aren't even monopolies. And yet here, in some places you have honest to God legal monopolie—Excel, for example—and the environmental justice, clean energy community in Minnesota just can't get enough of the company seemingly. That's my perception of politics in some of the places that continue to have a formal, legal monopolies on power generations.

Respondent 1: I think, I can very comfortably say that just from my experience with large Greens or small Greens, I don't know of anyone who is pro vertically integrated monopoly. And, again, maybe that is because so much of the advocacy has been in restructured jurisdiction, you know, friendly jurisdictions and I would think that the tenor would be we need to move away from that model.

Respondent 3: I do know about that, with those specific examples [OVERLAPPING VOICES]

Respondent 1: That, I'm not familiar with.

Respondent 2: And, again, there's a little bit of siloing going on here, I think, and a comfort level with what people experienced. I think you're also making an assumption about what everyone believes around economic theory and capitalism and monopoly power, and what people actually want. I don't know that everyone wants the, you know, the goals we're seeking are all liberal Democrats who have a unified, a unified view of the world. I think most people I've met don't actually have a one single worldview of the way the world should operate.

A USCPA attorney once many years said there was some anomalies in the regulations. Yes, there were. Many anomalies in the regulations. And they did not all make it perfectly coherent. And we saw a little bit of that this morning in the first panel. As different people have different views about capacity verses scarcity markets. I mean energy-only markets. It's a little bit of a Rorschach Test. But I sometimes sit back and observe those very things and these proceedings.

Moderator: Yes, next.

Question #12: [NOT SPEAKING INTO MICROPHONE] —but it doesn't stop me from trying to throw a bomb in here and I cleared it with my seatmates that nobody's talked about this yet. Let me throw out the proposition that your efforts are just extraordinarily misguided at this point. The electric industry has, if you look at the RTOs through competition, emissions have been reduced drastically and now, what's happening is the states are interfering, picking projects, PURPA all over again, picking long-term projects that are not economic, that are going to hit a point where ironically the more penetration, the more you need to keep the fossil fuel online, and you got to get revenues. You're not being honest with customers about how much this is going to cost. You are precluding newer gas technology that is out there from coming online at this point, that could displace more coals, certainly in PJM. Because of this push.

The reason I think it's so misplaced is our electric sector, at least in the RTOs, has gotten pretty damn clean on its own through competition. And now, it's being distorted with all sorts of incentives that are going to take away any of the pressure to keep going. And why you're not more focused on letting this sector blossom, if you will, which it is blossoming. Prices have come down, and focusing on the real problems here which are transportation and other industries. If you had the focus there, the political willpower that you seem to have garnered for the electric industry and transferred that political willpower to other sectors, you would have cross technological innovations. I mean gas turbines, the engines came from the airplane industry right? And we have cross-pollination.

So, I throw that out to you. I really do believe in

my heart it's misplaced at this point. That this industry has done radically well and that you are encouraging subsidies that are going to undermine, long-term, the very things you want. You're not going to get rid of gas forever, you're going to still need it until we get battery technology in place. That's a long way off. So, you see where I'm going with this. I'll stop and just throw it out.

Respondent 1: I've never seen such a heartfelt advocacy for RTOs and ISOs in my life in any context. My initial answer would be that it's not an either/or thing. I hear what you said and it makes sense as a narrative, but there are some things that I'd be interested in what you think. There are some budding issues, I know of what New York's trying to do with pricing and wants to tell NYISO how to do some pricing. I think we could do better on carbon pricing in the ISOs. And I would also say that I think a lot of people are very much focused on the transportation sector. It's not an either/or question in my thinking.

Respondent 2: I think the that's right. Emissions have declined significantly in PJM. No one denies, we know why that is. I mean Mercury and Air Toxics Rule plus Marcellus and Utica made a big difference. They haven't declined as much in MISO and SPP and in the South, although they're trending in the right direction. But they're nowhere near where we believe we need to go.

And that's why if we believe that the transportation and building sectors are also under our control, and we link them to the power sector broadly, so we think about it much more broadly, we don't want to have more gas fueling those needs. We just don't because our modeling all says that's too much. So, that's what we believe that it's too much. Yes, PJM has dropped a lot. There's a debate between Steve Huntoon, one of my colleagues and *RTO Insider*. That was another sort of apples-and-oranges thing. So, I guess that's where we come out. Take Illinois for example. It's a messy process, but I believe we don't need more gas in Illinois. We need more renewables. We need a strong energy standard. So, you look at what's happening in New York with the CLCPA. It's basically making gas unviable after maybe 2040. Will that happen? I don't know. I saw some page on this during the presentations around that. There's a lot to do between here and there, so I hear what you're saying. We just don't believe it's enough.

Questioner: In talking with consumers about the cost of all this, which I personally believe in carbon, I wish we had a tax, but the people aren't talking honestly. And if you talk to the politicians, they're very candid. We don't have to talk about cost because we only want two more terms and we're out of here. We don't care. And we don't care how long term, what the impacts are when you talk to the politicians and say, "You know, guys, you actually are going to need some flexible gas-fired units to remain online. Why aren't you talking about that?" "Because that doesn't get us elected." So, there's no reality anymore in these discussions and I guess that's why I'm picking on you because you guys could be the ones to push for the right changes while still talking about it more realistically and requiring a more realistic discussion about it.

Respondent 2: Sure. And, again, I disagree. I mean I think we take cost very seriously. And our analysis actually says, number one, that you can actually get to cost savings and, number two, if you can, in fact we were just working on this internally a couple days ago, and new sets of data we've run with gas still in the mix over the next 20 or 30 years for the flexibility. Declining for sure, definitely lower-capacity factors, but, I can't speak for all environmental organizations, but I think NRDC definitely sees a role in gas for the next several decades at least. I don't say Ridgefield. I disagree that it's a Ridgefield. I actually think that we won't need any more gas in 40 or 50 years. I've never met anyone in the gas industry who actually believes, they don't want to be a Ridgefield.

Respondent 1: No, they don't.

Questioner: That's not why they're building assets.

Respondent 3: So, wouldn't you say that if the imperative is—

Respondent 2: Can I say one other thing? The cost of not doing something is also significant in the national climate assessment. Trillions and trillions of dollars of just gross domestic economic cost. So, that's a piece of it, too, but I'm happy to sit down and go over some of the data we've got that we try to use. I agree the distance between the data and the report and what actually happens on the ground is often very wide, and then you throw in a lot of these price conflating mechanisms and policies that can screw it up. That's our challenge in environmental groups, to go from the modeling that we do to actually what's on the ground and getting those cost savings. And that goes back to the—

Moderator: And I'm going to interject that we have some name cards standing, maybe we can get some quick answers.

Question #13: I actually wanted to take the bait from the last question and do it in kind of a centrist way because facts do matter. So, let me start with a couple of facts. Thank you for telling house rules. Number one, stopping pipeline capacity into New York increases emission throughout the entire Northeast seaboard. We've documented that. That's a fact. Fact number two More than 50% of the natural gas in this country is produced as a byproduct of oil production. Which gives us two choices, flaring it or using it or emitting it. OK.

But just to get to the previous question's point. I'm looking at what the purpose of the Harvard Electricity Policy Group is and, when we think about the point you just made, that we still have a need for natural gas. Speaker 1 talked about the need for natural gas and the implications of allocating capital to different solutions. There are two mechanisms that we use in this country in order to bring about innovation to resolve problems that require emerging solutions. Two primary ones. The first one is government-stimulated R&D and spending. The second one is well-designed markets that foster competition, innovation and efficient use of capital. And ultimately that's why we're here and that's what we need to do in this market.

I could go on and on about things, for example, that California, states and other RTOs can be doing to foster those sorts of emergent solutions. At this point, we're generally falling short of what needs to be done from the standpoint of efficient markets that foster innovation and ultimately the kinds of solutions that we're going to need. I'll stop there.

Respondent 1: And I also think that Speaker 1 or 2 talked about R&D, and we've had very little discussion about the value of R&D in the future. And iwhen you look at the national and international commitments we need to make, we're falling woefully short on R&D investment.

Questioner: I want to offer something because I think it picks up on this conversation, if I can make the point very quickly. One of the things that I think has been a little bit lost from the very beginning of the conversation is it is inevitable that states and localities will have different polices from the beginning of the union that we've been trying to make more perfect, ever since it was created. Every state, every locality has chosen its own course to some degree on policy.

There's a *Wall Street Journal* article I'm looking at about the states of Kansas and Missouri, finally declaring a truce on businesses that would move every two or three years across the Mississippi River in order to get incentives to create jobs, just by moving from Kansas to Missouri and then from Missouri to Kansas and from Kansas to

Missouri. $350 million in incentives over 10 years paid by the two States. So, the point I want to get to is, given the conversation that we've just heard, how do we think about weaving together disparate state policies that are inevitable, all politics are local. That's an inevitability right. You're going to have regs. In some states you're going to have carbon taxes. I think our job isn't to say, and in all due respect, what's the perfect economic solution and price? How do we weave these things together and make them as good as they can be? I think that's the question we are challenged to answer given some of the stuff we were just hearing.

Comment: We have examples of national policy that preempt state sovereignty, don't we? I mean, we don't let the states decide what the safety regulations will be for their nuclear plants. The federal government decides what's required.

Respondent 2: I've given up on national energy policy at the moment. Maybe I'm too worried to think that this is reality, but I've given up on national energy policy at this point.

Comment: Well, it was an attempt to set a standard for fracking operations. And it was commonsensical and it was based on best practices. And that got deep-sixed. But that's an example of what federal government and federal policy can do across the state lines. It got deep-sixed.

Respondent 2: Once upon a time, things like the National Governors Association played a much more important leadership role in trying to get a consensus among the states what should be done. And the ultimate Con property, the ultimate ubiquitous fluke in CO_2, as opposed to say noise or local ground water contamination, that certainly should be a federal policy. But now the politics, the age, the National Governors Association is divided just like everyone else.

Respondent 3: I'll say that, like I had mentioned in my presentation, folks are trying. I know that's what I did. I'm just somebody who's been in the trenches in a number of jurisdictions and the only reason I can effect an efficacy on my personal behalf, I'm not trying to say it was all that monumental, but that's why I can say I've worked in New Jersey, Pennsylvania, New York, Hawaii, Illinois, California. Try it. It's burning up a lot of CO_2 fuel in the airplanes while doing it, actually.

Moderator: All right. Is this the designated quitting time? OK. I want to thank all our panelists.

Session Three.
Offshore Wind: Barriers and Challenges to Meaningful Market Entry

Offshore wind offers many attractions. With zero generation emissions and, as a general matter, a higher capacity factor than other intermittent renewable sources the benefits seem clear. That being said, offshore wind also has disadvantages in terms of cost and potentially severe engineering and scientific challenges. There are also complications that relate to policy. One is the question, of how the energy is moved to market. Obviously, it will require marine transmission lines, but what are the terms under which such a transmission system would be put in place and who should pay. One option is to enable developers of wind generation to simply build their own interconnection line to the mainland. That has the benefit of allocating costs to the beneficiary, but is unlikely to capture economies of scale or open access to competitors. An alternative option is to build out a large transmission system that would enable all generators to interconnect. That option may socialize, rather than allocate costs, at least initially, but would likely capture economies of scale, ease access, and increase competition. These issues are similar to debates that have characterized to development of onshore wind in Texas and California. But the environmental and siting requirements are more complex. Underwater construction affects commercial fishing and impacts aquatic life and ambience. Jurisdiction over such matters is split between federal authority offshore (Bureau of Ocean Energy Management) and state jurisdiction. How have the state and federal authorities interacted? Does the potential for such conflict impact the choice of the transmission development model?

Introductory remarks and introduction of the panel are missing from the recording.

Speaker 1.
—rotor size is around 170 meters in diameter, and tower height, 25 meters. Capacity factor is 40-55%, and capital costs are, you can see them here, 4,300 kilowatts in 2018. And they're expected to climb significantly by 2030. I should say, also, that much of my information, we work very closely with NREL and Sandia Labs, so a lot of the data that I'm going to present is from NREL and from the work being done from our participants in our program.

Just to step back and tell you kind of how we arrived where we are, a few years back DOE initiated a strategy to look at the opportunity for offshore wind in the US, and they issued a number of reports, which you can find online, to assess really what the opportunity is. And their assessment from 2016 was that there were 86 gigawatts of potential opportunity across the US, not only in the North Atlantic, but also off the Coastal Pacific, in the Gulf Coast, and even in the Great Lakes region. The capacity factors and, of course, the strength of the wind, which contributes to those, varies by region significantly, and I think we all know that the North Atlantic is a predominant place for this. But there are still economic opportunities in the long term for the other regions. You'll hear a lot about what's going on in the Northeast.

That's kind of the platform that DOE set a few years ago, with here's what we think can happen. And then the states started to step in, particularly in the Northeast, as they, as I think was spoken about yesterday, have significant goals or mandates to achieve greenhouse gas reduction in the next decades. And the only way they can see, at least in New England and parts of the Northeast, of achieving that is to pursue offshore wind. So, there have been a number of announcements over the past few years, even in the past four weeks, that are increasing these numbers dramatically. I think we're currently at, I'm sorry, this should say 26 gigawatts in the headline, 26 gigawatts of proposed offshore wind projects and mandates in Rhode Island, Connecticut, Massachusetts and New York.

A few weeks ago, a New Jersey executive order by the governor increased their target to 7½ gigawatts alone. New York is at nine gigawatts. And the other states are significant but a little bit smaller. In the Northeast alone, we're looking at 26 gigawatts of ambition, I should say, for offshore wind.

I think I have an opportunity in that I don't think my other panelists are going to do this, just to give you a little bit of sense of what the regulatory framework is for offshore wind, which is complex. Not that much different from other aspects of the power industry, but there are other players involved. Because, of course, we're off the coast in federal waters. BOEM has significant authority over permitting offshore wind projects under EPAC 2005, and there's a regulatory framework that exists under CFR 385. Lease sales began in 2011, although I would argue they began really in earnest just a few years ago, and we're going to show a map of those lease sales, which, at one point, the revenue raised from lease sales was somewhat insignificant, and now it's in the order of millions of dollars, hundreds of millions of dollars.

BOEM's process is to work with state task forces to identify what a lease area designation would be, and then they conduct an auction. For example, just this week, and yesterday, which is in part why I think we had a little bit of trouble getting an actual developer here, there was a large meeting to address the Gulf of Maine lease area. And that will be a long process when they identify the lease area, and the BOEM will conduct an auction just for those leases. To date, 16 areas have been sold in public auctions, which is about 21 gigawatts. Also, I included a little bit on BSEE here, which is involved in the process as well, and I'm going to speak to that in a little bit.

This is a map that many people have seen. This shows the identified lease areas across the US, so it includes both the East Coast, West Coast, and the South Pacific call areas. These are identified by what the depth of water is, which is significant from a technology perspective, and I'll address that in a moment. You can see it really runs the gamut all up and down the East Coast, and as I mentioned, now they're focused on the Gulf of Maine lease area and determining what that's going to look like.

What are the challenges? So, in my mind, putting aside kind of early stage things that happened with DOE, etc., and leasing, it seems somewhat easy relative to some of the other challenges that we face post-leasing. These are the ones that I think about the most right now, and that my members are thinking about at least in the context of the consortium, which is focused on R&D. One is recognition of capacity factors by ISO market rules. That's not something that we're focused on, but that will have a significant impact on development of wind projects and the actual revenue they receive. More on the technology side, offshore, onshore landing and transmission. There's a lot of conversation about it, but I think a lot more work needs to be done, real hard work on how this is actually going to work once these projects are going to be built.

While seemingly insignificant, but very challenging and unique to the offshore wind industry, is the transport of component parts and operations and maintenance, and that's due to restriction from the Jones Act that I'll address in a moment, and the relatively small size of ports and harbors that is relative to those in Europe, and relative to the component sizes that we're seeing being developed. Other challenges are deep water versus shallow requires different technology solutions, so you won't see the same technology used, even across the US, because both the environmental and weather conditions

and water conditions will require different technology solutions.

There are multiple permitting entities for our offshore and onshore requirements, and while seemingly not an R&D issue, it actually is, because much of the R&D that's being done is addressing those environmental and other permitting concerns. And then, finally, coordination among states and federal government. There is coordination at one level, but certainly not at the level in terms of ports and harbors, transmission, etc. That will come in time. But, right now, the states are really competing with each other to attract this business, the supply chain business, the ports and harbor business, etc. So, the coordination is difficult. But I know that the state commissions and economic development offices are trying to work together to ensure we have efficiencies in these areas.

I just thought I'd highlight the Jones Act, because I'm not sure folks in the room would know very much about it. I know it may have some impact on other aspects of the power industry, but its impact is significant here in the US on offshore wind, and it's an act from 1920. There's no one, as far as I know, proposing to change this act. It's impossible to change, given kind of the nationalist and patriotic issues around it. But, essentially, it requires any vessel transporting merchandise between two points in the US to be US-built, US-flagged and US-owned. Currently, there aren't any vessels of that nature in the US that could satisfy that requirement.

So, it's significant when you are trying to build multiple offshore wind projects, and you have components parts coming from Louisiana, from California, from different parts of the US, and trying to ship them to your port and install them where you need to be. The same is true for operations and maintenance. If you have an O&M team that needs to get from point A to point B, they have to meet these requirements. Factors considered by BOEM, which I mentioned their significance in the permitting process, and I'm not going to lay all that out here, because it's complicated, but these are the factors that go into consideration for permitting and potential challenges that technology is trying to solve, as well as other things.

There are physical requirements that they look at, all the biological impacts, and socioeconomic factors that are considered. The environmental consultations that BOEM has to take into effect are a number of acts. I just listed these here so you can see the magnitude: Historical Preservation Act, the Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, Marine Mammal Protection Act, and the Coastal Zone Management Act. And there are others. These are just the federal ones.

Don't forget there are state requirements when you hit onshore, of course. I just have a couple of slides on LCOE that are not my own. They're borrowed from NREL, but NREL's projections really are that we will see declining costs for floating structures. And as I mentioned, there are really two types of structures that will be used in the US for turbines. One will be floating, and the other will be fixed bottom. And floating structures will predominantly be used where waters are deeper. You have to have a floating structure. And in waters where they're more shallow, some places off the East Coast, you'll be looking at fixed bottom structures.

There are different LCOE costs projected for each of those. In both cases, there's expected to be significant decline as the technology improves. Here's where we are with projected floating offshore costs, and I should say, some of this is based on the experience in Europe so far. And here's a different trajectory for the fixed-bottom

costs under NREL's estimation based on a number of studies that have been done in Europe on the projects that are already installed there. I think we're going to circle back to this in our conversation.

So, really, what are the technical innovations addressing? These LCOE and environmental challenges and permitting challenges that I raised, advancements, and how you moor the projects in each of these areas, vessel adaptations to address the Jones Act, improved O&M capabilities. For example, I'm looking at proposals that include using drones and AI to collect data onsite from facilities, get it back to shore so you can assess real time what do you need to do in O&M? Maybe to give you a better example, right now O&M of most offshore wind facilities is conducted in Europe on a scheduled basis, as opposed to an as needed basis. Some of the research that we're looking would actually make that more anticipate what's going to happen, based on information and data coming directly from the turbines and other equipment itself.

An increase in wind turbine size, and this is the super sexy stuff everybody likes to talk about, it's really cool, and if you see these pictures I'm going to show you, they're pretty amazing. So, what's increasing turbine size, what's being used to do that? Lightweight materials, even in some of the wind blades, I was just looking at one from Italy, they still use wood material that reminded me of flying airplanes you used to put together when you were a kid, like this lightweight, super-lightweight wood material in some of the component parts, because it's very lightweight. Other things, advance control, high fidelity design and analysis tools, material and manufacturing innovations, all kinds of things going on in that area.

And the list goes on. You can imagine. And these are small companies and large companies over the US, all over Europe, working on these issues. And academic institutions. There are at least a handful of universities in the US, Tufts, Cornell, University of Maine, there's some out west, some in the south, that have labs that are focused on these issues. They're making proposals. And they're working with the commercial industry to work on immediate solutions, immediate meaning in the next decade solutions on some of these challenge areas.

I just thought I'd mention floating technology, because it's estimated that right now that will be around 58% of the resource need in the US, and this map, I think you can see the color distinction, the lighter blue and the dark blue. Fixed bottom is in the lighter blue, and floating is darker blue. So, those will need different technology solutions, which you can see on the left a little bit. This is just a digitized picture of the differences between fixed and floating bottom. And each of those has their own environmental and marine challenges, if you can imagine. If you have long cables attached to a floating turbine structure, you have different marine challenges that might be under a fixed structure.

Those are the sorts of things that people are thinking about, how to make those cables so they're less intrusive on a marine environment. And I just wanted to show you some examples of what these things might look like. These pictures aren't very good. I'm sorry. It's very hard, I think, to get a sense of the size of these things, unless you're in front of them. They are massive. On the turbine side, which, as I said earlier, is the sexy topic that gets all the headlines. I'm sorry, I must have had this slide in here twice.

These are some of the things that are happening, and I wanted to show you pictures. I'm sure most of you have heard about GE's 12-megawatt

turbine, haliade. This thing is, look at the people standing next to the turbine size. This is what needs to be shipped offshore, brought into ports and then shipped off source. So, that's where you get your vessel issue. Can you comply with the Jones Act, and can you actually fit into a harbor on the East Coast? Which you cannot under current harbor structures.

The point I wanted to make here is the significance of the size and the advancements going on. And I know GE is already thinking about increasing this turbine size by at least 25% in the next ten years. So, with the turbine that big, how big is your blade? The blade is significant, and I had the, I guess I'd call it pleasure, I don't know, in Boston, there's one of the only wind blade testing facilities in the US that can accommodate blades of this size. And it is actually too small. So, the wind blade testing facility in Massachusetts just won a grant to expand significantly to accommodate the size of these blades. This blade is 170 meters long.

If you stand next to it, it's pretty amazing. These have to be shipped, lifted up, hoisted up on cranes that actually can work in offshore waters, and work in a network system in the ports and harbors in the US. So, in sum, US states are implementing policies of over 26 gigawatts of offshore wind. Right now, that's predominantly in the northeast. Forecasts for offshore wind indicate that fixed bottoms may be near 50 megawatts an hour, and floating should be at 60 by 2032. That does include transmission, by the way. I should have mentioned that earlier.

Cost impacts are predominantly due to larger turbines. The bigger you get, the lower your cost on those component parts. Lower cost of capital, larger project sizes, lower turbine and platform unit cost. I'll just say, stop here for one second, though. What is happening with the larger turbine blades sizes is actually all the other balance-of-system costs, how do you ensure that the other aspects of installation, how can they accommodate turbines of this size and be constructed offshore as well? Significant challenges remain with grid integration, resource characterization and technological improvements.

So, think about things such as deep water, ice and hurricanes, things that are not necessarily experienced in Northern Europe, and we have to make sure that our technologies can accommodate those. And then finally, I just want to thank Walter Musial, who's from NREL, and really the leading technological expert in the US. He's helping us think through this, and helped me put this together for you this morning. Thank you.

Moderator: Thank you. I guess I was going to ask if we wanted to hold the clarifying questions until everybody's done. But go ahead.

Question: Real quick, the transmission costs, what are the assumptions that are made to come up with that number?

Speaker 1: They're pretty broad. It's essentially at this point that you can get it to shore. So, those numbers are very general, they're not on a specific project, except with the European data, which is the foundation for the LCOE cost. That does, in fact, include actual cost of those projects, because they've already been constructed. But the US numbers are, at least the ones I'm showing, are general and projected.

Moderator: Another clarifying question?

Question: You mentioned the Jones Act several times in your presentation. Has there been any attempt to get waivers from the Jones Act? I know that those are possible. And so, if the

technology or the shipping doesn't exist here in the US, has that even been considered?

Speaker 1: No one has spoken to me about it. It doesn't mean it's not happening. But I know that our roadmap, which is crafted by DOE, NREL and all the developers that are on my board, indicate ways to accommodate the Jones Act, not to get waivers or to change the policy itself. So, people I think are generally assuming they can't get a waiver, and the policy isn't going to change.

Questioner: [UNINTELLIGIBLE]

Speaker 1: I'm not hearing that that's a possibility here right now. But it's not to say that people won't attempt that. But they have other political—

Questioner: [UNINTELLIGIBLE]

Speaker 1: Yeah, understood. But there are other political challenges that are probably, you know, right now trying to be addressed.

Moderator: Yes?

Question: You were saying that some of the European experience we're trying to learn from is relevant, and some isn't. Could you give a little more detail about that?

Speaker 1: First and foremost, the majority of entities right now, developers, I should say, are from Europe, and they're bringing their experience over. And their experience is really the technology and deployment in these types of waters, which are, you're out in the ocean, and what is the O&M experience? How do you conduct O&M on projects that are miles and miles offshore in very harsh conditions? That's not something that US has a lot of experience with, in at least the energy market. We might have it in offshore drilling, etc., but not in terms of servicing turbines. So, that's one example.

Questioner: [UNINTELLIGIBLE]

Speaker 1: OK, what the difference here is really the depth of the water. And that's one issue. Hurricanes, which have not been addressed, the technology in Europe, for example. Those are two. The vessel issue, a significant issue, which I know we just spoke about. It's not really the Jones Act, but also our ports in the US are not big enough to accommodate bringing in these component parts. And either because they're not deep enough, or because there are structures around the ports that prohibit large ships from going up and down, or coming into the port. And while it's not directly related to the actual energy aspect of what we're talking about, it is related to the construction and O&M of these projects, and a significant issue that's very different than Europe. Think about the ports in Hamburg or Rotterdam, which are massive and can accommodate the shipping vessels to carry this equipment.

Moderator: I'm not seeing any other cards up. We'll throw it to the next speaker.

Speaker 2.

So we have my slides up? You did have the right slides. Just to give you an example, since we talked about that GE turbine, that 12 megawatt turbine, it's about 850 feet high, or 260 meters, so that's higher than the top of the Golden Gate Bridge and about three times as high as the Statue of Liberty. So, these are really big. And the ARPA-E is now working on a concept of a 50-megawatt single turbine that would be 1,500 feet high, as high as the One World Tower in New York. It's quite incredible. So, thank you for having me. Pardon?

I was going to give you an overview of how all that offshore fits in. And I think it's a little bit hard to imagine because it's a fairly new technology. Worldwide, there's about 23,000 megawatts of offshore wind installed. It's all in China and Europe. That compares to about almost 600,000 megawatts of onshore wind, and the US is second in onshore wind. We have about 100,000 megawatts, that's about half of what China has.

But the US, because it has such good onshore wind resources, doesn't really have anything offshore right now, but that's going to change quite a bit. Worldwide, we've seen about 5,000 to 6,000 megawatts installed in a year. We have cumulative installations of about 23,000 megawatts. Obviously, you can see it on the colors, and I'm sure you can take the slides with you once they're posted. It's mostly China, UK and the rest of Europe. Looking forward the next five years, China, Europe, with a little bit US.

The US is changing quite a bit, and we have about 30 projects under development, about 28,000 megawatts in the various states. A lot of that is earmarked in Massachusetts, because there's a lot of grade wind south of the Vineyard. And just to be clear, most of these sites are more than 20 miles offshore, so they're beyond the visible horizon. So, you won't even see these wind turbines when you are at the shore. This is sort of interesting, because it shows you that New England has the best offshore wind resources in the country. They have some good off the coast of Northern California in terms of wind speeds and capacity factors.

But the attractiveness of the Atlantic Coast is that you have fairly shallow seabeds. You can really go 50 feet out and have, what, 60-feet depths or 100. So, it's really shallow, which makes it uniquely suitable. NREL has done a study of potential, and we have about 2,000 gigawatts of offshore wind potential. Some of it is in deep water, above 60 meters, some of them shallow waters, less than 60 meters. So, and a lot of that, as you can see here, is in and around Massachusetts, New England. Florida has a lot, but the quality of the wind resources in Florida, as you've seen on the slide, is pretty low. So, we have about 24,000 megawatts of state commitments to offshore wind right now. These are firm commitments.

That is up from 5,000 megawatts just a year and a half ago. So, a lot has been happening here in the last two years. Costs, these are actual contract costs that NREL has translated to be apples to apples because the PPA, as I will show you, structures very differently, and it's not always easy to take a contract price and figure out what the cost is, because the contract might include some things but not others. What you see here is that those orange dots are actually Vineyard Wind. They came in. The PPA price came in at $75 and $65 a megawatt hour. But if you take out the investment tax credit, you are sort of going in the $90 a megawatt hour range.

But what's most notable here is that you see how quickly these costs have come down, and this is almost exclusively driven in Europe by sizing up the scale of these wind farms, because if you have a 12 megawatt wind farm turbine, rather than megawatt turbine, you have much less construction costs. You have less transmission costs, because you don't need to tie together as many of these turbines, and that all gets you tremendous cost savings.

So, this I find interesting, because LP&L did this study on what is offshore wind actually worth in different locations? And they look at the historical data, historical energy prices, capacity prices, and direct prices in different places, and what you can see here is that New York and New England actually has a value of offshore in the

$100 per megawatt hour range, and that has several reasons. (A), there is not a lot of good renewables in the Northeast, so direct prices are fairly high. But we also have really high winter gas prices. You know, gas prices in Massachusetts might be $10-17 in MCF, during cold snaps, and that's where the wind output is the highest, in the winter months, where gas prices are the highest. So, the value of energy from these offshore wind turbines is actually quite high, and ISO New England has done a study showing that offshore wind would have made a huge difference during the last three cold snaps.

Quickly, about sort of some of these development and contracting structures. Everybody talks about the PPA, the big contracts, but these contracts are very different. In Massachusetts, there was a PPA for the energy and the reqs. But it excluded the capacity. So, if you see a contract price of $65 a megawatt hour, you know that the developer gets the capacity payment, and that's worth about $5-10 a megawatt hour, so the cost is actually not the 65. The cost would probably be more like 65 plus the capacity price. But there, the developer is only on the hook for the capacity payments, which might change over time, but it's a fairly small piece of it.

In New York, they have a fixed price minus an index for energy and capacity. So, there, the developer is on the hook for the energy and capacity prices that are determined in the market, but because the energy and capacity price that's subtracted is based on a hub price, it's not the actual energy and capacity revenues earned by the developer. So, there's a basis differential and a shape differential, because the actual output of one wind farm might be different from the other, which might be different from the shape that [UNINTELLIGIBLE] is using in that index.

Now New Jersey has a fixed price for the O reqs. There, the wind developer is on the hook for the actual energy and capacity revenues and how they fluctuate.

Then you have some merchant plants in Europe. You had bids for basically the subsidy above market prices, and the last few auctions came in at zero. Meaning the developers have bid to build their wind farm and interconnect to the offshore transmission grid without a payment beyond the value of the energy and capacity. So, energy in Europe is a lot higher, because natural gas is more expensive. But you can see that even though everybody thinks they are long-term contracts, the structure of these contracts is very different, and the risk profile is very different. And how to bid into such an auction gets very complicated, because you have to figure out the risk of doing all of that. Plus, you don't even know exactly what the project costs are, what the interconnection situation is. You have to do a lot of homework.

So, there's a lot of risk analysis going on when the level of the market prices, the basis differential, the shape risk, but also the market saturation risk. As we know from onshore, the first wind farm is doing pretty well, and there might not be much congestion, but as people are adding more and more wind, the capacity value of the wind goes down. The congestion prices go up. And this is all something people have to consider if they want to make, earn these revenues for 20 years.

The other thing I want to talk about briefly, to set Speaker 3 up for his presentation is, you want to bring these wind farms in with gen ties of one at a time. You know, the typical size of these wind farms now is 400 megawatts. I think a 230 KV/AC line to shore. You can get about 30 to 40 miles for one of those lines before you have to build another midpoint reactive power station.

And beyond that you're being into DC, but the real question is, do you really want individual gen ties? We're talking about 20,000 megawatts of committed offshore resources already at 400 megawatts at par. There are a lot of individual gen ties, and there are not that many substations near shore, on the onshore grid. So, it's really difficult. Or we have some stations, and luckily a lot of older and now retiring power plants were built near shore, so those are perfect points for interconnecting offshore grids.

But some of these power plants might have an inlet that only accommodates one submarine cable. So, it might be an 1,800-megawatt plant, but if you only can get one or two of these cables in, you're really wasting that resource with 400-800 megawatts, unless you build a higher capacity cable that can use the full 1,800 megawatts.

So, these are some of the issues. The wind developers today generally do not like [UNINTELLIGIBLE] of offshore grids, because it's a project on project construction risk. They don't control the development schedule of the transmission. There's some bad initial experience in Europe where these offshore grids, HVDC grids and so on, got significantly delayed. So, that there's an issue of how to mitigate that project and project risk.

But the advantages from a permitting perspective, from a cost effectiveness perspective of an offshore grid are quite compelling, particularly for the large build-out that we are now talking about. If wind is further from shore, you're better off having larger-scale transmission coming to shore. If the offshore wind farms are near each other, so you can have sort of a star configuration, where you can bring a number of wind farms into shore with one or two or three lines, instead of ten lines, that is great. Some of the offshore grid does not work in places like the UK, where the individual wind farms are far from each other, because the shoreline is so long, so connecting the wind farms offshore is too distant.

These are some of the considerations, and we have a lot more here, but you could get more redundancy building an interconnected offshore grid, rather than one gen tie at a time, because some of these shore-to-offshore lines can be shared by multiple wind farms, so you get reliability benefits from that. And if you have a looped offshore network, such as Atlantic Wind has proposed back in 2013, you can actually reinforce the onshore grid, going from Northern Virginia to New Jersey to New York, if you have an offshore backbone. It will actually be really helpful because the congestion and energy and capacity price differentials along that corridor are pretty large. So, these are all considerations, but as you can imagine, it's really difficult. It's a chicken and egg problem that how much wind do you need to have, and can you build these offshore grids in segments, so you don't have that much upfront cost, only to find out that you might have built it in the wrong technology, or the wrong locations ten years later.

But the other thing that is very important in several of the locations is, you can actually make the industry more competitive by providing offshore interconnection. The to-shore interconnection process, many of you know how difficult it is to just have onshore interconnection. You don't know the cost. You don't know how much capability there is. It depends on where you are in the queue, or you have no idea how long it will take for the ISO to build a transmission up.

So, there is a lot of risk related to transmission. Some of the big developers can manage that risk. They figure if they are first in, they get the best interconnection spots. But if you can create a structure where people can interconnect offshore, you can actually create a more competitive

auction for these wind farms. And you can also get more competition between the transmission developers, because the transmission developers may have more experience than the wind farm developer building the transmission. But those are just some of the considerations.

We pretty much talked about the pros and cons already. But just as a mindset, for 24,000 megawatts of offshore committed wind, you need about 3,000 miles of offshore transmission. And you really want to have individual gen ties that would require 60 landing points, and there just aren't enough landing points down the East Coast. New York is particularly tricky, because it has 9,000 megawatts of commitment, and very few choice landing points. Massachusetts and Connecticut is different. You have these substations and plants that were retired, so New England could pretty easily accommodate about 6,000 megawatts with individual gen ties.

So, the case for the need for an offshore grid in New England is much less than it is in New York, even though the cost savings and reliability redundancy saving competitive benefits would be there in New England as well. And interestingly enough, in southern New England, injecting power in southern New England actually helps the onshore grid as well, because it's a counterflow to existing congestion patterns. So, that works pretty well. Whereas in northern New England, Maine or New Hampshire, you would add congestion that is already, along the already very limited transmission paths between Maine, New Hampshire and down into Massachusetts.

New Jersey is unique, also, in the sense that the wind locations are in the southern part of the state, but a lot of the great interconnection points are in the northern part of the state. So, the individual gen ties might be much longer. But if you have an offshore grid, like what Atlantic Wind had proposed back in 2013, this is a configuration for 6,000 megawatts of interconnecting into various substations. You can see that the solution really depends on where you are, the size of the wind commitment and a number of other factors. In New York, I think that's most active right now, because of the big commitment, and there are some great substations that you connect into in Brooklyn and Manhattan, but you have to come in through the harbor, and you can only lay so many cables in through the harbor. So, you almost have no choice but to build an offshore collection point of some fashion. But [UNINTELLIGIBLE] is in the process of studying that, and maybe Speaker 3 knows more about it.

So, how does the offshore grid interconnect with the onshore grid? And that's going to be a real challenge. Individual gen ties are fairly easy, because we know how to do that. There's an old power plant that's retired interconnecting there works pretty well for gen ties. But the onshore regional planning process for transmission is already really messy. And the ISOs have no experience with offshore transmission. So, the wind developers get made nervous by the thought that the ISOs would get involved in planning an offshore transmission grid, because it might take a decade for planning and cost allocation and never get anywhere. So, there's a lot of worry about that.

Ultimately, I think we have to plan for that, and plan in an integrated fashion, because there's no reason why an offshore grid could not be used to reinforce the onshore grid. In Europe, for example, they've just studied interconnecting 450,000 megawatts of offshore wind resources to the grid, and it's basically a sort of star configuration, where the offshore grid is actually used to interconnect Europe, because there are a lot of countries around the North Sea, and by building artificial islands as connection points, and then big HVDC cables interconnecting the

different countries, we actually create not just an offshore wind integration system, but is actually created a more integrated regional European power market.

The US obviously doesn't have the same coastline as Europe, but ultimately there is no reason why an offshore grid couldn't interconnect New England and New York and PJM more strongly. But people want to don't touch that with a ten-foot pole, because if you see what's going now between PJM and New York with a few small HVDC cables, and the cost allocation mess that that causes, people don't want to interconnect. But it makes no sense to not interconnect New Jersey, New York and southern New England, because it's a triangle, and it's sitting right there with great wind resources. So, I think I'll leave it here. We'll hear from Speaker 3 on how these things are actually being planned.

Moderator: Clarifying questions? Yes?

Question: I think from your grid that all of the proposed offshore for the US are AC. Is anybody talking about HVDC multiterminal for offshore interconnections?

Speaker 2: I think the offshore grids that are being considered would be HVDC. So far, people have been able to get a lot more out of the AC cables than people thought was possible, including long distances, by adding a midpoint reactive substation. But once you get past 400 megawatts and past certain distances, I think HVDC is the more economic solution. But Speaker 3 probably knows more about that.

Moderator: Yes?

Question: I was a bit surprised to see the Chinese market numbers. Who are the leading developers and technology vendors in that market? And what are they doing that we could learn from?

Speaker 2: Well, central planning works pretty well for those things, I'm afraid. I don't think that many permitting challenges, but I think China is using that, (A), they have a lot of load growth, and they have environmental problems. So, I think they actually are very actively pushing both solar, onshore wind and offshore wind. They also build massive HVDC lines, like 6,000 megawatt HVDC lines from the northeastern part of the country to the southeastern part of the country. China, technology-wise on these things, and size-wise is really leaving us in the dust. As you've seen, they already have twice as many onshore wind farms as the US, but I think these would all be Chinese manufacturers, although maybe they're importing some of that.

Speaker 1: Yeah, from a cable perspective and the other components parts, what we're trying to do is encourage US supply chain as much as we can. So, of course, GE, as I mentioned, with the turbines, etc. So, we took Japan's place. But just one additional thought on the, I don't know, I can't think of the adjective, but the, at least for the European developers that are coming here, and the manufacturers, and the O&M providers, service providers, they have full on support from their governments, and that, the German consulate and Norwegian consulate, all these places are hosting supply chain forums and conversations between US state economic development offices and those developers.

I mean, it's profound. A lot of mission trips to see the actual facilities, both the R&D facilities as well as the sites, and then trying to encourage and foster deployment of that expertise and that technology to the US. Significant resources are going into the marketing effort, I would argue. Particularly for the European companies right now.

Speaker 2: But just to give you an idea of the size of this, with the commitments that we have, the 24,000 megawatts of offshore wind, that's about $100 billion of investment.

Moderator: I'm not sure who was next. I'll right to left.

Question: I'm sort of assuming that the gen ties will be used initially to interconnect. I'm wondering, of the 24 gigs, how many get lost. Would they expect to able to interconnect through gen ties? I guess the secondary question is, have there been studies on the increased cost of having this initial wave interconnected through gen ties, and then trying to put some other limited quantity interconnected through a grid?

Speaker 2: I don't think anybody has really studied that. Based on some of the work we've seen, I think New England could probably handle about 6,000 megawatts within individual gen ties. Might not be the lowest cost solution, but I think there are enough substations near shore that makes this possible. In New York, I doubt you can do more than 2,000 megawatts.

Speaker 3: I think that's right, and I'm going to speak to this in my presentation. But it is two different questions. How much electricity can we get to shore through direct gen lead lines? And how much should we? That is to say, to Speaker 2's point, that if you run a cable into a substation that can handle 1,200, 1,600 megawatts, you run an 800-megawatt cable in, and you can't get another cable in, you've underutilized that substation. And there's a variety of other reasons, which I'll speak to.

Moderator: Next?

Questioner: [UNINTELLIGIBLE] —to have, I'm sorry, trying to get to better understand your ultimate message to us on the subject of interconnection. It seems to me there are sort of two spheres. There's two ways to go. There's the gen over connection process. And there's the transmission planning process in PJM's case, the public policy project under the generator interconnection. If there are no generators, if it's a platform without generators, you get into the questions of hoarding, taking up a place in the queue that pushes out other projects. If you go to the public policy project, you get all the risk of the project being dumped on the customer. So, I'm trying to understand your message between those two spheres. What are you recommending we do here?

Spaeker 2: Well, I would recommend that the ISOs are more proactive about this and take the lead on visioning what a good system would look like. The process today is still very reactive. You have to have an interconnection request to do an interconnection study. And that's a queue, and so on. And that works OK for individual wind farms that are just there.

But the public policy process, for PJM to wait for the states to come to you and say, "Oh, here's the offshore wind that we want. Please study it for us." I wouldn't wait that long. You see it is coming. And so, I would say, could PJM decide to do a study on its own, say, here is how we think the optimal way of integrating these, you know, New Jersey alone has now 7,500 megawatts of committed wind. Virginia has about 2,200 megawatts. Maryland has I think 500 or something like that. So, we already have about 9,000 megawatts of offshore wind goals. And so the question in my mind is, maybe PJM can step back and say, "Look, let's proactively figure out what we think is the ideal solution for the onshore grid, and the offshore grid, and then shop that around and see if people like it".

Questioner: I understand we could do lots of studies, and we do lots of those. But you're still

not answering my question about, at the end of the day, somebody's got to put the money up to get this project built. And I'm at the point of, it either enters as a queue, as a generator interconnection, which the developer is funding the project, paying for the upgrades. But then I've got this problem of hoarding capacity in the queue, holding up things while it's waiting for generators. Versus, the state's taking all the risk. So, I'm just, I'm beyond the studying what's right, and I'm in the question of—

Speaker 2: Of cost allocation? No, I misunderstood your question. I thought you meant, what should PJM do on the planning side? On the cost recovery side, that, of course, is also a challenging question. I think the way it's done in Europe is really that the states and the onshore grid operators, or transmission owners behind them, they are building the transmission, and then you can charge them back to the wind developers, if you want to.

I think what California did with the Tehachapi model might be a good model, where CalISO and Southern California Edison built a CalISO plant, Cal Edison built the Tehachapi transmission system that was sized to accommodate 4,500 megawatts of wind without specific projects being real yet. But once you've built that, the wind and solar developers can now interconnect, and the project initially funded through a transmission tariff is then being charged back to the interconnecting generators. So, there are many options like that.

I think the states ultimately will have to decide that they want to provide an offshore grid, because it makes offshore wind more competitive. But somebody clearly has to be willing to take on these costs, whether you prepay them through the states, or through a new offshore transmission tariff, and then charge them back to developers, or whether it's just going to be postage stamped. There are many options like that. I mean, you can have a quest type approach to it, or you could have a Tehachapi type approach to it.

Moderator: I was reminded as you were talking about the CREZ process in Texas, and the MVP process that occurred in MISO to develop transmission.

Speaker 2: No, the MVP process is actually another very good example, where it is driven by public policy, but it's clear, it provides more than public policy, because the big reliability and congestion relief benefits from that. And MISO has developed a new cost allocation mechanism just for those MVP projects. With the agreement of the states. Actually, the state committees, the OMS basically came up with that in conjunction with MISO.

Moderator: Yeah, I would argue that the wind in the northwestern part of MISO in some cases rivals the offshore wind off of New England. So, it's a similar challenge. But there's nobody, there's not a lot of load in the northwestern part of MISO. So, it's also comparable in that respect.

Speaker 3: And then the KREZ example is well worth looking, and I will speak to that in my presentation.

Speaker 2: As we now know how Texas feels about CREZ. [LAUGHTER]

Moderator: Thank you. With that, let's move on.

Speaker 3.
Well, thank you. It's really a delight to be with you all. I was very sorry to miss yesterday's conversation, especially the environmental conversation. Earlier in my career, I was president of the Union of Concerned Scientists for ten years, and in the middle of those ongoing

discussions within the environmental community, and then outwardly facing. So, I was really sorry to miss that.

Let me just start with a quick word about my company, Anbaric Development Partners. This is a company that was founded in 2004 by Ed Kraples, who many of you may know. But more recently, in 2017, we struck up a partnership with the Ontario Teachers' Pension Plan, OTPP, which is one of the top ten public pension plans in the world. And it was a model that Ed was looking for that wasn't as impatient and as pricy as the VC model. So, there's more patient capital. OTPP has staked us to about $2 billion from their investment kitty to invest in projects we develop. They expect a less aggressive return, etc. So, it's a model that has worked very well, and really liberated us to go after the most optimal projects.

Anbaric itself, over the years, has codeveloped two fairly complex projects in New York and New Jersey, the Hudson and Neptune projects. Each of these projects brought electrons from Northern New Jersey over, in the case of Hudson, to Midtown Manhattan, in the case of Neptune, Central Long Island. And if you have followed us at all, you may have heard about some of our recent filings. In this case, we have proposed, through the Department of Interior, Bureau of Ocean Energy Management, we've applied for a right of way, right of use and easement grant to build what we're calling our New York and New Jersey Ocean Grid.

This is a proposed approach to a planned open access transmission grid. If you are a wind developer, and you successfully buy an offshore lease at auction through BOEM, you get an automatic right of way to shore for your cable. You still have to get it permitted, but it's assumed you get that right of way. This is an alternative pathway that BOEM created for, in this instance, an independent transmission developer like us to put our best ideas forward. They have a very extensive elaborate process for how you move through this permitting process. We've been found to be legally, technically, financially qualified.

They put out a request for competitive interest. This is a step that happened this past summer where they're basically saying, are there any other projects out there who think that Anbaric's project would impede the development of their project? And, in this instance, because offshore wind is so new, BOEM decided to add a bunch of questions to this step, bigger picture questions: Should we be planning transmission, for example? They got 35 comments. It's a great docket, if you have spare time and the curiosity.

Of those, we saw only three comments that actually cited competitive interest, and our personal view is, we didn't think anybody met what is a pretty significant bar. It has to be a major project. And they really have to show that our proposed project would impede theirs. And one very important piece of information here is, these are non-exclusive leases. And ultimately, while each of those light blue squares that you see is three miles by three miles, the ultimate right of way is roughly 200 feet wide. And so, it's a big ocean. You can put multiple cables out there, as you need to.

Just last month we filed an additional right of way, right of use application to BOEM for what we're calling our Southern New England Grid. And you can see from the graphic here that this works from the well-established lease areas off of Massachusetts and Rhode Island, and proposes, this is all HVDC system. And it's a little hard to see, but those triangles that you see adjacent to the wind energy areas are offshore collector stations. And you'll see a little bit later in the presentation that that technology is really advancing, and in Europe is developing as we

speak two gigawatt offshore collector stations, and DC technology has the advantages of being able to put more power on each cable, etc., with fewer losses. I'll speak to that a little bit later.

But the idea is that these wind farms can plug into this system through those collector stations, and we would run fewer cables to shore. This is another fun project that we're developing. This is on the site of the old Brayton Point coal and oil-fired power plant in Somerset, Mass., which has been retired. The company that is in this business of redeveloping industrial sites has bought it, more recently dramatically imploded the cooling towers.

This is a vision for at least our portion of it, a renewable energy center, where we would host a 1,200-megawatt HVDC converter station, and up to 400 megawatts of battery storage, which as you know, is an ambitious target. One of the many things this speaks to is the town of Somerset, which hosted this very large power plant, has been devastated by the loss of property tax revenue. And they are very excited about this idea. Community Development Corp., the company that owns this property, and we have an agreement in place for this particular project, which would only take a fraction of this acreage. So, you can see a broader vision for renewable energy on that site.

In the recent New York procurement, the first-round procurement for offshore wind, we as an independent transmission developer, we're not eligible to bid. And this has been the case, and the wind developers from Europe coming over have successfully convinced the state procurement officials up and down the Eastern Seaboard, in the first round, that transmission and generation should be bundled. And that they should be able to own, build, finance, etc., those pieces.

In the first round, we want to build offshore transmission. So, we talked to the various eligible bidders. And by the way, to be eligible, you have to own an offshore wind lease that you procured at auction through the Department of the Interior. And in the instance of the first round of New York, Vineyard Wind asked us to come aboard, and we partnered on a project called Liberty Wind. Which comes from, it's a little hard to see from the graphic, but their second newer lease area, 0522, off of Massachusetts, and would run 170 seabed miles, and land on Jones Beach in Central Long Island, run 17 miles up into the Groden Road substation. So, a little bit more as we go along.

This is really the thesis for my talk this morning, that how often do we have a chance to build a new economic sector, a new energy sector, from scratch? Very rare. The closest imperfect analogy is the dawn of the commercial nuclear reactor, commercial nuclear power industry, and there are parallels in terms of the NRC had to develop the rules, the state regulators, and the PUCs and DPUs had to develop the rules, and so on, as well as the combination of public/private investment had to work its way through.

Core to our thesis is that, in fact, we have to do the planning now for transmission. And that if we don't, we're not going to achieve these lofty targets, which by the way, have rounded up to about 26 gigawatts, with New Jersey's raising it to 7,500, and we expect that those numbers will continue to grow. And our view is that we will never achieve numbers on that magnitude unless we do this thinking and this planning today.

Just a quick note on the economic opportunity, and my co-panelists spoke to this. This is from Stephanie McClellan at University of Delaware. She has projected there's $70 billion in capex for both the transmission and the generation components between now and 2030, based on, at

least the goal is to have a timesheet to that analysis. Stephanie has also teased out the number 40,000 jobs between now and 2030.

And the Workforce Development Institute in New York did a great piece of analysis where they looked at the many different occupations that are needed in this sector, and you see just a glance there. My background primarily is in government and the nonprofit sector. This is my first foray into the private sector. Coming out of the Department of Energy in the second Obama term, I was really convinced that, in many respects, it's up to the clean-tech sector, the big strategic corporations, to really drive the acceleration and the deployment of clean energy technology, to help us bend the carbon curves down.

Given that background, I always think in terms of what is in the public interest? What are the public policy values that we're thinking about? And I actually do believe that that makes for good business sense. And so, I won't walk through all of these, but Speaker 2 talked about competition, and how that has been key in Europe to driving down prices and creating zero subsidy bids. Affordability is very key here, and I know that's on the mind of many of you. If we don't get that piece right, if we load up ratepayers' electric bills, that's going to be an issue, not to mention a regressive one.

The three Rs or reliability, redundancy and resilience, as you know, they're cousins, but they mean distinctively different things. Reliability. Power has to be able to get to shore. We have to keep the lights on. Redundancy, what if a single cable goes down? What if an offshore platform goes down? What if an onshore converter station or substation is hit by a hurricane or a physical attack? We have to think about redundancy. And of course, resilience. Increasing intensity of tropical storms is a particular issue in the northeast. We think we can design and plan to a lot of these values to improve things.

And then over on the right, the concerns that are popping up, particularly in the fishing community, are understandable. You have a commercial fishing industry whose stock is under great stress because of overfishing, because of warming waters, ocean acidification, and other factors. And now we're telling them, we're coming right into their fishing waters with some of these very dramatic and large wind farms. We have to address that and shoreline communities, once you go onshore. And when we talk about an offshore wind grid, what we really mean is both the offshore infrastructure that we'll build from scratch, and the onshore grid, and I'll come to that in a moment.

So, this issue of bundling transmission and generation is something that we've resolved onshore, really going back to 1996, maybe before, where FERC was concerned about the same entity owning the power plant and the wires, about monopolistic tendencies. You might charge your competitor more. You might block them out from access. This is an issue one of you raised. We think it's worked fairly well onshore, and it ought to be applied offshore.

This is just a little more text behind those. That was from FERC Order 888. This is a simple graphic, but kind of makes the point that if every single wind farm that gets an award from the state runs its own line to shore, it's going to look like what's happening on the right, and you're going to have multiple pitched battles to get those cables to shore. You're going to have, we think, inefficiencies all up and down the coast, as opposed to on the left, where you would plan a system and run in fewer cables. One of the reasons you do this is because in the northeast, it's highly developed. And I have the company lead in New York, so I spend a lot time thinking

about this. On the right, this is a terrific graphic that shows everything, all the business and conflicts that you have in, coming into New York and New Jersey harbors, New York City harbor and parts of Northern New Jersey. The yellow, those are shipping channels.

You have pilot boarding areas, that you have historical here. You have Department of Defense taking training missions through, over much of this territory. That yellow dot is unexploded ordinance from World War II. But just to give you an idea that this is challenging to come into. And then, over on the left, this is coming into New York Harbor. You've got to come up under the Verrazzano-Narrows Bridge. And if you were to take out the shipping channel, and you would take out other existing utilities, pipes, cables, other things in the sea bed, you don't have a lot of elbow room, and we'll be fortunate to get one significant cable up there, maybe two.

This speaks to the very issue, because some of the best substations, Farragut, Gowanus, and on up the Hudson River, are right up through this channel. Speaker 2 covered a lot of this. This is just our particular take on it. Another example of what we call a spaghetti bowl of lines. And I won't repeat a lot of the points that Speaker 2 made. I think the last two bullets, though, are important, that there is a high incentive for the developers. We would do the same. You would pick the best interconnection position with the lowest upgrade cost, the easiest access, and you would incorporate that into your project. And if you got the award, you would very likely be taking that option off the table. If you're underutilizing it, both in terms of existing paths, and the ability to upgrade it to what we sometimes call a superstation, two gigawatts or more, it would take that off the table. And this is just the flip side of the coin, the various benefits.

Another way to think about this is, these are the benefits of planning. General Dwight Eisenhower famously said that planning is essential, but plans are useless. I think he slightly overstated that. He was talking about the fog of war. There's no reason why we shouldn't be planning in depth right now to each one of these values. And we think you can do it in a way that, as you lay in the first two rounds—really, the first procurement round—and we expect probably the second procurement round that's coming. We will still see the bundled and gen lead line approach.

Even there, we should be thinking about creating optionality for future expansion, and then we think we can plan this in a way that you can do it in a staged way that pays attention to these things. The states are actually giving serious thought to this. And these are three examples. Governor Cuomo, in his state of the state address in January directed his team to actually start thinking about planning. And I served on the New York Public Service Commission and so on, are doing this work. The PSC and the NYISO actually have an open public policy transmission planning process, where they did not start out thinking about this, but received comments from us and others. We hope that they are.

In Massachusetts, the signals are likely heading toward a transmission-only procurement as a next step, having done their first two rounds of generation procurement. And in New Jersey, same signals. There's a bill moving through the legislature right now that would authorize offshore wind transmission facilities to participate in procurements, and qualify for the O reqs in New Jersey, that it's the Assembly, this notes that that bill was unanimously ported out of the Senate Environment Public Works committee, and Assembly committee just did the exact same just yesterday.

So, tale of two states, and this speaks to CREZ, and no, it's not completely apples to apples. But it was an effort, a prescient effort by the legislature in the State of Texas, starting 2005. It was a multiyear policy formation, created competitive renewable energy zones and put in place a process for planning and procuring the transmission for their wind fields in North Texas, North and West Texas, where they went ahead and procured and built the transmission first, and then they followed that with the generation bids.

We think it's no excuse that Texas today has the highest amount of installed wind capacity in the country for the full quarter, 25,000 megawatts, 46 billion in capital investment. And then this last statistic is very key, $370 million annually in payments to ranchers, farmers and to property taxes for communities.

The issue in Maine, Speaker 2 referred to this, that the transmission infrastructure in Maine is extremely antiquated. It's not even connected north to south. So, Maine came out, in 2015, with a target, and they've updated it more recently with a new governor. But they have stumbled against that, and a number of wind farms have been cancelled because of transmission challenges.

I won't spend a whole lot of time on this slide, other than to say, you know, we're constantly thinking, alright, if the states or the feds agree with this idea, how do you do it? We think there is a step-by-step approach that you can take. This came up in the clarifying questions. The situation with the cabling technology, and with the transmission technology, is that innovation continues to proceed apace and give us option. So, AC was always considered good to about 50-60 miles. The winning Orsted bid in New York is 110-mile cable with a midpoint, AC cable with a midpoint compensation station. A brand-new approach and pushing the envelope. DC, again, the technology to handle more power over and over at an existing collector station and on cable continues to increase.

But basically, this says, you want to customize your technology choice to your need. And in our Liberty Wind proposal, we were coming a long distance, but by using DC technology, we could go to a 1,200-megawatt project, fewer energy losses. Vineyard's lease area actually had a superior capacity factor to some of the other lease areas.

And those combinations really put us in the competition price-wise with, say, the Equinor project, which was 40 miles off the coast of New York. But the real story here is innovation, and it's very important that government, corporations, the key universities continue to invest. And this is where Speaker 1's organization is so important.

I mentioned the TenneT two gigawatts, Equinor's Dogger Bank project off the northeast coast of England features three 1.2-gigawatt entry DC systems. Onshore, where frankly a lot of the project risk is, trying to bring this cabling infrastructure through Brooklyn, onshore to Brooklyn and tying up to a substation on Staten Island, or even parts of Long Island. The communities are going to be very concerned. It's not just landing and burying a cable coming up. But it's these onshore converter stations, or in an AC configuration you'd have, you'd need some kind of compensation set-up.

So, this is just a fun example of architecture getting into the game of designing these substations in a way that are much more attractive. This is one of ours, intended for the Deans substation, a project we have in New Jersey. It's designed to look like a very nice barn.

Battery storage we haven't talked a lot about, but it's a very important piece of the puzzle. Because of the intermittent sea of wind, we think there's real opportunity to fold in battery storage into some of these projects. This is out in Long Beach, a battery storage building. People are always curious what they look like. This is 100 megawatts of battery storage. So, again, a nice box store or maybe office park building. There's lots of ideas about designing this offshore grid. This is borrowed from ABB showing different configurations, again, driven by the resource, driven by need. This is from Pterra, and I wanted to include this in part because the idea of dedicated receiving substations is an interesting one. And you can see why the regulators and the authorities are a little concerned about picking winners and losers, because any one of those substations has ownership, has people who benefit from it financially.

But, at some point we do have to make choices. And right now, those choices are being made by developers, which is fine. But we think that we can do better. So, this is an imaging of a 6,000-megawatt offshore grid, fully built out. It would be built in stages. But it's a helpful graphic in that you can see a couple of the principles illustrated here. So, you see those HVAC collector stations. So, each of those wind farms would send their tethers in from the turbines onto that platform, and then you see that those, then, are concentrated into three HVDC platforms. Those AC platforms are connected between themselves. And that gives you a sense of redundancy. The DC platforms allows us to run three cables to shore for seven wind farms instead of stubbing the cables.

And then you see an illustration, as you're closer to shore, of the fork splicing and coming into a couple of substations. This is obviously simplistic for the purpose, but you give your grid operators some real options here. If something went out onshore, they could even use the system to wheel around power to another point onshore. That gives them some redundancy options if things get knocked out. Thank you..

Moderator: Thank you. We'll start the clarifying questions.

Question: I think it's a clarifying question on your last concept. Can you give us sense of sort idea of the miles offshore where some of that would be?

Speaker 3: Yes. So, as Speaker 2 said, most of these wind energy areas are, the closest in I think is the New York, Equinor is 15 miles offshore, at the closest. So, on average they're probably starting at 20, and they go out another, what, 20 miles, something like that. Another 20.

Speaker 2: Just because you're offshore 30 miles doesn't mean you need 30 miles of transmission, because the Orsted project off Martha's Vineyard might be 30 miles or 20 miles off Martha's Vineyard, but then they need 120 miles of cable to get to Long Island.

Questioner: So, the wind is 20-40 miles offshore. In this concept you'd have these HVAC collectors, sort of somewhere closer to the shore. Right?

Speaker 3: No, the AC collectors would be—

Questioner: Kind of right by the wind?

Speaker 3: Cheek to jowl, right next to the wind farm.

Questioner: Gotcha. OK. And then the DC would be about in that neighborhood as well?

Speaker 3: Here, it's a little tricky, because you want to site your DC platform at an optimal

location where multiple wind farms can plug in. And you see in our earlier graphic of our proposed ocean grid. We made some educated judgements as to where that would be. And then by the time we get to permitting stage, we have to do environmental assessment, we would have to make firm judgements. We would have to tell BOEM exactly where we would site them.

Moderator: Yes?

Question: You mentioned the connection in Massachusetts. If I remember correctly, there's an existing HVDC line in Massachusetts that was originally envisioned as a multiterminal HVDC but was only ever built as a two-terminal. Did you guys think about trying to get all the way to that and connect with that, and sort of perhaps take advantage of existing HVDC infrastructure onshore?

Speaker 3: I'm not as familiar with that specific line. But that's certainly the idea with the Brayton Point facility, which had at least a 1,000-megawatt Brayton Point fossil generating plant. So, you have the existing infrastructure there to an existing substation there. And you have pretty good access. But it's interesting to watch how the Vineyard Wind, of course, won the first 800-megawatt project off of Massachusetts coming into Barnstable Harbor, and then the project they just successfully bid into Connecticut, another 800 megawatts, they're also coming into Barnstable Harbor. So, everybody's trying to assess the existing infrastructure. Will it meet their needs at lowest cost, and you know, politically, a small P, can you win community acceptance? It's all those factors.

Speaker 2: And one thing to mention, also, in Southern New Jersey, the retirement of the Oyster Creek nuclear plant, which was right on the shore, provides a great interconnection point for new offshore wind.

Speaker 1: Yeah, it's interesting. I'm sure you know Pilgrim recently closed. Mystic is closing. All of those are interesting locations from an ocean perspective, but the issues with interconnecting there are complicated, and so, while they look ideal, they require upgrades and all sorts of things. And maybe we'll talk about this if people want to, but one of the challenges in New England is that the ISO is not looking at the picture comprehensively. They don't have the mechanism to do that. And, so, they're not doing the comprehensive work about how to integrate offshore wind. It's not incorporated in their planning process.

Question: Can you expand a little bit on they don't have the mechanism to look comprehensively?

Speaker 1: Yeah, I think they will, so for example, the ISO has joined a ten-year process, I was working on it in my last job, which I left in September, So Speaker 3 may have a better update. But, at the time, they would not recognize planned offshore wind unless there was a signed contract. So, mandates were not part of the planning process. And they would argue that they don't have a mechanism to do that.

Which means right now, for New England ISO, at the time anyway, in September, they were looking at 800 megawatts of offshore wind that would be installed by 2028 or 2029. So they need another mechanism to look at what's actually mandated, and maybe it doesn't all happen, but yet it is being planned. And so, there's got to be something in between, I would argue.

Speaker 3: Well, as you know, the ISOs, the RTOs are strictly governed by their tariffs, which are developed incrementally over time through extensive stakeholder processes. And we're actually engaging in those multiple places, trying

to move things along. The current system of individual developer, whether it's a generator or a transmission company, applies for interconnection position, goes through that study process, is responsible for the upgrade costs, etc., works to a point, and you know, we and our investors understand we'll be on the hook for probably fairly significant and certainly in the hundreds of millions of dollars of upgrade costs for these projects as we build them.

But where that process falls short is, there are many instances where if you were going to do a planned approach onshore, you would say, "You know what, we need to have this additional connection that no individual project's going to foresee." So, an example is in New York. The grid interconnections between Long Island and New York City are weak, and between Long Island, New York City and Upstate, the Hudson River Valley, are weak. No individual project is going to do that. And if you actually look at the average load in New York City and Long Island, is almost, just shy of 9,000. It's like 8,500 megawatts. 90% of time it's below the average load, average low load, and so, if you're going to bring 9,000, the only place to bring 9,000 megawatts into New York is Long Island and New York City. And if you're going to bring that to shore, you've long term you've got to sort that out. You've got to be able to get that to Upstate.

So, to your point, the existing process is falling short. It doesn't mean it can't be fixed. And I think everybody's kind of feeling their way, and I know the NYISO has gotten a lot of encouragement to use their own public policy transmission planning process to actually get at this.

Speaker 2: Yeah, I think the New York ISO's new public policy planning process is sort of a mechanism that can be used for a lot of this. This is much better than anything else we have on the east. The MVP process that MISO went through worked really well that way. How the CREZ project came about. But without leadership from either the states or the ISOs, none of that will happen. And the ISOs are hesitant to get involved, because the states don't always agree on things, and three states might want the ISO to study that, and the other number of states don't want the ISO to spend any money on studying that.

But I think this is a real opportunity for the system operators to show some leadership, because it is their system, and it's going to be Balkanized if we don't have a vision for where this should be doing. So, I think hiding behind a tariff which specifies what they have to do is one thing. But the tariff doesn't specify what they can do. And that's where the opportunity is.

Moderator: Who's next?

Question: I want to make sure I understand the model that's being proposed. It sounds to me like what you're saying is, instead of the offshore wind generators getting together and selecting a developer, what you're proposing is like a gas pipeline model, where you build it, you own the capacity, and then they will come. Am I getting that? Could these projects hire you? Maybe this is clarifying. I just want to make sure I understand the model.

Speaker 3: So, the answer to the last question is, yes. And that's what in fact happened in the Liberty Wind bid into New York, where we didn't have standing to compete, and it was interesting, because the New York PSC, in writing the underlying rule that authorized NYISO to offer procurement, took pains to say that only wind generators with a federal lease are qualified, but that they may partner with a transmission developer. And the truth is, these are the complex projects, and the generators at

the end of the day will be the EPC, and they will hire contractors across other cabling companies, and they'll go to Siemens and ABB for the offshore platforms, and so on and so forth.

Speaker 2: I think the real question is, does one transmission line go to one wind farm, or can you build shared transmission facilities that are shared by multiple wind farms? And that's where the economies come in. That's where the offshore reinforcing onshore grid comes in. That's where these kinds of solutions provide you a lower cost option, a more competitive option.

Because all these wind farms out there, they are competing with just interconnecting offshore. Whereas, once you get to shore, then the guys who come in first have the right of ways. They're using their right of way. They're excluding others from coming into the same substation. It gets very complicated. Massachusetts is considering a two-round bidding process, where the first round would bid for an offshore grid, and then the second round, individual wind developers would make two bids, one with their own gen ties, and the other one connecting to that offshore grid. And then the states, through a selection process, could figure out what's cheaper, whether you want to have individual gen ties, or whether you want to use the offshore grid selected in the first round.

Moderator: That question was of great interest to me, because I'm looking at this slide, and I'm going, that's the gas model. And, we'll probably get to this later, the gas model, when you get a new pipeline transmission system, you generally have a bunch of producers who need a place to go with their gas, or you've got a market that needs gas. And which do you have here? Maybe a combination of both

Let's take a break.

[BREAK]

Discussion.
Moderator: Alright, let's start.

Question #1: OK, thank you. And Speaker 2 and I already started this conversation. But I'd like to clarify what, at least in my mind I think the issue is, and more importantly what it isn't, and to get the panel's reaction to that, and frankly give you some of the real-life things that we're struggling with on this.

Issue one, to me it's not an issue about offshore wind, is it interesting or not? Is it good or not? I think it clearly is an intriguing technology. Unfortunately it gets often simplified to offshore wind, are you for it or against it? And I don't think that's the issue at all. I also think, in all due respect to my friend here, I don't think it's a leadership issue. I think it's really about what restructuring often was about, which is allocation of risk. OK? I think at the end of the day, that's the thing that it's about.

What I actually find, I'll give you the pros and cons, what I find very intriguing about this concept of a platform, which Speaker 3 sort of started with, separating out the requirements of generation and transmission coming in, the concept of a platform that's intriguing is, today the interconnection system, people are paying for upgrades to a system that was built and paid for by the ratepayers. At a very dear price by the ratepayers over the years. It is intriguing to get a grid built in the ocean that would be just not totally paid for by the customers, but actually the risks fall on entrepreneurial developers like Anbaric.

So, at least to me, and we've argued a lot about this in PJM, that's been a very intriguing concept. I can get a grid built. I can do it through the risk on the developer and the reward on the developer,

as opposed to the traditional systems. So, that part is very intriguing. The challenge is, you've got two ways you can do this. One is, back on the backs of the customer, through the planning process. We have a state agreement approach, we call it, where the states agree to pay for it. Offshore wind grid is risky, and I would just be going back to a system of, they would bear all those costs and all those risks, and frankly, I haven't had many states, including states that are very pro offshore wind, particularly wanting to bear that cost, nor do I think they should. So, that's one issue.

The other way to do it is the generator interconnection queue. OK? Which a merchant transmission can also participate in. The problem is, if you come in just as a transmission developer, without any generation under a build-it-and-they-will-come philosophy, that's great. That potentially bears the risk. But the way the queue works, you use up headroom. You are taking a position. And then the question is, how long do I hold that position open for you? What you're doing is, you're really hurting all the people later in the queue, which could be offshore wind, onshore wind, etc., because the headroom's now been taken up.

You could say that exists today, but in offshore wind, at what point do I say, "You know what? You held it long enough. I'll pulling the project. You're out of the queue." I can do that for onshore, but it's a little more difficult for offshore. So, these are some of the dilemmas that are: How do we, in my view, appropriately deal with the risk allocation, award entrepreneurial efforts, but on the other hand, not really hurt other developers, given that transmission interconnection in New Jersey is a scarce commodity? The system is conjected. So, holding a position in the queue really does have an impact on lots of other people. So, I welcome the panel's—

Respondent 1: I'm just going to comment from the perspective of my prior job running a small transmission company in New England. That problem, as you just said, it happens now. People hold queue positions for giant transmission projects, at least in New England, and sit on them.

Questioner: It's a huge problem. MISO has a problem. We have that problem.

Respondent 1: You know, this is no different. It is a challenge across the board.

Questioner: Why make it worse, is the question.

Respondent 1: Well, but I don't, not necessarily. I don't think it's fair to say it's just an offshore problem. It's a problem across the board.

Respondent 2: I also think that just because you get an interconnection request from a gen tie with a generator at the end, we know that only about a third of all interconnection requests ultimately get realized. So, the question is, is somebody who has a good transmission solution to a wind lease area with a number of leases, is that any less likely going to be realized, and an individual generator.

Say there are five generators competing for one RFP. All five submitting to connection requests, but only one of them is selected. I mean, the other four won't get realized. And you don't know whether the first one in the queue is going to be the one being selected. And the other thing about headroom, I have to say, is yes, every time you award an interconnection request to a generator that isn't getting realized, you take up headroom for the next one. But by ending up with an inefficient solution, you use up headroom by virtue of a piecemeal approach. If one were to put out a vision or what an efficient solution for limited interconnection onshore and a lot of

offshore wind would look like, that's how you create headroom, and I think that's where I think the vision should come in.

And of course, you have to deal with risk allocation, cost allocation, and so on. But risk and cost allocation is much easier if people have a vision of what an efficient system looks like, rather than doing it piecemeal, one project at a time. And we don't have anybody, other than some developers, who have their own interests to lay out what the vision of an efficient way of doing this should look like.

I think once you have a vision, you know, that was the case with Argos, that led to MVP, where people can visualize, yes, this makes sense, and it makes sense from a system perspective. It makes sense from an individual perspective. And with a good vision, you can rally people who come together, and that makes cost allocation and risk allocation easier as well. But without a good vision from a neutral party, like an ISO, this is much harder.

Questioner: If I could just follow up, go ahead.

Respondent 3: I know you want to respond. But, first of all, absolutely, you're asking the right questions. And I started out by saying that the authorities at the federal, regional, regional being the ISOs and the RTOs, state, etc., levels are not fully realized in offshore wind, because it wasn't anticipated seriously until about a decade ago.

And so that's where we, that's exactly where we are at. I don't know if this is a proxy for leadership, but policy formation is key to this. No merchant transmission developer will get the chance to build even a first installment of that vision without policy, that is to say, a state procurement, in this case, that ran a transmission-only procurement, and invited the best ideas. And then earned an award. So, the policy has to continue to evolve, and as it does, that should give some comfort to those of you really responding, with a great responsibility of managing the grid.

The other thing I'd note is, as you well know—and I'm more familiar with the ISO rules than the PJM rules—that process comes with expense and timetables. So, the timetables are fairly generous, but still, certainly for an independent developer like us, that's very pricy. Just going through the study process, and we probably hold ten interconnection positions, maybe eight in New York alone. And each one of those, hundreds of thousands of dollars actually move to the study process, etc. And then we're on a clock. We have to be able to deliver at some point. I know that that can be flexible. And then I think that is right, the points that my colleagues have made, that it does exist today, as you acknowledge. It doesn't mean it shouldn't be addressed, is all.

Questioner: It seems to me the nub of the issue is nondiscrimination. We are required to run an interconnection queue on a nondiscriminatory basis. There may be good arguments why offshore wind should have additional flexibility, additional relaxation of the timelines, but that case is not clear, and then it has an effect on everybody else. So, I think the policy issue is as much, not offshore wind is it good or not, but also, how do you apply the nondiscriminatory provisions of the Federal Power Act to offshore wind competing with other offshore wind projects, competing with onshore, when there's one single queue?

Respondent 1: I'm not answering your question. I'm just going to propose something, maybe a couple of people can respond to this. New England is about to issue really its first competitive solicitation for transmission, not related to offshore wind. And it goes through the process. It's the first time. It will come out, I think it's coming out on the 20th, I believe. Why

can't FERC's supposed support of competitive transmission solicitation procurement work, because everything is being bundled out of state, and therefore you can't have the ISOs issue a competitive solicitation?

Respondent 2: An [UNINTELLIGIBLE] tariff is different. The New York tariff for public policy projects, which they just recently created because the old tariff didn't work, is a great model, because they are bidding out the need. So, people are bidding in solutions rather than bidding in specific projects. And I think that is a great way to do, because you might get ten different solutions to address that need, and the creativity of which solutions people can come up with is a big advantage.

I think ISO New England has that flexibility. They haven't used it. But PJM actually has that ability, too, but MISO SPP, CalISO, for example, they bid out the projects that the ISOs design. But I think this is bigger and different, that we have to go beyond what the existing tariff provides.

Moderator: I appreciate you bringing up risk, because I think that's, to me, huge. I mean, the role of the competitive market was companies willing to put up at-risk capital, and I look at what's going on today, and to find something that's really at risk, I don't know where it is. I mean, everybody's got to have a PPA, and it sounds like some of the states are going to be putting up some money. Are there any provisions in the interconnection queue, and this is not just PJM, if anybody knows about anything else, a proposal that's more at risk gets better valuation results than something that's not at risk.

Comment: [UNINTELLIGIBLE] I mean, for example, North Carolina. Right? The assessment was done looking at what transmission was needed in addition to the resources that were going to be integrated. Is that your question?

Moderator: No, it's a much more 30,000-foot question. What if a proposal, under an ISO planning process, is going to be folded into an ISO tariff rate? The consumers are going to end up paying over 30 years, whatever the number is. If there's a proposal out there where the developer is willing to actually take the risk, in essence a merchant type of project, does that get better treatment in the evaluation of the queue process?

Respondent 1: Again, I'm going back to something I haven't done in six months. I thought the scoring in the MISO process took, I'm not talking about offshore wind, I'm just talking about transmission, when you submit a proposal through the process, the scoring for project, you got a better score if you took on more risk. I thought like that was one of the criteria, if I recall correctly.

Comment: Well, the short answer is yes. And the form of risk you take had to do with the way in which they were being paid for at some level, that the degree to which the developers were owning the risk of coming in at the cost that was bid, drove some of the scoring and ultimately drove some of the results around the Duff Coleman award. I was only tangentially involved in that. But I think it's an interesting question, and I do have a completely different question I want to get at some point.

Respondent 1: I'd like to just hang on for a minute, because that's for the transmission solutions, and we're not talking about transmission solutions, as I understand it. We're talking about generator interconnections.

Commenter: Exactly. That's exactly what I was going to say.

Respondent 1: And so the way it works is that you have couple of options, California being one that has a location-constrained resource interconnection that would say if there's enough commercial interest, we will build this line on the backs of the ratepayers, essentially. But absent that, absent enough interest, commercial interest, where the expectation is that the queue is open, the projects compete. Right? And you get different, ongoing improving levels of a knowledge about the project, knowledge about the cost of the project, knowledge about the developer's willingness to hang in there financially. And it isn't until those projects are commercially operated that they would actually get reimbursed in any sort of way from a ratepayer. So it's the risk management by the developers that hopefully creates the discipline of moving toward real projects, getting through a very clogged queue and a very clogged [OVERLAPPING VOICES].

Commenter: And just picking up on that, I don't, for the purposes of interconnection, I don't give a preference. Again, non-discrimination. I don't give a preference for, well, that project, they're really on a lot of risk. This competitor to a project is heavily state-subsidized. For purpose of interconnection, I don't get into any of that.

Moderator: To be clear, nor is MISO or any RRTL that I'm aware of.

Respondent 1: If you're heavily subsidized, your ability to maintain and manage that financing will push you through.

Commenter: Right, but for purposes of running the interconnection process, none of us—

Moderator: You can take up a queue position without, that's assuming risk.

Commenter: Well, no, not so much in MISO anymore. You have to put real money up sooner or later.

Respondent 1: But that's the point of the milestones.

Moderator: I'm talking about the bigger picture of risk of the project. But I could go in with this one forever. I wouldn't do, but I'm going to just do my job here and go to James.

Question #2: [UNINTELLIGIBLE]

Respondent 1: Well, we think that the long-term contract, the lateral contracts, are not an efficient solution to go about procuring all that wind. What's missing in the wholesale markets is a clean energy project, whether it's a capacity-type product, or just a carbon price, although carbon prices have a hard time getting financed, because they can change so quickly with people's policy changes.

So, we think there has to be some sort of forward clean energy product that is more sticky than a carbon price, that people can finance, similar to how people finance capacity, an ISO New England forward capacity market. And with that, I think offshore wind is in the money already. And it's continued to come down in costs. You see that in Europe that a number of bids, not including transmission, I have to say, and transmission is about a quarter of the cost of these offshore wind projects. A number of competitive bids have won purely based on market revenues, without a premium being paid. So, it is coming into the market, and I think it, that's a way to go about it. Now, the states still prefer carve-outs and PPAs and so on. But the PPAs are getting better, too. So, there's some hope.

Respondent 2: That's a very good question. And you're right. Here we are in a kind of evolving,

transitional moment, and so how far will costs come down? How much will innovation, technological innovation, systems management innovation, planned transmission approaches squeeze efficiencies out as we go.

But you started by flagging carbon pricing, and again, we're in an interesting place where you have a fairly mature climate change and clean energy public policy infrastructure. We don't have a national price on carbon. We don't have a national cap and trade. But if you look across the landscape, it's also uneven, of course, state to state. You've got really interesting policy infrastructure. If you look at New York, there is now, as a matter of law with the new climate bill, a target of 80% reduction greenhouse gas emissions statewide by, I think it's 2050, and 9,000 megawatts of offshore wind. That's codified. There's a Knox ruling that's knocking out the fossil peakers, there's a 1,500-megawatt battery storage target, and so on. And then you go to New York City, and you see a mirror of a lot of those policies.

But you're right, nowhere in there is a natural carbon tax or a cap and trade, although they participate in RGGI. So, that to me is an interesting thing to watch over time, because you could argue that the public policy goals at reducing carbon is worth some level of premium. But that has to really translate into reality, and it ultimately has to be fair to the rate payer.

Moderator: I guess one could say long lead times cold work to your advantage or disadvantage in policy changes.

Question #3: Except for one picture, I think it was Brayton Point, that you showed, Speaker 3, I didn't hear the word battery in this conversation. And you'll hear and read a lot about why batteries are terrific, but you can't make any money in the market, so everybody should be required to buy them. That's a policy discussion which goes on all the time, and I think most of those arguments are fallacious. And I'm a battery proponent. I've worked on with my colleagues in the School of Engineering, I try to get cheaper batteries. And it's really depressing, because it's hard to get batteries that are cheap enough to actually be justified. So, that's a problem.

The one area that I still have hope for is this area. Because you can see, I haven't added up all of these wind facilities out there, but I'm assuming that sometimes you're going to be generating more wind than the transmission connection can take. And then the marginal cost of the energy from the wind is zero, out there in the wind farm, because you're essentially curtailing the production, because you can't put it through. But if you had batteries, you could buy it for zero, and then you could sell it later on and do the price arbitrage story. How do batteries fit into this story here?

Respondent 1: We do have batteries, for example, on our roadmap as a technical challenge that people could come in and make proposals to. And to date, out of 40 proposals, I have none. Which is fascinating to me. It might be that that community, they're still a siloed community in some ways. I don't mean batteries in themselves. I just mean like people think about these things in silos, and they're not, in the big, macro picture we're talking about: "Oh, yeah, it makes sense."

But in terms of research and facilities, I'm not seeing proposals that combine the two, which is unfortunate. I have heard that some of the developers, I think National Grid and a few others, have contemplated batteries in their projects, part of their projects. But the size of the projects are so enormous that I don't know how many batteries you'd have to install to accommodate those fluctuations, and maybe Speaker 3, you can talk about that. But I haven't

seen the connection between the research that we're talking about on offshore wind, and the batteries yet. Unfortunately.

Questioner: If I might offer, from what I've seen, it's cheaper to upsize the transmission and be able to put all of the power onto the grid than it is to build batteries on it at current pricing.

Comment: Yet again. [LAUGHTER]

Respondent 2: I think we've actually looked into this a bit. If interconnection capacity is costly or scarce because you would have to have major system upgrades, what you see in some of the solar plus storage, beyond getting the ITC on the battery, if it's behind the meter, you might only have a 60 megawatt interconnection capability, but the optimal size for a storage might be 100 megawatts, and you put a 40 megawatt battery there to take care of the difference. That pans out only if that battery also participates in the energy and ancillary service markets, because as was said, they're still fairly expensive.

But we have seen and done some calculations where current cost of batteries, you can actually make the economics work by the interconnection benefit of, I mean, I did add up Speaker 3's numbers, and he's only interconnecting 6,000 megawatts of wind farms, but you should probably put in 7,000 megawatts of wind farms with a 6,000 megawatts of onshore transmission capacity and put a battery out. What I don't know is if anybody has put batteries into an offshore platform and whether maintenance and so on would work.

Respondent 1: I have talked to a couple of people about if you put batteries out in the platform, is there corrosion or other things you have to take into consideration that would deteriorate the effectiveness of the battery much more quickly than they would be onshore, or the cold weather, you know, it's quite cold in some of these locations. So, that's the sort of thing that I'm hoping to see form a technical standpoint.

Comment: The battery on land, unless the interconnection is your limit, the battery on land doesn't solve your transmission problem from the cell back to, or from the connection back to shore.

Comment: You have to put it out in the wind farm. ARPA-E is doing stuff on this, which is to deal with the corrosion problems, I know, and they try to get things that are at least physically survivable in the environment where you have the wind farms. What I haven't seen is the underlying economics to justify. Suppose you had that. OK? How cheap does it have to be in order to make it worthwhile, so you have a 7,000 or an 8,000 megawatt, with a 6,000-megawatt wind farm maximum capacity, and then you've got 1,000 or 6,000 megawatts or transfer capability. And you keep it full most of the time, or all the time.

Respondent 1: That's really interesting, because I see a lot of effort right now in what I call the sexy stuff, the big turbine and the big blades. Maybe what comes next is matching that storage capability and making it more economically efficient, because if you continue to increase the turbine size, you're going to increase your transmission problem.

Respondent 2: Part of the problem is also that all these contracts are carve-outs. So, I wonder if an offshore wind plus battery bid would actually be evaluated on its pure economics, where they'll say, "Well, we only asked for wind." [LAUGHTER]

Respondent 3: In fact, in our Liberty Wind proposal, we put a teaser in that we would be glad to discuss with NYISO a very significant battery

storage facility. We say with that project. But it wasn't going to be scored, and it wasn't invited.

We were trying to plant the seeds. But I just wanted to note an interesting middle ground. ConEd has an open, I don't know if it's still open, but they're running a procurement exercise on battery storage. And so, it would be interesting to see what awards come out of that, what ideas come out of that. But one that I'm familiar with is that Eastern Generation today owns a natural gas, I think they're more reliability than peakers, but natural gas turbines at their Gowanus site and at their Narrows site. And in both instances, those turbines, they're 50-year-old GE, I think they're aircraft engines, but they're on barges, sticking out into the river right, tied to the shore.

They put a proposal forward to repower, in the face of the Knox rules, the Gowanus turbines, but to retire the Narrows one. And then they turned around and bid into the ConEd battery procurement, I think it's a 60-megawatt battery storage facility on half of their barge space. So, just to the point about where there's room to put them. Our sense is that you need for every 100 megawatts of battery storage, you need an acre to two of real estate, and of course, we're talking about the boroughs of New York or of many other parts of developed land. And that's pricy.

Comment: I'm sorry, is that treated as conditional generation in the wholesale market or neither? How is it going to be treated? Because batteries won't necessarily work in a grid right now. Sorry, I was trying to ask Speaker 3 if in that instance, is it identified as generation or transmission? Because the revenue, right, is not necessarily recognized as for battery storage.

Respondent 1: And I don't know. I don't know. I mean, I suspect ConEd is running the procurement in part because of the new state policy that's now been codified for things like this, battery storage target. And for their own system management reasons. Anyway, it's something to keep an eye on to track as they make their decisions.

Respondent 2: Some of these market rules are also getting in the way of batteries being more efficient solutions, but usually you have to allow the battery to have multiple functions, not just the T&D issue, but if, since they can, why not let them also participate in wholesale markets, and you get into all kinds of complications in some places. You know, Texas, for example, AP I think has proposed that they could install an $8 million battery towards $16 million in transmission upgrades. But they can't do it because they're not allowed to charge the battery from the wholesale market, because the T&D company is not allowed to own an asset that interacts with the wholesale market.

So, there are things like that that make it very complicated. And you know, these are fees. If they attribute no value to using a battery to make things more efficient, you know, I think those carveouts are a real problem.

Moderator: Alright, next.

Question #4: I'm actually struggling with understanding what problem we're trying to solve. Or are we just saying, there's a whole bunch of problems? I've counted a few.

Are we trying to address public policy goals that are not being effectively addressed, like carbon reduction goals? State standards? Something like that? Are we trying to figure out how to make more efficient use of the transmission interconnection capacity we have, which I think is what this diagram is showing? Which, by the way, that's a big problem. That's not just an offshore wind problem. That's a problem generally, just the whole queue process is the

cluster. [LAUGHTER] Are we trying to solve the risk allocation question? And who pays? Or are we, I've heard a couple of people talk about a need for leadership, and maybe a means to try and solve all of these problems.

I will note, and Speaker 2 and I had this conversation over drinks last night. RTOs are not a vehicle to lead on policy. At least that's not what they were created to do. RTOs generally are policy takers, not policy makers. What we can do and have done very effectively over the years is to help figure out the best way to get to a policy end, and in some we can convene policy-makers and stakeholders so that they can come to some general agreement on what the policy ought to be. But, that's why I'm struggling with what exactly, what is the problem we're trying to solve? And to the extent that it's efficient use of transmission interconnection capacity, and then there's a lot of work going on around that, on queue processes and interconnection.

Respondent 1: That's a really good question. I don't think the ISO's expected to lead on developing policy. But here we have, depending on how we count it, 24,000 megawatts or 28,000 megawatts of committed offshore wind procurements that will happen over the next decade. And we know there's not enough inter-tied capacity easily available for individual gen ties.

The queue process, doing it one generation interconnection request at a time, won't get you there. We already know that. So, I think the ISOs can be a leadership on proposing vision and solutions in response to the policy requirements that are already in law and on the table. And it's not going to be a reform of the generation interconnection process, because it's not a piecemeal kind of—

Questioner: I think that's something RTOs can and have done in the past. We've already talked about MISO's MVP process. We've talked about ERCOT engagement with the state on the CREZ process and all that sort of stuff. But to the extent that there's a view of someone needs to lead on, are we allocating risk to the developers? Are we allocating risk to the consumers? It just wasn't clear to me what the primary problem was that we were trying to solve. And if you can narrow it down, if you can say, "OK, let's figure out how to interconnect this stuff in an efficient way," I think it can be a more compelling challenge for RTOs and for stakeholders to take on.

Respondent 1: In my mind, there needs to be a vision for an efficient solution, and a vision for what happens if you don't have an efficient solution, and risk allocation and cost allocations will natural flow from that. But that's not happening right now.

What's happening right now is our interconnection process does not allow for a transmission interconnection if there isn't a generator on the other end already fully committed. And it's trying to squeeze that into the current tariff, and the current processes that are not optimally set up for that. I mean, MISO had the vision with MVP, because before MVP, the tariff didn't have any provisions for that. Texas did it with CREZ.

What I think the solution is, to come up with a vision, like the CREZ development process, where you study this, and come up with five different solutions and pick the best one that then gets the backing from the policy makers. And the interesting thing about offshore wind, there's actually much more policy commitment behind offshore wind than we had with CREZ. I mean, there was no real commitment for how much wind to develop. It was just—

Questioner: I think there's one gap in what you've just described, which I think has worked. It's worked in Texas. It worked in the Midwest. What started that wasn't an RTO vision. It was not. ERCOT didn't lead on the notions of CREZ, and MISO didn't lead on the original notions of a wind superhighway from the west to the east. Policy makers, NGOs led on that, and then the RTOs stepped in and said, "We can help here. We can help figure out how to do this effectively and efficiently."

So, I would offer that, again, back to policy takers, not policy makers. I think the place for this isn't to say, RTOs go, come back with some grand plan. It's policy makers who said, "We want this built, need to go to the RTOs and say, 'We need help.'" In which case most RTOs will step up, at least the ones that I've worked with, which is a lot.

Respondent 2: I agree with you, and that's one of the challenges they have, is that the states are competing with each other right now, and so are the developers for these projects, and to win the prize at the end of the day. They'll all win. I mean, there'll be construction up and down at least the East Coast. So, and it's an obvious statement, there does need to be more regional, within each region, cooperation on the transitions, as we always say, and it has to happen in this instance as well. It's not happening yet. I know that Massachusetts, for example, is thinking about this right now, about can we pull our fellow states into this conversation? Share the risk, share the cost, etc. Nevertheless, the fact that, at least in New England, and I'll say it again, they're doing a ten-year planning process that they always do, and they don't recognize offshore wind for the capacity value that it has. It's sort of a problem that the ISOs could fix.

Respondent 1: I also think the states have said, "Here is what we want." So, it could be up to the ISOs to say, "This is what you want. And we can help with that."

Questioner: I can only speak, and I'm not speaking for MISO, but what MISO has said publicly in our case is, "We have stated RPSs, we have state goals. Here's what we're doing to need to do in order to have a system that's capable of meeting those goals." And we laid out the vision. Now we're deep in the weeds on cost allocation around that, and I think we actually just filed something, if memory serves.

Respondent 1: But that stepping up hasn't happened on the East Coast yet.

Respondent 3: In fact, that's where I was heading. I think you're hitting on something very important. And so, in terms of problems, what are the problems we're trying to solve here? I don't think it is climate and clean energy policy. I think, as I said, I think we've got enough pieces there, particularly on the Eastern Seaboard, and California, the Pacific Northwest, where the goals are crystalized and have been codified, etc.

But then there's the layer of policy below that, which is, how do you do it? And how do you do it to meet those public policy goals of affordability and ensuring competition and so on? And I think that's where the RTOs have a middle role between policy takers and makers. Right? You're experts in the world of transmission, which is arcane and complex and very involved, with very high stakes. So, I think the way you just described, the way it played out in the Midwest with states adopting the RPSs, and then you guys figured out the process to optimally get there, is a good way to describe it.

Respondent 1: And then you do the cost allocation at the end, once people see that this is an efficient solution, rather than starting with cost

allocation, because nobody can agree on that up front.

Moderator: You didn't use this term in the question, but I heard facilitation. And a place for those discussions to happen. And maybe the best in terms of, quote unquote, leadership solution.

Question #5: Because we were unable to get a developer on the panel, I wanted to develop some of the thinking on the offshore grid or direct connections for the generators. That obviously embarks and lays out a position. Intuitively, it seems to me there are a lot of benefits for a lot of reasons for having an offshore grid. But I'm trying to, other than hearing references, I don't know which speaker went into this, but to concerns about delays and being in control of their own circumstances. What other grounds are there that the developers are advancing for their general opposite, or non-willingness to work with an offshore grid provider? What really are they? Are there policy arguments? I mean, what undergirds those arguments?

Respondent 1: Well, the main argument that I hear people make is project-on-project risk. Because the development schedule has to be tightly coordinated, because if they have an online data for 2022, and they commit, and the transmission leg is two years late, it just totally blows up the economics of that. And I think large companies like Orsted, they're also very strategic about it. They are large enough and experienced enough that they know how to do it all.

So, a system that requires people to do it all will give them a big advantage over many others. Whereas a system where people can interconnect offshore, you know, makes it a lot easier for folks who might have the offshore wind experience, but not the transmission experience. I think people also realize that if they are first, there is some strategic advantage of being first and taking up the space for others, but what you publicly hear is, project-on-project risk, and the bad experience with the first HVDC gathering system that Siemens built in Germany. That was about two or three years late, and that had billions of dollars in losses as a result.

Interesting enough, and I think that's going to be a challenge for Speaker 3, the gathering systems that people have been building in Europe since then, there's actually a regulatory mechanism to hold the wind farm developer harmless for delays in the transmission infrastructure. And I'm not quite sure who in the US would do that.

Respondent 2: Maybe just to highlight like one specific risk that the developers face is supply chain risk. Let's say you're supposed to come online in 2028. There's a backlog for cables right now. That's three to five years. So, it's significant. You have to plan that far ahead to make sure your equipment's there on time. That benefits the larger developers, to some extent, because they have the financial wherewithal, or the relationship with those suppliers.

But I know there's a shortage in much of the supply aspects of this, and you have to plan well ahead to make sure that the manufacturing's there to supply the needed parts. And this is a lot of component parts for 26 gigawatts. There need to be plants, the whole supply chain is super, super important.

Respondent 1: Yeah, right now there's not the manufacturing capability to deliver this all on time.

Moderator: And I'm not sure that anyone here would have advocated anything differently than wind generation developers for the first couple of rounds, because they come over. It's a brand-new sector. The governance and procurement roles are immature and still being developed, etc. But

I know that most of the developers are on the generation side, certainly privately and increasingly publicly are acknowledging that that will work for the first couple of rounds, but we're not going to get to the full vision, unless we do some measure of planning.

And it is striking, as was said, they still point to that earlier experience in Germany, which was how many years ago? When they struggled with that? A decade or more?

Respondent 1: No. I think five years.

Moderator Five years? But since then, certainly in the Netherlands, Germany, they have figured it out, and they've successfully been planning transmission and running out ahead of generation procurement.

The other thing I would note is this argument about project-on-project risk, exists for the developers whether we separate transmission and generation, and run separate procurements, or whether it's bundled. That is to say, and yes, they're deeply experiences, the US DEDs, and the Equinors and so on. But they're still going to, over here in the States, contract with companies that know how to do this on land. And the biggest project risk we think is onshore. It's not trivial to build out the infrastructure in the ocean, but you're doing it on a blank canvas. Onshore, you're stepping into a really complex, often, morass. And I'm going to sound like I'm our marketing lead, but you know, a seasoned transmission developer in the states lives in these communities, has fought these fights, knows the regulators up and down the chain, works with the labor unions, works with the business community. And I think that's where the biggest project risk probably is for a lot of these projects. And it's the onshore interconnection.

So, just an argument against. They do argue first and foremost project-on-project risk. And you can't blame them for wanting to control that. Oh, and by the way, even in a construct where a generator takes on a transmission partner, there are established ways to do that, joint development agreements with penalties for nonperformance. I mean, that's well-tread turf.

Question #6: Yeah, I can't let it go with a, this charge that nothing's happening in the east. Nobody's tried to facilitate any of this. We did that. We did that. OK? We had an extensive process to look at, because again, back to my point, I think the platform concept is a very intriguing one to deal with risk allocations, not avoiding a lot of spaghetti lines onto the east and using up headroom. All the points you said.

We went through that process and presented some workable ways to enable, not to pick that that is the solution, that is the model, but here's how to make that model work outside of the existing process. States came to the table and said, "We have nothing we can say about this right now. Because my commission hasn't acted, or we're still thinking about it, etc." It went on for months. Got no support from any of the states for the project, for the proposals. Frankly didn't get a lot of support from Anbaric. Didn't get a lot of support from the developers.

The whole process, we're very frustrated, because the whole process that was designed to accomplish this very thing was something that tried and foundered. And now we're debating internally, do we just serve this up to the FERC? Is the FERC capable, has the DNA to address these big policy issues, query whether that's the right place? To the point, which I think is right on, is you have developers in competition. And you have states wanting to do their own thing. I don't think Governor Cuomo would be too excited if you went to him and said, "I've got a

great offshore wind project that's going to interconnect in New Jersey." I don't think that's going to sell. And vice versa. I mean, that's just the realities that we have.

So, yeah, of course regional solutions make sense. Of course they do. Of course, it would be nice to come up with the solution. But it's just not the reality. Is that an excuse for doing nothing? No. It is not. But the real rub is, it's the ultimate who decides question here. When the states themselves are very fractured, the industry has these competitive pressures, not even sure if the FERC is the right place to bring those "I don't know how to get this done. I don't know how to move this ball forward." You can lay it all on the RTOs, but if I have no one willing to step up and say, "Yeah, that may make sense, that may be one way to do it, or why don't you do it this way?" We found ourselves talking to ourselves in our stakeholder process on this issue. And it was very frustrating.

Respondent 1: I think the one thing I have to say, I feel for all of you working at the ISOs, because it's sort of a thankless job, because what you do well nobody talks about, and what doesn't work well, everybody complains about. So, all you hear is complaints all the time, because the stuff that works well is not worth time spending with. But having said that, I think a couple of years ago, the time wasn't right. Now, we have these massive commitments.

New Jersey just had 7,500 megawatts of offshore wind. Now we have commitments, and maybe a process like the UMTDI Argos MVP process that happened in MISO at the time would be helpful, where you know, UMTDI was the Upper Midwest. A subset of MISO transmission owners got together and said, "Look, there has to be a better way of doing that." That led us, led into the OMS and MISO are doing the Argos study. And the Argos study then yielded the MVP projects. But that was I think leadership came from the RTOs that had really good experience with Capex 2020, of getting together and finding a better solution, a multi RTO solution, a regional solution that then was the Upper Midwest Transmission Development Initiative, I don't even remember the acronym. UMTDI.

And then the regional generation outlet study that MISO did. And you had a confluence of good initiatives coming together, and that really yielded an outcome that we haven't seen in that part of the country since 2011. And I think that's how I would envision it. I don't think you want to touch the interregional stuff between PJM and New York or New England. But there's enough going on, I think, in PJM right now that you could make a difference. And New England I think is even worse, because ISO New England has only been focused on reliability planning. They spent $10 billion in reliability upgrades and it does nothing to integrate renewables, which is a pity.

Respondent 2: Yeah, I know to this crowd it's going to sound like whining, but an observation of someone that's been on the inside. I just spent a year and a half at the ISO New England and then on the outside. If you are a developer that is new to the market, it's like a foreign land. You know? You have to figure out that you've got to hire somebody to sit there every day for three years and pay them $500 an hour to understand the tariff. So, I'm not complaining about it. I'm just pointing out that there is an insider/outsider problem. And maybe the timing thing will help, now that developers actually have a real obligation, they will spend the time and money.

I mean, it is a foreign, I mean, it is literally a foreign land. It's a tough thing to get your head around. And that's not excusing it. It just—

Respondent 1: As long as the states are their worst enemies in some of that.

Question #7: I want to go back a little bit on what we were getting at, because there's certain things that are different here that the analogy with the MVP process breaks down. And that has to do heavily with, where are you locating maintenance terminals? Where are the jobs going to go? Where this is, at some level, going to be a negotiation among the states to sort through, and now throw in the mix of, and it's in New York, New York ISO versus PJM and, you know, so at least in MISO you had people building wind farms, and you had developers that were willing to build manufacturing plants in places like Iowa, and also have large operations in Illinois, and you also had the benefits being widely diffused.

So, the cost allocation was a little simpler, probably. I don't know that an RTO is in a position to start figuring out what are the economic benefits of putting a maintenance terminal in Hoboken, versus in Jersey City. Or somewhere on the New England coast. The challenge is a little different.

Respondent 1: No, you're absolutely right. I think the only thing the ISO can say is that here is an efficient way to solve the transmission puzzle to this, and—

Questioner: I'm just saying, my experience in these processes is, the efficient answer isn't usually the one that gets picked, because politics isn't about efficiency.

Respondent 1: No, the other pieces are happening simultaneously. I think to deliver 25,000 megawatts of offshore wind, we actually don't have the infrastructure and the manufacturing facilities and the stage facilities anywhere on the East Coast. I think there will be enough to go around for every one of the coastal states to get significant benefits.

Moderator: We're going to go to the next question.

Question #8: Right, I'm just going to hop on the train here. The other problem we have is that there's not enough load to take this all in. So, first of all, I don't agree with the assumption that this is an efficient solution. It's a public policy solution that someone has picked. And so, to solve this transmission problem, we have a single state ISO. You spend $8 billion in California, $6 billion in Texas to integrate this stuff, and it's still not enough. Right? So, we're now adding to those numbers everywhere you have a single state ISO that can make this decision.

Then New Jersey decides they're going to put in, I think the number somebody threw out was 7,500 megawatts. The peak load of the entire state is 18,000 megawatts. That's the peak. That's the most they can ever take. And so now, what we're going to have to not only look at is, can we build out so someone else that doesn't have one of these policies, maybe they want some? And it could go north, it could go whatever, but it shouldn't be on everybody else using the system that doesn't have the public policy to pay for New Jersey's public policy. Right? So, that's part one.

And then as we see in California, as we're seeing in other places, we now have, and I do interconnection studies and integration studies all the time. I can guarantee that I'll be back two years later to start writing your curtailment protocols. [LAUGHTER] And so that's the other problem we have, is that we just don't have enough load. And I'm jealous of some of you, because you don't have to worry about the coastal wind, because you don't have a coast. Right? But eventually the goal is to get it all over the place. But right now, you know, and that solution is decades away, maybe generations away.

Respondent 1: I have to disagree on the load. I think the amount of wind that has been proposed now is less than what Texas already deals with compared to its load. I mean, 7,500 megawatts to 18,000 megawatts of state load, we see it Europe, where you have many places like Denmark, where the total wind output exceeds the peak load during many hours of the year, and where you are part of a regional market that can absorb that. I think—

Questioner: But you have arguments—

Respondent 1: What we're talking about now is fairly easy. It doesn't get you close to 80% renewables or anything like that. You know it's getting harder once you get a larger penetration, but I think at this point, the East Coast is so far behind from where SPP already is, from where ERCOT already is, from where MISO already is. I don't see these things as a problem.

Questioner: Yeah, the topography is different where you have those tight networks, and lots and lots of load, like in the northeast corridor. And I think we're going to be instructed by Europe, where you have Germany now not so happy about some, like the TeneT DC line, and others that are paying for it don't necessarily benefit from it. And so, I think there's more coming. That's just from my view.

Respondent 1: Well, I have no doubt we'll fight over cost allocation, be realistic about the fight that you have to take.

Moderator: Until our children are in these seats.

Questioner: Well, I think my last word, whatever, because we all have planes to catch, is that at least in the northeast, nothing else is getting built for the most part. Nothing else will get built in the next 20 years but offshore wind. So, we've got to figure out how to make it happen, and it's going to be really hard. But no other significant generation will be constructed. The decision's been made. Or multiple decisions have been made to get us to this point, for better or for worse.

Moderator: So, let's thank our panelists. [APPLAUSE] I wish you good luck on the way to the airport.