

**HARVARD ELECTRICITY POLICY GROUP
SEVENTY-SECOND PLENARY SESSION**

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Rapporteur's Summary***Session One. Twenty Years of Market Reformation: Where Have We Been and Where Are We Going?**

In 1993, Congress had just passed the Energy Policy Act of 1992 (EPAct 92) the Clinton Administration, with its FERC "Dream Team," had just come into office contemplating what to do with its new powers under the law, and the North American electricity world was poised for something different, but no one knew exactly what. Everyone recognized the magnitude of the quake, but the dust had not settled. Harvard decided to create a forum to help explore all of these matters in two quick years. With that high degree of prescience, and involvement from many very smart electricity cognoscenti, the Harvard Electricity Policy Group set off to define the contours of the new market. The country's most capital intensive industry has gone through a revolutionary change in its business model, market structure, legal and regulatory framework, and institutional settings that neither the framers of the 1992 Act, nor the advocates of its passage, ever envisioned. It is worth a look back at what has been accomplished, what we have learned, and where we are going. In particular, what were the critical decisions and events that shaped the direction we have taken, what might we have done differently (or more effectively), and what lessons have we learned?

Moderator: I'm going to make a couple of introductory remarks, and try and put 20 years on one page. "Twenty Years for Dummies," I call it, and then we'll go to my colleagues on the panel.

I did think about a technical conference at FERC that was the last one, I think, that we had in 1992, when Martin Allday was chairman. We were talking about electronic bulletin boards, as they were known at the time, and a senior

executive from a "just say no" utility (I think some of you in the room know what that means) stood up and said, "You know, this isn't going to work, to have this stuff electronically. Every single transaction has to have its own contract. And nobody except us knows how to manage the wires and how much room there is on the wires..." and so on and so forth. So it was a diatribe.

There was no transmission open access. I'm proud to say that Bill and I, with help from a lot of people in this room, pioneered that over the

* HEPG sessions are off the record. The Rapporteur's Summary captures the ideas of the session without identifying the discussants. Participant comments have been edited for clarity and readability.

years. There was limited competition among generators. The only ones competing were the sort of trendy ones, like PURPA utilities. Power prices were cost based, except for PURPA qualifying facilities. There were no RTOs or ISOs. We really hadn't even invented the concept yet. There were some limited tight power pools, particularly the one here in New England. Wholesale sales did require FERC approval for each contract that they entered into. The Internet was not robust. Indeed, when we talked about doing things on the Internet, as we were developing open access, people said, "Oh, no, it's not dependable. You know, you just can't imagine having something that important happen on the Internet." There was no federal reliability authority. The incumbent utilities governed and owned the wires and had all the secrets about this capacity. And there was no federal transmission siting authority.

So those were the good old days. Now, 20 years later, and still counting, we have robust open access at the wholesale level. We have robust competition among generators. There are still states that have cost-based generation for local stuff, but they sell off-system, as they call it, at market rates. ISOs and RTOs serve most of the population, though you'll see the maps (and I know you know the maps anyway, because a lot of people in this room have been present at the creation of those things.) They serve most of the population, but there are important differences between RTOs and ISOs, and seams unfortunately still exist that inhibit transactional flexibility. FERC provides blanket authority for commercial transactions. We have an Internet-based commercial world. (It turns out it really was dependable.) We have mandatory reliability standards at the federal level, with NERC blessed by the Congress, to be the reliability authority, though there are some difficulties in that relationship. We have transmission as a separate business for a lot of companies, and a lot of companies have separated themselves or sold their transmission. We do still have ineffective federal transmission siting authority, in spite of the best efforts of a bunch of people

in Congress (and some of the worst efforts, too, I might add).

However, there are lots of issues for people in this room to address. Capacity markets, I would call the new competitive battlefield. We want to talk about what's working and what's not, and where we go from here. That's part of the discussion in the next day and a half.

Minimum offer pricing rules, MOPRs--how should we deal with subsidized generation, favorite generation in states, and when they are trying to charge others for otherwise uneconomic projects, and what does that do to the market?

Demand side management is a very big deal. How dependable is demand side management? How do we measure the baseline? Is there such a thing as too much DSM?

Integrating green resources. California, as usual--that Left Coast, they do strange things out there--they're leading the way. I just heard they're talking about a 50% renewable portfolio standard, and Governor Brown thinks he has the votes for that in the legislature. Whew. Doesn't have the transmission, barely survived the summer... [LAUGHTER] But you know, these are details.

What do we do about pricing subsidized resources in competitive markets? Like wind, which has a production tax credit, so they make money even if prices are negative, and those negative prices affect everybody in the RTO. So the wind people make money, because they've got the tax credit, but nobody else does. Is that a good thing, or is that a bad thing? I think there are differences of opinion in this room about that very subject. And are these subsidized resources killing competitive markets?

And then, of course, we have the old variability questions, and wind doesn't blow when the capacity is most needed. I think California maybe will figure that out for us. You're now

being able to control wind from a technology point of view in ways that you couldn't control it when you first came on the market. But it's still a very different creature than good old base load power plants.

So then we have the coming attractions of the impact of the Clean Air Rules on competitive markets and on the generation mix, and whether there will be massive coal plant and nuclear plant retirements with the implementation of the Clean Air Act rules. Can anyone compete with natural gas for new generating capacity if they're not subsidized? Should economic regulators care about the generation mix? A lot of people in the room have been or are economic regulators. And do they care?

We still have issues with transmission siting, especially across state lines.

And then what else is out there by way of a challenge?

So there is, I think, plenty of work to do. I will say that HEPG has played a vital role in the ongoing transformation of the electric sector, both as a convener of thought leaders and in providing the intellectual leadership and academic heft for the discussion. The rules of the participants in this room, that what is said in this room stays in this room, at least as to source, is a very important thing. And I think there are plenty of issues for another two or perhaps another 20 years. [LAUGHTER] And I look forward to it. Thank you very much.

Speaker 1.

This is a high-level summary of what I consider to be the real pivotal milestones in the evolution of U.S. electricity markets. The UK and restructuring in 1991 was very pivotal, because until that time, much of the debate was people saying things like, "You can't have a market, because the lights won't stay on." And the UK market had a lot of problems that still need to be

solved, but it proved the lights will stay on. You can make the lights stay on, and you can have trading.

And the timeline goes on to when Congress passed the Energy Policy Act in 1993, and FERC issued the Open Access Order three years later, and when PJM and NYISO introduced their nodal wholesale markets, and when retail access began.

I went to TVA in 2002, and one month later, FERC issued its "Standard Market Design" NOPR. And three months later, the War Between the States broke out again. It was the South and the Northeast against those commies in Washington (although Pat Wood was from Texas, so I don't know how they factored that in). But all hell broke loose -- I read it as more of a push-back of Northern aggression on the South. We got our own way of doing things down here. And so there was these big boil back fires lit against the Standard Market Design.

And what happened? We had the second Northeast blackout. And that just changed everything about what the focus was. People said, "We've got to fix reliability. We've got to stop this chitter chatter about...we've got other stuff to do, but this has got to be front and center." And after that, a lot of the progress that's been made that you'll hear about in this meeting has really been done through the hard work of the individual ISOs and their constituents in the trenches, pushing ahead, and I'm sure a lot of them can tell you in much better detail about how hard that work was. But real progress has been made.

This is a map that shows where we have RTOs. (I'm going to call them all wholesale markets. Some are not as well developed as others. Some of them are still working on it.) But about 2/3 of the citizens in the country now are served in areas which have restructured wholesale markets.

This is the retail picture, and the green is where you have retail choice. There's not as much progress in retail markets. And we'll get into some of the reasons for that.

So, we were asked to look at the question, "What did we get right, and what did we get wrong?" And to answer that question, I always have to go back to asking, what were we trying to accomplish in the first place?

Prices were outrageously high in high cost states, states that had built nuclear plants in particular—in the west coast, the northeast, and Texas. And management and/or bad regulation were perceived to be the problem, and so the hope was that competition in generation would result in really cheap electricity. We had industrial customers who literally believed they would get two cent power forever, even though we were very clear that cost only covers fuel. It can't stay that low. If it did, nobody would ever be able to build capacity.

There was a hope that we would shift the risk to the people who made the decisions, and get all kinds of new value added services, not unlike the cell phone packages that you have today, and punish the incumbents, which included incompetent utility managers and misguided regulators.

So what were the problems that had to be solved? I like to talk about the four categories. We've got the money issues, which are stranded costs. We've got the technical issues, which is the market design--how do we make all this work? (Which we're still working on in the RTOs.) The who's in charge issues, because until this law was passed, FERC's role in electricity was really relatively minor if you looked at the percentage of the money that they regulated. And when you opened up access, FERC asserted jurisdiction all the way down to the meter, and that was a big thing--I think some states probably still aren't over that. So all that still has to be sorted out, especially around things like transmission siting. And then you just

have an enormous amount of rules that had to be written about who's going to go first, and how you introduce retail access. And who cuts out service if somebody doesn't pay? And which bill gets paid? And then, physically, how do you separate generation from transmission? Those were the immediate kind of day one problems that people were working on.

So what did we get right? I think stranded cost recovery was handled through settlements, and even though that was a loud, noisy, painful process (sometimes it felt like a public flogging, being a utility that was one of the first to have to go through this), amazingly enough, it's largely resolved, and you almost never hear it mentioned anymore. We got through it, and we settled. Some people are not happy in hindsight, but, hey, you know, you signed up. You had something to do with that. So move on.

And I think we have the basic principles of workable competitive markets, and I'm not going to go through this, because we have a whole panel on that this afternoon.

What did we get largely wrong? I think the potential for short term efficiency gains in generation that would lead to further price reductions was grossly overestimated. It was largely a problem of excess capacity, nuclear plants, and mandated IPP (Independent Power Producer) purchases that drove down prices. We were very wrong about the economics of commodity retailing. I say "we"--I mean, a lot of you guys were wrong about that, [LAUGHTER] because I told you. [LAUGHTER]

And at the retail end of it, the really small volumes are tough. They need to have workable wholesale markets before opening up a lot of retail customers to competition. And maybe we'll talk more about that in the Q&A.

One of the things that bugs me the most is when people want to talk about whether competitive markets are better. I mean, you had the South and the upper Northwest that had a lot of old,

almost fully depreciated hydro, and old, almost fully depreciated coal plants, and markets are, always reflect marginal costs. So they are never equal. And to me, that's not the right measure. You have to decide, what do you want? If you want economic efficiency, then clearly the market model is superior because it's forward looking.

But the real differences in design are these, I think, (and I borrowed something from the guys who wrote *Nudge*. Who decides? Who takes the risks? Who builds? Who acquires? Those are the decisions around how you want to structure this. And you can follow through the incentives that setting up that power and decision-making make.

What should we worry about? I think I'll leave this to the discussion, because others have this in their presentations. But I do want to say a few words to echo what our moderator has said. I've been to a lot of conferences in my career, but none has had the longevity--I mean, this is 20 years we've been going at this, four to six sessions a year. Jo-Ann tells me this is our 106th meeting. I didn't go to all of them, but I went to a lot of them. The sustained focus on the issues as they evolve, and keeping the energy and bringing people together, is what's remarkable about this group, plus the way the environment is. I don't know whether anybody's ever broken the "everything's off the record" rule, but that makes it possible for people to actually speak their minds more freely than they otherwise would.

This is very different from trying to have a debate about restructuring in a forum like a rate case. In my experience of that, it was unbelievable the reaction that we got. It couldn't have been a bigger disaster. And people just piled onto that rate case. And the rate cases vary by state, but in New York they're very rigidly litigated. There's an 11 month suspension period. You file this then. Then you get interrogatories. Then you get rebuttal and surrebuttal, and more interrogatories, and

hearings, and an ALJ decision, and comments on that, and then a commission decision. And it is extremely inflexible. It's not the kind of forum you can use to kind of figure out, "Hey, we don't have a roadmap for this. How are we actually going to do this? And how are we going to go through this?" And so when you compare, coming here was like Heaven—"Oh, thank God. I can talk, and somebody's not beating on me from like three sides." [LAUGHTER]

Speaker 2.

I'm really pleased to be here today. When Ashley called me about this, I thought, well, this is really going to be an interesting day. And I began to think back on the last 20 years.

I happen to be a guy who was just at the right place at the right time. And I got appointed to FERC. And when I got to the commission, we were all very focused on the gas restructuring.

There were four of us that were brand new at the time, in 1993. We went through the confirmation process together, and we had a sense of camaraderie. And we came to the commission wanting to do something. We didn't want to just be caretakers. And we were implementing Order 636, and it seemed pretty cool--open access pipelines, not quite common carriers, but some of the same attributes, competition to connect thousands of producers with thousands of customers. What a cool idea. So we were actually, within the commission, heavily influenced by Order 636, that implemented restructuring on the gas side. We were also heavily influenced, of course, by EPAct 1992, and we saw that as the political signal that, hey, moving to markets and opening up this old fashioned system has some political acceptance. Maybe we ought to do it. We were also influenced by the electric restructuring in Great Britain, which Speaker 1 mentioned. In 1994, a FERC colleague and I got on a plane and went to London for a pipeline conference. But while

we were there, we met with National Power, and the grid company, and some other electricity market participants in the new market and talked with them about how it was done. We thought that it was a really interesting idea to do this. And on the plane coming back, we sat and chatted about this and whether we could actually do it.

The staff at the commission had laid the groundwork for this. I mean, we were just kind of the pretty faces. (I know that's hard for you to believe.) [LAUGHTER] We were really the implementers, but a lot of the groundwork had already been laid by the staff. And staff knew how to do this, because they'd been thinking about it for a long, long time.

So we based order 888, actually not on the EPAct 1992, legally. We based it on the responsibility, the actual duty, according to Section 206 of the Federal Power Act, that when you find undue discrimination, you've got to eliminate it. You've got no choice. Well, we just redefined "undue discrimination" and told the staff to write it up. That was the sausage-making that took place. But there was a lot of work at the staff level to make sure that it was going to sing. We made some astute political compromises. They were very controversial at the time. But we did provide for stranded cost recovery, which there were virtually no economists in the country or within the Harvard Electric Policy Group that thought that was a good idea at the time. (Except for Speaker 1).

But I tell you what stranded cost recovery did. It paved the way for a political success. I mean, EEI (the Edison Electric Institute) actually embraced Order 888, because it included the recovery of stranded costs. And actually there weren't a lot of stranded costs that ultimately needed to get recovered, anyway. So it ended up being kind of a nothing burger.

The second thing we did--you know, the Federal Power Act says, "FERC, you've got jurisdiction over all transmission of electric energy and

interstate commerce." It doesn't say "wholesale" or "retail" on transmission. It says all of it. So we obviously had jurisdiction over wholesale transmission. That was clear. When states had unbundled, we decided, "OK, they've unbundled. They've separated transmission. That's ours now." So we took jurisdiction over unbundled retail transmission. What we left to the states was jurisdiction over bundled retail transmission.

And for those of you who have followed the industry, that precise issue went to the US Supreme Court in *New York vs. FERC*. New York challenged FERC and said, "FERC, you went too far. FERC, you've got no business taking jurisdiction over any retail transmission at all." Enron intervened and said, "FERC, you didn't go far enough. You should have taken jurisdiction over all transmission of electric energy in interstate commerce, including bundled retail transmission." And the Supreme Court affirmed the political compromise that FERC had reached with a three justice dissent, saying, "FERC, you really should have gone farther."

We had terrific FERC staff support. The DC Circuit, in ruling on Order 888 said, "This is a terrific order."

The other thing we did was to plant a seed for the ISO concept, which was already under development in some states. But we defined the functions and characteristics of an ISO in Order 888, which I think was important.

Also, politically, average rolled-in rates were very high at the time. The next increment of a combined cycle gas plant was low. So you had average wholesale rolled-in rates priced up here (high). The next increment of capacity that the munis, the co-ops, and the ELCON (Electricity Consumers Resource Council) members wanted to access was priced down here (low). So, politically, I think that made it a much easier decision for us as well.

There were key FERC orders issued in 1996-97 regarding implementation of LMP in PJM. (It may have been '98. I didn't go back and look it up.) There was a crisis in PJM because we hadn't gotten the pricing right. There was no locational marginal pricing in PJM when it first started up. There was a pricing crisis. And we put our heads together and said, "All right, we've been coming to these HEPG meetings..." We knew what the right thing to do was. We believed that congestion had to be priced. We understood that the old-fashioned contract path wasn't going to work forever. And so we told PJM to implement LMP. And that was the right thing to do. It was a good move. It showed that it worked. I mean, we knew it would work anyway. But it was an important milestone and step.

Order Number 2000, issued December 31, 1999, defined the RTOs. We mandated that all transmission-owning utilities "voluntarily consider" [LAUGHTER] forming an RTO. Now, that was required: "You've got to take a look at this now." It was really tough love. There was a strong independence requirement, which I think has been durable, and there were solid definitions of functions and characteristics of RTOs. However, as a political compromise, we did not insist on LMP. We did say, "We want you to use market-based pricing for congestion."

Order 2000 provided a platform for regional wholesale markets. Was the voluntary formation a sage political compromise or a missed opportunity? You can judge for yourself which it was. But RTOs now serve 2/3 of the country.

2000/2001 saw the California Crisis. The Commission had deferred to the California market design. Why did we do that when our staff was telling us it wouldn't work? Because literally every politician, every member of the legislature, every member of the congressional delegation wrote us a letter and said, "Don't touch a hair on its head. There are all sorts of political compromises that go into this divided structure, a separate ISO with sequentially

closing markets, a separate power exchange..." You know, San Diego Gas & Electric originally proposed locational marginal pricing. They hired Hogan to be their consultant, but under political pressure from California, they withdrew the proposal.

So FERC deferred, because this is what the fifth largest economy in the world wanted to do. When the crisis hit in May of 2000, I remember sitting in my office, and my electric policy assistant rushed in and said, "Prices in California have spiked from \$30 to 280." And it began. A complaint was filed asking us to price cap the market, which we should have done immediately, and which I voted for. It's one of the votes I'm the proudest of. But we didn't do it, and it took the Commission a year to get that under control. So electricity that had cost California \$7 ½ billion in 1999 cost \$30 billion in the year 2000. We had limited enforcement authority at the time. And it was tough to get it under control. PG&E, as you know, was having to buy high in the wholesale markets and sell low at capped retail rates.

You know, the State of California wasn't all that cooperative, either, in this whole thing. PG&E went into bankruptcy. The crisis was an incredible disaster for electricity, on the front page of every newspaper around the world for almost a year, reported as, "This is what markets do in the United States of America. This is what electricity markets give us." But the only message from California is that a poor market design will give you a poor result. A disastrous market design may give you a disastrous result. That's the message. But everybody's learned a lot since then. It still haunts us.

Arizona just pulled out of the debate on retail competition. My own political view is that California still haunts us. And it haunts us in debates about moving to retail choice across the country.

The proposed Standard Market Design, which I voted for, it was the right thing to do. It did not

work out politically. I think we could have been smarter about how we rolled it out. It was perceived as a federal power grab. That's how the Southeast and Northwest characterized it, and they went to Congress and killed it.

The EPOA of 2005, gave FERC a clear authority over reliability and eliminating market manipulation.

My main message is about challenges. We all know that electricity may be the most political of commodities in the United States of America. We have a law passed in 1935 that governs a 21st century industry, for the most part. That is a problem. We have a nonsensical bifurcated wholesale market structure with a third of the country still using contract path transmission services and bilateral markets. To me it makes absolutely no sense as a matter of logic. It may make sense politically to have this bifurcated structure. We have stalled movement to retail competition, and irrational transmission siting authority. Federal/state conflicts abound. The problem at FERC is that you can't get anything done if you defer to the states on everything.

And so the question is, what is FERC's role going forward? Getting the rules right, trying to rise above politics to the extent they can, and moving forward. And there is a lack of a common vision, but I will say that HEPG, over the years, has done more than any other enterprise to help people coalesce around a common vision for this industry. HEPG has been a safe place to discuss these critical issues. I'm just happy that I've been involved with it for all these many years, even though I haven't been to an HEPG meeting in several years. Thank you.

Speaker 3.

I'm delighted to have been invited to participate. I haven't been as close to this business as Bill has, in particular, over the years. But it has been

a long and winding road. I'm reminded as I prepared for this that this is the 30th anniversary of *Markets for Power*, basically and, well, 25th, 30th, whatever. It's a long time. And a lot of things in that book read very strangely now, because it describes a world that has passed in most of the country. But one of the things that was right is that deregulation is "part of a long-term process" that involves "regulatory and structural reform."

So what I want to do today is step back. As I said, I haven't been in the trenches. So let me get some altitude and ask, how far have we come down the road? And also to look across the Atlantic a little bit, since folks in the EU started about the same time with very different initial conditions, and have gotten to a somewhat different place. And it's worth, I think, reflecting a little bit.

So what's the general wish list? I don't know if this is what everybody would list, and people have different versions of it. But particularly in Europe, which was home to state enterprises in large numbers, privatization was high on the list, because they wanted generation to act in a competitive manner, not in a political manner. Also on the wish list: competitive wholesale markets for energy and ancillary services, with LMP pricing, uncapped of course, because why would you want to have price caps in a competitive market? Transmission systems were meant to be, open access, independently operated, ideally separated, as the FERC has said on a number of occasions, in ownership terms, from generation, to make sure the open access was really open access, but at the very least, separated in operation.

And I have to say, I was never a big fan of competitive retail markets, but on the wish list, you'd like competitive retail markets, and to have that, you'd kind of like the folks that sell the energy to be separate from the folks that run the wires (again, to avoid obvious kinds of discrimination and joint cost problems and so forth). And, finally, you'd like to get the prices

right to customers. Right? You want efficiency in production, and you want efficiency in use, and efficiency in use is going to require appropriate pricing at retail.

So I want to ask, how have we done? On privatization (going down the wish list), we always think of privatization as a European issue, but of course, it's not just a European issue. This map shows sales of federal electric utilities as a percent of retail sales by state. These numbers are still rough. But 20 states and the District of Columbia have no sales from federal utilities. The states in dark red, the federal utilities, TVA, Bonneville, the others, the power marketing authorities, account for more than 15% of retail sales. That's interesting, because most of the red states really are red states, and most of the states that get no federal ("socialist") electricity voted Democratic. [LAUGHTER] So I would say privatization is not just a European issue, and if I ever get this paper done, it's an interesting commentary on interest versus ideology and the power of inertia. So we're pretty far down the road, and the Europeans are pretty far down the road. They haven't completely severed ties. There's a lot of state ownership. But there's a lot more here at the generation level than one might think, particularly if you live in the Northeast.

Do we have competitive wholesale markets? Well, as people have said, we have competitive wholesale markets in about 2/3 of the country. The Europeans have gone farther, at least in terms of the geographic spread of nominally wholesale markets. And there's no sign of real movement here. This is, as previous speakers have said, kind of a stalled story. (There is no sign of movement on the privatization front either, of course. Even though Obama said something about privatizing TVA, the idea kind of died fast.)

How about pricing? Well, here, I think, we win, where we have wholesale markets. I think the Southwest Power Pool (SPP) will be the last RTO to move to LMP, and they plan that next

year, is my understanding. But we'll have it wherever we have organized markets. The Europeans are moving next year towards this strange kind of system that's supposedly...(it's been explained to me, but it's hard to keep it in your head) each country is a copperplate, but they're somehow linked, and when a generator's making a European bid, which then goes back to the national facility, the national authorities that of course ignore the fact that there are wires, not copperplates. So they're still doing politics, not physics. Both markets have ceilings and floors, and problems related to the, both sets of markets. We've adopted capacity markets in a lot of places. Bill's doing some interesting things in ERCOT, and maybe we'll see alternatives. We'll see how that plays. When you talk to the Europeans about capacity markets, you get religion. It's very hard to understand, you know, there are pro and con arguments, but for many Europeans, it's been religion. That seems to be softening, I am told. And we may see movements in that direction in Europe. So I'd say in terms of pricing, we're pretty far down the road in some respects. The Europeans, I think, have sort of gone off the road.

What about independent ownership of transmission and generation? Both places have independent operation where they have markets. In Europe, the TSOs tend to own the transmission assets. That makes nondiscrimination not really an issue, because they're separated by ownership—there's a structural separation from generation. Of course, we don't do that. Our ISOs don't own transmission assets. And I don't know the extent to which there is separation. I've never seen data on it, but I do know that it's not forced by FERC, and it's interesting to observe Entergy trying to sell its transmission assets, which in the hands of an independent owner would be entitled to a premium rate of return by the FERC, and the state commissions having figured out that a higher rate of return on transmission means, all else equal, higher retail rates. And so movement in that direction is hard to induce with that particular carrot.

On retail competition, this is the latest retail competition map I could find from the Compete Coalition. We have retail competition in some places, but if you ask around, the effectiveness varies, particularly for small customers. I mean, we've had retail competition in Massachusetts for a long time, and I have never, ever received an ad from a competitive supplier. So there may be competition, but it's not visible at retail, and I would not be surprised if that weren't true many places outside Texas. The effectiveness of competition varies. We don't separate wires from energy, as far as I know. The wires company is usually a player, often the default supplier, as here. And as was said, there's no forward momentum.

Now, I have to say, I was never until recently a particularly big believer in retail competition, because, you know, you're selling kilowatt hours at a flat price that doesn't vary, and you're buying in a competitive market, if the market exists, otherwise God knows what you're doing. It was always hard for me to see why this was a high priority. But if you think about dynamic pricing, I think it gets to be a little more interesting. I think it was the *Journal* that reported that the US has deployed 60 million smart meters, the first number I had seen. But of course, these are very intelligent devices capable of a lot of two-way communication that are presumably going mad, because this intelligence is not utilized, and they're not talking too much. We don't use them for dynamic pricing, except for some customers in parts of the country--and for legitimate reasons. Right? I mean, the Europeans aren't down this road, either. They've deployed smart meters, and they're not doing much dynamic pricing, because no regulator and no distribution utility really wants to face customers who have had a sudden dramatic bill shock in August because it was a hot August and prices have gone through the roof, and what the hell does this mean?

I think this smart meter technology is the best argument for retail competition, because it ought to be possible to do deals, because you can now

automate conversations between meters and appliances. GE is putting a lot of intelligence into appliances for this purpose, looking down the road. Cisco and others are very interested in this business. I can't imagine a state any time soon ordering dynamic pricing. I also can't imagine a European regulator ordering it. But I could imagine a retail competitor offering a deal which is, "If you let me do some automation, I will give you a lower flat rate and automate the response to price changes to some extent," as an option, not as a requirement. So I'm beginning to become an enthusiast here, which I never was before. But there's not much movement in this direction anywhere.

So let me wrap up a little early. It seems to me that if you look back and read *Markets for Power*, and consider the world described there, where there were a few pools in some parts of the country. And they did this economic dispatch thing, that, both in the US and in Europe, which was a world of state monopolies, we've come a long distance. And I'll join the chorus. This organization, with its incredible staying power and intellectual energy, has played an important role--obviously in the US, but ideas do travel.

But we're not at the end of the road in either place. There's a lot more to be done. Just that ISO/RTO map tells an interesting story. It tells an interesting political story. It's not completely orthogonal to the importance of government, a federal utilities map that I put up just before it, which also tells an interesting story. And the difference between the US and the EU—obviously, we've gone in different directions to an important extent. The EU is moving. There is an EU-wide regulator. There is a new market design. They're moving. You might not like the direction in all particulars, but they're moving, and we're not. Whether they are moving forward is a question, because there is some question about some of the things they're doing. It's interesting to speculate about where the differences come from, and I guess one thing that strikes me is, it was a lot easier, once you

decided to do something, if you had a unitary government enterprise, because you could split it and put it out in pieces of various sorts. You didn't have to deal with nasty things like private property and shareholders and stakeholders of various kinds. The Europeans had the lure of money from selling the stuff off, and they could sell it, by and large, in whatever pieces made sense. We have problems with state/federal relations. The Europeans have different problems, but problems between their nation states. They haven't had anything quite like the state/federal wars that we had over Standard Market Design, but they have their issues--and national sovereignty is at least as big a deal as state sovereignty--but they're managed to move. They've managed to move. So I see at least 20 more years of hard work here. Thank you very much.

Speaker 4.

I really appreciate being invited here. Let me also say, it's an incredible pleasure to be on a panel with such stellar individuals, however aging they might be. Speaker 1 mentioned the generational difference of some people not having exposure, and I remember at one of the early functions here, there was a young woman who was in the utility sector rising in management, and she was asked why she was so intently interested in competition. And she said, "Because it means advancement." She said that she figured (and rightfully so) that at the top of the utility section, there were all these old pale male stale folks who wouldn't know how to run a competitive market, so they would need change. And believe it or not, it was a significant cultural change in many of these institutions in this country, and it took them a long time to work out the cultural difference between those who understood and could figure out how to make a market work, and those who know the technical and regulatory side of things. And it was a massive problem.

That wasn't what I meant to preach here. I'm delighted to be back for the 20th anniversary, and I was particularly pleased to see the innovation that has been instituted here. The moderator has moved from that end of the panel down to this end of the panel. [LAUGHTER] And the name plates used to be made of paper, and it was so disgusting. They would fall off constantly. So after 18 years or 20 years, I applaud the progress that's been made here. [LAUGHTER]

Well, I'm going to take us down memory lane for one more trip, and you'll forgive me for that. Obviously the gray hair helps explain why that's the case. And I'm going to try to give some intellectual respectability to my comments by claiming it's in the field of political economy. This is a legitimate course of study at Oxford University. But here at Harvard, and in American academic tradition, the political scientists are on one side of the campus, and the economists are on the other. And, by God, they all know they should never talk to each other.

Let me take us back to 1991 and 1992, when we did the Energy Policy Act, which was one of those comprehensive energy bills which are never comprehensive. They're never coherent. They're just a collection of dealing-with-a-whole-bunch-of-problems-in-the-various-sectors-of-energy things. And, just to be very clear about it, electricity was clearly second hand, and some people thought we would never finish the game when we got into the conference committee. It was always a stepchild of the issues going through, except for a limited number of players. And, by the way, we had a Republican president, and both houses of Congress controlled by the Democrats, and you sometimes couldn't tell who was whom in that process. No difficulty with that today. [LAUGHTER]

But speaking to the electricity provisions of the 1992 EPAct, although we had tons of hearings on this, we did not really have a grand vision about creating competitive markets for electricity, and that needs to be understood. This

didn't start out as this rational process in which Bill Hogan had done the theoretical work, and others, and now we just went ahead and decided to implement it. We didn't ask, "What does it take to create a competitive market?" That wasn't the approach that was being taken on Capitol Hill. It might have been taken in a few circles, but if it was, we never heard about it. But what rather was going on was, we asked, "How can we inject competition into this system?" because of all the various complaints that we were hearing from people about monopolies. Monopolies are not responsive to their customers, and industrial customers were particularly honked off. Monopolies are not very innovative. They are stodgy. They are stale. They don't get around to doing things. They overinvest and cost the consumer excessive amounts of money, and they misallocate things which a competitive market would do more effectively. And then they abuse their power over the transmission grid so that others who are in the business, like the municipal power systems, if they've got extra power to sell--well, you can be sure that Indiana Michigan Electric isn't going to let Richmond Power and Light sell across its wires without some excessive charge that never happened. This is how I learned about electricity and the power of the monopoly and its disgusting habits in my home area. And by the way, several other members of our committee, Republican and Democrat, learned a similar lesson, which was sort of behind a part of our thinking, not totally. We weren't total captives of any one thing.

Let me suggest to you that there was an outside coalition that had come together to try to reform what was called the Public Utility Holding Company Act (PUHCA). And there were probably lawyers in Washington who were sending their children through college on their litigation on the Public Utility Holding Company, and there may have been two members, and probably someone at FERC or somebody on the Senate or House staff who actually knew what it was. This had been done in the New Deal, and nobody had any idea how

it worked, and it had never been dealt with on Capitol Hill in the lifetime of most of the people that were there, that kind of proposition. But it was this coalition, which had environmentalists in it. Of course, Ken Lay was in the natural gas business at the time. It wasn't Enron yet. He was very interested in this. And it had a mixture of people, including a few utility people, and all of the public utilities, meaning the munis and the REMCs and things like that, who dreaded the monopoly transmission power of the IOUs. They were all in this coalition, and though the stakeholders had actually worked out some agreed-upon principles of how you would change PUHCA.

Now, what was the key thing there? The problem was, that if you got into the business of generation, you became a regulated utility, and you took all that on. Well, how many private investors, or how many other people, wanted to go that route? If they weren't in the route of investing through a utility system, they sure as heck didn't want to get into the route of being trapped. There were a lot of other considerations that went into it, but this political coalition was very important.

Now, it's also important to remember a thing that Speaker 2 mentioned, which is that they were dealing with Order 636 on natural gas. We had previously gone through this massive civil war in this country, a 30 years war over whether to regulate or not to regulate the prices of natural gas, and we had finally found a very complicated way to take the regulations off. And lo and behold, guess what. It worked. The sky did not fall. The customers were not screwed. It was just amazing, and society went forward, and we actually had more gas than people believed. So this gas experience influenced me and other people, saying, "You know, don't just be stuck in the mud with what things were like in the 1930s. They aren't that way in the 1970s, '80s, and '90s. Some of us managed to be there all that time. So we had this gas experience coming on.

And the other big experience that I think fed into this was PURPA, the Public Utility Regulatory Policies Act, which we adopted in 1978. It was what nailed Niagara Mohawk to the wall. They had to go out and buy and sign certain contracts, because the state of New York set the alternative price very high. And so they had these PURPA contracts. Now, we didn't give a damn about their problem, but that drove various people into saying, "They've got to do something." But what it taught a lot of the rest of us was to question this myth that the "just say no" people constantly perpetrated, which was that, "Oh, trust us. You cannot mess with this system. It has to be monopoly controlled in order for it to be reliable and produce power and get it to customers. Do not screw with this." The "just say no" coalition in Indiana came to me when we were considering these provisions to change PUHCA. And four of the CEOs came together. And they came into my office, and they said, "You just don't understand. In fact, I'm not sure I fully understand. Let me bring in the engineers to explain to you how the system operates and why you mustn't, mustn't, mustn't, mustn't tamper with it." Now, we had one crazy CEO in Indiana who just didn't play ball. In fact, they wouldn't play golf with him after a while. His name is Jim Rogers. [LAUGHTER] I am now on his board of directors. He is about to retire after being the chairman of the board. But all of you have been exposed to Jim at some point. He's an extraordinary individual. But he didn't buy into this vision. So it actually helped me a little bit politically, the fact that there wasn't a united front from Indiana.

But the point was that the notion of monopoly control was clearly and strongly under attack, not just by the theorists, but also in the marketplace and various places. And in the broader context, we were in an era of market liberalization. People forget. They think that it was just a matter of electing Ronald Reagan, and that we suddenly decided that all the old regulatory systems weren't up to snuff. Actually, Jimmy Carter put some of this on the. In fact, he probably got nailed when he got renominated,

because he did go in for decontrolling oil prices. I'm not trying to defend him. I'm just trying to say, in both parties, there had emerged factions. The Republican Party, generally, was on that wavelength. But there was a faction of us now in the Democratic Party that really saw we had to change the regulatory systems in order to have a more vigorous economy and a more productive society. And so it was happening in oil and gas. It was happening in trucking. It was happening in communications. It ultimately happened in banking, which some people have lived to regret.

Now, let me suggest to you that not only did we not have a vision as to where we wanted to go, but we sure as hell did not expect it to have the profound and disruptive consequences that were to flow over the next decade. In fact, I would argue, politically, we would never have done what we did, if we had known that would be the consequence. I tell you, the interests would have been all over us and saying, "Don't, don't, don't, don't," and the coalition of "just say no" would have not just sounded like a bunch of fossils. It would have sounded like much of society in this process.

Let me mention the two things that we did do, because most of the credit goes to FERC for all these changes, as has somewhat been alluded to here. One was the changes in this PUHCA so that other people could get in the business, and they didn't have to become regulated utilities. And here, the technology change, in which you had natural gas combined cycle plants, had come into play. They were easier to site. They were a hell of a lot cheaper than a nuclear plant or a coal plant. They could be built fast. They were not nearly as costly. So you could have a different economic take this on. You didn't have to have this massive rate base in order make sure you could get your investment back.

Now, one of the consequences over the next decade of this was that we obviously went out and overbuilt capacity in the natural gas combined cycle plants. And so there was, for a

long time, a lot of unused natural gas generating capacity in the system. This turned out to be a blessing once we actually had natural gas. [LAUGHTER] By overdoing it, of course, we ended up short of natural gas in the year 2000. The prices went up. But then in comes shale gas, and this, of course, led to the real significant turnaround, when the price of gas dropped. That's what led to the pressure on coal. EPA hadn't even gotten a shot at how to make this change at that time.

The second thing, of course, that was done was on transmission, and this was significant, not for what we actually did, but for the blessing it gave to FERC to move forward. And this part we actually glued onto the bill in the House, and that was giving FERC some stronger authority so they could order wholesale wheeling. So if that ugly monopolist over the transmission system wouldn't let your power get across, you could go and get an order to see that that was done. And we thought this would happen on a case by case basis, and some people thought, "Oh, this is way too bureaucratic." That was one of the challenges of it. And my answer in, I think, in the public debate was, "Well, yeah, it would be if you had to go every time you got an order. But if FERC will just exercise a strong order up front on one, then everybody will know they've got to negotiate more, because there's always a risk somebody will run to FERC and use the authority." The threat was good enough. But we really did not foresee open access. That was just not in the cards, as far as I remember.

Let me say, we did something I think that was very important and positive in 1993, by just having hearings. Now, most of what you think about as Congressional hearings is they're not exactly elevating experiences. [LAUGHTER] But we had the entire commission come before our subcommittee, and all we did was reinforce with them, and they then reinforced on the record, that we were serious about carrying out these provisions in trying to inject competition into the wholesale market. And that gave them partly the blessing that they had.

Now, I think what's really important to remember from a political economy point of view, though, is that that it was the dream team, that Betsy Moler and Mike, and William, and the others were the dream team in multiple ways. They were smart. They were innovative, as I said. They were also politically connected, so that when people would run to the senators and run to the House and start complaining and everything like that, we'd say, "Well, you know, we trust them," that kind of thing. Let me just contrast that with when Pat Wood, whom I was an admirer of, and I think he came up with some terrific stuff under Standard Market Design, when they tried to push that later, he clearly had the ear of the White House and the President when he went on, and that was one of his strong suits. What he did not have, by virtue of his previous lack of experience with Capitol Hill (and this can be blamed on some people on Capitol Hill as well), is real connections there in a solid way that protected the agency when it started to move into aggressive ways. And I don't think that's the be-all and end-all on this. I think it's just an element of the way in which power was distributed.

Let me jump us a little bit to today, because I think that we are possibly on the brink of a new round of restructuring of the utility system in this country. And all you've got to do is have your ears up, and you hear things like, "Well, we need a new business model. We need a new regulatory model." And I think there are about a dozen different groups around the country, stakeholders that are groping each other over, "How can we do this?" Because if you hear the utilities, they will tell you they are under tremendous pressures. Demand, lo and behold, isn't going up. It may be even going down. Natural gas prices have again created a whole bunch of stranded investments and have messed up future investment plans. Also, technology, innovation, and state and public policy on renewables is having a real impact.

And now these communicating technologies that Speaker 3 was talking about, which used to be

called “prices to devices,” are really possible, because when you buy a new refrigerator, it’s ready to do that. And now you’ve got stuff embedded in all kinds of places in the utility system. It’s not a pure system yet. But you have real technological possibilities.

More significantly, politically and economically, you have a whole bunch of barbarians at the gate of the monopoly. You have a number of people in other industries, and in small businesses and everything else, who say, “Let me in. I can show you how do to it cheaper. I can show you how to do it more efficiently. I can actually make your customers happy.” And the digital revolution has really started to take hold in this industry big time. So you have big data. In fact, utilities don’t even know what to do with the massive amounts of data that’s coming in over their systems at the moment. And there are big companies coming in and saying, “We’ll show you what you can do with that. You can even know where the theft is in your system. We can show you that you can make huge efficiency gains. You can even make a couple of hundred million dollars a year off of better operations of your transmission system.” Whether these claims are accurate doesn’t matter. It’s never has mattered. [LAUGHTER] The technology is enabling radically different kinds of things, and it’s especially in the information technology where this is coming to play.

Now, of course, there is going to be the issue of, “Can we protect the system with all this new interactive communication that’s going on?” Something called cyber security. Some people think it’s all about privacy. I think it’s all about whether you can operate without other people operating it for you or against you or undermining you.

So there are lots of issues on the table. One has to do with net metering. Is net metering the be all and end all? Where does it fit in this broader system? And I think it’s valuable to have the broader conversation to know how to put those things in perspective as to whether they really

are problems or not. And, of course, California is right on the front line again. [LAUGHTER] (Although Arizona’s out there.) But in California, would you believe the legislature decided to get out of the business of rate making, now that it’s controversial? They got into the business of rate making after the crisis of 2000 and said, “You’ve got to have a tiered system hit the people that are using the most at the top, protect the people at the bottom.” It’s a four tiered system, and that’s what they’ve been struggling with and using at the Public Utility Commission for the last decade or so. Now, suddenly, they’ve passed legislation that has thrown it back to the normal, more regulatory processes in which they’re going to go through rate design. They also, as I understand it, empowered the Public Utility Commission to be able to put a charge on for backup power--since some of the utility executives themselves found that they were in the high and fourth quarter payment system, and they decided to take advantage of the solar benefits, and they put solar on their roofs, and when you do that, you get a double whammy. You get a tremendous solar benefit in California, because of this high rate structure. And so, actually, the same utility executives are arguing that you’ve got to change the system. But they were the good customers, and they played into it. (Excuse me. I couldn’t resist.) [LAUGHTER]

But I will say this. I think the intellectual question is, are there roles for the utilities to play that are necessary over the next ten to 15 years for this system to function well? I mean, is there still an argument for the utility because of the need for universal access, which we generally achieved in this country? Is there really an integration operation role, now especially that you have so many different factors going on in this system? Does it really require somebody who’s really on top of this? Does it require an entity of size to be able to finance at a reasonable basis and take financial risks?

And I would say the other big question that’s now on the table, that Sandy brings home

tremendously, is restoration. What does it take to restore these complex systems that are vulnerable, especially since some believe we're going to face a lot more of the kind of weather events that are going to be very destructive? What happened in Sandy was not just regional. What happened is that the utility system, which has worked out very well in terms of having mutual assistance pacts in which the surrounding utilities will help out a utility when it's under stress, they discovered that wasn't big enough. And they had to expand it, and they ran into real operational questions. It's unbelievable what people did and the sacrifices they made to help, just like with Katrina. But they discovered, and they're working it out in the utility system now, that they had to have a much broader reach. The breadth of that was so much bigger. It required, not just mutual assistance, it required regional, even long distance, assistance. But that's a serious managerial thing.

Now, how are you going to finance that if you break up the utility system? I don't know. Maybe you can. But the point is, I think restoration becomes a new function that is much more prominent.

Well, let me close by just saying, I think HEPG has played an absolutely critical role in this, and my hat's off to Bill, and my hat's off to Ashley and others for doing this, because it's been sustained. It's been of high intellectual content. And it's been very relevant to what's going on. And I think the lesson here is that in our society, in which we have well-developed market institutions, it is very difficult to step back and do a redesign. In fact, it's probably a non-starter, in that there's nobody we want to give enough political power to do that, and there's nobody, frankly, with the intellectual dynamite to be able to say, "Oh, I can make all this work." It's a huge complex thing, whether it's in healthcare, in finance, or in electricity, and I think what this means is that we need to have these ongoing intellectual networks that are engaged. And I don't mean just in the academic community. They have to be engaged within the industry

itself. And this represents, for academicians, and for others, a big change, which this institution has survived. The isolated genius was always a myth. There are a few examples historically over the last 500 years where it existed. But it remains a heroic example in academia. Knowledge is a social activity, and certainly you know that in the economics department, and the academic world knows that. But a social activity that reaches across economic interests without getting polluted by the interests, that is a lot harder to sell and to make work. And I think this institution has done that, and I think it's remarkable in its contribution. And I think we need to copy it in other parts of our society. Thank you.

General discussion.

Question 1: Well, thank you, that was terrific. I wanted to just poke at something that Speaker 3 had in his charts, which is the crazy, bifurcated map of the United States, with all the different systems of ownership and regulation, which clearly is not stable in the long term, although I say all the time, and assume, that when I'm toes up, it will still not be all one color. But I have a little sort of thing I usually say in speeches, that we are seeing incremental movement towards more markets, with Entergy applying to join MISO, East Kentucky applying to join PJM (or now in PJM), and PacifiCorp approaching the California ISO about running an energy imbalance market for them. And beyond that, we see the places that are already markets going deeper in, with SPP going from an imbalance market to a real-time market, and California and Texas having discussions about something that seems to maybe kind of have increments of a capacity market, even though they're smart enough not to call it that, maybe. And the West is talking about whether they should take the first step to an energy imbalance market. So we're seeing incremental movement.

But with respect to your premise that there's not forward movement, do I have something like 888 myopia? Maybe like FERC disease, where you look at the map and see what you want to see? What does this smart group think? Are we seeing movement? Or are we just stuck? I throw that out to the gang.

Speaker 3: Just a quick response. I have the same sense that you have, that there's a lot of discussion, and that there is some movement on the margins. But you know, still, in important ways, we are stuck. I mean, we don't actually have a national electricity policy. Does the EU have an EU-wide electricity policy? Yes. With clear goals—there are some national differences, but there is a vision, and there's movement towards it. Do we have that? No. Now, this is not an intellectual criticism. This is a statement of political reality. And, yes, there's movement, and people are beginning to understand even more that markets actually do work in this industry. While my mike is on, let me just say, I was involved in the AT&T antitrust case years ago, and listening to AT&T people talk about how, “Only we can run telecommunications. If there's any competition, we're all going to die,” was exactly like the electrics.

Speaker 1: Well, I made speeches and said, “If you took the generation apart from the transmission, they were actually built to go together...” and I gave that speech again and again and again in the late '80s and the early '90s. Turned out to be entirely untrue. [LAUGHTER]

Moderator: Well, they still need to be connected, surely. [LAUGHTER]

Comment: To the questioner, I agree with you. There is some movement. It's actually coming from the ground up, rather than the top down. We tried it top-down with Standard Market Design, but it's coming from the ground up. I mean, if you want to have a market, ultimately you've got to get to balancing and the right rules

for a balancing market, if it's really going to work. And some of this is being driven by the renewable energy industry, some by customers. So it's being driven from the ground up, but it's painfully slow, and to me, it's just illogical to have this bifurcated system and to realize that what's stopping the movement is, I think, is mostly politics.

Speaker 1: Well, it's the point that a couple of people made on the panel, whether you're talking about strategies for environmental improvement or other elements of energy, the decision making is so disaggregated in so many different players that we have different systems.

Question 2: Well, thank you to the moderator and thank you to this terrific panel. Whoever organized it deserves a lot of credit. I would like to tell just a little bit of a war story, which I think is relevant, and then talk about the implications for today, and I'm going to direct that question to the panel.

So, before the Energy Policy Act passed, (most people don't know this, Ashley does, and a few others) Ashley and I started a process about a year ahead of time to go around and talk to John Rowe and Ken Lay and people like that across the industry, and to say, “There's all this conversation that's coming because of what happened to natural gas. It's coming to electricity. Should we get together and organize a group at Harvard to come and talk about these policy issues?” And after about six months of talking to lots of people in various places, I decided it was a bad idea. [LAUGHTER] And the reason I decided it was a bad idea was, everybody knew what they thought, so that everybody had a vision of what was going to happen. They were all different, so there was a lot of controversy and being contested, but nobody was in doubt. So there was this “just say no” crowd. There was the “open it up so I can go get the cheap power” crowd. There were all these different kinds of things that were going on. But everybody was in full lobbying mode.

And there was no opportunity for a conversation across the boundaries and across different kinds of ideas. So we didn't do it.

So then the Energy Policy Act passed, and the small little, you know, two or three sentences about wholesale competition and nondiscrimination, "undue discrimination," and it was clear to me, and it was clear to many other people pretty quickly, that this was going to create events which were going to create effects, which were going to open new possibilities, and you weren't going to be able to stop it. I would characterize this as a virtuous circle. This is the camel's nose argument about under the tent, and it was going to fundamentally change the industry, and it was going to change even how we define things, and so on. And so I went around and made the circuit again to the same crowd, and now everybody was saying, "Oh my God, what does this mean? [LAUGHTER] I have no idea what this means." The interest hadn't changed, and things that people wanted to see and what they thought. But they now had doubt. As a matter of fact, they had no idea where this was going to go.

And that's how this process got started, and that has a lot to do with the design features which include not only off the record, but also, as you all know from long experience, that we have no mandate for consensus here. So if it happens, that's fine, and that's not a bad thing. But we don't constrain what we do on the grounds that we all have to agree and come out with a statement about what it is that we agree upon. We don't make statements like that, and so we can argue and disagree, and for those of you who can remember back to the meetings with Jeff Skilling, there was disagreement. [LAUGHTER].

Yes, it was amazing. [LAUGHTER] And I think that problem still persists, and some of it was mentioned here as we're thinking about going forward. So I would expand the list a little bit to think about the green agenda and how to deal

with the problems. I mean, I would argue, off the record, that the technologies which we have available today are not going to cut it. Period. And so we just don't have the technology out there to meet what we say we're trying to do on this green agenda, and the problems of high cost and renewables not performing in the way that we think that they should be coming back to haunt us. So we have to have massive innovation. And how to have that massive innovation and create the environment and the opportunity for entry when you don't know what it is that you are transitioning to is a real challenge. I mean, if we knew what technology it was that we need, we could just mandate it. You know, that would be easy. But we don't. And there are a few other things like that on my list--to what extent does that situation apply today, where we don't know exactly what to do, we don't know exactly where we're going, and we have doubt, and we need this kind of exchange and opportunity to continue? Or has it gotten to a point where now it's just all about competing interests, and we can politically compromise, and we can move forward?

If we knew what to do, and it was just a question of choosing the right design and choosing the right things and going forward, that problem would be easy. But I think on a lot of these things we don't know what to do, in the sense that we don't know what technology is going to be embraced. We don't know exactly what kind of market design to use. And I can have a conversation about this with good intent, and we can disagree dramatically on where we should be going and what should we be doing, because I think there is a lot of uncertainty about how to address the problems that we see before us when we look more than a year ahead, and we're trying to think about, particularly, this green agenda.

Speaker 1: Let me take a whack at it. I think there is very little consensus about the green agenda, if you will. I think some of the reasons are still reminiscent of the "just say no" crowd.

You have the entrenched entrepreneurs who have made the investment. You have those who want to make the investment, and I agree that there will have to be some technological advances in order to make it function properly. But I also believe that the innovation capability's got to be there if we spend the time and effort and money to do so. Where you do have consensus, where markets are evolving toward your LMP model, there is progress. So I think you have an emerging consensus on some of the stuff, you are seeing the SPP and Heaven forbid Entergy is moving that way, and the other things that we've already talked about.

But we're not close to a consensus on the next generation of generation particularly in, I would contend, what ought to be a carbon constrained world, just as we're not anywhere near consensus on the carbon issue. I mean, that is a red/blue war.

Speaker 3: There's also a question of what the heck the "green agenda" is. Right? It doesn't exist in some places. It exists in others. A lot of us say, "Well, it ought to have to do with carbon." But of course, if it has to do with carbon, you're obviously right, we don't have the technologies to deal with it adequately, and every economist will say, "Well, that means you've got to get the incentives right and have the system as flexible as possible, so there are incentives to innovate, and the best technology wins, which means a carbon tax, or cap and trade"--on which there's absolutely no consensus, because "green" doesn't mean "carbon" to some people. It's not clear what it means if it doesn't mean carbon. If you look at the state RPS legislation, the recent pieces of legislation talk about jobs and energy security. Michigan put in its renewable portfolio standard "for Michigan energy security." And you have to say, what are they worried about in Michigan?

Comment: Indiana. [LAUGHTER]

Speaker 3: Indiana, I guess. I don't know. [LAUGHTER] So you know, I think we have a lot of policy, and all of the RPS regimes are different. Most of them make weird technology choices. I don't think we have a coherent green agenda. So it's certainly not clear what technologies will best respond to it.

Speaker 2: Well, you know, the issues associated with the green agenda pop up in a variety of forms. You know, there was a conference yesterday at FERC on capacity markets. And part of the focus of the conference was what to do with state renewable energy policies in the context of the capacity market, whether to defer to the states, or to have FERC make its own decision. I remember in the early days at FERC, I had just dissented on a case because I was agreeing with the state, and we were walking out of the meeting, and the chair came up to me and said, "You know, you'll get over it. [LAUGHTER] Because if you defer to the states, you can't get anything done at FERC."

But this issue pops up in a variety of ways, and I think without one or more forums where people can safely discuss the issues outside of the political spotlight, I think these very, very tough issues aren't going to go away, and are going to have to be dealt with, and it's better to have opportunities to discuss them in a safe place. It's better for policymakers and for everybody. That's my view.

Speaker 4: I think it's certainly true that we don't have a clear vision, and we don't have it worked out, and I would simply go back to the fact that we were irrational when we started this process. [LAUGHTER] So get used to it.

I'm partly being facetious. First of all, I believe the consensus around the science is actually strengthening, not weakening, internationally and in the country, and generationally in the United States. So we're at least going to see progress following the hearse, if not sooner.

Secondly, I think that I disagree partly with you. I agree that if you have the grand vision of what is necessary 30 years from now to be a truly carbon reduced economy, then clearly we have technological work and things to do. But we in fact have a lot of cutting edge technologies, and a lot of room from where we are and where we might be. It's not the end game. And so what we've got to do is at every step of the way is do what we can to keep markets and regulations organized in such a way that they tend to embrace innovation instead of stop it, and that's not simple, as you well know. I think, too, that we do want to keep up federal research and development and learn new ways to do it more effectively. I just heard the woman who's a deputy at ARPA-E speak last night in New York City, and my God, I thought, with that kind of competence, the federal government might actually get something done. She was just phenomenal. And the whole agency may well be. So I just think there are pluses going on that don't seem evident on Capitol Hill.

But also, I would say that the environmental movement has certainly had to adjust to the fact that there's not going to be a grand international bargain, and there's not likely to be in the near future a grand national policy, about which many of us would advocate, which is, let's have a carbon tax, or let's have a carbon price through cap and trade, or some mechanism that capitalizes on that market as much as you can. But instead we're going to get it in lots of pieces. That has a lot of inefficiencies, but it also can mean that you don't have to wait around for the grand plan. The states are doing stuff--some of it will pay off and some of it will prove to be stupid and costly.

I would say the focus now is on those EPA rules. There will be a massive fight against them. I think that fight will lose in the courts at the end of the day. It may send them back day after day to redraft the rules, but the Supreme Court is not going to overturn *Massachusetts v. EPA*. And so, "Engage on those rules," is my

recommendation to the industry and everybody else.

The second thing is, we can write those rules in different fashion. We can make them highly prescriptive and dictate the fuel choices and the technology choices, and we'll clearly get some certain improvement. The much wiser thing to do is to take a risk that we don't wring as much carbon out of the system as we could under that approach, and leave more flexibility to the states. We can have regional state compacts that actually engage in trading credits and all kinds of things that will be cheaper and more innovative, as well as meeting industry needs to be left choices. And this is a real live choice that we have in the regulatory decision making that is going on now.

Question 3: Just a comment and then a question, and I'll keep them both brief. I think Speaker 2 said that he didn't think people were hurt by stranded costs. In the state of New Jersey, PSE&G customers got creamed with over a billion dollars of stranded costs. The parent company kept the generating facilities, and got money. We were paying for stranded cost. And they made a frigging fortune with those generating facilities. So we were hurt, and it was a bad decision on stranded costs being allowed.

My question is on the future, though. Capacity markets. There have been discussions. We had discussions here in this group about capacity markets and whether in fact they did what they were supposed to do. I have liked capacity markets since I figured them out about five or six years ago. There are other people who will go nameless, but they know this stuff pretty well. It has not done what it was supposed to do. And it is costing a fortune for a lot of states like mine and others. So while PJM has had a capacity market for a while, it's been very ineffective in doing what it was supposed to do. And MISO is heading in that direction, which makes no sense to me personally. So what do you guys think about capacity markets?

Speaker 1: I want to answer the question about the stranded costs and the customers getting creamed. At my company, we insisted that the stranded cost payment be a hedge for customers, and people laughed, and almost every other state, including yours, insisted, “Oh, no, we want to do a ten year forecast, and we want our money now, and you’re going to get screwed going to the market”. And you lost that bet. You played craps. And I thought it was the --

Questioner: Unfortunately, I wasn’t involved in that decision.

Speaker 1: OK, whoever represented them, and I remember trying to talk to people about this, and they were just so sure they knew where market prices were going to be. They couldn’t wait to get out from under it. We insisted on the hedge, because we figured, if the market went up, the Commission would figure out a way to screw us out of the money anyway. And if it went down, customers would get a hedge, which they deserve, because they’re paying for the cost of those contracts. And we’re done. That is phased out. Ten years went by. It was all settled. There was a little bit of local press about it. But I was astonished, as an insider, watching state after state, and some of the people in this room who will go nameless (maybe after a couple of drinks, I’ll say, “Hey, you said that,”) complained that the utilities made money. You know, that they took the stranded cost payments. And then the market went up, and they sold it again. Those thieves. And I said, “Why don’t you look in the mirror pal? You signed that deal. That didn’t just happen in a vacuum. Nobody forced you to do that.”

And that’s another lesson we never seen to learn in this industry. We can’t forecast squat about what’s going to happen. [LAUGHTER] We forecast because we have to, because it’s a very capital intensive industry, and these investments have 30 and 40 year lives. We don’t have a choice. That doesn’t mean we have to drink the

Kool-Aid and say, “Yeah, that’s exactly what’s going to happen, boss.” In six months, sometimes, it flips completely around.

Question 4: Since California’s been mentioned a number of times, I thought I would throw in a few comments from California, picking up on this theme of, are we stuck or are we actually moving? And I feel like in California, we’re moving, and what I want to put in front of the panel is a couple of suggestions that maybe where we’re moving is in a direction that’s somewhat orthogonal to the trajectory we’ve been on for a long time. So the expected path that we have intended to see play out is maybe different from what’s actually playing out.

Two things that I would observe is that one, talk about the future path that seemed to be dominant this morning, still is around a model of selling kilowatt hours to end use customers. And I’d like to suggest that maybe that’s something that’s breaking down right now. It may not be about selling kilowatt hours to end use customers anymore, especially because of the explosion of alternative things that are happening on the distribution system: rooftop solar, net energy metering, all of these things, different ways for customers to get the services they need without necessarily buying a lot of kilowatt hours from a big centralized system.

And the question is, how do you see these alternative pathways playing out? And I would just like to add about the comment about Hurricane Sandy, that I think similarly the notion of resilience can become much more a local solution rather than a centralized massive infrastructure solution. Thank you.

Speaker 2: I agree with a lot of your comments about these new technologies coming on. There’s a lot of work on what the utility of the future will be, and this utility will actually do. And as long as the utility has an incentive to sell more kilowatt hours, that’s a real problem. And so we’ve had a decoupling debate. Then the

question is, what do you do with the utility's stranded distribution cost, right, if you're not using it? So the whole stranded cost issue is going to come back again, too.

But I think a lot of these new technologies are compelling. They're coming on. We're going to have to figure out how to deal with them. I think they can have very positive impacts. I still think we have to get the rules for pricing in the market right so that you know how to price these services in the marketplace. And I also think, and this is a personal philosophy, that unless we have good markets at both the wholesale and retail levels, we're not going to value these products correctly. The barbarians at the gate won't be able to get into the market and serve. And so I think the old fashioned monopoly model for utilities is not long for this world.

Question 5: Thank you. I have two questions. One a generic one and one a specific one based on my personal take on this. The generic one is that if we had the luxury of going back 20 years ago, and I would like to ask the people on the panel who want a take on this, what would you think that demand response debate would have been from the beginning? Would it be different from what we hear today? And the second one, my personal observation, is that, yes, the demand side of electricity is largely controlled on the state level. And so that opens up the question of federal/state jurisdictional coordination. And the specific question is, knowing what we know today, if we had gone back to 20 years ago, how much more emphasis would we put on that topic?

Speaker 3: Being very old, I can actually remember 30 years ago. Yesterday's hard. [LAUGHTER] It really wasn't discussed. I mean, Fred Schweppe talked about spot pricing. But it was a dream. It was a dream, because the technology really wouldn't let you do it. And there was some clear debate about whether you could actually get response. I mean, physically. And we all understood, we understood even then

that time of day pricing wasn't what was needed. You really needed something that had a real-time component, and I think 30 years ago, it just was not on technically. Forget organizationally. So the debate didn't arise, because there was nothing to do with it. I mean, you knew that you weren't going to send spot prices into the household. Even Fred wouldn't argue for that, because you didn't have the metering. You couldn't see the prices. You couldn't response to the prices. And if we had asked, "Well, do we think the demand side will become more important?" I think at least economists said, "Well, yes, in theory you'd like to get the prices right, not just to large customers, but you'd like to get the prices right generally. But we don't know how to do that."

Now, the notion of intermediaries, like EnerNOC and others, that do an aggregation function and automate the response and do a variety of things, was not conceived of that long ago. It would have been welcomed, but it doesn't get you all the way there. You don't just want critical periods. You want it more broadly. But I think it just was off the table because it had to be off the table.

Speaker 4: I would just say, I think it was off the table in a lot of the serious design questions. But it was always politically on the table because the environmental movement put it on the table in a way that was dismissed at the time, and it was a stepchild argument. The argument was that you're building towards a peak, so what can you do to shave the peak? And then you don't have to add the things. And consumer groups were to some degree advocating that, too. So that theory was being driven very greatly for environmental or for consumer protection reasons. But it wasn't clear to people how you would do it.

And I would even say there was another thing, which is, the mindset of consumers and businesses that was interpreted by the people who often didn't have any idea what their customers wanted, the utilities and others.

[LAUGHTER] There was this attitude of, “Well, they’ll never accept that.” You know? “The local industry in my area would never cut back at 3:00 in the afternoon. They just wouldn’t operate that way.” Well, guess what. If there’s an economic incentive to operate that way, they do. Economics 101 comes into play.

So it was a part of the political debate. But it never got the traction, and it was dismissed as another one of those theoretical “people that don’t know what they’re talking about” things.

Question 6: I just want to respond to Speaker 3’s comment about not being sure what the green agenda is (and I think Speaker 4 gave a partial response to that). I think it’s clear that the green agenda is based in addressing the climate change issue that Speaker 4 talked about. The confusion has been the politics of getting it passed in different states--RPSes and other in-state requirements. There’s got to have been a coalition built to get those measures passed. And those coalition members are not in that coalition because of the issue of climate change. They’re in it for job creation or some other economic interest. So I just want to make sure not to confuse the two. We’ve sold a lot of environmental measures, not just on climate change, but on the coalition that was necessary to get stuff passed. And I think it has created problems, because you have preferences for what has to be produced, and you are driving up prices unnecessarily to solve the green agenda, which is a climate issue. But it’s been driven up because of other political incentives or reasons why that was necessary to get passed.

Speaker 3: Can I just give a quick reaction? I agree that the drivers and the folks who say, “Well, we have to do this,” are talking about climate. But boy, you look at those programs. Rhode Island has, I think, four tiers. On your point that building the coalition affected the program—boy, did it affect the program. New Jersey has a requirement for offshore in-state wind. North Carolina has a requirement for

electricity generated from poultry waste. Rhode Island has three different tranches of technology. And you’ve got to ask, what do these people think they’re doing?

Questioner: It was necessary to get it passed.

Speaker 3: I’ll tell you. Clearly.

Speaker 4: Also, it was poultry waste which saved the RPS from the political counterattack this last year. It’s amazing, and this shows you the barbarians that are at the gate. There are whole new political coalitions as a result of people that are in business. And so a Tea Party ideologue who came to the legislature to get rid of all this nonsense that the left wingers in Washington had imposed on the society voted with poultry waste and stopped the withdrawal of the RPS in North Carolina. So never underestimate coalition building. [LAUGHTER]

Speaker 3: Going back to climate, there is the possibility that this next decade we’re going to see much more focus on methane instead of on carbon dioxide. We’re already seeing it on the question of methane fugitive emissions at the drilling sites. But now we’re going to look down the pike (down the pipe), and I think what we’re going to discover is, there is a hell of a lot more emissions than we’ve ever assumed that are leaking out there. And the only economic incentive to prevent them from leaking has been safety. It has not been economics, because the cost of stopping leakage versus what you lose probably doesn’t add up. So I just put that on the table. I don’t think it’s a show stopper. But I think the debate we’ve been having over carbon will continue, but it’s going to expand now, and this may reshape some of this natural gas enthusiasm.

Question 7: I am puzzling about where the locus of reformat activity will be going forward. Is it in the states? Is it FERC, CFTC, Capitol Hill, agencies like EPA? Or is it just decentralized? What’s the perspective?

Speaker 1: For what it's worth, my judgment for now is that among the federal agencies, FERC will continue to do its job, but the hot place is clearly the EPA, particularly with the agenda that they have. And then in the states, they continue to be laboratories, and there's no one-size-fits-all kind of circumstance.

Speaker 2: I think it's going to be all of the above. We're just going to muddle through. I will say, having come from FERC, I'm aware that FERC has a lot more authority than it has used. And the limitations are political. I mean, what if FERC took this jurisdiction over all transmission, even bundled retail, truly down to the meter? What if they just declared that it's required to eliminate undue discrimination? They clearly have the authority to do it. The Supreme Court has said, "You can do it." But I don't think that's going to happen. And so I think we're going to muddle through.

Speaker 3: It's interesting how it happened in telecommunications. You don't hear much about local PUCs making telecom policy. That has been effectively federalized, except for wire line rates and such. And as a result, we actually do have a fairly coherent national telecommunications policy.

Question 8: I have a related question. It was fascinating to hear how the stars came into alignment to kind of lead the regulatory market changes that caused like two thirds of the country to be under organized markets. And then we're left with this bifurcation, as you put it. And maybe incrementally things will move more towards organized markets. Maybe not.

So my question is, what would be the realistic scenario to imagine the sort of change that would be needed to cause the remaining one-third of the country to adopt an organized market like the other two-thirds has? Can you envision that? Is there anything realistic out there that...or are we resigned to this?

Speaker 4: The simplistic answer is, so what's in it for us? And that's what you have to politically demonstrate. What drove this, overwhelmingly, was the theory that you were going to get lower prices. And you just look at the states, and almost all the ones that made any real effort were well above the national average in the cost of electricity, and they were sold on the notion this was the path to be like coal-burning Indiana and Alabama. And then you're supposed to also do it without coal.

So it's not that it's not possible. It's just that there has to be more than just a theoretical reason, that maybe things will be better, to overcome the current operation. Why should you bother? Why should you go through the political and economic turmoil and all of this? Is there isn't some pain that you're trying to alleviate or some real benefit out there? And I think that has to be demonstrable. I don't think it's enough just to say it's a damned good idea.

Speaker 2: My view is, there won't be a grand stroke. You know, if Congress were to adopt a cap and trade system, that would be an organizing principle that would drive everything. I don't see that happening. I don't see FERC doing it. I think it's going to come from the ground up by the barbarians at the gate. And I don't know that they're going insist on RTOs. But I do think that over time they will insist on markets, because otherwise they can't get in, other than going through the utility company, who can say no. So I think all these new technologies and barbarians and those who just want to serve and provide something new are going to drive it.

Speaker 3: I also think the federal role will be an issue in some areas. It's going to be hard to say to people in the Pacific Northwest, "If we replace your local federal utility, Bonneville, with a private utility, your rates will go down." I think that's a tough sell. And similarly in TVA. But if you keep a big federal presence--this is

the European problem, which we have in certain regions--if you keep a big government enterprise presence, it's hard to make markets work smoothly.

Speaker 4: There's one other pathway. This may be strange, and I don't know exactly if it will work or how it will work. But if we get this existing-source rule on greenhouse gasses, then we go to state implementation plans, and I alluded to the fact that one pathway may be to get regional plans or the like. You might find out you're designing those in ways such that at least certain elements become regional markets, markets for your renewables, or whatever your solution is to reducing your emissions, might be an entry point for at least some of these issues. I don't know if that would be the case.

Question 9: A lot of people have mentioned the new business model--the new technologies coming through and the new services that are being offered. What is your view about whether these things are simply marginal changes that are irritations or small distortions in the market? Or is this big process we've described in the EU and the US to roll out this system actually rolling out a system that's going to be overtaken by events, by environmental policy that happens, and indeed by technology, which is may lead us to a very different place ultimately?

Speaker 4: I'm not speaking for Duke Energy. But certainly, the intensity of interest at Duke and at other places on these issues suggest that they are either painfully or gleefully aware of the opportunities that exist with change. And this is not viewed as marginal. This is viewed as significant. And the shocker to almost everybody in the analytical and other fields is how rapidly solar price came down, and how much it's engaged in the marketplace and how indebted we are to the Chinese. [LAUGHTER]

But the point is that these are shaking up, and there is obviously a big movement to examine what's happening in Germany and try to claim

that's what's going to happen in America, and that that's a disaster. Whether it is or not is going to be debated. So there's renewed interest in Europe, but for perhaps the wrong reasons.

But I think it is being taken very seriously. I think there's a lot of good independent analytical work to be done to figure out just how serious the net metering issue is, or these others. Aren't these marginal? Can't adjustments be made? And to be honest with you, I think how the Public Utility Commission in California does their rate design and deals with these questions, because they're all wrapped up together there, may set a pattern as to whether you think you're going to really turn this upside down or go forward or not. I'm betting it's more marginal and incremental. But that is not the talk.

Speaker 3: I think that renewables, particularly rooftop solar, raise a number of questions. Rate design in particular, wires versus energy, and so forth. Can you accommodate them without radical change? I think so. I think so. Will you? Who knows.

Speaker 4: Probably the largest question is what role do utilities want to play, and what role will the regulators and legislators allow them to play? Are they going to be the people that put the solar rooftop on and control it and make money out of it? Are they going to be the losers who have to make up for any gaps? And this issue's been debated for 400 years in this country. And it's older than HEPG.

Question 10: I'm going to speak to the issue that we began with, and that is the success or failure, to whatever degree, of retail competition.

I'll begin with the premise that the utilities far outlast all the regulators and most of the legislators. That's a big, big problem. Now, I will agree that back in the day, when all this got started, we dove in and said, "Sure, you can recover your stranded costs. That makes sense, because you had a covenant with the state. All of

a sudden we come along and say, 'Well, wait a minute, you're going to have competition.' So you can recover your stranded cost." Fine.

Over time, transitions take place. New governors, new regulators, new legislators. And then pretty soon, you do have some degree of shopping. You have migration. And what happens when you migrate? Oh my goodness, there's more stranded costs. Well, wait a minute. You had the opportunity a long time ago. But we're no longer there to tell them that. So you have new commissioners, with no great institutional knowledge or history. And the companies get non-bypassable charges. So if you're going to shop, you're still going to pay for that. That, to me, has been the greatest impediment that I've been able to see in the success of retail competition. Now, you know, that's a rhetorical question, obviously, and I don't know if there's response to it or not. But I think --

Speaker 1: I have a response.

Questioner: Oh, I could count on that. [LAUGHTER]

Speaker 1: If you've deregulated your generation, why do you have stranded costs as the market evolves? If they're stranded, then the generator eats it. There's none.

Questioner: They put them on the wires. And they're allowed to.

Speaker 1: In Ohio, yes. [LAUGHTER] If it's distribution costs that are stranded, because we don't have customer charges nearly where they should be, those should be recovered. But the generation, it shouldn't be. They make their money or they lose their money, and that was the purpose of putting competition in place.

Questioner: But the wires are not deregulated. I mean, the wires --

Speaker 1: If it's wires charges, they should be recovered, because this "running the meter backwards" stuff is nuts from a financial point of view. Those costs don't go away. That system's there to serve that load when you need it, and if you want to run the meter both ways, set the price so that what they save is what you avoid, which is a piece of generation. You don't avoid the wires costs. So I'm not accepting the premise that in a market that it should work that way. And if it does, where is that state?

Questioner: Well, I mean, to the extent that net metering exists, that certainly is not a compelling issue at this point, in terms of dollars and cents.

Speaker 1: I think it is in California. It's a big one. And it's going to be growing.

Question 11: I think some of this has already been addressed, but I've been struck by the conversation. Speaker 3, you mentioned the need for markets. We need flexibility to get innovation. Speaker 4, you talked about flexibility under Section 111(d) of the Clean Air Act as we look at CO2 regulations going forward. And I think about how markets have met the challenge, especially wholesale power markets, in thinking about meeting the MATS (Mercury and Air Toxics Standards) rule. PJM has had over 22,000 megawatts of actual retirements or pending retirements, due to the MATS rule, mostly coal units, some units in New Jersey, due to the high electricity demand day rule for nitrogen oxides. The presence and the transparency offered by market prices, especially in the capacity market, has essentially made low gas prices, MATS, a nonevent in PJM from a reliability perspective. I mean, we're moving forward. We're clearing our capacity market at a 20% installed reserve margin when our target is 15%. I would say that's a success for wholesale markets. We have met the challenge. And we've met the challenge with flying colors.

However. [LAUGHTER] This is the question looking forward: can we meet the challenge of the future as we see continued Marcellus shale gas, CO2 regulations of different sorts with different state implementation plans, and how we cobble those together? Can wholesale markets alone meet those challenges? Or are we in search of other markets that complement wholesale markets to help wholesale markets work better, that they can work with to meet these challenges? Because I get the sense that we're looking at wholesale markets alone as trying to meet all these challenges, and I'm dubious as to whether that's even possible.

Moderator: I'm going to try and simplify the question. In restructured markets, where the generation is now selling at market-based rates, the companies that own that generation are at risk. They've made a bet. They either are going to benefit or suffer accordingly, and you're already seeing that with what's happened to high cost production facilities. You've seen it a lot in PJM, because they can't compete with low gas prices. But in states that have rate-base generation, they will continue to not bear the risk. So right now I don't see something that will change the dichotomy there, unless it's just a huge revolution in technology. And then I don't think customers would be expected to pick up the tab. But maybe I'm not far sighted enough on that.

Question 12: I appreciate the trip down memory lane. I was a hitchhiker all along, because I'm interested in choices for customers. And by the way, I don't know where along the way you decided choices for customers was which large Texas utility subsidiary you buy at the same price from. Choices for customers meant that we would diversify spatially, temporally, by volume, by term, etc. to satiate customers' demands, because we know they aren't constant.

So I think you solved the easy problem. But it was an easy problem in the sense that the mathematics and engineering was there. All you

needed was the politics in place. I'm impressed by a lot of the things I didn't know about the politics.

So who's going to solve the other problem now? Most of the benefits of competition are supposed to come at the retail level when customers get a chance to either buy off the five minute wire, or buy a ten year fixed price. There's nothing wrong with that in principle. That would be good for the market. So ten years from now, is the group going to be meeting again? Are you going to still be talking about how to fiddle at the margin with wholesale markets? Is it going to take a whole new set of people to address the issue of how to bring choice to customers?

Speaker 2: A whole new set of people. [LAUGHTER] No, I'm kidding about that. You put your finger on the problem. I mean, we have, for electricity, the most fractured market you can imagine. We have RTO regions and non-RTO regions. We have competition states and non-competition states. We have seams all over the place. We have differences in pricing. And we have a very disaggregated regulatory system. And if you think about Google trying to do business in the United States, if they had to get permission from 51 state regulators to do it, it would be an impossible situation. So I think we're going to continue to muddle through, and my hunch is, ten years from now, we'll still be having this conversation, as long as we have a 1935 law governing a 2013 or 2023 electrical system.

Speaker 3: I would add that I think that the technical problems are much less than the political problems. I mean, the notion that you're going to have effective retail competition when you haven't decoupled the wires from the energy organizationally...Just as you can design a wholesale market badly, you can design retail badly. You can favor the default supplier who also happens to have the wires. I think California's going to be interesting, because, again, you're dealing with distributed

generation. You're dealing with customer charges. But the political issue of whether you can decouple, I think, is the hard one. I don't see what makes that happen.

Question 13: We're having a huge amount of coal retirements in the middle of the country in response to the MAPS rules. We now have the cheapest gas in the country in the northeast of the country, with new power plants being built there, and the gas utilities racing to change the compressors and the pipelines from the Henry Hub so we can flow gas from the Northeast down to Texas and potentially even export it.

And there are big changes coming over the next five years or so, and my question is really about the role of transmission. Because it seems like the policy here has been and continues to be, "We need to build as much transmission as possible everywhere in order to get power out from the middle of the country, to get it to the East and make the customers all pay for that," and a lot of the utilities like that, and other folks like that. But I wonder whether that is really the right thing to do in the face of the changes that are going on. The billions of dollars we're investing in transmission--is that really the right policy for the commission, given all these changes that are taking place? And can the market handle that instead by putting generation in the places where it's needed?

Speaker 3: Until we get effective federal siting authority, you don't have to be worried about a flood of transmission lines crossing state lines.

Speaker 4: Well, I think what this is also about is the fact that who cares about transmission and who advocates for it has radically changed. You're talking about the regional change, and the Midwest coal producers could sell elsewhere. The remarkable political thing that is often missed is the environmental movement supporting long-term transmission, a radical shift in their perspective for these people,

obviously in order to get wind where it's most lucrative.

Of course, so much relates to that new gas supply. And so the whole pipeline system is having to change. You talked about reversing pipelines. But what I think this gets to is, and to Speaker 3's point, is that it's a lot easier in this country to build pipelines than transmission, and FERC has more authority over pipelines than it does over transmission. And it's a lot easier in general to site pipelines, and takes less time, and so gas is going to have that flavor.

Now, I think the interesting thing about this is whether or not the gas distribution system is going to be responsible for flexibility and prices on natural gas to electric utilities, more than this broader argument over how much gas is there, and whether it's going to be available at a consistently low price. Obviously, we saw in New England, when the gas was just not getting to the generators, and they had to redispatch the system, the importance of how gas flows. And I think that is going to be a significant thing for the entire energy system, where gas is going to flow (and oil, by the way, too, the same thing is happening there).

Speaker 2: if you look at the gas market, the US gas market is the envy of the world. Now, why is that? I mean, it was the envy of the world even before shale gas. And my view is, there is a very robust transmission system for natural gas on an open-access platform. And so I don't think we ought to be throwing money at high-voltage electric transmission. On the other hand, to provide that foundation for the markets, I think, is critically important, and we see that on the gas side. And I think it's all about getting the prices right. On the gas side, the pipes are at risk when they build a new pipeline. So they have to come to FERC. And FERC will approve the siting of the pipeline and say, "Good luck to you." You know, if you have a market, and you can make money, that's great. You may not. And that may

be something we ought to be thinking about for electric transmission.

Question 14: When you look at what happened, the takeoff from the '92 act was a remarkable assertion of regulatory authority. It went far beyond what Congress literally authorized. And as Speaker 2 points out, it came from authority that FDR gave them, actually. And the question I have is, when you look at the lynch mob with Ron Binz that's going on right now on the Hill, just where is the future of regulatory independence and the ability of regulators to do the kinds of things that you guys did, and for Congress to actually, for whatever reasons, stand back and let it happen and not interfere with it?

Speaker 1: I feel very strongly that what is happening with Ron Binz is indicative of how broken our politics are these days. And the fact that the "just say no" coal guys have organized themselves to go after him and to impugn the integrity of every sitting commissioner across this country with the *Wall Street Journal's* editorial board attacks on him and commissioners, I think, is a travesty. And I think it's how broken politics is. It reminds me why I got out of politics, why I don't want to lobby anymore and don't. And I think it's a travesty. (Not that I feel strongly about it.) [LAUGHTER]

Speaker 2: Yes, this circus that's going on now with Ron, it's horrible for FERC. This would not have happened at FERC 20 years ago, I don't think. But it's happening now, because FERC is in a very central role. I mean, energy policy is getting done at FERC in many, many ways. And I think that it reflects that, and I think to prejudge that a nominee will have a certain perspective is just absolutely wrong. So if our broken political system continues down this track, I'm not sure any federal agencies will be able to function.

Speaker 4: I don't disagree, except I would argue that this, too, will pass. And I wasn't really arguing that it was regulatory

independence that was key 20 years ago. I was suggesting it was different than that. The notion that the regulator can be totally independent from our politics, that is a noble idea and what not, but it's precisely because these people had political relationships, because they were politically savvy enough to figure out what to do about stranded costs, that they did not stir up at that moment the political opposition that would weigh in later on SMD. And I would argue that what you saw there actually went against what a number of the people in Congress claimed they were for. But they ended up being against SMDs. And you had this unbelievable coalition of the left wingers from the Northwest and the right wingers from the Southeast in bed together. The only thing you can count on about political bedfellows is that it's usually short term. They don't copulate for long. [LAUGHTER] So that coalition broke up quickly. But it was strong enough to kill SMD. And didn't you say just now that those senators all sent letters against your nomination?

So this is not brand new, this effort to meddle and to push and to pull and things like that. I do think we want to reinforce that this is an important role, and the reason for the independence is because you want an arena in which there is a disciplined conversation under disciplined rule, and there's no historic evidence that that's in the Congress. [LAUGHTER] But you do not want to disconnect, in this complicated economy and society, these regulators who sit off like they're in Heaven, and they're going to decide this in a theoretical and academic way. That may work for two days, but within four days, you actually will energize the US Congress.

Session Two.

Regional Transmission Organizations: Successes and Challenges

A major institutional innovation of electricity restructuring, the independent system operator was a sharp break with the past. In the early days of the HEPG, a critical topic, second only in perceived importance to the treatment of stranded assets, was the debate about the requirements of wholesale power markets in order to support the paired objectives of open access and non-discrimination. The debate ended with the recognition of the requirements of successful market design (SMD) and the critical role of the system operator coordinating economic dispatch. The importance of the independent system operator and the responsibilities of the regional transmission organization follow directly from the interaction of the dictates of policy and the laws of physics. Core responsibilities include maintaining efficient market design and operation, ensuring system reliability, and coordinating transmission planning. What are the principal successes of RTOs? How has mission creep expanded or burdened the mission focus? How well is regulatory oversight working, balancing national, regional, and local interests? What have been the major problems and hiccups along the way? If we could roll back the clock, what would we do differently? What are the most pressing challenges ahead for both operations and governance?

Moderator: Good afternoon and welcome to the afternoon session, which is entitled, “Regional Transmission Organizations: Successes and Challenges.”

A couple of comments just as an introduction to what the panel’s going to say. Starting around 1999, when we had started retail access in Illinois, we had retail access in Illinois without a market, and very quickly learned that that is a difficult proposition, where you have no balancing market and people are buying blocks of power, where you have no capacity requirement and the new entrants feel no reason to purchase capacity. And so if there was ever a reason that, if you’re going to have retail access, you have to have an organized market and requirements, I think Illinois proved it.

We’ve got a whole lot of academics to thank for a lot of the underpinnings of RTOs. Professor Hogan, Professor Schmalensee, Dr. Joskow, and Fred Schweppe, who provided a lot of the engineering basis for what we have now. And of course the leadership at FERC, Betsy Moler and the dream team, Pat Wood (who has been roasted a number of times for standard market design, but Pat pushed the RTOs), and the commissions before, in-between, and the commissions we have now.

And the last thing I would say is one of the problems, is that we may be facing RTO against RTO, where you have different independent boards, but they’re not independent of their own stakeholder interest. And that may be one of the next fronts that have to be battled.

And, finally, people should remember that SMD now stands for “successful market design.”

Speaker 1.

Thank you. Well, I was going to start with a confession, which is my background in engineering. And so what that means is that you may have to take some of my comments with a grain of salt. I have a propensity, if I see something broken, to want to fix it. If I see something inefficient, I tend to have comments on how to make it more efficient.

So with that, it’s been my pleasure to work in this industry for what’s going on to be close to 30 years. And it’s been my pleasure to serve customers along the way. And when I was preparing for this session, I couldn’t help but stop to think about what the customers would be

thinking about RTOs, their successes and their challenges.

And so there are a couple of questions that I came up with. I really, in the end, only came up with two and a half questions that I think the customers really care about, the half question being markets (and the two main questions being about reliability and cost). I think that the only reason customers care about markets is how it impacts their cost of service in the end.

I think that customers expect reliability, and they expect reliability 24/7. The industry has done a very good job over the past 50 years of instilling that expectation of a high level of reliability. And that's part of what we need to really start thinking about over the next couple of years, as we start our transition.

In today's environment, it's more important than ever to look at things from the customer's perspective. And for anybody who's gone through stakeholder processes at the various RTOs, it can get lost in the mix. And we can focus on individual items that might impact our financial bottom line or our future opportunities. But in the end, the only reason that we're here and in business is to serve customers. And that has to be fundamental. And it has to be fundamental to the RTOs, as well as all of us as stakeholders in that process. So as an industry, we really need to reflect on what we're doing and how it's going to impact the customers.

I liked the quote at the bottom of the page, "Without reflection, we go blindly on our way, creating more unintended consequences, and failing to achieve anything useful." I thought it was particularly pertinent. And I think that when we think about how well the industry is doing, how well FERC is doing, how well the RTOs are doing, it's all a matter of perspective.

There are a couple of things that we have to keep in mind with respect to the perspective from which we are currently viewing the RTOs.

And one of the more important things, I think, to reflect on is the fact that RTOs really have been created and have advanced pretty successfully in an environment of surplus. We have plenty of generation. There's a lot of excess generation, has been since the formation of the RTOs. There's fuel diversity in most areas of the country. And we have a strong transmission system that the RTOs inherited from a number of the utilities that either had come together like they did in New England to build the 345 KV Loop or individually developed these robust transmission systems, 500 in the Northwest, 500 in the southwest, as well as 765 in the heartland of the country.

So the RTOs are really starting from a pretty good spot, in my opinion. I think they work well. I think operational coordination works extremely well. I think that, for the most part, there are very few problems associated with the communications between the various operators of the system. I think planning within the RTO has improved. And it certainly has met the needs of the system in a situation of surplus.

And, finally, I think what has also been done well is the stakeholder process. It is a very open and transparent process, which is a good thing, just like these discussions. It really allows people of different views to come together, hear each other, and come collectively to some solutions.

Now, I think there are some challenges with that as well that we also need to reflect on. Earlier there were some great questions about the future of our generation portfolio in the U.S. Are we prepared for that future? I think that's the question that each of us has to ask ourselves. I am fearful of that. I just reflect on that saying, "What got us here won't get us there." And to emphasize that, I'll tell you a short story that I've told a couple of people here this morning. I was in Colorado for an EEI conference the week of September 9th. And then my phone rang. And it's the guy who's in charge of my operation

center, and he said, “This system is tight. We’re very close to dropping load.” And we dropped load. We dropped a small town on the Indiana/Michigan border. The flows were unprecedented--flows going really from East to West, which is traditionally not how the flows are operating on our system. It was not a peak. It was certainly a peak for September 9th. But it was only about 93% of the summer peak in terms of load. I was of course talking with our president, who wasn’t happy. He wasn’t happy the next day when Tuesday came and we dropped that same community, again, because of the PJM directive and the fact that we have to evaluate the system at that time, which was really about an N minus five situation. Then came Wednesday. Luckily, we didn’t have to drop that town on Wednesday.

By the end of the week, I had nine data requests from the Indiana commission. They were certainly not happy about the events. PJM was very helpful in helping us respond to those events. But what really scares me are the answers to a couple of questions. So one of the questions was, was your generation on? Yup, it was on. Everything was up and running. Did you have any unplanned transmission outages? Nope. Were there planned transmission outages? Yes, but a number of them had been canceled. Ones that could be canceled, PJM canceled, as they normally would.

So what keeps me up at night is the fact that we’re not even beginning the outages that are necessary to rebuild the grid in PJM to prepare for the 2015 generation retirements. Thirteen gigawatts of generation has announced retirements in 2015. I’m sure there will be more, given market prices and so forth. And the solutions that we’re advancing are rebuilds. AEP has to do a lot of those rebuilds live line. So live line rebuilds are challenging. There aren’t a lot of people in the country who can do that type of work. We’ve had to do that kind of work in Texas. So we do have experience with it, but it’s challenging. And it can’t all be done live. So I

just wonder, what’s going to happen as we face a huge change in our generation portfolio?

To me, what this boils down to is the fact that there’s an interrelationship between markets and reliability. And it has to be recognized. There’s a lot of talk about markets. There’s a lot of talk about markets for markets sake. Again, I’m an engineer. I’m not an economist. But when there are large scale changes in the generation landscape, additional measures are needed to ensure that reliability is maintained across the system. And so that’s, I think, an area that really needs to have a higher level of focus in the coming months, because I don’t think that we’ve got a lot of time to deal with this.

So what’s the next big change with respect to RTOs? I think that’s Order 1000. I think that’s going to have a number of changes and adaptations along the way for both the states and the RTOs. I would say what RTOs need for this falls under two general themes that I would advocate. And one is the need for independence.

I think that we can always get very comfortable with the status quo, whether the status quo is the “just say no crowd,” or, you know, whether it’s how we plan the system. We need to challenge ourselves. And again, we need to be mindful of, what are the customer expectations? If the customer’s expectations are that they want a reliable system and they want a reasonable cost, then both the states and the RTOs really need to look at it that way, and not try to circumvent the intention of Order 1,000. I won’t comment as to whether it’s good, bad, or what have you. It’s really just something we as an industry have to adapt to. And so that means, from an RTO perspective, there would be an expectation that all ideas would be considered and vetted. It would be an open and transparent process, the kind of thing that the RTOs have done very well to date, and that projects be awarded on a fair basis with a fair evaluation of the competencies of the folks, not just on what the local TOs in that area would like to see happen.

Open-mindedness, it's going to be a real challenge I think on the states. A lot of these new entrants would have to get public utility status and so forth. I think that the states really need to reflect on what's important to the customers in their states. What are the kinds of questions that they're going to ask folks? But I really would encourage states to be open-minded about it and just listen to what new entrants have to say. We certainly have a large territory that we would want to protect. But by the same token, again, it really does come down to, what's the right thing to do? And the states are best positioned to figure out who's best suited to construct in that state.

This last slide gets back to the customer perspective. And to reflect on what I see as the challenges in the industry today, ten, twenty years ago, we had a lot of load growth. We had our assets, whether it be generation or transmission. We could decide what got built, and where it got built. It might have been somewhat paternalistic, but the buck stopped there, and you knew where the buck stopped.

It's a little hard now to figure out, where does that buck stop? I know when it comes to the Indiana Commission, it stops with a call to my office. I know who will be hung out to dry if things don't go well in the summer of 2015, when a lot of these generation units retire. But by the same token, the utilities can no longer control a lot of what happens. We can have an opinion. I have a lot of opinions on what transmission should be built in different places. But I can't effectuate that. I can't make that happen. Those decisions have been diffused over time. So now it's the RTOs who take that role.

So we have to really look to see how we can make sure that there's ownership and that we're all in this together. I mean, we have to own this. The states, FERC, the RTOs, utilities, we have to own this, particularly the utilities, because, again, of that phone call.

Now, there are success stories, and I just wanted to share one that we had, which is relative to shale gas development. We actually sit on some of the largest shale gas areas in the country. And it was interesting. When we first were being approached by folks, we gave them, sadly, the standard answer. So how long does it take for me to get transmission service? Eighteen to twenty-four months. That didn't go over too well, as you might imagine.

But a couple of things really clicked. I would say from our standpoint, one of the things that we did is we challenged our engineers. And we said, "Look, that's not acceptable. How can you make this happen? How can we make this happen faster?" And in essence, what we did is we developed what's called skid station technology, and we've deployed it in Texas, and we've deployed it in Ohio. And so what ends up happening is that it's more like a modular station that we assemble. It takes three to six weeks to assemble. And then a new substation is built right next door. And then we pack up the skid station and deploy it to the next spot. That, in conjunction with the Ohio Commission proactively changing rules with respect to the siting process, enabled a much faster process of building transmission lines that were needed to support renewable integration, generation retirements, or shale gas development. So it is possible for things to come together and to work well. We're just going to need to see a lot more of that.

The right side of this page has where I think the future is. The future is a time where there isn't load growth, not the kind of load growth that we used to see in the '80s and '90s, certainly. I mean, we're pretty much stagnant in terms of load growth. Customers want greater choice. Decisions are made at different places that impact the industry.

So what do we do about that? I think transmission owners, as well as other entities,

need to be creative about that. We have been long time advocates of 765-Kv transmission, because of the fact that it's a highly efficient voltage class. Well, not every RTO was comfortable with 765. And so we challenged our engineers again to say, can you make double circuit 345 look and feel like 765 or 500? And they came back with a solution. We call it the BOLD (Breakthrough Overhead Line Design) Line. We filed for three patents, two design patents, which we've received. And we're still awaiting our utility patent on it. And EPRI is currently testing the towers and line design in Lenox, Massachusetts.

But this is just an example of how when there's a challenge, it's incumbent upon us to step up to that challenge and try and figure out better ways of cracking that nut. So with that, in conclusion, I would just like to say, thank you for being here. Thank you to the Harvard Energy Policy Group for hosting this. I think it's a great opportunity for each of us to share ideas and remember reliability and customer cost. Those are number one. Thank you.

Speaker 2.

Thank you. We don't really have any problems in California. I come to you directly from the petri dish, exactly from the laboratory, as they would say. The things in California are certainly interesting and going to get more interesting. I thought I'd tell you a little bit about that, tell you about what we're doing about it, and talk to you about the West in general, because the West is an interesting place as well.

I think everyone knows that California has a well-crafted 33% renewable portfolio standard. And we're well on our way to meeting that. We're at about 25% now.

Exacerbating our problem is the fact that about 25% of our generation fleet is once-through cooled. In other words, it's coastal units. They

use coastal waters to cool. And we have a state regulation that by 2020, those units are supposed to be retired or retrofitted. These plants are 50 years-old, 60 years-old. They're not very effective and efficient units anyway. So we have that.

Then, just as I thought things would be good, we have this little unit called San Onofre, which is a nuclear unit down in southern California. It would have been great if it had been out in the desert, but it's not. It straddles two critical local capacity areas, San Diego and Los Angeles/Orange County. Neither of them like unreliable power. So we have that stew and mix that we're working through.

The other element, too, is that as the system evolves, we have rolled out the duck chart. Maybe you have seen the duck chart. I should have brought it to show on the overhead. But this is the duck chart. We hand it out. You can see that I have a laminated version of it. But the critical element about the duck chart is, we're going to add about 10,000 megawatts of solar onto our system, notwithstanding distributed generation. I'll come to that in a second. What that does is, it creates a belly of a duck. It pushes the load of the day down really low. And we have to then ramp up, particularly in the shoulder months. And so we have to have a fleet that ramps and is flexible in response, not like those old plants. The old plants on the coast can take two days to start. We need plants that can start in ten minutes.

So how do we handle all of that? Part of it is the capacity market issue that we've all been talking about here. And otherwise, we have to evolve our system. So what are we doing to evolve? First, we have to evolve our market. We are putting in products that incent and compensate people for ramping and meeting other flexibility needs. We will continue to do that because energy will be less and less of an item for us as renewables continue to kick in and take over. And ramping will be a critical element of it.

We've also implemented a renewable desk on our operating floor. Whereas we used to dispatch plants, now we predict what plants will do. And that's a different paradigm. And so we have a group down there. And frankly, they're getting very good at meteorology, which is an art and science into itself.

On the capacity issue, once you have a unit that rolls off of its power purchase agreement, it no longer gets compensation for energy. There's just simply not enough money out of the energy market. So what are we going to do to compensate them? And that is a big debate in California now because, as everyone knows, FERC is evil, and we don't want a market that is FERC jurisdictional. That's our PUC's point of view, because FERC didn't respond to the energy crisis. FERC is perceived as not interested in the state's policies and best interests. So therefore, that's a problem. I'll come back to evil FERC here in a minute, too, because that's a charge out in the West. So that's what we're evolving to do.

Now let's talk about the West a little bit. Let me talk about that. Because we did talk about markets. There's a conversation in the West now, as you get more renewables on the system. And keep in mind, the West is largely municipal utilities. It's also the Federal power marketing agency. So to our north, we have BPA (the Bonneville Power Administration). And BPA is not too interested in change. We also have the Salt River Project. We also have WAPA (the Western Area Power Administration). Now, we do have some willing people in the West from a market perspective. The people in Colorado are interested in it. PacifiCorp has joined us to do an energy imbalance market. PacifiCorp, or MidAmerican, which owns PacifiCorp, just bought Nevada Energy as well. So you can see this march of the willing in the West. And I think we're going to see some movement. At the end of the day, what we've done is we've said to them, as they looked around and said, "We'd like to have a market, we'd like to form this

market, and it ought to look like this and ought to look like that," we raised our hand and said, "Well, we have a market. You could use it. We spent \$200 million on it." They were planning to go do a market for about \$15 million. And I believe Texas spent a bit more than that on their market as well. It's not for the faint of heart.

So we have people coming to California and talking to us about a market. But they do say a couple of things. They say, "Number one, you're governed by California. We don't like that. We don't like California, your name. We don't like you. But please, we'd like to use your platform." The munis in the West say, "Well, we'd certainly like to participate in your EIM. But we don't want FERC jurisdiction." And we say, "Well, that's kind of challenging since we're a FERC jurisdictional entity. We really can't negotiate that away." So that's part of the conversation.

But the good news is, the reasons for the market development in the West are clear. It makes economic sense. You can no longer dispatch the market or the system on an hourly basis. Much of the West is still dispatched on the hourly basis. You can't do that. You certainly can't do it under Order 764. And a five-minute dispatch is far more efficient for renewables. So people are coming to us. I think that we will continue to see that develop. I think the role of the ISOs will continue to expand under FERC Order 1000. We've already done one contestable transmission line. We have two more that are underway. We are setting ourselves up for the process to decide who can build the transmission line. It's a place that ISOs have never been before. In addition to that, our PUC was going to evaluate a contestable transmission line as well. And they came to us and said, "We can't do it. You do it for us." So we said sure.

Our board, and in fact the leadership in the state, wants us to be more in a policy position. It's a position that ISOs don't normally take and it's a position that ISOs aren't necessarily comfortable

in. There are leadership vacuums that we tried to resolve.

But I would also submit to you that there are bigger issues at play that I think that this organization (HEPG) should talk about in the future. And it's this. In San Diego, they have a lot of solar rooftops. And the number of solar rooftops is growing at about 5% a month. If you think about that compound rate of growth, pretty soon you have this specter of disintermediation.

Let me tell you some other things that are going on. You heard about the California rate structure. At my home, I'm a PG&E customer, after I run my refrigerator and a light bulb goes on, I move into the 34-cent tier. That's my tier that I pay now. And all my neighbors are putting on solar. Why wouldn't they? They can get it for less than 20 cents. Now the PUC just got the ability to change those rates again. And they will try to flatten them out, because they recognize that piling onto those top tiers is a solar incentive rate. And people will just go get that. The other element is our friends at Tesla. You guys know them. You all yearn for their cars. They make batteries. And right now, they expect that within a couple years that they can make battery storage units for \$500 a kilowatt hour. So you compare solar, which is dropping in cost and will continue to drop in cost. You get storage units. Pretty soon, you have a classic disintermediation cycle. And then what's the role of the utility? What's the role of the ISO? And I think we have to begin that conversation, because while California is an interesting basket case, frankly, we have very coherent energy policy out there. This is something I think we all need to talk about because it is on the spectrum now--when will it come to your state? It's already come to California. When will it come to your area? I think it's something to think about, too. And I'll leave the conversation there.

Speaker 3.

Thank you. I'm going to start out with an elephant. Imagine that elephant is an RTO. And if you remember the parable of the blind man and the elephant, what you thought about the elephant very much was relative to the way you saw the elephant and faced the elephant. This is not part of the parable. But what you think of the elephant really depends on which end of the elephant you're at.

When I look at RTO markets, we're trying to align five different things at once. The first two are the ones people think about. The first one is physics, engineering realities. You're trying to develop a model. And what we're talking about is a model. This thing that we call the "market" is a model that simulates the system. It can predict what's going to happen when things change in the system and how the physics of the system work.

On top of that, the second thing we are trying to align is market theory. We're trying to apply a market theory that you figure out a way of pricing resources such that you can get to a physical state in which the system will continue to run. But you apply market principles.

The third element is tariff language. You have to write that all down into tariffs that can be readable and understandable and clear to people.

The fourth is IT constraints. You've got incredible constraints, just by the IT factors of being able to make changes to these complex models and markets.

Finally, overlaying all that is a whole lot of public policy and politics.

Now, to align those five things is a huge challenge.

Let's just start with the engineering. There is the Eastern Interconnect. It has been called, many,

many times, the “largest machine in the world.” The Eastern Interconnect planning process is a huge process, involving tens and tens of thousands of different points of entry and exit. You know, the old saying about it is that what happens in Manitoba can affect things in Florida. I don't know if that's true or not. That's what they claim. On top of that, now you're trying to do subsets of this.

So in New York, we tried to get our part of the system correct so that, least we didn't have to do the whole Eastern Interconnect. We just needed to do New York. But we also know very well that we're affected by all our neighbors. And especially in the beginning, we were working with imperfect knowledge of each other.

So that's just trying to get the engineering right. Overlaying that are models that simulate markets. Now we've got the physics. Now we're trying to apply economic theory and pricing to choose these resources in the most cost effective manner. We're trying to co-optimize these things so that you're choosing the best set of generation, spinning reserve, non-spin reserve, and other ancillary services. You're trying to do this all at once in this very large model that simulates market. In the beginning, there was the church of Hogan and the church of Tabors. In the end, the books of Hogan I think have won out. It's kind of like Matthew, Mark, Luke, and John. The others are like the book of Fred that you don't get to see anymore.

And on top of all this, it's a product where, unlike almost any other market on Earth, there cannot be shortages. That cannot be allowed. Those are outages. And as Speaker 1 points out, they're frowned upon very much. So this is a major market constraint.

On tariffs, if you don't get the tariff language right, there are plenty of lawyers out there that are willing to try to read them and figure out a way to perhaps use them to their advantage. We had frequent disputes. And I can tell the story

that, when I was inside the ISO, even the people inside the ISO for a long time just kind of ignored the tariff language, something like, “Well, I know that's what the tariff says, but that's not how we do it.” I'll give Mark Lynch, who was the CEO there for awhile, the credit for countering this. And he was the engineer that kept reading the tariff language. And he said, “That isn't what it says.” So we ended up more than once at FERC and had our friends at the federal level have to kind of adjudicate the correct meanings of the tariffs. If you don't get them right, sometimes even if you do get them right, it can open the door for market manipulation and imprecise prices that come out of the tariffs, which is hugely important and was totally underrated, I think, at the beginning of the markets.

The fourth issue was the IT constraints. This was much more prevalent than I think was originally anticipated. All the time we'd say, “Well let's, make this small tweak to the market.” And the IT guys get back to us, say, “Well, we can get that done by 2017.” It's, like, you know, we've got a backlog. So just changing things was not as simple as you might expect. A story that just kind of proves what happens here, is that there was a flywheel that got built in New York that could respond to needs in six seconds. Our rules were written such that if you could respond to needs in five minutes, you got paid. If you did it in six seconds, you didn't get paid any more than the guy that did it in five minutes. Well, we all agreed that rule need to be changed. And I know PJM actually had led the way on doing some of that rules changing. And it took us a little over a year to get it changed. Unfortunately the builder of the flywheel, by that time, was bankrupt. He couldn't make it in the market. The rules got changed, and somebody is now operating this very effectively and very efficiently and making money on it, I believe, because the rules got changed. But it couldn't happen fast enough to accommodate the people that began there. So there were a lot of

unanticipated outcomes that we saw along the way.

And on top of this, you know, the importance of public policy and political factors is reality. I'm going to talk about this in a minute. But renewable portfolio standards are about as anti-market as you can get. They are taking a resource that can't make it economically and paying them some sort of extra payment so that they happen. And there are a lot of good public policy reasons why you want that to happen. But it's not particularly market friendly. But we've got to accommodate that. And the ISOs have to accommodate that. And they've done a good job of trying to make rules that can accommodate out-of-market resources.

The original public policy political debate was bid caps, price caps. You know, in New York, I remember the fear was *The New York Post* headline, you know, of a generator in his pirate outfit. And so we all decided on a thousand dollars, you know, bid cap, price cap. And we've been paying for that ever since, to some degree. And I'll talk about that.

We've been imposing many planning responsibilities on the RTOs. And we'll talk about that a bit.

And with respect to retail pricing policy, regulators still haven't had the stomach in most places to subject everybody to real-time pricing. In New York, about 40% of our load is real-time pricing. But those are commercial/industrial customers, over 300 KW. So you still have the disconnect between the retail prices and the wholesale prices. Because of those bid cap/price caps, what we have is what has been called (not by me, by millions of people) "the case of the missing money." With bid caps/price caps, the theory says that the market should have enough revenues to encourage new entry when supplies are tight. That's the economic theory that underlies all this. But we've done a bunch of things. We've told bidders, "You've got to bid

your marginal costs. You can't bid shortage costs. You've got to bid your marginal costs." Well people's marginal costs are rarely high enough to result in there being enough money in the market when the time comes. We've imposed reserve margin requirements. Pick a number out of the air. How about one out of ten? That sounds good. Let's go with it. And so when you hit that one out of ten point, that's when you have to have enough money in the market to make it go. And once again, shortages are not an alternative to all this. So the case of the missing money is, I think, what has been driving debate for at least 20 years. The fact that FERC was having a technical conference yesterday on capacity markets says the debate is hardly over, and in some areas is just beginning.

We have invented scarcity pricing, a very useful tool that lets the conditions set the price increases. If the conditions get to a certain point, you set the price at a certain level to try to get enough money into the market so that you can trigger new entry. And we've had demand respond triggers along the way.

On capacity markets, do we need them? We're still debating. But we need money somewhere. Locational capacity requirements--get it wrong, and you've got real consequences. And I always compare and contrast New York and New England. New York started with locational capacity requirements. We got seven power plants built in New York City. New England started without locational capacity requirements. They got seven plants built in Maine and then had to figure out how to get the power down to Connecticut. We're still arguing about time duration on capacity markets--six months, one month, three years, five years. What's it buy you? We've had to impose demand curves to try to get the boom and bust cycle out of the capacity markets. And if you've got too small of a capacity zone, you end up with what could be described as lumpiness issues. A large new plant can take all the economics away from the whole incentive of them building the new plant.

What are the successes of the RTOs? I think there's more than these five. But these five jumped out at me very quickly. Open access to the system has really changed the system everywhere, and the market players. We've had merchant transmission very successfully built in New York. We've got merchant projects being proposed as we speak. I think that has been a major player in trying to keep costs lower and putting pressure on the utility costs.

Power plant operations is another area of success. The nuclears are the case studies. They used to run at 60% capacity factors. Refueling cycles were three months. Now they're running at 95% capacity factors, and refueling cycles are three weeks.

Risk shifting--at least some of the risk has been shifted away from the ratepayers who generally ended up paying when the old vertically-integrated utility that had cost overruns to developers who now take some of that risk.

I mentioned before that I think cooptimization has been a success, as has getting price signals out at the wholesale level and getting out locational signals.

How has mission creep expanded or burdened the mission focus? I think it was a naïve expectation that regulators were going to close their eyes and hope really, really hard that markets worked and there'd be no problems. Regulators and politicians are never going to be able to do that with something as crucial as an electricity product. They're going to want to have some assurance. They're going to want to have their finger on it, to some degree. And I think that is just a reality. So I would say mission creep has expanded and it has burdened the RTOs. It's not an either/or situation.

What have been the major problems? I'll start with market manipulations. You know, I'm hopeful that the efficiencies brought about by

markets save billions and billions of dollars nationwide. But there's been at least a billion dollars skimmed off the top of that, when you start adding up all the market manipulations around the nation that have been caught. That doesn't maybe count the ones that have not been caught. When you see some of the fines that have been levied against some major traders, it is worrisome that some of the efficiencies of the markets are being eaten up by market manipulations.

One of the hiccups, I think, has been imperfect competition. Certainly, in New York City, we don't have perfect competition. So we've got to do all sorts of workarounds to try to make that work. I think it's not just a New York City problem. I think that in lots of places, competition is not what you might hope.

Getting the seams right along the way is another problem area. There are examples of that--you know, who ever thought they needed to know about phase angle regulators in Michigan until we found out the effects they were having on our market?

And (I stole this word from Leave It To Beaver) "clunky governance," which doesn't move quickly. I see three problems. One, it doesn't move quickly. Two, it is controlled, generally, by the incumbents. And three, because this is so complex, you need a lot of expertise. There's a limited universe of people that can really put all these pieces together. And they tend to be used by the people who are incumbent, so... Sometimes governance doesn't work as well as it could.

If we could roll back the clock, what would we do differently? Well, I'll tell you one thing that we'd do differently in New York is having better market monitoring and financial settlements capability before start up. And all I have to do is tell the story. We started with two people at our market monitoring department and two people in financial settlements. How naïve can you get?

The second thing we'd do differently is just something that concerns me--it's been the treatment of nuclear facilities. I have a theory that rate payers have paid at least twice for nuclear power plants. They certainly paid upfront in the costs when utilities were investing in them as their own projects. The plants then got sold (way under market, as it turns out). And then they got the clearing price. And, basically, with all the money that you spent upfront in order to get this cheap resource, the resource became another natural gas combined cycle facility, because that was the clearing price that they got paid. So all of the advantage that you might have gotten for spending the \$800 million for the nuclear facility that cost \$6 billion, you paid again.

And, finally, one of the most pressing challenges. I am concerned that if we move to a more diversified system, that the ISO/RTOs may have difficulty adjusting from what I call the "hub and spoke" system to a system that's much more distributed generation, smart grid renewables. Can rules and market models adopt quickly enough as this changes? Are all voices being heard in the governance process? The general counsel at the ISO always likes to say, "You know what? This is [blanking] rocket science." With that, I leave. If anybody has any questions, be happy to answer. Thank you.

Speaker 4.

Thanks for the invitation, Bill and Ashley. And congratulations on 20 years. I really enjoyed the first panel, which gave me some perspective on how much impact you have had on this whole discussion and how our system operates (whether you want credit for it or not, I'm sure, at times).

So I thought I'd do two things, one, just a little background on myself, which I think is relevant to this topic today, and then I'm going to go

through what I see are the success and challenges of the RTOs, certainly not all of them, but hit on some highlights.

Looking back on the late 1990's, I was part of a discussion of restructuring in Iowa. But in 1999, Iowa was in the deep end discussion about restructuring. So I quickly got up to speed on electric markets and whole electric system. And we ended up in Iowa through about a year and a half meetings, really pinning it down to what were people's chief concerns? And ultimately, the biggest concern was, did we have adequate resources for the long-term? The legislation that resulted from that led Iowa not to restructure. Of course that was all taking place right in the middle of California, too, which certainly had an influence, I think, on the outcome. But what was passed became known as the "advanced ratemaking principles," which provide some rate of return certainty for our incumbent utilities and led to a great deal of generation being built in just a few years subsequent that legislation, and resolved the number one issue or concern people have about whether we would have adequate resources for the long haul.

Now I also was involved with the Organization of MISO States (OMS), right when they were going through gearing up the market. And it was interesting. One of my strongest memories of that first year or two on OMS was just that every meeting, the request from the state regulatory environment was, "MISO, give us the metrics. We need to know the value you're providing to the system." Even still today, I think there's a continual pressure on the RTOs or ISOs to be able to quantify the benefits that consumers are getting from the existence of the organized markets. So does that ever end? I'm not sure. But I think there's continued pressure on the organized markets to show us the value in the RTO and ISO, wholesale markets.

I think the biggest successes of the RTOs are in operations and planning. Operationally, primarily the security constrained economic

dispatch, the more efficient utilization of resources, the deployment of the most cost effective generation, and the use of the transmission system in most efficient way possible.

I think consumers have seen savings from more efficient dispatch. We have a more reliable system because of better utilization of resources to meet reliability needs. And environmental benefits, I think, come from lower fuel usage and reduced emissions because of that more efficient security constrained economic dispatch. I don't remember how we quantified it at MISO, but with recent studies by Charles River and Associates estimates a billion in production cost savings over ten years by joining MISO. The California study and the EIM for the West estimates between \$95 and \$295 million annually just for an energy imbalance market. So I think there's evidence here, both in historical performance and in projections going forward of real savings for consumers.

I think there's also been a better integration of new technologies as a result of the RTOs, particularly on the demand side, with demand response, and also on the optimization to be able to handle intermittent resources, which is why we're having a debate in the West about the need for an energy imbalance market to more efficiently handle the variable resources in the West. So I think those are real successes in shifting risk away from customers to the industry.

On the transmission planning side, I think we've seen better utilization of the transmission system, and through Order 1000 taken that next step forward by utilizing the RTOs to create better and more efficient transmission plans and make sure the best projects are selected and developed throughout the regions. Also I think there's increased ability to focus on getting transmission to location-constrained resources as a result of the RTO planning processes. So most everything I think fits in those two buckets of

operational and planning efficiencies that are successes from the RTOs and ISOs.

The challenges? Certainly I think one challenge is the complexity of the markets that have been established and the ones that continue to evolve, and just operating in these different markets is a challenge for the industry as a whole. It's particularly challenging for entities that are more resource limited--the number of meetings, the amount of data to process to stay on top of what's happening in the RTO. You really have a minority group of stakeholders that I think are unfairly disadvantaged. I think that's a challenge.

The capacity markets--I have to hold myself back. I had enough of that yesterday. And I haven't fully digested all that I heard yesterday over those eight hours. But I think everyone shares the opinion of what the most prevalent problems are to try and deal with. Maybe I should call that a success. But answers to those problems didn't just jump out of the woodwork. So we still have some work to do. But it is problematic. We're trying to address the unsolved problems of a not purely competitive energy market and then creating another market on top of that to solve those problems. I don't think it will ever not be complex. And it will probably have to be adjusted to address different problems that come our way. That's the hard part--how do you change the rules in the game, but also provide certainty for the investors going forward? That, to me, is the crux of a problem, and a challenge for us going forward is getting capacity markets right.

Another thing I took away from yesterday is that perhaps the next best action is for us to seek comment on best practices. The phrase "Standard Market Design" came up yesterday, and we all batted that right back down. We can't use that phrase, or try and make capacity markets consistent across at least the three Eastern RTOs. But I do think there's probably an appetite for understanding what the best

practices are and how we can do some evaluation of those and provide some guidance, or help the different RTO stakeholder processes analyze those best practices, and perhaps from that get more consistent rules across the RTOs that would address some of those inter-RTO, inter-regional issues and make it easier for multiple entities to provide services in all three RTOs and not have the added cost of navigating a whole different set of rules in each one.

Another challenge that remains are the seams issues. Just look at the design of the RTOs--I mean, no one could have possibly drawn those lines with any strategy in mind of what entities are in what RTOs. So seams issues are going to be prevalent, unless, of course, we get some consolidation.

My point is, there are some inherent inefficiencies of multiple RTOs with crazy lines across the Eastern Interconnect. But there are also, I'm sure, huge hurdles to get over to ever bring some RTOs together. So I'm not advocating that today. (I'm sure I've got some people already texting back home right now.)

But the point is, seams issues are difficult to deal with. We've got to find ways. If we've adopted this theory that we want to get better utilization of the transmission system resources, that's part of the rationale of Order 1000 going beyond just regional plans, but requiring inter-regional plans. It reflects a notion that we can become more efficient by better integration with our neighbors. So that remains a challenge.

Governance, I think, remains a challenge. The stakeholder processes are different throughout the different RTOs. States have different state commissions. State governments have different levels of authority within the different RTOs, reflecting different theories on how much impact state policies should have on the governance of RTOs. I think it's a challenge going forward getting that right and also making sure that folks who find it difficult to adequately participate

because they're resource constrained, their voices are heard in the stakeholder process.

I think a lot of what we heard in the first panel had to do with how the impetus for the creation of these markets came because of high prices. And so the hurdle was, can you lower prices for consumers by more efficient operations? In the rest of the country, to a large part, you don't have RTOs in or you have RTOs that haven't gone as far. You don't have the price pressure. I'm talking more residential consumers now. I know businesses have to compete; international market energy prices, for some businesses, are a big factor. But still, in some parts of the country, the price for your electricity for your home is less than \$100 bucks a month. And I'm not sure that there's going to be pressure to expand the market and retail structure for markets, and a push towards a broadening of wholesale competitive markets throughout other parts of the country, particularly now we have gas prices where they're at on top of that. So I think we're probably looking at what we have right now, at least in the near- to mid-term future, working on our existing markets that we have and trying to make them better and refine them. And I think some pressure is coming on in the West because of the increasing penetration of intermittent resources and how energy imbalance markets, just based on those study figures I gave you, may help make the case for the evolution of a market in the West.

But you still have the big elephant in the room that is slow to come to the table, if you will, on seeing the need for a change in their structure because they have incredibly low prices. So I'm not sure that the demand is there for a great expansion at this point, particularly with gas prices where they're at. So I'm glad we're focusing on the successes, where we've been so far. And my guess is, the efforts going forward will probably remain focused on where our existing market structures, competitive structures are in place and trying to make those better. Thanks.

Speaker 5.

Thank you for the invitation to be here. The RTOs, obviously they've had tremendous success and obviously some challenges.

The three core functions that RTOs have is regional planning, market operation, and reliability. There was some debate early on, at least in PJM, about whether we should do regional planning or not. I think we actually come up with the right answer, which was, yes, we should. Obviously it's been affected by some of the governance issues I'll speak of. But in general, that's been successful. I think if you look at the market operation of reliability in the regional planning and how tightly they're all integrated, it's been a success. And I think having the visibility into how the system works is good--the way I used to describe it back in the period when we were first forming is we essentially took the control room and put it on the Internet so folks could see the power balance equations. They could see what was occurring. And it was a fantastic revelation, I think, to those who cared to look.

But I also want to talk a little bit about mission creep. There was just recently a letter that ended up going to the PJM board chairman, from a chairman of a state commission, and was very upset about a situation in PJM. Essentially, PJM had some coal plants retiring in Western PA. First Energy is actually the entity retiring the plant. And they went out in the press and said, "The market's dysfunctional. We've got to retire these plants for the wrong reasons. You know, it's not making enough money in the market." Well, the chairman of the utility commission wrote a letter to PJM saying, "You should go out and argue that in the press and say that the reason they're going out of business is because they made bad business decisions." I'm, like, "Whoa." You know? Whoa. Whoa. That's not

our role. Our role is to present facts. It's not to argue these things in the public.

And I get a lot of that, "You should do this. You should do that. You should testify here. You should testify there," a lot of pressures to engage in mission creep. Probably one of the better things that I created, is I actually have a conscience group. When we're going to put something out, instead of me making the call, I send it to a group of peers and say, "Is this a balanced way to present things?" Because I want to make sure that we're not inadvertently putting out something that would be considered, how should I say, trying something in the press.

So I think that kind of mission creep is always there. Given the type of organization we are, everybody wants to hear what we have to say because we're supposed to be independent. That's such a responsibility. The pressures to act like you're independent but not be so, I think, are there. We've got to watch that very closely. And believe me, it has a lot of visibility within the PJM walls that when we state something, it has to be duly reviewed. So that's an issue.

Let me take a step back, though, and talk a little bit about market evolution. I'd like to tell you that I dreamed this all up one night after I met Bill Hogan back in the day, and saw how these markets would evolve. But obviously it did evolve, at least in PJM, very incrementally. The market evolution and the way that we went from reliable grid operations to real-time market operations to day-ahead markets to the financial forwards that developed around these markets, I think, was fantastic. Obviously PJM did some of it. The industry did the rest. I think it all developed very well. I think the PJM forward contracts for electricity actually were a catalyst that made this market grow even bigger. So I think the way the market actually took hold from what was, at that time, a real-time only market was an enormous success. And, you know, the market more or less feeds on itself and develops. That was a great part of the experiment.

With that, let me turn to some direct answers to the questions about successes and challenges. I think I agree with Speaker 4 and others who said that the biggest success is wholesale competition. I think it was enormous success. I think it actually lived up to the dream. The operational efficiencies, whether it be how we manage congestion to the efficiencies with which we run the real-time operations and scheduling of generation, were a success and have caused billions of dollars of savings. And it was very obvious that, even over the power pool days, when we went to this type of transparent market, it was even a factor of two or three gain in efficiency. Transparency has been fantastic, whether it be transparency of operations, or transparency of the stakeholder process—how decisions get made, how our board works. The board actually meets with the members and has dialogue almost every time they meet, and the ability to get a little bit of insight into how they make decisions I think has been great. Obviously another success has been reduction to barriers and innovation, whether it be demand response or the other types of innovation.

Let me spend some time on challenges. The first and foremost, I think, is governance. It's been a struggle to make sure that the RTO governance actually makes sense. I'll give you an example in the PJM market. There are two individuals who control 40% of the vote. Our individual members form coalitions, and the end use customer sector effectively is all represented by one law firm. So that person comes, and he gets a stack of voting boxes at his desk when he sits. It's now all Internet-based, so he doesn't carry the stack anymore. But he just punches the buttons through and votes and basically controls 20% of the vote. There's another group which is very similar—their representative controls maybe not the entire 20% of the vote, but let's say it's 15% of the vote. He doesn't have the entire sector. But that's fairly significant. So any time anything needs to go through the stakeholder process, those people are crucial. So

that kind of thing in governance has been a challenge.

I think there are other challenges in governance. One of them is the forced compromise on design. I think at times it's wonderful. I call it "the wisdom of the stakeholder process." It is fantastic at times, where you go through a process of discussion where things people never thought of come out as you go through the discussion and the result is actually a more robust design. And I'd say that probably more than half of the time, we end up with a better solution because we talked about it.

But then there are the other times. Folks ask, "Why are the markets so complex?" You know, we would go through and say, "We sort of know what the design needs to be, but how you allocate uplifts? Should you even have uplifts? How are prices formed that would minimize uplifts?" And you make a decision just to get through and actually have something working instead of nothing. Then four years later, you're band-aiding it, or even five months later, you're band-aiding it, because essentially you had to make a decision that was probably less than optimal. That's happened a lot. And I think it makes folks wonder. I've heard people say, "You have the market design back in the garage too often." And it wasn't that we didn't know how to do it. It was that you couldn't do it. It really just wasn't able to be done. And that's been one of the challenges we've had. The good news in PJM, at least, is that we were able to accelerate through some of those changes a little bit quicker than others. But I think it's plagued us all as RTOs.

Regional differences and seams issues are also challenges. It's like we're not allowed to learn from each other. Whether we've built a better mousetrap at PJM, or New England did, or New York did, whoever, as you go try to pick that thing up and drop it into your market, it's like you committed sacrilege, heresy. It's terrible. I think that type of thing has been difficult.

The seams issue is very tough. That's probably our single biggest issue moving forward. There are a lot of cost shifts between members of the various regions. And it's probably going to create ongoing issues, and probably ongoing litigation, for some time to come.

Lastly, another challenge is complexity. I'm probably the last one to tell you the markets are too complex, although I think the PJM manuals are now at 5,000 pages, to interpret how the tariff, which is 2,000 pages, works. Some of the complexity is probably driven by some of the items that needed to be compromised on.

And lastly, I think that over the years, and I think lately, the market's been over-mitigated. That's why we have capacity markets. We can't let the energy market work as it needs to work. I'm not naïve enough to say that you could have an energy only market, because we obviously have resource adequacy needs. We have reserve needs. You've got to operate a power grid. You're always going to have excess generation running. Obviously, there are ways to price that with reserve markets and other things like that. But you still need high prices and you still need those prices to hit high levels at some point. We can't get there without that. And I think that's been probably one of the most fundamental difficulties, this concept that it has to be controlled and we can't let the market work, and that you can't let competition run it. We can't seem to make the leap of faith as an industry. And again, it's no one individual, no one area. It's just that, as a group, we're not there. The gas industry did well. My hat's off to all those folk. But unfortunately, we in electricity, we can't get there.

Lastly, Speaker 3 alluded to the "manipulation issue." One person's manipulation is another person's response to price signals. Let's be realistic. I mean, as an industry, I think we're going too far. We're slapping people who were just following incentives. They had no intent to

manipulate. But they're getting hammered. That is going to cause a problem for us as we move forward. I've got to admit, some of these people-I don't know where they get their advice on writing emails. I read them, I'm, like, "What were you thinking?" You'll never see an email from me like that in the public domain because I don't do it. But people aren't very careful with that.

But those are my lists. These could be couched as commercials, but I think it's important you all understand what happens under the hood.

There are a couple things about RTOs that I think are also worth mentioning. The ability of PJM or another RTO to take collectively the members' money and invest it in technology, so we're making a change on one system for the benefit of, whatever, 500 companies, gives us the ability to create a lot of horsepower, mostly in software technology. A couple of examples here: the eLoad response, the ability for us to get demand response, in other words--how do you actually control 5,000 different load sites and actually make sure that they can be dispatchable? Basically, the eLoad response system does that. It aggregates all the demand responders up, puts them down to substation level, and allows us to see, with some visibility, what's going on, on DR. It's relatively new, but it's a fairly big innovation. I think it will serve us well as we move forward.

The other example is the ability for us to take time coupled optimizations--the way we actually do deployment of resources is light years above what it was even five years ago. I don't think it could have been done if there weren't an RTO making that investment on behalf of customers.

Another thing worth mentioning is resiliency. And each utility does this on their own, too. But at the grid level, the multi-regional level, getting investment in dual control centers, etc., has been a unique innovation.

And I can't go without my two favorite examples. I make decisions quickly all the time because of the job we have, right? So you have a, spend about two minutes on something and make a decision, because of ops and things like that. I got a call from one of my staff, some economist from Wharton, I think it was. At least that's what I thought he was. He wanted us to dump for him, like, three years worth or five years worth of interconnector flow data. I'm, like, "Who's this idiot? What's he want?" So I said, "Is the data confidential?" They said, "no." I said, "He's an academic. Go ahead and give it to him." Best decision I ever made. What he did was, he looked at the AEP integration into PJM. He looked at the transmission interconnector flows (the utilization of transmission) the year before they integrated and the year after they integrated. And that's this chart (which shows a significant jump in transmission flows beginning on the date of integration).

I was actually in the control room that night. The change in flows on the system almost instantaneously were dramatic. We went to 3,000 megawatts of flow increase just like that. The efficiency gain was phenomenal. I think AEP and their traders, I think ComEd and their traders, thought they were doing a great job pre-integration with trying to maximize our utilization of the system. They couldn't. They couldn't. They didn't have enough information. So it was a fantastic paper. If you haven't seen it, this is a great reference. The only reason I'm giving it to you is because I use it all the time in Europe and everywhere else.

The other case is the Dominion integration. They were a big buyer. And essentially they couldn't buy from the market when they were outside. And once they went in, I mean, it was just a tremendous change—the same transmission system but much higher utilization. It speaks for itself. I'm sure MISO and others have examples of these same types of things. But these are two that, if you ever want to point to them, you can.

Question: Why couldn't they buy before the integration?

Speaker 5: For example, for AEP, the only way they could make that transaction happen, to send more into the load centers in the East, was to get Allegheny to back down their coal plant. And there's no way that they could make a transaction to go to Allegheny and say, "Hey, take three of your coal plants down. That'll be a 500 megawatt re-dispatch. And then I can send 3,000 more interchange into PJM." And if they could have called them up and said, "I'll pay you to reduce," they could have made that deal. But they couldn't do it. What happened when you went to LMP is, we could pay Allegheny to reduce because they'd have scheduled day-ahead, they'd reduce real-time, and get paid for it—and then it would happen. You really couldn't bring the transparency to the bilateral market. It's a classic story.

Dominion was a little bit different in that it wasn't only transmission there. It was also visibility into who could give them a deal that was reachable. In other words, they could go sort of one layer beyond, but they didn't think to go two or three. There was a lack of transparency at the time.

General discussion.

Question 1: Speaker 5, for the benefit of the newbies in the audience and the oldies like me who can't quite remember how the tight power pools operated, can you give a user-friendly description? I can't remember, did each utility, because I wasn't in that part of the business, do its own load forecast, dispatch its units, and then do business with the pool at the margin for exchanges, and then the pool had limited ability to change things if there was a reliability event? And is that what accounts for the huge savings once you do a broader economic dispatch over a

larger area and more units to see where trading could get benefits over running your own units?

Speaker 5: Effectively, in the power pool days, there was the ability for the power pool to have economic dispatch. But it was limited. There was no state estimator, no real-time power flow that was the basis of an actual constrained optimization that was running the system in real-time. It was more looking at nomograms and people doing dispatch by hand, if you will.

So we did have a pooled dispatch, but it was very rudimentary. And the accounting was more or less a split the savings kind of accounting. So there wasn't a lot of incentive, necessarily, to wring out all the efficiency of operation down at the granular level. So you looked at broad transmission constraints, not individual ones.

Moderator: I'd like to add a little bit to what Speaker 5 said about when they expanded the pools. With respect to the slide that Speaker 5 presented on the AEP, Dayton, and ComEd integration--these were utilities that were not part of tight power pools. And so in order to move power, for example, from Chicago to Philadelphia, you had to go through multiple utilities. You had to have multiple evaluations of transmission service. And if you wanted long-term service, if your transmission capacity failed in one hour, then you couldn't get it. And there was no efficient way to ask for re-dispatch outside of the pool, because the best you could do under the rules for re-dispatch, if you did it, was to break even, and then for someone to take you to FERC arguing about your accounting, which was not a good business proposition. And so by having the visible LMPs and (I will use the word in quote) "free flowing" ties, that was what was responsible for allowing exactly those transactions that Speaker 5 showed on the slide.

Question 2: There's something that has worried me for a long time. One view is that regional transmission organizations are run by engineers. And the engineers have a very strong ethic and

cultural practice of doing the right thing. And they understand the engineering of the system. And they now come to think about efficient operation of markets and why markets help. Although they might disagree about some of the details, basically they have a broad view, which focuses on efficient market operations, reliability, and the things that were on Speaker 5's graphic there. And their job is to speak up for that model and to defend it and to administer it and not mission creep and all the other kinds of things that come along with it. So that's one model. And that's a model which depends a lot on the engineering ethic and the survival of the engineering ethic.

The other model is one that would be taught across the river in the Business School, which is that this is a corporation and it's a business and it should be looking at what customers want. And who are their customers? Well, their customers are the stakeholders and the regulators and they're supposed to listen to what the stakeholders and the regulators want. And if they want a Rube Goldberg machine, we'll give it to them. And if they want something that's highly inefficient, we'll give it to them. Because we're supposed to respond to what they want, and even though we might not think it's consistent with the efficient markets and so on, we're going to give it to them.

And those pressures are always there. A lot of people are worried about the governance structure of RTOs because it doesn't have a mechanism for dealing with this. I've met with various people who are on boards of some of these different RTOs. You talk to them, and you get really nervous because they're thinking about this customer model and serving the model as opposed to the fiduciary role of the engineers. How are we doing?

Speaker 1: I'll take a stab at that one. From my point of view, there isn't one way or the other. It's not an extreme, such that it's either engineers running the system or it's folks from

the Business School trying to create incentives and figure out ways of modeling the electric system in such a way that you get the right decisions. It's complicated. We all saw that with the evolution of markets. There are a lot of mistakes along the way. You know, at the time I was in New England. And you saw a lot of mistakes. Money was gained and lost in a day. But it was just money. And if you put engineering on the shelf and you say that it's going to be the Business School making the decisions, and you make the wrong decision, and you don't have the right physical infrastructure in place, then you have brownouts. You have blackouts. You have poor system reliability. When you think about the system, you really just need to test it, just like you test the markets. And you're trying to figure out, how is that market design going to work to encourage the right behaviors? That level of detail that needs to be there from a planning perspective, particularly when you have just massive changes, needs to be higher than it would otherwise be during a time when things are pretty stagnant.

If you think about five years ago, five years ago there weren't big changes in the generation fleet or anything else. So whether you decided to build a transmission line or didn't decide to build a transmission line, the world was probably not going to fall apart. Somebody might pay more. Fine. You can live with that consequence. But you can't live with the consequence of poor system stability and so forth. So you have to really just make sure that the system is being adequately tested, just like when you design a market model you make sure that it's being adequately tested. And the way of testing the transmission system or the infrastructure of the grid is really to do scenario planning. You can sit there and say, "Gee, what would happen if the EPA were to impose a carbon tax? What would that do the generation in our footprint?" And that's, quite frankly, where a lot of the economists can come in and figure out, what would that individual impact be? Then you model it on the electric system and

figure out, what does that do to the system? How does that affect my stability? How does that affect my power flows? Where am I overloading the system? So it's a blend.

Questioner: That was a very interesting answer, given the nature of the question. I think it revealed that you're an engineer.

It makes me feel good, because I like that ethic and that way of thinking about the problem. It's exactly right.

The alternative I was trying to suppose was not looking at incentives and the economist's perspective, which I think should be integrated with the engineering perspective, I agree completely. The alternative I was proposing was to approach thing from the perspective that it's all about the votes. So we can do something which makes no sense from an economic point of view and makes no sense from an electric engineering point of view. But if that's the way the votes go, that's the way the votes go. And that's our job. And our job is not to stand up and tell our customers that they don't know what they're talking about. It's not our job to stand up and tell the regulators that what they're doing is profoundly at odds with the engineering and the economic incentives, and it's a mistake. And we'll just roll over and do whatever they tell us to do. And then we'll just run the system more and more conservatively in order to make that possible. And that's the failure mode that I'm afraid of.

I don't think we're there yet, because I think we're being saved by the engineers, frankly, and the engineering culture. But I don't see anything inherent in the system which creates and preserves that ethic over the long-run. And I see a lot of pressure from the stakeholder process to go in exactly the opposite direction. And so I'm glad you're an engineer. I'm glad you're in the job you're in. That makes me feel better. I'm worried about the person who's going to replace the person who's going to replace you.

Speaker 3: Let me flip your example on its head a little, because engineers have been known to over-engineer. And so the engineer might say, "Demand response, we cannot trust it." I have heard engineers say this, "It doesn't produce a megawatt hour and therefore it cannot be trusted. I don't want anything to do with it on the system." If market participants say, "No, we think that that's a resource that can help meet our needs," did they just override the engineer, and is that bad? Or did they actually do the more rational thing for the market? Engineers might say, "Every generator's got to have firm gas or we can't count on them," when in reality, all our generators have interruptible gas and have a back-up supply and it works. So I'd be concerned about the flipside as well, because where you draw the line on engineering is not black and white.

Speaker 5: I worry about the same thing you do. In our case, we actually do debate it, both at the executive level and at the board level. And I think it is a series of individuals who have to maintain the ethic that basically says, "We need to be customer responsive. We absolutely need to be customer responsive. But we also have three main missions that we've got to address: grid reliability, obviously; fair, efficient markets; and basically making sure a group of members can't unduly influence what happens."

And I think reliability is clear. I mean, you can or you can't do something reliably. And what we debate within PJM is, if something's very clear, like you need something very efficient, an economic dispatch or the capacity market, it was very clear we needed to go a certain way, and it was very difficult to go that way, but we went that way. On the big things and on the stuff that really matters, I think we're able to do it despite the difficulties. The cost allocation issues, like uplifts, those are much more difficult, because I can't go to my peers and my board and say, "That clearly must be done this way because it's an efficiency thing, etc." Those are the issues I

struggle with, because those are sometimes the areas where people get in trouble, because there's sort of a goofy charge that gets levied. It doesn't make a whole lot of sense. They follow the price signal and then they get whapped on the mitigation thing. That was what I was talking about before, because it creates a set of complexities that can create some damage to the market, but it's not high enough level damage that we would say, "We've got to invoke the broader purpose."

So I think it's a tension. I think PJM has managed to deal well with that. I think on the big issues, on the reliability issues, on the big market efficiency issues. But the creep of it is, when do you throw the customer service trigger? I don't think there is an answer. And I'll just stop there.

Speaker 2: I have to add a little vignette here because I actually think there's a third thing that's creeping in. Of course, California is crazy and we do crazy stuff. But other policy goals are creeping into this as well. Say you have a pure engineering question. I can give you a live example of this. There are two principle transmission lines that run into San Diego from the East. And they run kind of parallel to each other, and then they kind of branch off. Well, if you ever read much about summers in California, particularly late summers, we have lot of fires. They burn transmission lines, and it causes them to relay and go out. And in 2007, we almost lost San Diego completely, which is about 4,000 megawatts of load, because of these fires.

We have N minus one minus one contingency. Well, the planning criteria say that you can drop load for that contingency. And right now we have about a thousand megawatts of load armed for dropping in case we have that contingency. Well, if you talk to the people that turn their lights on and run their air conditioners, they would say they don't want that. But I got a letter from the Sierra Club accusing me of

environmental damage because we're using the N minus one minus one to require more generation in San Diego. And the policymakers don't want us to do that. So you have these other things that are creeping into what we do, too. I find myself in front of local legislative Senate hearings more often than I would like. But that's becoming a bigger issue, too. And you have to navigate that, in addition to the stakeholder versus what's the right thing issue. Hopefully it'll be contained to California, and you guys won't have to worry about it. But it's an issue for us.

Moderator: Let me just add, I think the panelists have hit various pieces of your argument. In the end, the RTO has a fiduciary duty to make an independent decision. They know what happens. I don't care about the NERC criteria. I don't care what the LOLE criterion is. I know what the real LOLE criterion is for the states. It's zero days, no outages. You can't be short, outside of a catastrophic weather event. The problem I think the RTOs are facing now, and Speaker 1 hit on this, is the velocity of change. A lot of the rules that were set up, I believe were set up for incremental generation changes, slow load estimate changes, slow retirement changes. We're now in an era where, at least in the Midwest, PJM and MISO are seeing large changes in the generation fleet. In New England, they're seeing the issue of natural gas reliance. And at some point the RTOs have to use their flexibility, which they have, to say, "Look, this doesn't strictly meet the N minus one or N minus one minus one criteria. We acknowledge that. But probabilities come into play and judgment comes into play. And the number one rule is keeping the lights on. And there is so much risk if we don't go ahead and so little cost on the downside that we have to pull the trigger." And then it's up to the states, if it's on the transmission side, to make that decision and site it.

On the issue that was raised about engineers resisting DSM, yes, a lot of engineers said it

wouldn't work. There was a great deal of analytical work done in PJM to show that economic demand response is something you can rely on for resource adequacy. And it was done in the right way. It was done through the stakeholder process. But it was done rigorously. But in the end, it was the independent RTO that made that decision. I don't think they could have done it without the stringent analytical work that was done. I think that's part of the problem. You see people shooting from the gut or looking at short-term outcomes, where the RTO has to be able to explain it to FERC. You have to explain it to your state commissions. And it has to be rigorous work.

So it's really good management, in my view, whether it's engineering management or whether it's economic management. It all comes down to good management, good boards, and having the responsibility to do the right thing, because that's what they're being paid to do.

Question 3: I want to take the discussion a slightly different way and ask you to look at some scenarios that are possibly just a little bit over the hill in some areas, but that I think are coming in California and maybe some other places. We're seeing more and more resources and more and more complexity on the edge of the grid. So, you know, Speaker 2 talked about the 10,000 megawatts of PV. Much of that, I assume, is probably on the distribution system. In the Midwest, we have more distributed demand coming in at different places in the system. In the East, in response to Sandy and other things, we've seen distributed generation come in. And I'm wondering, how is this changing RTO planning and operations, number one? And number two, it strikes me that to the extent we're seeing these things occur on distribution systems, particularly the network distribution systems in urban areas, these things, if they're going to be operated efficiently, are going to take on characters that look more like the system operations that we've seen at the transmission level. Are there lessons which

distribution utilities and state regulators ought to take from the experience of RTOs and FERC in looking at how this question migrates to the edge of the grid?

Speaker 5: It is changing. Back in the day, you could have, whatever, 600 or 700 control points on the system. The rest were sort of just load-fed in. About a year and a half ago, we actually adapted our entire model to basically say, any substation can have a control point. So in other words, we can have a variable price responsive load, for example, at any control point on the system. We basically changed the entire software cycle to cover that. We are seeing the need to model disaggregated resources. Most of it is not price responsive yet, but the load is not a function of just weather. It's a function of price and weather, or it's a function of whatever. So we're adapting the models to do that. As far as planning, you're just seeing essentially a net reduction in load as far as an impact of the PV stuff. But, operationally, yes, I think it's forcing us to think more globally about how we do control points.

Speaker 1: I think we're going to need to see a transition in the industry. When we model the transmission system, it's an N minus one, N minus two, N minus five type of analysis. Right? I think what the RTOs are going to need to do is to start thinking about it more from an event analysis standpoint. So what happens if there is a hurricane, or a forest fire under some lines in Southern California, or that, coupled with a hurricane or tsunami or something like that? I mean, those are the kinds of things that we have to think about. I know that Terry Boston often talks about his concern with respect to natural gas and what happens if there's an interruption in the pipeline. So I don't think it's a problem. If natural gas is only 20% of your fuel base, you might not worry about it. When it's 80%, then you've got to worry about it. I always think of spider charts and multivariable analyses and so forth. That's what we're going to have to get into. And what's so interesting about this is,

what we're trying to do is figure out, how do we model and structure an RTO to do what the states and utilities have done for 100 years together? And that's really what it is. It's that migration from one paradigm to another, that we've got to get good at sooner rather than later.

Speaker 2: I'll make three points about this. One is, I think we will adapt to this new world. I mean, we're growing fairly quickly on the renewables side. And the control room operators, you know, they get it. The sun comes up. The solar picks up. And they get that. Operationally, I'm less concerned, because we can forecast it. We're investing a lot of money in forecasting. It becomes a load issue, because if the clouds come over a place where you have 1,000 megawatts of solar, you're going to get load pick-up. So we try to monitor that.

I think the bigger issue, though, is (and again, California's going to be more exacerbated about this) that if you're in a load pocket, and you have significant transmission going to the load pocket, and that load pocket picks up 1,000 or 2,000 megawatts of PV on rooftops, do you need that transmission capacity? And then you get into the stranded asset issue that we talked about earlier. And I think that becomes a bigger issue, because transmission planning is going to be far more complicated under those scenarios. For example, having Southern California Edison get 1,000 or 2,000 megawatts of rooftop solar in the next ten years is not out of the question at all. So what does that do to the flows of the system? The problem we have is, I don't know where it's going to go. Should we assume it will go to the affluent areas, because they're the ones that can afford it? So that's what we're trying to grapple with now. And as the system evolves and distributed generation becomes more prevalent, what does that do to our transmission system? I think it's a big deal.

Speaker 4: This topic came up yesterday at our capacity conference. One other concern in this area is adequately accounting for DG growth

and the calculation of resource adequacy. I heard some varying answers amongst the RTOs yesterday, but it's an important piece for us to look at. And I also think we're more likely to learn from the bottom-up on this, from the distribution network and how DG's handled, as opposed to top-down.

Speaker 1: There is an interesting nuance with distributed generation, if you think about it. Let's just say that hurricane Sandy comes back again. And at that point in time, maybe 25% of the homes are equipped with rooftop solar.

That solar power will be gone with that storm. And I think back to, when I first moved to Ohio, it was 2006. I think it was 2008, and there was a category one hurricane that came through Ohio. And I was on the phone with my mother. And a chunk of my roof just came off and landed in my driveway. It was about a six-by-six foot portion. And so along with a lot of other homes in central Ohio, people lost their roofs. Well it took about six months or so--people had tarps over their roofs and so forth--to get that back. And that's just a roof. That's just tar paper and shingles. So what happens when there's all of that solar there that needs to be put back on? How long do customers stay without power? And one can say, "Well, the grid is there." Well, let's go ten years out in time. And we're in 2023. Well, we didn't build that transmission. We didn't build that distribution capacity, because we assumed that there would be zero load growth. Now is it fair for the customers who had been paying for electricity through the various utilities to endure brownouts and blackouts so that we can plug everybody else back in? I mean, these are just some of the staggering questions that I think we do need to deal with. I do think, even with distributed generation, that some form of event analysis could be helpful.

Speaker 4: Did we say the same thing when we build nuclear plants? What happens if that goes down? How do we replace that? I mean, is that

fair as a reason to not move forward on distributed generation of solar panels?

Speaker 1: I'm not saying not to move forward with it. But I think that from a planning standpoint, you do have to just figure out, are you truly going to assume no load growth? Or are you going to say that that is a contingency that you're going to model in that planning process? So you can have loss of a nuke. That's planned for through the planning process. Right? That's just a contingency that is modeled into the system. If you've got a large DC line coming down from Canada, that's modeled as well. But, again, it's one event. Right? So say there is one storm that hits and now all of a sudden changes your load, and now it's up by 20%, should we maybe think about actually designing the system so that it can accommodate a little bit of load growth along the way? And I don't know what the right answer is. It's just that I do think that we need to think about those kinds of things. It will be a much more complex grid in the future. And I think we just need to think about what the ramifications of that are.

Moderator: From one utility's point of view on a nuclear plant, there's a 765 line that ties the ComEd system with AEP that was justified on the basis of being able to live through a long-term outage of 2,000 megawatt nuclear plant.

Speaker 4: My point is, you modeled and planned for that.

Moderator: Even though it was beyond the normal criteria, it was considered a prudent thing. Of course, had high hopes back when the nuclear plants were built that they would be too cheap to meter and would continue to operate. But there was a time they were down to 50% capacity factor, and that big line turned out to have paid for itself. But it was, you know, beyond the strict NERC criteria, but a matter of judgment as to the probability and the risk if that event happened.

Speaker 4: Maybe I misheard the earlier comment by Speaker 1, but I thought it was saying, if you're going to have a whole bunch of solar rooftop DG, and you have a hurricane in Ohio, are you going to lose 2,000 megawatts? Like, you might lose a plant, or the 765 line could go down. And can you not model and plan for that as well? That was my point.

Moderator: I think it was the opposite point, that it was being driven to plan that as no load growth. And you needed to plan for load growth, because there were contingencies that could lose that solar and you would need the transmission.

Speaker 1: Right. It's really just thinking about planning the system from an event standpoint and not just an N minus one or N minus two. So let's use gas as an example. Maybe that's easier. So if the generation in PJM is 20% natural gas fed, you don't worry about it. Right? You don't have a contingency that says, what if I lose a pipeline? But if it goes to 80% gas, you might want to sit there and have that as a contingency that you look at and say, what happens to the system? So applying that same type of methodology to distributed generation, again, with 10% DG, something small, I don't think that that's a problem. If it gets to something that is very significant, I think it can be a problem. Or, you know, folks are just going to be without power for a long period of time.

And people don't like that. They don't like it for a day.

Comment: Or a second, because they have to reset their clock.

Speaker 5: Something to consider on DG2 that we haven't touched on is voltage control. Is it a huge issue there? I'll leave it at that.

Question 4: Thanks. And going in a bit of a philosophically different direction, I think unquestionably we see that the RTOs have provided extraordinary benefits in the regions

that they've been in. But looking at it as I now do, you know, here in New England, representing generators, I think one of the challenges that we really see is ensuring that there are adequate revenues across the energy capacity and ancillary services markets for those generators needed for reliability, as well as to support any needed new entry.

And as we look at, particularly, the capacity markets, which end up being the tail that wags the dog in these conversations, they were largely developed through settlements. As I look and think more of how these markets work together, I think about how the Declaration of Independence was written, where it was edited by a committee, but one guy held the pen, and was the architect of it and was the author of it. And I start to wonder, with the stakeholder processes being what they are and the complexities that have been noted on the interrelationship between the energy and capacity markets, the governance issues being what they are, stakeholder processes that are going to continue in 300 meetings a year in some markets, how do we make sure all these pieces fit together? How do we make sure that the mural that's being put together here through these different aspects, through settlements--where I think the only outcomes that we can all agree to from settlements is that everybody's going to be unhappy with what the outcome is--how do we make sure that these pieces fit together in these unquestionably complicated markets? Is it enough, to look at sets of best practices? And should the burden be on FERC? Or are there other places where having that single person or that single entity that holds the pen and makes sure all the pieces fit together make sense? Is that the RTO?

Speaker 5: There was that very debate within PJM, where the board and the executives were discussing, are we adequate? Can this market sustain reliability and efficient investment? In other words, are we getting what we're supposed to get? And can the market sustain itself

effectively? I think it goes back to something Speaker 1 said. And if it can't, we ought to do a course correction. And it's not going to be popular, if we say, "Whoa, we see a major problem," and the good news is, we came out and said, "We see a couple minor problems." The world knows about a set of the minor problems having to do with capacity markets. You don't yet know about the other problem that we're going to come out with that said, "You know, we've got to do some course corrections."

But I think what it takes, though, is for the RTO to say, "Hey, we've got to call a halt and do something that's going to be controversial and difficult." I think as Speaker 1 said, there has to be a way that you see a major change coming and say, "We've got a problem."

I equate it back to 2007, when PJM said, "We've got to have a forward capacity market." I don't think there was a single stakeholder who was happy with that. It was a very, very difficult thing to do. And it was shaking the very foundation of the organization.

So I don't have a good answer to that question. But it's a tough call. I think the RTO has got to make it, because I don't think it's possible for it to be made at FERC, necessarily, because nobody's going to put a proceeding in front of them that says, "Is this whole thing working?" There's nothing in front of them. The RTOs almost have to do it.

Speaker 3: To build on Speaker 5's point, the markets need to be self-correcting. That's the goal--that when your times are tight, there's somebody that's willing to step up to the plate, and there's enough money in the market for them to make it. But there's a lot of crying wolf going on. There's a 17% reserve margin requirement. There's a 27% actual reserve margin. You know what? If some generators go bankrupt, that's not a bad outcome. That's the correct outcome. And yet that's being pointed at by some as a flaw in the system, because people

say that there isn't enough money there. Well, there shouldn't be, at 27% reserve margin. Rate payers are paying too much if we're trying to keep that up, and we only need a 17% margin.

So when times get tight, I think that's when you really have to have designed the market so that hopefully there will be incentives for generators, or demand response, or whatever else to step up to the plate and fill in the blank. And if not, I think Speaker 5 is absolutely right. You're going to have to take a look at your system, and make whatever corrections. But there's a lot of predicting what's going to happen when they get there, and it never kind of turns out like it's predicted.

Speaker 1: I think it's an excellent question. I think it's a really thought provoking question. I can't say that I have a specific answer to it. I think Speaker 5 did an excellent job in summarizing it. I guess the only modification that I would say is that it's all of us, not just the RTOs. Right? If we see something that is going to happen, we need to call it to each other's attention. And some will agree and some will not agree, and the truth always lies somewhere in the middle, between what all the different views are. But I think the onus is truly on all of us to try and keep this system together. This is what we all got into this business for, whether it be folks who are serving on a public commission, whether it be transmission owners, or distribution companies. This is what we do. We take care of customers, and we need to make sure that we flag these issues ahead of time. And ultimately, I do believe it is the RTOs that are going to have to balance and make the final call.

Speaker 4: To the degree that pieces ever all fit together, they won't stay fitting together long because they're constantly changing. That's the problem. I think I've come to accept that. And so, as we learned yesterday at the capacity market conference, there's people who think we needed to solve the situation California is facing with the need for flexible resources--I mean, that's going to happen elsewhere after

California. And some of the participants think that need should be answered in the energy and ancillary services market. I'm not saying it shouldn't, but we also know those aren't just pure energy markets. At some point, there's going to be a failure in the market in delivering the right amount of flexible resources. And so people are going to look, as we do now, to capacity market to fill in where the other market is not working.

So that's just an example of the changing dynamic of our electric system, and the pieces are going to be changing sizes. I think we're going to rely upon each RTO, because they have certain uniqueness to them in their design on the energy market side and the capacity market side. We're going to have to bring forward potential solutions to realign those pieces.

Speaker 2: I'll just say this quickly. I agree with what everyone said here. I know that the California ISO does a strategic plan every two years. It looks hard at what the market's doing, what it's not doing, what are the issues out there. The ISO tries to resolve these things. I think there is an obligation. It's part of scope creep. There is an obligation for leadership to try to move these things forward. If you know about this duck chart, you can't just sit there and wait for it. You've got to lead through it. And part of that is, how do you make sure you get the ramping you need, so you need market products for that? How do you make sure these generators stay around when there's no revenue to them? That's part of what the ISO has to do as well. So I do think the ISO has an obligation for leadership. I think, generally, they accept it.

Question 5: Getting wholesale prices down to retail would be important for DR and distributed resources in terms of alleviating some of these transmission constraints. So that, say, in San Diego perhaps, people could see prices and go, "Prices are getting high. I'll get off the system before having to be forcefully curtailed." Or alternatively, something that came up when I

visited London and spoke with folks in the U.K. at National Grid and at Ofgem, was special protection schemes. We were asked, "Why don't you use special protection schemes in the U.S. more, in the sense that you could actually contract with somebody to interrupt?" So then you could actually operate the transmission system at the "ragged edge" in various places, and then if the contingency occurs that you need to shed load, you've got somebody under contract there that'll do it in the right location, and they'll trip off line and do that.

And so my question is, is that a way for us to go forward to manage some of these issues, is to start thinking like that, outside the box? Or is that just something that's just not feasible here in the context of our RTO markets in the U.S.?

Moderator: Having come from a system that used something like special protection systems, they worked, at least giving you my experience, on a discrete basis, where they displaced an expensive line. And you said, "Look, I'm going to get a three-phase fault with a breaker failure once every 40 years. I can put in a relay scheme and it's going to save a \$20 million dollar line." (I'm putting this in 1970 dollars of course.) PJM has found, and I think others have found, that they have made operability much more difficult. And as you start relying and relying and relying on those special arrangements--OK, you've done it for A, well, now do it for B, now do it for C, now do it for D...I'm an engineer. I've had engineers work for me. They will go, "Yes, sir. We will make it work." And by the time you're done, the whole is so much worse than the sum of the parts. You have made a mess for those people left to operate the system. It is a legitimate way to look at things, and maybe on a discrete basis. But I think at least PJM's philosophy, that any new systems can only be temporary, is probably a better system from a long-term operability and resiliency condition. And I'll let the experts talk, having put in some of these systems.

Speaker 2: First of all, we have SPSs all over the system. And the example I used of the load sheds in San Diego, sheds like that. It's automated. If you get under voltage, you get load shed. And it's an automatic system. And you use them fairly frequently to avoid having to have other generation or transmission. So they are widely used. We have them, and I agree with the moderator. They compound upon one another. And unless you're really, really good at making sure they all trigger the right ways, you can have them trigger in ways you don't want them to, under certain events. And so you need to be careful with them.

So the guidance I've given my people is, to be careful with these protection schemes. They're appropriate, but you have to use judgment. And you kind of delved into the rate design, and some other things like that. Here's what I think. All of this is possible. You can do it really expensively or you can do it more economically. The real expensive way is to build lots of transmission and lots of generation to deal with this. The less expensive way is to harmonize policies and structures across the system.

Let me give you an example. If you put in variable pricing for customers, I may not have to have as much peak generating capacity, as an example. What's stopping us from doing that? Well, regulatory regimes are stopping us from doing that. What's stopping us from getting load shifts and things like that? Regulatory regimes. They're all fixable. We don't have to build as much as we do if the regulatory fiat, I think, were a little more nimble. And, frankly, I will say that that fiat is less at FERC, because I think they've been more proactive with FERC Order 1000, 764, and things like that, to get ahead of the changing world. But the state commission (I will speak to our state commission), in my opinion, is too slow to adapt. And it's going to cost a hell of a lot of money.

Speaker 3: Especially with the storms lately and resiliency, I think there's going to be much more

of a need to take a look at individual customers and what their desires are. Right now, it's one size of utility fits all. Now, ComEd has different requirements than somebody upstate. But if you're a ComEd customer, you pay the same in the overhead system in Westchester County as you do in the underground system in, even though you're far more resilient in Manhattan than you are in Westchester.

The only time we made differentials is if there is a large industrial site that can't go down. A plant may pay for extra lines so that if one line goes down, they're going to be able to stay up. And they pay for that. But customers really don't get an option, at this point, to pay for resiliency. If NYU or Princeton wanted to maintain electricity during outages, they had to end run the utility and build their own combined heat and power project. The idea of the utilities stepping up and saying, "Well, I can give you more resilience at a cost"--utilities aren't allowed to do that. Regulators don't let them. And if these storms are going to happen more often, I think we're going to have to start looking at customers' individual needs and allowing the utilities to respond. They can charge more money to this customer. But they can help them with a combined heat and power system. They can double up the circuitry. They can do what needs to get done if the customer is willing to pay for it. We don't normally allow that to happen. I think we're going to need to in the future.

Speaker 5: I think there's some deployment of technology that actually is efficient, you know, whether it be the optimization central to the RTO that I talked about, or certain customer response technology that makes demand response much more reliable, predictable, and granular. That's great stuff. And I think it's sustainable. The difference with an SPS is that it's really more of an accommodation, us using technology to sort of get around or reduce, implicitly, the reliability criteria. I don't think that is long-term sustainable. So I think from a sustainable reliability perspective, an SPS is too

close to the edge. So I would guess you won't see those pop up that much. Other types of technology are more reliable. I think we've already seen efficiencies there.

Speaker 3: And that was the flipside of what I was talking about. Are there customers that are willing to pay less, with the understanding that they could be interrupted at a moment's notice? So if we start taking a look at the continuum, instead of one-size-fits-all for all customers, I think you can get a more adaptable system in the future.

Speaker 1: I think the viability of SPS or any other tool is completely tied to what your goal is. If your goal is to never build another mile of transmission line, then use them all day long.

Now, I will say this. We all use them. We use them quite a bit when we can't get a transmission line in service. I mean, the RTO might need to have a transmission line in service, but you can't get it through the siting process or something else is going on. So you've got that. Now, the customers don't tend to know that they're on that. Those customers in Indiana probably were not too happy with the fact that they were the load that was dropped. And that's the reality—a special protection scheme is really just dropping load. And so how you feel about that, putting my engineering hat back on again, is really a function of three things. It's the impact. It's the size of it. Dropping seven megawatts is a lot different than dropping 1,000 megawatts. And if the operational effect—if you've got a lot of these in the system, everything's got to work just right. If it doesn't work just right, again, you've got that much higher risk of possibly having a cascading effect. And, maybe most importantly, it's frequency. If it happens once every ten years, fine. If it happens every other day...two days was too much in a row for the folks in Indiana. So that's really what people have to understand, I think. What's the goal and what's the cost?

Moderator: I think just using the term SPS encompasses so much. It encompasses, as Speaker 3 mentioned, systems that could drop load based on contractual, voluntary agreements. It can cover a runback of a generator for a stability situation. Or it can cover, you know, the system that I happen to be familiar with at ComEd, which was originally designed for one contingency. It's grown to 20 contingencies, which is unmanageable, and as Speaker 1 said, can run into lots of problems. And so I think you need to further define what you're saying and what the consequences of its going haywire would be.

So there's a broad spectrum, where in some places, the consequences are voluntary and are minor, or are very, very economic. You're not going to build a 400-mile line for a contingency that's going to occur once in 20 years. But something in the middle of the system that can cause large scale outages is a different matter, so, it's broader than just the term SPS.

Questioner: I got kind of the answers I somewhat expected. But it's interesting how the perspective is different here in North America, in terms of how we view SPSs versus how they view them in Europe and other parts of the world, in New Zealand and Australia, where they've actually implemented a lot of these as a matter of an economic choice, you know, in terms of operations. It's very helpful to think about that.

Question 6: I'll start with something really positive about RTOs, which is that I do believe they've done an excellent job in generation efficiency and making sure that, you know, least cost generated is dispatched, etc. But I actually do believe that RTOs have not done a good job in transmission efficiency, which is sort of along the lines of what the last questioner was discussing. And some of us remember the definition of smart grid. It wasn't just having, you know, a meter by the customer and the customer curtailing based on prices. One of the

factors for smart grid was actually to, in essence, re-dispatch the transmission in real time in order to divert flows from one line to another, and what have you. And I've seen very little progress in RTOs in terms of actually dispatching the transmission system efficiently. There's this huge fear about switching lines on or off. I mean, just the debate we just heard about SPSes, where people are saying things like, "Oh well, you know, the operator has to have five different procedures." But they don't have to have five different procedures if it's automated. And, actually, I would offer that there was a special protection scheme for congestion in our area which was very much appreciated by my company. But we got so much pushback from NERC, because it is run by engineers. And nobody is challenging NERC on, you know, the N minus one criterion, or the one day in ten criterion, what have you. So I just wanted to hear the panelists' comments regarding transmission efficiency and why that has been sort of dropped from the smart grid concept.

Speaker 2: Well, when we run our secure economic dispatch, we certainly do bring in the constraints on the transmission system and try to run that as efficiently as we can. So I'm not sure how we can push that that much farther forward. The bigger issue, at least for us in the West, are the contract paths. And the contracts really get in the way, and they have to do more with the inter-ties, and I think there are a lot of efficiencies that could be had off the inter-ties. Unfortunately, by definition, it's a seams issue. And for us, the seams we have where it's inefficient are particularly to our north, which is where BPA (the Bonneville Power Administration) is. And BPA waves their contracts around whenever we talk to them about more effectively and efficiently using the transmission. So that's something we need to deal with. Former Secretary of Energy Chu wrote a letter, which some of you may know about. It's the famous Chu letter to the power marketing agencies. And to say it stirred up a

hornet's nest would be an understatement. I'll leave it at that.

Speaker 3: I guess I, at least for New York, reject the premise a little. Our philosophy in smart grid, first, has been to start at the higher voltage levels and work our way down, not to start at the meters and work our way up. Our biggest individual project was a series of PMUs (power management units) that the ISO and a variety of the utilities put in to try to get some more real-time information about the system and use that data to use the transmission system more efficiently. So, at least in New York, that's exactly where we're starting, at the higher voltage place.

Speaker 5: Yes. Certainly we've done optimization in the sense of optimized voltage control to allow us to operate with thinner reserve margins. I think we've done that. I think where you may be talking about actually installing devices and/or switchable lines to say, "I'm going to actually change transmission topology to try to include that in the optimization," and that we haven't gone to. So if that's what you're saying, I agree. I don't think that's something that has been launched. I'm not sure we've figured out a way to get that in there. I agree with that. But I'm also questioning a bit, about whether it would actually create that much more transmission margin. Maybe it depends on the system.

Speaker 5: I'm not sure that I'm understanding the question as well as I should. But, you know, to Speaker 5's point, we've kind of viewed the system as something that's always on. You don't shut the lines off or on, or that kind of thing. But there are technologies that you can use. So we have a VFT (variable-frequency transformer) on the U.S./Mexican border. That can be used. So I think in certain unique circumstances, on the edges of systems, that you can use that type of technology to make the system more efficient. But I do think it tends to be more of the exception rather than the rule.

Moderator: As you probably know, the ComEd system, for a while, was being switched almost every evening when there was over-generation from the West. And the judgment was that this was both an operability issue and was ultimately making the system marginally less secure. So it was being done until PJM did the light load upgrades, which solved the problem. But to be reconfiguring the system every night and having to run through the security constrained dispatch was...and maybe that's a judgment call. But I think it was a judgment call, both on the company's part and PJM's part, that it was not a long-term solution. A short-term solution, yes. And now we have long-term solutions.

Question 6. I just want to add that ARPA-E is funding several million dollars worth of grants on topology control. And the reason they're funding it (present panel excepted) is because the electrical engineers all challenged this as being something that was impossible to do. And ARPA-E says, "Well, we're looking for disruptive technologies." And there is an all-day conference on November 19th on optimal topology control. Yes, it's not there yet. You can't put it into your optimization algorithms. The switching choices create an unbelievably difficult computational problem. But it certainly is intriguing to look at the topology. An all-in topology is a stupid topology. There are tons of examples where it doesn't make any sense.

Speaker 5: And again, yes, absolutely it is something we need to look at. But what I was trying to impress was, it's not there yet. It's certainly not a generally accepted way to operate the grid. And there may be able to be some areas of the system you could get some efficiencies out of. I agree with you. We need to research it more. That's part of innovation.

Question 7: My company has well developed complexes in both natural gas and power. And for as long as we've had those complexes, we've been studying the relationship between power

and gas on a number of different levels. And we've noted some important trends. In 2000, natural gas was 15% of total generation. It's now doubled to 30%. Coal was 51%. It's now 37%. So it's very clear to us right now that to understand power dynamics, you really need to understand natural gas dynamics. Right now, for today's delivery, \$3.58 will buy an MMBTU on the East Coast, and it will buy it at the Henry Hub. There's amazing uniformity on the power side in terms of where power prices are. Thirty-six dollars is a pretty common price throughout the country. The emergence of the Marcellus has driven a lot of the issues connected with the gas-power interface. And it's happened recently. The Marcellus ramped up recently. Looking at Pennsylvania production, it went vertical in '11, '12, and '13.

The question is, for the ISO participants, do you see the need for greater coordination between gas and power? We know that we've studied the gas day. That's an important part. Do you think that the central control we have on the power side should be mirrored on the natural gas side? Or is the pipeline control structure adequate without a natural gas RTO?

Speaker 5: Absolutely we must do more coordination between gas and electric. In PJM alone this year, we've had two events where we had a relatively close, I'll say, emergency on the electric system, only to find that the unit that we needed to have online couldn't get gas because they were sending the gas to storage, and we freaked out, saying, "You're sending gas to storage and you won't send it to the power plant when we're about ready to shed electric loads?" So that's happened twice to us this year.

So, absolutely, we've got to coordinate. I think, first, you're going to see reliability coordination come to the fore. I mean, look at New England's concerns. They're probably even worse off than we are from that perspective. Whether we ever actually get to a centrally controlled gas market like we have in electricity, where you have the

equivalent of an RTO, I'm not sure. I don't think it'll have to go that far. I think it will have to go to much, much tighter coordination. And on the gas side, they're going to have to figure out a way to accommodate firm power. You know, power plants can't buy 24/7 firm gas because it's not economic. I mean, there's got to be something give there, too.

Speaker 1: I agree with that. I think the one way of looking at it is, again, through that event analysis. I agree with Speaker 5. I don't think there needs to be an RTO for the gas market or anything. But the question I guess I'll leave you with is what happens when black start capacity is all natural gas? Then what? How do we restart the grid?

Speaker 3: I'll just note that in the Department of Energy's Eastern Interconnect planning process, the next part of their study is the gas electric connection and how to move forward. Meetings have already been held with representatives of gas groups to discuss many of these issues that are going to be ongoing. And that's open to the public if anybody wants to get involved in that.

Speaker 2: Well, I'm delighted to say that the percentage of generation in California for natural gas is already about 70%. We're already on the cutting edge, as with most things. It's probably why I don't have any hair. (Also I drink a lot of scotch, too.) Actually there does need to be a lot of coordination, I think. Much more can be done. I know that FERC is looking at that. I applaud that. I encourage continued changes there, much as Speaker 5 said, because we've had events as well.

But I can tell you this. The most important thing is that now our operators talk to the gas system guys. And just the fact that we're communicating and coordinating with them has done worlds of good. So I suggest we start there. As an example, there was a pressure problem in Southern California. For what it's worth,

Southern California is the bane of my existence in a lot of ways. But they had gas pressure problems up there. So the good news is, we could move our system. So we moved generation up north and let them pack the pipeline down south. And that's the kind of coordination that we've done. Another time, when Texas froze, the gas, two days later, didn't show up in California. Same kind of thing, we moved around the electric system to help the gas guys. And now we regularly communicate with them and coordinate our operations with them. And I think it's been very effective.

Speaker 4: Yes, I think the communication level within the RTOs has gone up immensely in the last 12 months. Some of it would have happened on its own. But a lot of it also, I think, was a result of the conferences that FERC had throughout the country on this issue. I don't think that a central gas market, if that's how you characterize it, really rose to a level of serious consideration in all those discussions and in comments to the commission. But we are seriously looking at the issues of whether you should change the time for bidding in on the gas market, and whether you should make adjustments in the gas day or electric day or align them to make it easier to schedule them and coordinate between the two markets. So we're looking at a number of options. But I don't think that we got much serious input on a gas central market RTO.

Session Three. The Green Agenda: Electricity and the Environment

At the formation of HEPG, the U.S. was implementing the Clean Air Act Amendments of 1990. That statute constituted a landmark shift in environmental regulation from command and control to a market based system of emissions trading with a cap on emissions of sulfur dioxide. While the potential for trading schemes to be deployed to attain environmental objectives is still topical, the 2013 environmental challenges for the power sector are even more profound, more complicated, and more global in nature. Carbon emissions are, of course, at the forefront of the environmental debate and will remain a critical challenge despite the retirement of many older coal fired plants and an increase in the use of natural gas and renewable generation. In fact, the percent of electricity generated by coal in the U.S. has fallen from 52% in 1997 to 38% today. A major factor has been the shale revolution, which carries its own environmental controversies. The Obama Administration has said that it will use the power of the Executive Branch to reduce carbon emissions. China has indicated that it may adopt a carbon tax or some other method of controlling emissions in the near future. Thus, international pressure on the U.S. to reduce emissions should continue. Additionally, other consequences of using fossil fuels such as with mercury and suspended particles are issues for regulators and policy makers. Given all of these environmental considerations, ironies, and uncertainties, how do we make sound economic and good environmental choices? Moreover, how do we balance the economic and environmental interests in ways that make the costs and risks manageable and sustainable? What will be the impacts on the evolution of the electricity system?

Moderator: I'd like to welcome you all this morning. I think I was picked for this job of moderator because I'm old, and actually was around when a lot of the environment movement was started.

So putting this in perspective, I think it's fair to say that environmental issues have evolved through multiple stages. In the very early 70s, the emphasis was on enforcement and reducing emissions and doing so in sweeping and dramatic fashion. Political and popular support was close to unanimous. To put that in perspective, President Nixon, who was no friend of environmentalists, made speeches and took pro-environmental positions that even President Obama might be reluctant to take today. And Bill Ruckelshaus became a national hero.

As the worst polluters were run in to court, air and water quality improved, and the most visible pollution began to dissipate, the debate began to focus on regional economics and the impacts of government regulation. While health costs might justify more stringent air standards, cost issues

began to constrain how far the government was willing to go in reducing air emissions. A 10-year battle over acid rain from transported air pollutants, ensued, which was only resolved by a visionary republican president, and a willingness by the Congress to embrace market mechanisms over command and control regulation.

Today, the battles over conventional pollutants continue as the administration fights to reduce mercury pollution and transported pollutants. Stronger particulate standards will soon be added to this list. But the biggest battle is over carbon dioxide, a pollutant that is not visible, whose demand function lies more in the future than the present, and which is a true global commons problem, providing great opportunities for free riders and measurable short-term cost to those countries who choose to proceed in advance of others.

On the energy side, the electric utilities face increasingly stringent renewable portfolio standards, flat demand growth, and siting difficulties, not just for fossil fuel generation, but also for wind machines and transmission

lines. How much should we, as a society, be subsidizing renewable energy when we have the potential of large supplies of cheap natural gas? If we're going to push renewables, are we confident that we can integrate them effectively into a grid system that was not built for intermittent power?

Politically, the days of consensus around environmental issues is over. Public support may not have disappeared, but it is far from vigorous. The opponents of stricter air pollution standards have derided the administration for conducting a war on coal, and labeled EPA as a job-destroyer. On the other hand, scientists warn of even more dire consequences if we do not act on carbon dioxide, and study after study documents that more stringent standards for suspended particulates will save thousands of lives.

The electric utility industry is in the eye of this political storm. What constitutes good policy in meeting the country's environmental, economic, and energy goals? How, in this polarized political environment, do we arrive at reasonable and constructive solutions?

So we are very fortunate today to have a panel that will answer those questions.

Speaker 1.

Thank you. I'm going to talk about two topics. First, the context for CO₂ and the role of the power sector, both globally and in the United States, on climate, and then, second, what we can do about it. I'll spend some time on the use of EPA's authority under the Clean Air Act to set standards for power plants.

Coal is certainly the largest account in the global carbon bank of fossil fuels. And the concept I want to talk about first is that managing carbon is different than conventional environmental pollutant problems in that we've got one budget to spend. Due to the long lifetime of CO₂ in the

atmosphere, it stays up there, and we can calculate what total cumulative emissions over a period of decades is consistent with a given concentration in the atmosphere.

We have more difficulty in predicting what all the consequences of that higher elevation of concentrations is, but we have a pretty good handle on just how much we can put up there. And the EIA has presented some summary calculations based on the best papers out there. In round numbers, we've got just shy of 900 billion tons of CO₂ that can be released globally if we're going to have a shot at the 450 PPM/2 degrees centigrade target. So just keep that number in mind.

The reason that number is challenging is this next slide, where this 900 billion is a small fraction of the total amount of fossil fuel proven reserves, which is 2.9 trillion tons of embedded CO₂. And, I emphasize, these are proven reserves. We're not talking about resources, we're talking about booked assets that are identified in filings by fossil fuel companies and by government, accounting for amounts of fossil fuels that are technically capable of being produced today, using today's technologies at today's market prices. So if all that stuff is burned, we bust way through the budget.

And the thing that is challenging about coal-fired power plants in particular is the lock-in effect. It takes a long time to build a coal-fired power plant, and, once it's built, it lasts a long time. And that means that you've got a cumulative consumption of the budget associated with coal power which is very pronounced.

If we take a look at what the IEA's current projections are, right now we've got a little over 1,600 gigawatts of coal capacity operating today. And in the next two decades plus a few years, IEA is projecting 1,700 more gigawatts. China is the big player here, as you can see, with India coming up a distant second. But that's a lot

of coal capacity to be built, essentially more than what's operating today, and all of that in about two decades.

More daunting than the amount is what the associated CO₂ is. So on the left side of the graph is that carbon budget that gives us a 50% probability of keeping temperature increases below two degrees centigrade. So this is not an analysis that would lead you to decide to get on a plane if the pilot said, "Well we've got a 50% chance of reaching our destination." We'd like to have a better shot than 50%, but the carbon budget numbers are considerably smaller if you want an 80 or a 90% chance. So one can say this is a conservative analysis, or an overestimate of what that actual carbon budget might look like.

But that said, those power plants that are on that IEA forecast, plus the remaining CO₂ from the remaining useful life of the existing fleet, busts that budget. It's about 120% of that budget, just that chunk. And that's the entire budget for all carbon dioxide emissions from all human, from all industrial activities. So one sector, power, and one fuel consumes more than the entire budget.

So what can we do about that? Well, if you analyze the opportunities to cut, starting with the new plants, there's actually a way to eat deeply into that budget consumption, which is displayed on the right-hand bar chart. First, we cannot build as many coal plants. We can build other facilities instead. And if we do that, we will cut the 1,700 gigawatts of projected coal capacity down to a little over 800 gigawatts of coal capacity, with the rest being supplied by other resources. But then we can apply carbon capture and storage to a goodly fraction of the coal plants that are built. And if we do that, we can dramatically reduce the amount of carbon budget consumption associated with power plants. And this is something that we think is an important policy priority.

But let's take a look at existing capacity. This is, again, an IEA analysis, where they've basically looked at the inventory of existing coal plants, a little over 1,600 gigawatts. Of that, about 1100 gigawatts are large units, and therefore potentially attractive for CCS retrofit. But then you want to look at ones that have a fair amount of life left in them. So if you take another cut and say, "Well, OK, what are the large units that are also teenagers, and less than 20 years old?" that gives you about 660 gigawatts of coal capacity.

Now, that's a big chunk. The striking feature of the distribution of these young, large coal plants is that more than 80% of them are in China. Nearly 500 gigawatts of that 660 gigawatts are in China. So China is a huge player. And the next biggest players are the US, India, Japan, and Korea. So this is the target community.

You might look at this chart and say, "Well, OK, so we should only be paying attention to China." Well, our view is that the United States policy is a tremendously important driver of behavior globally on environmental performance standards. We've seen it with sulfur dioxide scrubbers. We've seen it with getting lead out of gasoline. We've seen it with catalytic converters. If the United States leads, eventually other countries follow. And if the United States fails to lead, then other countries typically fail to lead as well. So a focus on the United States is very important, instrumentally as well as for what it does in the United States.

Which leads us to the question, what are we doing? In 1999, an effort began to get EPA to use its authority under the Clean Air Act to regulate carbon dioxide. It took a number of years to wind its way through the courts, with the Supreme Court eventually saying, "Yes, Virginia and Mr. Cucinelli, the EPA does have the authority to regulate CO₂." The Obama administration did proceed to do so for motor vehicles, and just recently has proposed to do the same for the power sector. And the power sector

proposed rules were announced just a week ago, and they are outlined on this slide.

They propose two standards, one for new natural gas combined cycle units, and a second for new coal units. And the numbers are up there, 1,000 pounds per megawatt hour for gas, and a range of 1,000 to 1,100 pounds for coal. The latter can only be met with some use of carbon capture and storage, and the agency has analyzed both the technical feasibility and the economics of so doing.

There's been a lot of commentary that, "Well, EPA can't do this, because there aren't any existing coal plants that are using CCS on a large fraction of their exhaust stream, therefore it isn't demonstrated." Well, that's not the test under the Clean Air Act. The test is whether the technology has been demonstrated at commercial scales in applications that are relevant (that is the case for carbon capture systems and for injection of CO₂ into geologic formations), and that the cost of applying it to the regulated sector would have reasonable economic impacts.

And the agency has come up with an analysis that shows that, too, where basically there's a difference in the incremental cost of CCS, depending on what you do with the CO₂ that you capture. If you can sell it to enhanced oil recovery operators, then obviously your net costs are reduced. If you can't sell it, EPA's estimates are that equipping a super critical coal plant with CCS is about 20% more expensive in terms of levelized cost of electricity than running the plant without it. And if you are able to sell the proceeds for EOR, then you're in the range of plus or minus 5%. And the numbers are there. And they also point out that a new coal with CCS is about the same cost of electricity as a new nuclear facility.

But of course, the CO₂ today is in the existing fleet, and that means that we need to look at how we regulate and cut emissions there. And,

interestingly, the Clean Air Act does provide EPA with the authority to set in motion state regulation of CO₂ from existing power plants, as well as having backstop federal authority. And the President has issued a directive that would have EPA proceed on a schedule to propose and adopt those regulations, and it's laid out on the slide.

NRDC has been advocating this for a number of years, and as a result, last year published a proposed approach for use of this existing plant authority under the Clean Air Act. And this slide outlines the benefits of achieving that approach. And I want to jump to the principle point, which is relevant to a lot of you in this room.

How would the proposal that we are advocating work with the functioning of the electric power system? And there are two features I want to flag. One is, how do you set the target? What's the emission limit? How is it structured? And then, even more importantly, how do you frame up the compliance mechanism?

One of the speakers mentioned yesterday that it would be great if we could have a more flexible compliance approach to using this authority, even if it came at the cost of maybe not getting as much in the way of emission reduction. Well, actually, the good news is that we are advocating a flexible approach, and the more flexible approach actually gets you more emission reductions than a traditional approach that is based only on what kind of hardware you can stick on an existing power plant. So the features of this are that, in our approach, EPA would set a target for each state's fossil fuel fleet, expressed as pounds of CO₂ per megawatt hour of generation from the fossil fuel fleet.

And the targets would vary by state, based on the carbon intensity of their fossil fuel fleet in a historic baseline period. We chose for analysis 2008 to 2010. That reflects the fact that a state that starts with a very carbon intensive mix of coal and gas will have a harder time meeting any

numerical standard than one that starts with a less carbon intensive mix. To come up with the numerical values, we assigned a bogey of 1,500 pounds per megawatt hour CO₂ for coal plants, and 1,000 pounds for gas.

And then you apply those numbers to the fractional share of coal and gas in a state's historic generating period. So the state, for example, that had 100% coal generation in its baseline would have a target standard of 1,500. A state that had 100% gas in its baseline period would have a target of 1,000. And again, these percentages are of the fossil fleet generation, not the entire state's generation. So you have a sliding scale that ranges from 1,000 to 1,500.

But moving into the second aspect of the proposal, the important feature of the NRDC proposal is that, rather than applying unit-by-unit for compliance purposes the way historic traditional EPA standards have been, we are advocating a system where, essentially, the regulated units, the coal and gas plants, would be responsible for compliance, but they would be able to count any activities in the power system, including demand-side management, that had the effect of reducing emissions at fossil fuel generating units. So that would include greater dispatch of natural gas, greater dispatch of nuclear, greater dispatch of renewable or constructing new renewable energy, increased energy efficiency on the demand side or on the supply side. So all of those things would count.

This is a projection of what the impacts would be in 2020. We ran this through the Integrated Planning Model that ICF does, and, essentially, under the assumptions in the model, efficiency backs out coal. Gas does not increase much, renewables don't increase much, nuclear doesn't increase much at all.

The point I will leave you with is that this is not a prediction of what the electricity mix will be. This is simply illustrating the dynamic that, if you set a standard that's structured this way,

what it does is create a market for low-carbon alternatives. And we don't know right now which one of these low-carbon alternatives is going to be the winner. In this round of modeling, energy efficiency was the winner. But it could just as easily be renewable energy. It could even conceivably be, in part, nuclear. It could be, you know, greater dispatch of a natural gas.

And the final point I'll make is that, because this would allow a tradable market, it actually creates a significant revenue stream for zero-emitting resources. If the CO₂ permits trade for \$20 a ton of CO₂, that's worth \$10 to \$15 per megawatt hour for a zero-emitting resources, and that could change the investment incentive for these technologies. So I'll leave it at that. We will see what the EPA does with this idea, as well as the many other ideas, and stay tuned.

Question: I'm wondering, does your 2020 reference case include the impact of any retirements associated with Mercury and Air Toxics Standards (MATS) or particulate rules?

Speaker 1: Yes, it does. In these slides we started with the 2011 EIA reference case, and then we superimposed on them the MATS rules, and an estimate of what the coal ash rules would be, and the cooling tower rules. And yes, there are about 60 gigawatts of coal plant retirements in that reference case.

Question: Just to clarify, you're still seeing an increase relative to 2012 actual, even with that?

Speaker 1: That's right, because the capacity factor in the remaining coal units, is expected to increase.

Question: Do you expect a cap and trade system to take place, or a carbon tax, or this is regardless of any action like that?

Speaker 1: This is a regulatory proposal, and it's neither a carbon tax nor a cap and trade system.

What it is, is an emission-averaging approach that allows the regulated units to take credit for displaced generation in addition to anything they do at their own facilities. So this is simply a way of taking an emission limit that applies to an individual coal unit, but allowing that coal unit, in doing its calculation of pounds per megawatt hour, to deduct credits that are based on generation increases for other, lower-carbon or non-emitting resources on the system. And that, and the ability of the unit to, in effect, assume ownership of those credits, would be incorporated through a permit trading system, much like a renewable portfolio standard certificate system.

Question: So you think that EPA has the legal authority to do that? It doesn't need legislation?

Speaker 1: Correct.

Question: You said that carbon capture and sequestration had been demonstrated at scale. Where, what scale?

Speaker 1: I'll start by saying, you won't find a carbon capture system on the full exhaust stream of a fossil fuel power plant, here or anywhere else in the world. What you will find are industrial applications of carbon capture systems on exhaust gases that are very similar to those of power plants. And EPA relies extensively on two projects which are under construction, both of which are going to be using a high level of carbon capture, one in Mississippi and one in Saskatchewan. EPA also points to the fact that we know how to inject CO₂ into geologic formations, and that's been done for decades in enhanced oil recovery operations. So, basically, EPA's conclusion is that all of the elements of the system have been demonstrated at commercial scales, and that they are transferrable at costs that can be estimated and concluded to be reasonable to the power sector.

Speaker 2.

Thank you. I am going to talk about the role of nuclear in meeting the carbon goals that Speaker 1 laid out.

I was in Disney World this spring with my husband and my kids, and after my daughter dragged me on the Tower of Terror two times, and Space Mountain more times than I can remember, I noticed this ride in Epcot called "Ellen's Energy Adventure." And it was, you know, one of these sort of animatronic part-video, part-live-action, you're sitting in your chairs moving, and it's 40 minutes on energy.

I said, "This is great. You know, I have suffered this whole trip, and these people, my children, are going to sit through this energy thing and they're going to see what I do every day." And it was really quite well done. And, you know, heavily focused on things like fossil fuels, because then you could show dinosaurs, because right, the origin of fossil energy is the era of the dinosaurs. And renewables, there was lots of emphasis on that.

And I'm just waiting, you know, thinking, "When are they going to start talking about, you know, 20% of the nation's energy comes from nuclear? They've got to mention it at some point." We're about 30 minutes into the ride. And there was one sentence on nuclear: "It's expensive and very controversial." And then they go on. And my kids were picking me up off.... And I think the industry by and large just, they try to run the plants safely, they keep the capacity factors up, but otherwise, they keep their head down. Like, you know, there's just no good thing that comes from being public about what the nuclear power industry does.

But the, as the debate changes in Washington to what EPA is going to do under 111D, and as we look at the economic pressures facing nuclear, I think it's valuable to look at, what is this resource? Do we need it, at least on a transitional basis? And what are we going to do

about the fact that we're losing some of the stations?

What I'm going to focus on today is a little bit of nuclear propaganda on this slide. Hopefully much of this is familiar to you, but you know, a little bit over 62% of all the clean energy in the country comes from nuclear stations, which have high capacity factors, low fuel cost, high-paying jobs, etc. I won't bore you with all of this. But the point that I've raised at the outset is the one I really want to spend most of the time talking about. The top line on this chart is the EIA forecast of nuclear energy going out to 2040. The red line is actually what will happen if all the stations that haven't announced retirement continue on until the end of their 60 year licensed period.

So we have a number of stations that have, that are into their first extension period. I don't think there are any that are at the point where they're asking for an extension to go beyond 60 years. There's some, you know, significant questions about whether they will be able to go beyond 60 years, based on the physics of the station, and the comfort that the NRC may have with respect to their future safety. But 60 years is represented by the red line.

So the provocative line here is the blue one. We've had a number of retirements announced this year, some of which are safety-related, some of which are economics-related. And if that trend continues at the pace that we saw this year, that's what you'll see in terms of nuclear generation. So you know, the out years are probably not as relevant as the near-term. In 2020, just looking at the difference between where the government is expecting the nuclear generation to be and where it could be, about 25% of the fleet could go away.

So what would that do to our carbon goals? This slide shows you the commonly accepted emission target in 2020 being 17% off of 2005 levels. It shows progress that we've made so far.

And then it adds up announced retirements and potential future retirements. Again, this is just intended to be provocative, it's not a projection. It shows what that will do to our capacity to meet our near-term carbon goals, how much it increased the remaining reductions that we would need. And this, by the way, reflects the nuclear capacity that is under construction in some of the regulated states.

So who actually thinks that will happen? This represents a number of the analysts who cover this sector, and some academics too, who have concluded that there are more to come in terms of nuclear retirements. And I don't want to overstate that point. These analysts don't necessarily think about the long-term, they think about this year and next year. But the question it raises in my mind, from a policy perspective, is, what are we going to do about this?

We have a lot of debates in Washington about subsidies, and we had some discussions yesterday about the role of government programs that give a leg-up to otherwise uneconomic resources, representing a choice that society, or at least government, has made, that that's a good thing to do. So the question is, given the state of nuclear and what that's going to mean in terms of potential new government programs, is whether this industry, or some plant owners, will ask for their own economic leg up and say that it's justified on a carbon basis.

So you know, that puts us in sort of an interesting situation. We have a core belief in competitive markets, and in my company it's in our vision and values statement. And we are very much interested in market-based solutions. We were right there with all the people that went down in 2009 with Waxman-Markey. So it turns the question to what EPA's going to do under 111D. And you know, answering the question, if we want this kind of resource, at least on a transitional basis, what are we going to do about it?

So this is an excerpt from one of those reports that I just mentioned, listing some of the stations in the country where they've either announced retirements or the analysts have concluded that there is a risk of them.

There are about 100 reactors in the country operating right now. They are licensed through varying dates. The soonest that one will reach the 60 years is 2022, and the latest is 2046, with the average around 2030. And, nationally, you know, it's a similar trend in terms of when the stations went into operation. About half of them are in competitive states and half of them are in traditionally-regulated states. Of course, all of these on this list are in competitive states, the regulated states not having the same sort of cost pressures.

So I think you're probably all aware of some of the key influences that have led to the economic challenges to the stations on the last chart and others. Oil and natural gas prices since 2008, load growth being down, and then the decision that we've made to subsidize some new generation having a suppressive effect on prices in many regions. And as an aside, you know, we had a discussion yesterday about RPSes and how strange they are.

And we all sort of concluded that they were political compromises that were necessary to get them passed, but we sort of stopped there. There is a fair amount of litigation going on around these RPSes. Colorado is in US district court right now. There's the Minnesota RPS, which says, not just that you have to buy renewables, but that you can buy renewables in-state, but that you can't buy carbon-intensive power from out of state, which seems destined in my mind to go down. (I do have a law degree, I don't think that will withstand a commerce clause challenge, but...)

Some of you may have seen Judge Posner's decision in a recent FERC appeal, concluding just because he felt like it that the Michigan RPS

was unconstitutional under the commerce clause. So you know, there seems to be an increasing willingness of folks to challenge these statutes, and it may be that there will be a change, at least in terms of the in-state preference, in what we see in the future.

From a market influence kind of perspective, this is just another way to think about why larger plants that have lower per-unit costs are not facing the same kind of pressures as the single-unit sites Vermont Yankee and one other that have announced retirements this year. Location matters quite a bit, given that market prices tend to be lower in the Midwest, and you know, the differences in the capacity markets also makes quite a difference.

So I'm going to turn to a little bit more specific data. The left side is the Midwest version of the duck curve, which has been the subject of some conversation at my dinner table. I was thinking we needed an animal to define what the Midwest duck curve looks like, and I thought, you know, duck, duck, it might be nice if we say it looked like a goose. My kids did not think that was funny at all. Clearly you guys don't either. But I think it looks like an elephant, you can, you know, choose your own animal. But the lines on this chart represent net demand, which is consumer demand minus wind, over the course of the years represented on this chart. You can see that line moving down steadily, year over year, to the point where in the most recent year, 2012, that line is going below the black line, the black line representing the nuclear energy on the grid.

And this is over the course of a day. So, you know, while the California duck curve looks different because the dip happens in the afternoon because it's due to solar, this dip is due to wind, so it's happening in the middle of the night. And the chart is showing that line going below the nuclear capacity, which means at night the nuclear stations are seeing negative prices, and, you know, with their limited

capacity to ramp, they're paying to produce energy.

This is a fascinating curve. From our perspective, it calls for the question, what's competing at that hour of the day? I mean, you have two no-carbon resources that are the ones that are available, and they're squeezing each other. Whereas during the high point of the day, the peak, you don't have any government program trying to bring on no-carbon resources, and it's just sort of inverted. It's just sort of illogical. But that's sort of the consequence in this part of the country of the government policies that we have.

And then on the right side is, you know, just more sad news for nuclear. These are some Midwest nuclear stations, and the basis spread between a local pricing point of PJM, and what our stations are seeing. Neither of these charts are good, and I'm just showing you historic stuff.

Looking at projections, these charts show fuel O&M and capital, just to keep the plants running, versus a forward projection, a 2015 forecast of market prices in different regions. This is the time when all the coal stations are supposed to be retired.

This is the forecast of the good energy prices, right? And still you can see that putting aside the red shaded, which is, I'll talk about in a minute, the actual market-price forecasts are well below just the operating costs to keep the stations open. No return on equity. The red shaded boxes are what would happen if the EPA policy under 111D (not that it will be in effect in 2015, but at some point in the near future, 2020) and there was, for example, a \$10 carbon price.

The boxes are different sizes because some stations are in areas where there already is cap and trade, for example in the New England, so this is sort of incremental to what RGGI would otherwise produce. But even if you add a \$10

carbon price onto some of these stations, you're still not getting near profitability. And the picture's somewhat better when you look at a large single unit, but not much. It's the same principle. And then you can sort of see, when you get to a larger dual unit, they're already pretty profitable, and the carbon price is going to be less critical to their going-forward economics.

So what's the point of this? If we assume that we need this resource to meet carbon goals, and we want to keep celebrating, like we did yesterday, how great competitive markets are... I mean, our whole theory is, they're going to keep in the resources we want, and they're going to let the resources we don't need retire. If we conclude that we need these resources, how are we going to do that without getting into a situation where we're giving these resources also some sort of out-of-market contract? What does the EPA program need to achieve in order to prevent that?

This is what the next two years in DC is going to be about. And I think if you look at 99% of Speaker 1's slides, you would conclude what you probably already thought, which is that it's going to be about the coal companies versus the environmentalists. But the nuclear folks are going to be in the mix, too, and I think some of this probably showed you why that is. So thanks for your attention.

Speaker 3.

Thank you. It's a real pleasure to be here and to participate in this conversation. I thought I'd reflect on environmental policy first from the perspective of an economist, and then second thinking about the perspective of lawyers. And then I'll conclude with the perspective of dreamers.

So, first, economists. As the moderator noted, at the dawn of the modern environmental movement in the 1970s, there was an approach

to environmental policy that focused on what we call “command and control” regulation. And it really wasn’t until the 1990 Clean Air Act amendments that we saw our very first major policy experiment with market-based approaches to environmental policy, in this case the SO₂ cap and trade program. And this is something that economists have been writing about for, you know, decades, most of the time just writing to each other. But we finally got the word out to people who actually craft and implement policy about the potential benefits of market-based approaches like cap and trade.

And so when we reflect on the two decades of experience with the SO₂ cap and trade program, first there are some real, I think, important conclusions one can draw about its success. First, the benefits dramatically exceeded the cost. The cost wound up being much less than what we’d anticipated. Allowance prices, for the most part, were much lower than people had anticipated. Opportunities for innovation--technological innovation, process innovation, even business innovation--really helped keep costs low.

Having said that, I think there are also some lessons about how well the program is run. Some of the price volatility in allowances, especially as we started to see the interplay of potential new regulations affecting the market, I think, had an adverse impact on the market and potentially on business decisions around sulfur emissions. Certainly there are lessons, I think, that can be learned from the system of allocation. Certainly this is the case as it’s been played out, as other parts of the world have replicated this experiment, when we look at the European Union and their emission trading scheme for CO₂.

It’s also important to note that the SO₂ cap and trade program is dead. So what we’ve found is that, while we can implement what appears to be a market-based approach to pollution, it can deliver significant gains and significant

reductions in emissions, effect reductions much faster than we had actually anticipated or called for in the law, that when we overlay additional regulations, at the end of the day, the market established by cap and trade may not need to operate. It may not even be binding on participants. These other regulations may have a more significant impact on the decisions that utilities and plant managers make.

And so it raises questions about how we think about the mix of policies, which I think is very important. Because, you know, if you ever walk across the yard and go to a seminar in the econ department, and they talk about cap and trade, there would be almost no discussion about the fact that there might be at least one other regulation on the books trying to tackle this issue, or have an impact on this issue, whether it’s in the power sector or whatever part of the economy you may be trying to regulate.

You know, I talk to economists who do research on how to reduce greenhouse gas emissions globally, and they’ll model one policy. And that’s some common carbon price, whether through cap and trade or a carbon tax. And I then I go to, say, reports from the UN Framework Commission on Climate Change, and they note there are more than 1,000 policies in just the developed world trying to reduce greenhouse gas emissions.

So our models sometimes are a little simpler than what we see in the real world, and I think it’s something important for us as economists, when we think about how to bring our best insights to bear for policy design, to recognize--that while we have successful experience with market-based approaches like cap and trade, we need to better understand the potential interactive effects with other regulations.

I think from this experience with SO₂, we’ve seen sort of a proliferation of trading-like programs. Certainly renewable portfolio standards are a version of cap and trade, and

we've seen those in operation in a majority of states now in the country. We've seen this used to tackle other air pollutants such as NOx. We had this tackling local air pollutants in southern California with Reclaim, which was not the smoothest operating cap and trade program at the end of the 90s and the beginning of the naughts, but then again, that was not the smoothest operating electricity market, either. We've seen this in other parts of the energy economy. So, effectively, in transportation fuels, the requirement for renewable fuels to be blended with conventional petroleum-based fuels is a version of cap and trade.

I think it's important, as we try to address the challenge of climate change, that we're seeing this implemented at the state level, both in California as well as here in the Northeast with the regional greenhouse gas initiative. I think it's interesting, because when I was in the administration, we of course tried to work on legislation to push for a national cap and trade program. I would say that the prospects for that look obviously dim any time in the near future. And that's why we have Speaker 1 giving a very different talk now than he would have given, say, in 2009.

But this then gives me an opportunity to transition to think about the lawyers. The lawyers are going to be very busy. The Clean Air Act and Greenhouse Gas Regulatory Authority under the Clean Air Act, I think, is going to engage lawyers on all sides of the issue. As I'm sure many of you know, the EPA administrator is typically the most sued person in America. And we certainly see this right now. Next week, the Supreme Court is going to make a decision on its evaluation of nine petitions of various greenhouse gas regulatory cases that people want to be heard by the court.

And my colleague over at the law school, Richard Lazarus, who's very much an expert on these issues, suggests that the Supreme Court will probably take up some fraction of those

nine petitions. And so at some point over the course of the next year, they will actually take argument on at least a couple of these petitions. So we'll see climate change potentially returning to the Supreme Court.

Speaker 1 went through in detail describing how to use Clean Air Act regulatory authority to address emissions from power plants, both at new sources and existing sources. I don't want to get into the details. Speaker 1 did a very good job of that. I would just note that the existing source regulatory provisions that he described in the proposal that the NRDC has put forward, which I applaud, because it's trying to say, "Let's be creative, let's try to take the best that we can in terms of market-based approaches, allow for this kind of flexibility that borrows to the extent that we think we can under the Act, implement a form of trading." We haven't done this before. You know, the modern Clean Air Act's been on the books since 1970. We're talking about a provision that has not been implemented. And so there are obviously going to be some legal concerns then about how the EPA interprets this statute. I suspect that once they come out with their rules, as soon as it goes final, they'll be sued by all sides.

And I think that raises some questions. Because more significant regulation in terms of both environmental gain and minimizing cost for that environmental gain probably puts you at greater legal risk. And some of this is going to be an issue, not just when EPA goes forward and they get sued, but as a part of the existing source standards, they will have to work with the states. And some states like California will say, "Thank you, it's about time. We've been implementing AB32 for a while now. This probably should be sufficient to meet your standards."

And then I think there will be other states that are going to be a little less enthusiastic in pulling together their plans for EPA. I'll point fingers at a couple, because they're the ones petitioning the Supreme Court to challenge EPA rules, like

Texas and Virginia. I wouldn't be surprised if there's others who say, "We don't really want to do existing source standards." And then there will be this kind of fight, I think, with EPA, over the course of the end of this administration, on how they resolve that.

As this is going on, of course, one may ask whether or not there is a role for Congress. Congress does have the opportunity to review regulations under the Congressional Review Act--anything that is deemed a major regulation, and certainly one could imagine that the economic consequences of an existing source standard would satisfy that threshold under law. Having said that, it's hard to imagine that Congress could pass resolutions that are veto-proof. But there's still the sort of political headaches associated with this.

I mean, in my experience working in the White House, if there's a bad bill that looks like it has some prospects of, or some legs in Congress, the administration will issue a veto threat. But there's a fair amount of political capital that has been used when one starts getting into those kinds of negotiations, recognizing that there are some members of the President's party who might be a little reluctant to have to cast a vote on a Congressional Review Act. Maybe even more important would be the prospect of appropriate riders, right?

So sometimes Congress can't rewrite statutes to stop regulations, and maybe they can't reject regulations through the Congressional Review Act. But then they say, "Agencies can't spend any money to implement their rules." That's why the light bulb rule that's supposed to get rid of incandescent light bulbs hasn't been implemented. There's been a rider, and it's not really been considered, I think, politically important enough to serve as the basis for a fight that might stop an appropriations bill.

So if we were to live in an alternative world where we'd actually write appropriations bills

again, we might have a discussion about potential appropriations riders. And it depends, in part, on what the next Congress may look like. You know, when I worked in the Clinton administration in the late 90s, every year for I think three or four years, the transportation bill had an appropriations rider preventing the administration from changing fuel economy standards.

And so it's possible one could see that as a potential role for Congress. If we could have thoughtful policy reform, something more comprehensive, economy-wide, and longer-term is probably desirable. We would love to see that in Congress...but maybe that's the appropriate time for me to transition to my discussion of dreamers.

So I want to say a couple things about dreamers. One, and I know some of this was discussed yesterday, technological innovation, I think, is starting to really change this sector. I mean, in some sense, the power sector's sort of moved along a standard model, with these very large-scale power plants, the same way for decades after decades. And we've seen here, I think, in the past decade, a number of potential really big game-changers. I shouldn't say potential. Natural gas is a game-changer. In fact, we probably ought to retire the term "game-changer" with natural gas. It's been overused. But I think about this also in the context of, say, solar, and its potential when we think about how much distributed generation could change the economic model.

And when we think about technological innovation and we think about these potential dreams, what's the role for policy? And in fact, in particular, how much should we be subsidizing these dreams? Should we be out there with tax credits, grants, loan guarantees, etc., for some of these technologies? When I look at natural gas, and especially when I hear talk about how there is a war on coal, and it's being waged by natural gas, and it's being

waged incredibly effectively...If there were a regulation that reduced coal generation by a quarter in five years, Congress would be going absolutely berserk. You know, they would have the head of that regulator, if they had cut power generation from coal by a quarter. Instead, we're seeing this from market forces and natural gas pushing out coal. So, you know, it's one thing when we can say, these various regulations that are either already on the books or on the road are going to have an adverse impact on coal. I'm not going to sit here and say they won't have an adverse impact on the economics of coal. But cheap gas is much more serious in terms of the impacts, I think, on coal than what the regulations will have over the next few years.

The second set of dreamers I'd like to talk about are those in China, because I think they actually have an important impact here. Anyone who's been to China recently knows how bad the air pollution is. You can read about it in the papers as well, you know, the fact that some of the Chinese party leadership are getting photographed when they get in their limos going to their oxygen tank, which doesn't make for good PR.

At some point, and I think some point soon, you're going to see really serious efforts in China to reduce the air pollution. They're experimenting with policies. They're trying to figure out what works. But it's, of course, running up against a very aggressive economic engine that really demands a lot of power, and from that, obviously, a lot of coal. And I think that was evident from some of the charts that Speaker 1 put up.

But when China really makes a serious effort in combating its air pollution, especially its PM and sulfur pollution, first, I think that has an impact on those in the US who have developed expertise with scrubber technology and how to retrofit various kinds of systems with scrubber technology. So there's a potential opportunity there. Second, I think it really raises the question

on Powder River Basin coal. You know, there have been efforts to try to look at ways to try to export through the Pacific some of the coal from Wyoming and Montana, and certainly one can imagine that if there's a serious effort to address sulfur pollution in China, they would really like that low-sulfur coal.

There's also a question here, I think, in terms of what's the impact on warming if China really meaningfully reduces its sulfur emissions. So there's been this discussion, in fact I've been reading about it this past week with the IPCC, about the sort of slowdown in temperature. And what hasn't come up in what I've read in the press is what I have heard in conversations with some others where they say, "Part of what's going on is that China's burning so much coal that has such a high-sulfur content, and that sulfur has a net cooling effect. So even though there's CO₂ that's being burned over the next 50, 100 years or more, and we'll have a net warming effect, the near-term effects of sulfur counteracts that rather significantly."

And so some of the models say that if you think China's going to make a big effort to reduce sulfur pollution in the next decade, you're then going to see potentially a big jump in the near-term in temperatures, because we've been sort of masking the growth we should be expecting because of that sulfur. If that happens, that may start to change how the public thinks about climate change and how we might think about tackling this in the international context. It also raises a question, which is, if China starts to really impose serious environmental regulations, and it raises the cost of electricity, it starts to affect how we think about competitiveness issues between the US and China and our relative environmental regulatory programs.

The third set of dreamers I'm going to talk about are economists, and I'm going to talk about a carbon tax. You know, we've been talking about taxing pollution for a long time, about as long as we've been talking about cap and trade. At least

we finally got the point across on cap and trade a while ago. You know, there are some economists who, over the past couple of years, have been talking more about a carbon tax, because not only would it seriously reduce our emissions, but it could provide some basis for fiscal reform, and maybe serve as a key element of tax and fiscal reform.

So I think, you know, there are still those in my profession who dream about this, who at least will write about this and speak about this. And I think the question is whether or not, if we think we're going to have a serious debate on fiscal and tax issues, whether or not the long-term revenue needs changes the calculus to the point where we'd start to think about whether or not we'd use tax instruments to address pollution.

My colleague Dale Jorgenson over in the econ department has written some on this, on what the potential revenue gains could be if we just taxed pollution from fossil fuels at their current social costs. And the vast majority of those costs are public health costs. Some of the cost is the climate component. But it's a relatively modest share of the overall cost. And I don't think this is quite as far-fetched as some may think, in part because when you look at a state level, when you look at California, or you look at the Regional Greenhouse Gas Initiative, these are cap and trade programs where they're auctioning off the allowances.

Now, for the most part right now, they're using the monies for some kind of energy or environmentally-related uses. But at some point, given state finances, I wouldn't be surprised if they're like, "Hey, we've got a revenue source, we need this to sort of fill the hole in our budget, and let's think about doing that." And so I think that that's something that is going to potentially play out at some point, if we have a serious debate on these kinds of issues in Congress again.

And I will conclude as a dreamer, and just note, you know, at some point we can make a dent on climate, we can make a dent on the environment, through existing regulatory authorities. We've sort of lucked into natural gas. I mean, I know the administration just submitted to the UN FCCC about how we expect to meet our goal of lowering emissions in the range of 17% by 2005 by 2020. You know, that is not a function of just regulatory intervention. That is a lot riding on what's happening with natural gas in the power sector.

But when we look at what we need to do long-term, whether it's the goals the President set out, the goals that we hear scientists and my colleagues over in the yard will talk about, or some of the goals that Speaker 1 and his colleagues talk about. I think we need something that is much more thoughtful, comprehensive, and long-term than what I think are the available tools under current law. And when I think about dreaming, I think that at some point we can have a serious debate again in our Congress on how we do this so that we can adequately tackle these challenges in an environmentally sound and economically sensible way.

Speaker 4.

Thanks very much. I'm very happy to be here. I really enjoyed the session yesterday of the folks who were present at the creation, if you will. And there was very much that was familiar, really, with the way FERC operates today. And one thing that I just wanted to call out was the statement about the importance of staff.

As you all know, FERC is not an environmental regulator. FERCE is at bottom an economic regulator; however, the work that FERC does on energy infrastructure and the energy markets is very much shaped by the environmental decisions that are being made at the federal and state level. And what I thought I'd do is talk a little bit about how some of the environmental

work is shaping FERC's work, and reflect a bit on the tech conference FERC had earlier this week, and some of the intersections between power markets and environmental choices.

As I said, power supply changes in one shape or another are probably driving the majority of the work at FERC right now in some way. Everyone in this room knows what's driving changes in the power supply. First and foremost, the availability and thus affordability of domestic natural gas. Second, the growth of renewables and demand-side resources, spurred by a lot of different policies, but I'd put the 30 states that have renewable portfolio standards and production tax codes high on that list. And, finally, the EPA regulations, most prominently recently the mercury and air toxics, the new source performance, and then the impending existing source rules.

How has FERC been responsive? Most obviously in FERC's work with EPA directly on the mercury standards to identify new local reliability issues and be a convener. But in a broader way, that's shaping a lot of our electric transmission work. It's the need to get your location-constrained resources that's really driving some of Order 1000, new transmission cost allocation schemes, certainly powering FERC's gas rate work. The gas is coming from different places and being used in different ways, so a lot of the gas rates are in for a tune-up. And FERC is looking, as was talked about yesterday, at the interdependence between the gas markets and the electric markets, at simple things like communications, at medium-hard things like scheduling changes, and really hard things like how you change the electric markets to make them work better.

And FERC has made a lot of specific changes in the electric market rules as new resources come online: Order 745 on paying demand response in the energy markets, Order 755 on paying storage in the ancillary services markets, Order 764 on

variable energy resources and how you time them into the energy markets.

FERC has been doing an awful lot of specific targeted work on changes in the markets, like the tech conference that FERC held on Tuesday on what's new for the capacity markets, and what does all this change in power supply really mean for them? I think it was summed up in this morning's *Burrito*. I'm sure some of you read Gary Ackerman's *Burrito*, which said that we had to set up the capacity markets because of problems in letting the energy markets get too high. Now the capacity markets are a political lightning rod. So where is the missing money going to go next? Where can it hide?

Tuesday's conference exceeded my expectation in terms of the value of the conversation. We started with the ISOs and RTOs. This was focused just on the three eastern RTOs, New England, New York, PJM. Not surprisingly, they each basically said they thought their markets were working well. But then as you kept them talking (I think this was one of the Hogan rules) details count, market details count.

Several different things, by no means limited to the capacity markets, that would make them work better, kept coming back again and again. Sharper scarcity pricing, changes in ancillary services markets for the ducks and the elephants and the geese that are coming, because more and more, we'll be paying plants to stand around and be ready when we need them. Demand curves, commitment periods, length of forward commitment periods, just coming back and back around the details that are really driving these markets to work or not.

One of my big questions that I kept asking everyone is what investors need to put money into these markets. And I got two somewhat inconsistent answers. "Stability," constantly, "Stability, stability, predictability," but, "Fix everything that's broken." We'll work on that, and try to, I guess, show a basic confidence in

the markets while continuing to refine them every time FERC orders are voted out.

And then I thought that the hardest thing at the conference, which was really the driver, was how you reconcile state environmental rules, particularly the targeted renewable portfolio standards, with capacity markets. Because clearly they're in fundamental ideological conflict. There's the model of a region getting together with everyone on board, the states and the utilities, and getting together and saying, "We're going to run models that are going to tell us economically what plan to run next, or what plan to pay to be there in the future, and we're going to do that economically by some kind of regional single market clearing price system." And then there's the model of a myriad of states saying, "We are going to preference, you need 5% of this and 5% of that, it becomes 7% next year, then 20% and then this and that." Those don't naturally dovetail.

A lot of people talked a lot about the problem. I think the two conclusions that we drew so far are, different market designs work a little better or a little worse for this. Demand curves in larger markets with a little more wiggle room can accommodate some renewable portfolio standards without completely clearing the markets. Vertical demand curves are less forgiving of specific things.

The big idea that was being tossed about, which first came from the Regulatory Assistance Project, and then Sue Tierney and others were talking about it, was some kind of redesign of the markets with tranche-ing, where maybe you go in and you buy a tranche of base load, and then you buy another tranche of flexible ramping load, and then you also pay for a tranche of renewable, and how you do that. And we talked a lot about what level of complexity these markets could absorb and still call themselves markets, and came to no conclusions. But that certainly was an interesting theme throughout the day.

And I also was both pleased and displeased that people wanted FERC to do something about it. Pleased because they weren't saying, "Just go away." But displeased that there didn't seem to be any emerging consensus on what that something might be that FERC should do next. There was some advice for FERC about what not to do, "Please do not do a full, all-comprehensive, Notice of Proposed Rule-making on redesigning all the markets for standard market design." And, OK, FERC wasn't planning to do that. But the question is, what, short of that, what should be done?

But now, reflecting with the space of a couple days, the sort of themes that started to get teased out on Tuesday of how environmental rules and the markets work together, I think, are going to become a much louder motif as we go through the next few years. I believe the defining challenge of our generation is climate change. I strongly believe that. Something is going to happen. These states have renewable portfolio standards for a reason, and the production tax credits are there for a reason, and everything that's being done by EPA, these are being done because of legitimate environmental drivers.

On the other hand, our power markets are--I think they're past the terrible twos, they're in the difficult teenage years. And they cannot necessarily absorb all of the changes that are happening comfortably. Some kinds of environmental regulation, I think, work very well for power markets. Command and control, broad-based carbon pricing that the dreamers dream of, cap and trade, that's either geographically out of synch with the space of your market, or larger than your market. Targeted subsidies, very specific required purchases really don't work well with markets.

I heard Speaker 1 talk about environmental dispatch specific to states. It makes perfect sense when you have your carbon hat on. If you picture yourself in the PJM control room trying

to do environmental dispatch by states, it's a real change to the model that we've thought about. So, obviously, you know I'm going to say I don't have any answers. But I think these issues of how the environmental change works through the market change are going to give the Harvard Electricity Policy Group plenty to work on in the next few years. Thank you very much.

Speaker 1: I'd just make a clarifying comment, which is under NRDC's proposal, dispatch would not be limited to state boundaries. States could join up and have their regime coincident with the various electricity markets.

Speaker 4: I think that's actually very helpful.

Speaker 5.

Thank you very much. I didn't have the benefit of being at the earlier conferences, but if Speaker 4 had asked me that question, I would have said, "Stability, stability, stability, and then change, fix what's broken." Because there's an awful lot of that around.

Just to give a little background, I'm the chief risk officer of a business that invests in the energy space. We've done about \$28 billion of investments the last ten years since I've been the chief risk officer. We have about \$18 billion remaining on our books. That's just because of runoff. We sell some assets, and there's churn in the portfolio all the time.

We've invested fairly evenly across the power space, about a third in renewables, about a third in oil and gas, and about a third in thermal. One of the issues we face as a large conglomerate is, we get lauded on one hand for investing in the renewable space, we get heavily criticized on the other hand for taking advantage of tax policies that drive us to a low tax rate. So you know, it's a complex world, and we face a lot of those issues.

Our investments are largely North America, largely US. We say we're a large international investor, and we are, but 90% of our investments are in the US. And we invest across a capital spectrum, whether we're debt equity or some quasi-debt equity instrument. And that's important because we have to think about all of the issues.

It seems like the old days were easy. My first power investment I made was about 25 years ago. It was in a renewable asset in Upstate New York, a small hydro plant. It was a pretty easy, it was a PPA in place, long-term PPA, we locked in the fuel price, you knew effectively sort of what your water flows were, up and down a little bit depending on some weather. And it seemed easy. Of course, looking back it always seems easier than it was at the time.

There was a lot more equity underneath us, the coverages were higher, and the length of the financing was far less than the PPA and far less than the life of the assets. So it was a simpler time. As the world has gotten a little bit more complicated and we've moved to more market-driven type of environment, you know, we've had to consider a lot more things when we make investments. We have to consider regulatory change, we have to consider, you know, environmental change as a subset of regulatory change.

We have to clearly consider, the fuel cost change. And I think, as Speaker 3 said, the word for the natural gas, you know, that's been a "game changer," is overused. It's basically turned the energy space upside down, at least from an investing perspective. I can recall working on a project in 2006 that was supporting an LNG import facility into the United States. And all the charts, all the analysis said, "We're going to run out of natural gas. We have to build these facilities. It's critical."

And big companies signed term of use agreements to buy imported gas. Those facilities

today sit largely unused, and are now, many of them, applying for permits to export gas. So the world changed dramatically overnight, although overnight's a short expression. I think, you know, George Mitchell, the father of horizontal fracking, spent 17 years trying to figure out how to do it, and he pulled it together over 17 years. So maybe it wasn't overnight. But in terms of the investment community in the industry, people really didn't see it coming. And that has changed quite a bit.

I think the other side we have to look at is, when we invest in something that is subsidized through some sort of support mechanism, because it's viewed as favorable social policy, is the question of whether that social policy will remain relevant over the life of the investment. And will those who pay that cost today be continuing to be willing to pay that cost in the future?

And we see elements of that across the world today, where people are starting to resist that. And of course we've seen it in spades in Spain, where they had a policy in place that supported green investing, and that policy has been changed dramatically, such that a lot of people who have made green investments have lost their money, or will lose their money. Now, it wasn't solely the green initiatives that was the problem in Spain, it was a lot of other problems that obviously contributed to that, but when you see that type of dramatic change in policy, you have to take a much more jaundiced eye when you're looking at investments, and say, "Will the consumer continue to support this investment? Will the policy-makers continue to support that?" So, obviously, we like to see the transparency, we like to see the consumers know up-front that these costs are in their bills, and you want to see them, you know, endorsing that through their willingness to pay. That consumer sentiment can change over time, and that's always a concern in subsidized investments.

So with that said, you know, each technology has flaws, has Achilles heels. You know, obviously coal,--SO_x, NO_x, CO₂--if you invest in coal, can you recoup all the additional changes you have to make to the plants going forward? It's a big question you have to ask every day. The same with gas. If you invest in a base load plant today, will it be a favored plant in the future, given the changes in the market?

If a lot of renewables come into that space, a base load gas plant really isn't all that attractive, necessarily. Well, a peaking plant, or a plant with quick-start ramping capability might be more favored. And if you're investing over a 10, 15, or 20 year horizon, those are hard questions you have to get your arms around. And you have to understand the flexibilities, or pretend you understand, because things change so much.

And obviously the big question on renewables today is, how much more? How much longer will the policy support renewables? And then, how do we pay for the additional cost to renewables, whether it's, you know, quick-start capacity or transmission, or other things like that? You know, we made a large investment in a power plant in California that sits amongst what looks like a museum to wind farms outside of Palm Springs. We see all kinds of wind farms that, you know, date as far back as wind farms go up to the latest current technology. And its attractiveness to the utility that ended up purchasing the power from that was its ability to ramp up quickly, to go from basically zero to full load in less than 10 minutes, about 800 megawatts.

But that was needed to basically balance load, because if the wind stops blowing, somebody's got to come in real quickly. They are expensive plants. It's a billion dollar plant. The ratepayers are picking that up, and that's a cost of wind that often isn't talked about. But it's real. It's there. I think everyone in this room knows it and acknowledges it.

And so when I sit there and think about investment decisions every day, I have to weight each of these, the technology changes, the policy changes, and the consumer sentiment changes. Something I think we really didn't think about as much 20 years ago. And, you know, maybe that's a good thing.

So my answer to that today is, effectively, to diversify. You go into different pockets. If you place all your bets in one pool, you know, you run a higher risk. You find other ways to earn some fees off of what you do. We look much more at the revenue stream, not the capacity factor, because you know, you can get paid capacity in some markets and some other markets you can't.

And we, frankly, have moved up higher in the capital structure, just to be safer. The uncertainty levels are higher, and we keep moving in that direction. And we try to advance less, and advance at a higher cost, because the uncertainty means we have a higher IRR we need to achieve. Not every deal will get done, not every deal we see gets done, and you know, we make our assessments effectively based on what we see today. Our crystal balls aren't that great.

You know, I think we tend to suffer, I think largely the whole investment community tends to suffer from overreacting over what we think's going to happen in the next two years, and under-reacting over what's going to happen in the next 10 years. And we try to be conscious of that, but you know, we also suffer from a lot of changing people and everything. And I think what we in the investment community compete with (and we try not to compete with) is that there's probably seven-year memories in ten-year cycles. So a lot of the same mistakes get made over and over again.

And it's hard, when you're in an environment where you want to be a growing investor, but you don't want to compete with people that you think are going to make the mistakes of the past

one more time. Not that it doesn't mean we won't make new mistakes going forward, because we certainly seem to find ways to do that every day.

Moderator: Let me just mention a few points this panel has touched on. One is, there's been a lot of talk about policies that were well-intentioned, but have had unanticipated consequences. We decided that we wanted to subsidize renewables, and we did it, in many areas, through renewable portfolio standards. But these have not jibed perfectly with existing markets, as was pointed out by Speaker 2. It may be beginning to put negative pressure on one of our low-carbon options. And maybe RPS standards, which seem to be getting stricter and stricter, are not the long-term way of pushing renewables.

Which leads to a second question, which is, should we be pushing renewables, or do we want to leave these decisions to the market as we build better and better markets? We have a carbon rule that is on the horizon, there's some question about whether the technology exists to do CCS. There are questions about cost. And there is a question about whether it will stimulate a stampede of lawyers to try to hold it up and to stretch out its time, which as Speaker 1 pointed out is already three to four years before the existing regulation takes hold. And what I hear from everybody is the need to be flexible, but yet flexibility runs into, how do we get 50 states all to agree on the same flexible option? Does that matter if we don't get all 50 states to agree? How do we get lawyers and different interest groups to be willing to trust flexibility? So we go back to the question I started with, which is, "What is the process and what are the best alternatives if we're going to achieve our goals going forward?" So think about those, and we'll be back in 15 minutes.

General Discussion.

Question 1: Speaker 3 and I have talked about these issues a lot, as you can imagine around here. And I thought he was referring to me when he was, this category of dreamers, and I took it in the friendly spirit which was offered. And I am a dreamer, and I am dreaming about dealing with the environmental problems, but especially the carbon problems.

And let me tell you about my nightmare, OK? And my nightmare is that we're Spain, and that we're seeing the nightmare playing out in Spain. And the nightmare problem is, this is a huge challenge. The numbers--you look at that picture that Speaker 1 showed about the archived solar (coal) power, and you just say, "Your plan is we're going to leave that there? And the Chinese are going to leave that there and they're not going to use that?" And Gina McCarthy says that CCS is a reasonable cost.

Well, it may be reasonable to her, but I don't think it's reasonable to anybody else who is going to have any choice. So I don't think we have the technologies out there to meet the challenge and to sustain, over the decades that it has to be sustained, the political consensus in order to do these kinds of things. And worse, what I worry about, and my view of what happened in Spain is an example of this, is that we're promising something we can't deliver, that we can in fact meet these challenges with technologies that are cheap and reasonable and are not going to be problematic going forward. And I don't think it's true.

I mean, my formulation of the problem of dealing with carbon is that it's going to be expensive, and it's worth it. And until we transform all of our policies and think about all of the things we have to do by way of innovation, we're not going to be able to really address this problem. And most of the things we're doing now carry the seeds of their own destruction, because of the reaction that you're

getting in Spain, which is, "You didn't deliver on what you promised here, and this is really expensive," and now, you know, it was true there were other pressures, it wasn't just the cost, but it was other pressures that drove it, but that's the problem, you know, that there are going to be other pressures like that.

So I really, I see this as kind of a race of bad policies, trying to avoid the worst ones, and to really focus on the long-term problem, which is one of convincing everybody that it's worth it, and secondly, dramatic innovation, beyond the scope of what anybody's talking about. My favorite summary of this is the Google mantra of, "Renewable energy less than the cost of coal." And if we could achieve that, well, that would be a different world. And I'd like us to see that.

But I'm worried about this. My nightmare is that we're kidding ourselves, we're adopting policies which are going to be counterproductive in the long run, even though they look attractive in the short run, because we're destroying the credibility of the policy by promising something we can't deliver. Is my nightmare misplaced? And are there things that we could do in the short-run to help avoid it?

Comment: Besides therapy?

Speaker 1: I think with respect to the EPA carbon standard, your nightmare is misplaced. I'd say a couple of things. First, you know, our dream is not based on a vision of all of that coal being left in the ground. That's where CCS comes in. It allows climate policy to be decoupled from resource use. The market will determine how much of that coal gets left in the ground under that approach. The cost of CCS--is it unreasonably high? Well, it's going to be seen as unreasonably high to the owners of the existing coal-fired power plants.

But what about, you know, the function of electricity in the economy? You know, our view

is, if the DOE's numbers are anywhere near right, you could gradually build a fleet of coal, probably not as large as the one we have today, equipped with CCS, retrofit some CCS, and not have a negative impact on the economy. You know, we can increase the cost of electricity significantly, and still be within the range of fluctuations in electricity prices on a decadal basis.

So, you know, we don't think this is a big challenge, economically. And as far as the specific mandates for things like renewable portfolio standards, yeah, I think there's a bigger risk for political backlash with some of those than there is with a standard that gradually imposes a cost of doing business if you emit carbon and shifts resources toward the lower-emitting resources. And that's certainly a lot closer to an efficient carbon tax than are the resource-specific policies that seem to be easier to enact politically. So I would argue that an emission limit that is coupled with a flexible compliance regime is an important step away from your nightmare.

Questioner: Can I respond to that? Because, I mean, I just think that that's fundamentally wrong. And I think it's really important, because the answer was, "We can do this without ruining the economy." And if that was the standard, then I would say, "Terrific, I agree with that." I mean, could we survive with doubling the cost of energy in the economy? Sure. That's not the end of the world, and we could live with that, and I could live with that, and I wouldn't be unhappy with that.

I once attended a conference in Newark with a very talented regulator who was talking about smart meters, and installing smart meters in New Jersey. And this unnamed regulator said, "Look, a dollar a month is a lot of money. A dollar a month is a lot of money, politically." We heard it earlier this week at the law school, in a discussion of what happened with Waxman-Markey. Well, if we had adopted this standard,

rates would have gone up 20% in Indiana, and that was completely politically untenable. OK?

So it's true that we can adopt these technologies without ruining the economy, but we can't adopt them without getting people to take on things that they don't want to take on. And that's the problem--how do we get them so that they want to take on these higher costs in order to achieve these objectives? And I don't think the fact that it doesn't ruin the economy is a sufficient answer. It might be for Gina McCarthy, it might be for me, and it might be for you, but I don't think it is for the world at large, and when you look at those numbers, you see we've got to get everybody doing this for a long time. And how are we going to do that?

Speaker 2: On public opinion, we've done some polling on this, both on the issue of what is clean (which of course is raised by my presentation--you ask people what they think clean energy is, only 4% of them say nuclear), but as to sort of what's possible, to the extent we've been hand-wringing since 2009 that nothing's going to happen, something's going to happen at EPA. In 2011 Gina had a bunch of listening sessions with industry. She opened them by saying, "We are not doing cap and trade." She just took it off the table from the start.

Last week, EPA sent out a bunch of questions to industry and stakeholders to answer on how they should designed 111D. They actually asked them, should they have a mass-based approach? So I mean, the conversation is shifting a little bit in Washington towards the kinds of things that you might like to see and I might like to see. You know, what the political environment will be when they actually implement these is a different matter. But there is a little bit of reason to have some hope. That's not going to answer your RPS question, but there is hope that there may be something logical coming out of Washington, as strange as that seems.

Speaker 4: Well, a lot of what you said really resonated with me, because I think we've talked about the economists and the lawyers, but then there's also the politics. And I think the problem is, because of the political compromises that have to be made to get these things done, we have a tendency to overpromise. I mean, everyone knows there are tradeoffs between reliability, cost, and environmental improvement. That's just embedded in choices. But there's a tendency to say, "Not only will this be cleaner, it will be cheaper and it will bring more jobs and save the economy in the short run," because that's how you get things done.

So what I think, to wake up from your nightmare, the best thing to happen would be a broad societal consensus on the problem, such that we could then move to what we want to spend to solve the problem, which may be low, may be high, but I don't think we have that now. And so there's a tendency to overpromise in other ways. That's why the renewable portfolio standards got so complicated, because they want to lard them in with other little goodies to make them palatable. And until we get a consensus on the problem, the way, you know, in Los Angeles when you could see the dirty air, people were willing to spend money to get rid of the dirty air, until people believe this is real in a societal way, on a more consensus basis, then I think they'll be willing to spend the money.

Moderator: But let me turn to Speaker 3. We've been aggressively pushing renewables, but it's not altogether clear always that aggressively pushing renewables is the cheapest way to reduce carbon. And that's why economists always come back to carbon taxes and cap and trade. So, but help our questioner sleep.

Speaker 3: I was going to actually suggest that the questioner might have problems sleeping. And that's because I look at the current political environment, and it's not obvious to me that if something along the lines of what you described started to unfold, we actually have the means to

have a thoughtful reform. You know, we're using a 43-year-old law that was never intended for regulating pollutants like greenhouse gases, because we couldn't get a reasonable compromise in Congress.

And the thing is, it's somewhat frustrating, because if you thought, we are going to do this sort of industry-by-industry and by new source and existing source--I mean, it's a long dance to do this to tackle greenhouse gases under the Clean Air Act. There are a lot of people on the left who would like to see something, you know, much more comprehensive and longer-term. We couldn't get that.

There are certainly those on the right that would like, I think, a policy that gives them better certainty and could probably be, I think, more efficient than what we can do under existing law. But we can't find that sort of ground for compromise. And I think that's the concern, which is that right now I think those who want climate regulation think, "Well, we've got the Clean Air Act, we're going to do everything possible to defend it."

And the other side, instead of saying, "Wait, here's a thoughtful way to reform it," say, "We're going to do everything possible to keep you from using the Clean Air Act. We're going to use the courts, we're going to use Congress, we're going to use appropriations." And there's not a meaningful discussion on, "Well, wait, what should this policy look like? What would be a better way forward right now?" There's just, I don't think a lot of appetite for that, at least at the national level.

So the question is whether or not, in some of the states that are going forward, we might be able to push on that. But I think at the end of the day, if we're going to really address your concerns, it means a thoughtful, comprehensive federal policy, in part because you need the long term signals to drive innovation in the private sector, and I think you need some kind of meaningful

revenue in the public sector to complement that on the R&D.

Otherwise, we're not going to have that kind of suite of technologies that we're going to need to get down to the really low levels, or even zero level, of emissions that people call for by mid-century and beyond. So I have concerns when I look at the current political environment about whether or not, if things don't work exactly the way we'd like in terms of being a thoughtful way forward on this issue, we can try to come up with some kind of thoughtful course correction.

Speaker 1: Just very quickly, neither of the EPA rules is going to have the effect of driving up electricity rates the way some of the claims about Waxman-Markey said that legislation would. First, the new source rule. The basic effect of the new source rule is not going to be driven by what the cost of CCS is. The most likely scenario is, the industry is going to chug ahead and build new gas plants, and new coal plants are going to be few and far between. And if there are one or two that actually manage to get financed and put CCS on, they'll go into the rate base, and they're not going to have a huge impact. And if they do have a huge impact, they're not going to get approved. And the electric system will work just fine.

With respect to the existing source rule, if EPA follows the structure that NDRC has recommended, you know, the analysis based on the ICF model, and we try to do it conservatively, is that it's not going to have an upward impact on prices. In fact, it's going to have a somewhat depressing impact on wholesale prices, which gives my friend Speaker 2 some problems, because it makes it less easy to run those nukes. So we just don't see the scenario flowing from these EPA rules that it's going to produce a price impact that's going to cause a political backlash.

Speaker 5: I just wanted to add one thing quickly. I share your nightmare, but I think there

are sort of three fundamental problems right now. One is, natural gas is very inexpensive, and it's really going to delay any kind of change, because people really aren't willing to pay higher utility bills.

The second thing is, you know, the question about whether new coal plants will be built. It's unlikely, because of natural gas. But it's also unlikely because as a financier, if you're looking at carbon sequestration, the question is, what are the rules about carbon sequestration? What happens if the carbon leaks back out of the ground? There are no rules today. You know, you can just see the quagmire that could turn into. So they're not financeable, at least from my perspective.

And the last thing is, how do you accelerate, or bring forward, the concern over global warming, or whatever, climate change? If people can't see it, taste it today, it's very, very difficult to get their arms around. We've been talking, as a country, about social security, and, you know, how it's going to go bankrupt at some point in the future. I don't think the average person today really cares much about that, because they have other fundamental issues in front of them.

You know, in a poor economy (and I guess our economy's growing, but not growing that strongly) all of those things get pushed to the back burner. And I think you asked the key question. It's worth it. How do you accelerate it up front today so that it really seems worth it to the average person so the political will is there to do something? I don't know the answer to it, but that is the key question.

Question 2: Thinking about, you know, a number of mentions of how cheap gas is, and the notion of pushing renewables by subsidizing, it seems to me that there's an elephant in the room that we're kind of ignoring that's pushed by economists, which is a group I include myself in, and that's the notion of externality, and the

fact that when we look at the relative costs of things, we don't really include all the costs.

And so we can say we're subsidizing renewable energy and gas is cheap only because we don't include the true cost of producing gas. And I'm not talking just about carbon emissions. It's the whole extraction, transportation, and consumption chain, starting with the damage to water supplies from fracking, to taking the mountaintops off of West Virginia and dumping them into streams so that you can extract the coal. In nuclear, there are costs that are not included. We haven't figured out what to do with the waste.

So if we really want to look for market-based solutions, why don't we get rid of this term "externality?" Let's call them "subsidized production costs," or "subsidized consumption costs," get all the costs into the equation, and have a real discussion about relative costs. In which case, gas won't be so cheap. Electricity prices will go up, but then with the relative costs of different approaches, we can have an honest debate about that.

Speaker 3: Sounds like you're one of the dreamers.

Questioner: Guilty as charged.

Speaker 3: When I made the reference to my colleague, Dale Jorgenson, this is what he's proposed, and what he testified about before the Senate Finance Committee last year. And I think it would be a fantastic way to move forward, both from an environmental standpoint and a fiscal standpoint. Politically, I think it's a very, very, very steep mountain to climb. But you know, there was a National Research Council report. Bill's not a big fan of it, because it didn't answer all the questions he wanted answered, but it's a report on "The Hidden Cost of Energy." And it goes through some of this.

And it's kind of shocking when you look at, like, well, what would be the full cost of our fossil fuel use, especially? I think it's politically inconvenient, because it really does say, there are parts of this country that had, effectively, subsidized energy for a very long time, and they're going to see significant increases in their prices if you were to fully incorporate some of the costs which they don't bear. You know, some of this stuff goes up the stack and it ends up blowing east of where they live, and so you really start to bring in, I think, a lot of the distributional issues that make this politically tough.

Speaker 1: There's also an IMF report from a few months ago on energy subsidies, it basically points out, the largest energy subsidy in the world is the failure of governments to require energy to bear its full costs.

Speaker 2: Well, you might have an unintended consequence of that, which is commissioners quitting the FERC. Because, I mean, every single bid would be its own rate case. How do you figure out what all those costs are and price them in? I don't think you could get anyone to serve on the FERC at that point.

Speaker 4: Some might think that's a positive externality. [LAUGHTER]

Question 3: I thought it might be useful just to sort of give a perspective from some of the things we've been doing in the UK. And clearly, you know, we have at least a political consensus. The politicians are agreed, at least, that we should be tackling climate change. I mean, interestingly, talking to people this week, I don't know whether the public perception is wildly different from here. So I'd describe it as sort of soft support. So there's room to do something, but that action has limits.

Having said that, we've kind of gone from a situation where we used to be called a few years ago a leader in the world in terms of setting

itself targets. And now we're moving from that to trying to deliver against these targets, and it is tough.

But I do agree with the earlier questioner that the scale of change you are describing is big across the economy. It's particularly big in power for two reasons. One is, you're turning over a huge amount of infrastructure in a relatively short space of time. But also, when you look at the technological possibilities for the other sectors, for heating your house, for driving around the country, electricity is not necessarily, you know, it's not the only one that might serve this, but it certainly potentially will. And therefore you may need to see not only turning over your existing infrastructure, but additional infrastructure as well.

It's worth just dwelling a bit on the politics, because I don't think you can do the supply-side changes you need without also having a robust demand-side strategy. And that does mean making products and appliances more efficient. That does mean making heating more efficient, and indeed insulating homes sort of more robust than it is today. And, you know, one of the successes I've seen over the last five years is a 25% drop in demand for heating for homes. And that's driven in part by some very unglamorous things like filling cavity walls and putting loft insulation in. But it's also driven by a very basic standard on the heaters.

So the heaters have simply become a lot more efficient. And so you can find some downward pressure on bills, even though there is some upward pressure on pricing. But in terms of power, the scale is huge. I think our perspective, and my personal perspective, is that at this stage, you should be generating options. So I agree, actually, that we should be looking hard at new nuclear.

I also agree that we should be looking hard at CCS, because when you look globally, I cannot see any global strategy to tackle climate change

that doesn't involve CCS, given the amount of existing coal and the amount of coal that's bound to be built, no matter what. Equally, I see a place for renewables, simply because when we look at this problem, you need every single option you can get. And that means getting some things down the cost curve.

In terms of policy, we tried a carbon price. Anyone who knows the history of the European carbon market at the moment knows that's not likely to drive investor behavior. It's not only because carbon permits are so low today, it's simply, coming back to Speaker 5's point, that investors don't have the sight of what governments are going to do in ten years' time, and therefore find it incredibly hard to invest against any carbon tax and any carbon price, because, frankly, a chancellor or a government can overturn those very, very easily. So I believe there is a role for technology-specific support. I agree it's clunky. It's definitely a second-best mechanism, but there is a role for something that will help grow specific technologies.

My last point, though, goes back to one of Bill's principles from last night, which was, "You can't ignore the physics." So when physics meets economics, physics will always win. Well, there is a law of physics here, and you know, the IPCC have come out today with a report that reaffirms by and large what they've said before, with a few minor changes in boundaries. And we all need to bear in mind, therefore, the pace at which we address this issue is something that is important. And that may mean using more expensive technologies than those that if we had the luxury of waiting 10 or 15 years we could use.

My last point is, I cannot conceive this scale of change not having an impact on the way you structure your market. So coming back to some of those conversations we had in this room yesterday, I cannot see how you would make the sorts of changes we're describing, integrate a massive externality into your market, without

this having serious consequences for market design.

And I don't really defend the UK or the European approach. I think we're kind of the first people ever to build a house. You know, we're doing it with wood, mud, and straw, and I'm sure there are better ways. Someone's going to invent brick, someone's going to invent tiles. And what I'd encourage this group to do over the next few years is actually to use all of your amazing regulatory brains to try and crack what I think is going to be the next big problem for the energy sector and for the transport sector.

Question 4: I want to say bravo to that last statement. And I want to stress what Governor Patrick always says about natural gas, which is, "Let's remember that it's not clean." It's not clean for a couple of reasons. But it gives us a little bit of cover for a little while, perhaps, to work on other strategies like renewables and energy efficiency.

We're used to calling natural gas clean because it has about 50% of the CO₂ implications of coal from combustion alone. But that's not including the methane emissions associated with its extraction. And we don't even have any handle on the methane emissions associated with the distribution system. And we in Massachusetts have just awarded a contract to try to get a handle on that issue.

Two other quick things. To the earlier questioner, hopefully you woke up from your nightmare and read the *Boston Globe* (not always the best solution for dealing with nightmares), and you may have seen that the long-term contract proposals that are now before the DPU for wind from northern New England actually costs less than coal. So, to the extent you said that was your dream, I think there are at least some signs of that dream being reality.

And one last thought. I think in some ways, the terrible storms we've had in the Northeast over

the last couple of years give us an opportunity to talk to the public about the need to spend more on the electric system. Now, that's not directly related to dealing with CO₂, but I think it's an opening. So that's the silver lining on the storm issue.

Moderator: Can I just add, I've heard a number of people say that the environmental regulations, which may be very much driven by real problems that we've got to address, are going to create a need to really rethink some of the market design for electricity. What are the problems between environmental regulation and market design going forward? And what are the ones we most need to pay attention to?

Speaker 4: Well, certainly one is the one I articulated earlier, which is that if you have specific requirements to purchase certain amounts of certain resources in an integrated resource management type regime, and you're also choosing markets to choose resources, those don't necessarily translate together. If you then take the resources out of the markets, then the markets become smaller and might not give the right price signals, and you could get into a vicious circle. So we need to think through how targeted resource requirements affect market choices for reliability.

Another one: we saw in the talks yesterday that the structures of the control areas, the dispatch, the electricity in the United States are these funny shapes of lines that are not necessarily even coincident with states and have in some cases multiple states. And so, should we develop environmental dispatch or other things of the type that Speaker 1 was talking about, that has significant implications for the way security constrained dispatch works.

That doesn't mean it can't work, it's just a real change of thinking from how it's been done for the last couple decades. And those are two that occur to me off the bat. But markets are supposed to use the invisible hand of people all

protecting their own interests to get a result. And if you then require certain results and don't rely on the invisible hand, you're not really using a market. That might not be bad, it just means it requires some real thought. I think we can't just blunder through and pretend the markets are working while we're not letting them work. Down the road, that might have consequences.

Moderator: So, translated, the more we go with command and control regulation, as opposed to market incentives market mechanisms to achieve the environmental goals, the more it's going to create this tension with the markets.

Speaker 4: I'm not an expert, but I think true command and control, something like, "You can only emit X amount of sulfur dioxide, or X amount of mercury," I don't think messes up the market, because although there are still containment areas and all, that's just kind of priced in. But specific rules such as, "You have to buy this, you have to buy that, you have to buy so much of this and so much of that," does kind of run against the market.

Question 5: The moderator raised the question about whether we should be pushing renewable energies or not. Should they be subsidized?

Moderator: Just whether we should be pushing renewables if it is not the least-cost carbon option.

Questioner: And, following what was said earlier, if you factor in everything, you need to do what New Jersey did, and other states are doing, states being the places where you can get things done, because Congress is not going to act, very clearly. We've been doing pilots around the country in different states. I was involved in negotiating RGGI.

That was done with the pure intent, for me, to show that a cap and trade could work, so Washington could get their act together. It was a Republican Pataki-Romney plan, which is why

we did it. But the states showed and are showing that it works. When New Jersey did solar, and took it from six solar facilities up to, God knows, over a gigawatt, that was a pilot, and we started with subsidies. But New Jersey didn't do what Spain did, or other countries, or other states (like California) did, and throw money at solar. We started with subsidies of 70%, ratcheted down to a couple years ago. So, solar, renewable energy credits, which is a market based policy, and it works, unless the legislature gets involved.

So I think that states make a lot of sense, and Congress is not going to act on this front. And I'm very depressed about that, but that's just a political reality. So states are doing what they can do. What California did with their cap and trade, which is much more expansive than RGGI, makes sense. And the subsidies start, but then the price of solar obviously has come down. It creates a lot of jobs. An issue with renewables, wind and solar especially, is that obviously you need storage.

I've been, not depressed, but annoyed (but it's political, I understand it) by how a lot of stimulus money went to, for instance, smart meters. I think almost a billion dollars worth, which I thought was ludicrous, when it should have gone to energy storage, which is really the silver bullet to help make this all work. There are technologies of storage, and the technologies are really where we need to go. But we don't have much federal money for research, even though DOE and the labs are doing their best. There are energy storage projects now--there's one in New Jersey, and they're doing a pilot at a large residential building, which can have a six-hour storage battery for that building.

That's the type of common-sense approach that is very reasonable to do and that we need to do more of. I agree with everything our friend from the UK said. Clearly, we have to try to deal with the coal issue, and carbon capture and storage makes some sense. I'm a little nervous about it,

but it makes sense to try that. But with the cost of that being, it was said, comparable to a new nuke, it's not going to happen in a restructured state. It can only happen in traditional states, because it's too costly.

So what it comes down to is that I think the states are absolutely necessary. I'm still living my nightmare. And unfortunately, I think probably until I die I'll be living my nightmare. But groups like this get the information out, and hopefully someday the Republicans who used to be leaders in this issue, like Senator McCain, will start leading again. So actually Washington can do something. Gina McCarthy is a practical person. I dealt with her when we negotiated RGGI. She is doing the best she can within the legal bounds of what she can do. But with all honesty, the people in this room are thought-leaders. You've got to start pushing out there, outside of this room. That wasn't a question.

Question 6. I probably should have asked this as a clarifying question. It's for Speaker 1. With respect to CCS, do either you or EPA have factored into their cost the impact on the parasitic load of the factory? Because we've got a plant that's under development in west Texas, and will avail itself of enhanced oil recovery as a market. Yet the actual net to the grid is about half. And so if you retrofit plants, if it's even possible, you'll also be reducing dramatically the output of those plants, which may affect the economics, if they're only selling half their power on the grid, or whatever the net is, and depending on the price of that carbon for oil recovery.

Speaker 1: The levelized cost of electricity calculations that EPA is using does include the energy penalty. The energy penalty for retrofit to existing plants isn't relevant to the proposal that was released a week ago. That's a proposal for new plants only. But that number does include the energy penalty. On the question of the energy penalty for existing plants, this is something that is very much a moving target.

For AEP's pilot at its mountaineer project, I believe they said they got the energy penalty from that down to about 15%, and they were hoping to get it down further when they scaled up. Of course, they didn't scale up, because in the absence of a carbon policy, they couldn't get regulatory approval to make the investment.

Question 7: I kind of both have dreams and nightmares. Let me start with the dream. The dream I have is very simple. We do something like cap and trade. We let markets work. I share that dream, Speaker 3. And that would be easy, from an RTO perspective. It wouldn't take much to implement, because we've already seen the sulfur dioxide trading program, the NOx budget program--prices on allowances go into the costs for generating that, it gets factored into dispatch, so you do security-constrained economic dispatch. That accounts for the environmental costs. It's all good, it's done, it's easy, it's simple.

To give you an example of what that's done, even without a CO2 price, since 2005 in PJM, we've actually seen CO2 emissions (and that factors in the expansion of the footprint), fall 6% since 2005. We've seen the CO2 emissions rate come down 15%, all because of this switching to gas. Market prices work, and we should hopefully continue that, I would think.

But then I also have a nightmare with 111D. What happens in a footprint the size of PJM, and MISO's going to face the same thing, I'm sure, with the size of their footprint, if I have 14 different jurisdictions that come up with 14 different disparate policies that are not market-based, that are very much command and control? How do we deal with that? Now, RTOs will try to deal with that. We will maintain reliability. But there are going to be costs. And those costs are going to be often hidden.

And so to one of the points that Speaker 3 made that I almost wanted to jump out of my seat on, was about the SO2 trading program, saying that

the costs were lower than we expected, and the prices were lower. Yes, the prices were lower. Why? Because the compliance costs were higher than they needed to be, because expensive technologies were installed on many plants that were not necessary. So price and cost do not necessarily correlate here. And so when I see proposals on the table using energy efficiency as a resource, Speaker 1, that kind of violates what I'll call the corollary to the Hogan adage that demand response should be a result, not a resource. Energy efficiency should be a result, and not a resource, in this case. So you've got two polar extremes here that we're looking at.

And so, from the perspective of an RTO, and I'd like to get everybody's opinion on this if I could, given that we'll probably end up somewhere in between, not at either extreme, what is the role of the RTO in implementing and informing policy, to try to not only achieve these goals, but to make sure that we can maintain reliable operations?

Speaker 2: I could jump in on that just with one easy point, which is, you have all the cost data. You have the bid data, you have the price data, and you have the results. So you could be a resource to show, this model is going to cost customers this, versus this model is going to cost customers that. Just get the cost data out there—for example, switching dispatch is a cheap way to achieve the same kind of reductions that you could do if you had a command and control model. You know, help get the data out there. That would be a big service.

Questioner: Are you going to add two more days to the week, and a couple more hours each day?

Speaker 2: I'm going to get you ten more people on your staff, that's what I'm going to do.

Questioner: I love the way you think.

Speaker 1: So, NRDC has tried to design the 111D proposal so that it could fit nicely into a

market like PJM. If it were implemented the way we think it should be, you would simply see a dollar-per-megawatt adder on the costs of high carbon intensity resources, and a dollar-per-megawatt hour credit on the cost of low or zero-carbon emitting resources.

In terms of the balkanized threat, what I would recommend that PJM and other RTOs do is commission some analyses right up front that basically say, here are the differences in system costs if you go a balkanized route, versus going a harmonized route. And just put it out there with, you know, area by area what the impact on the cost of electricity of some bogey performance standard would be, and it's going to be a dramatic difference, and you will create a record that will be very difficult for individual states to ignore, because it's going to be more expensive for them, it's going to be more expensive for everyone else if they choose the balkanized approach.

Speaker 4: On the balkanized approach, I just have to repeat a joke that Mark Spitzer made, that when we use "balkanized" when we talk about some of these things in electricity, it's an insult to Macedonia. [LAUGHTER] But I think in terms of the role of the RTOs, there's a front end and a back end role. On the front end, to the extent that various iterations of policy are going to be a severe operating challenge to something that society has put so much resources in, as creating these regional markets, I think the RTOs and others have to be a policy voice.

Certainly in the Mercury and Air Toxic Standard, which is looking like a much simpler problem than this, we did find that the EPA air people were very willing to reach out to the RTOs. They worked very well with FERC staff. We've had them at NARUC meetings every single time. And I think that there should be an openness to that as that goes forward. However, I'm not so naïve as to think that whatever you suggest is necessarily going to come out, because there are so many policy vectors at the

state and federal level here, that there has to be a back-end role in adapting the best we can, as you have to so many other things.

Whether down the long road this makes changes to the shape of some of the RTOs, it depends on how much happens at the state level, whether you'll be able to have a state like Indiana, half in one RTO, half in another. If Indiana has one state implementation plan, they might need to be more readily in one or the other. But, I mean, that's beyond my prognostication ability. So I think right now you have to think about the front-end, and the back-end will come when it's here.

Questioner: Can I at least respond to that? We are not the Borg, and we will not assimilate people.

Question 8: I'm sort of picking up on question 1, and I share the view that the technologies we have today are not enough. And I start by looking at Speaker 1's slide about where the new coal is, and depending on how I treat these categories of "rest of the world," you know, it looks like up to 90% of the new coal is coming in the developing world. I have a very hard time imagining, unless carbon capture gets very inexpensive and the certainty about what happens when you put it underground becomes much higher, that we're going to see countries that are choosing between lifting people out of poverty and addressing, you know, carbon capture, spend significant amounts of money on carbon capture.

Which leads me then to the point of, how do we get to technologies that in fact can be inexpensive enough to be globally adopted? How do we create those options? I look at an industry in electric power that spends, I think the figure is around two tenths of one percent of revenue on R&D, compared to the economy as a whole, where that figure is 3.8%. And you look at the most successful industries, and it's clearly much higher.

And as a former regulator, I look at the fact that we've developed a regulatory system that is focused on sort of static kinds of efficiencies of, how do you minimize utility costs, rather than more dynamic efficiency over time. And I look at a federal government where we have one house of congress that is proposing cuts in ARPA-E, which is perhaps the most successful R&D program we've had come out of the federal government in a couple of decades, and the other house zeroing it out. And so my question to this panel is, how do we begin to play a role, as an industry, as a country, in developing the technologies that will ultimately be needed to solve the problem?

Moderator: If I can just add to that, if the way to deal with the climate is, we've got to help the developing countries with these technologies, what's the role of the United States in achieving that end?

Speaker 1: Well, the politics of that are terrible. You know, particularly in the last few years, and until we are more out of the recession than we are, they're going to remain terrible. I think, you know, there are a couple of paths that can be followed. One is that there will be sufficient activity that we will get some projects on CCS that will actually produce some real learning, and we will bring down the costs enough so that at some point during that forecast period that I showed, it will be plausible, especially when combined with international financing, to have the developing world applying these technologies to the new build.

The other scenario is, that doesn't happen, and that we don't modify our path on emissions. And the destruction that will come from climate disruption will become so pronounced that it will start to be seen as a threat that is similar to national security threats that have motivated political alliances in the past and created military-industrial complexes that have invested trillions of dollars, a lot of which has flowed to

other countries. That's the hard way to do it, and definitely not the good way to do it. But I think one of those two scenarios is likely to bound the problem.

Moderator: But can you resolve the problem, even in the crisis, by throwing enormous amounts of money at it, like we did in World War II to build tanks and planes? Is that going to build the technological innovation that's going to solve China's problem? I'm not sure.

Speaker 1: Well, you know, CCS is an interesting example, because if you want to build a power-generating unit that is a commercial unit, you've got to make the economic proposition, and you have to introduce it into a landscape where whether it operates or not, it's going to be competing against all the incumbent units, none of which have any cost associated with managing their carbon. So how's that going to happen? Well, you could hypothesize the dream of a carbon tax so high that it would be a logical choice.

But that high a carbon tax is never going to be passed. And I think never is probably an accurate term. The simpler way to do it is to come up with a targeted subsidy that will get a few of these things launched, and start creating the learning. There is a proposal that is an interesting one, which is a tax credit for carbon capture where the CO₂ goes to enhanced oil recovery. And that's a condition of the tax credit. And the reason that that's a condition is that the increased economic activity associated with that enhanced oil recovery increases revenues to the treasury that are actually larger than the up-front cost of the tax credit.

So if CBO agrees to tweak its scoring rules, it can be scored as revenue-neutral. And it's got a number of interesting aspects. It helps with the oil patch politics, which are often red-state politics, because you're putting jobs into these areas where you could be pulling a lot more oil out of existing oil fields, and putting a lot more

people to work. There's even an environmental community angle, which I've been trying to convince my colleagues of, which is, if we pull oil out of fields that are already developed, that reduces the pressure to go to other places that are pristine or risky, like deep offshore. So we should actually be encouraging this, even though it is financing the production of oil. It's financing the production of less environmentally destructive oil than the alternative. So those are some thoughts.

Speaker 5: I work for a company that spends about 6% of its revenues in R&D. And in order to get a budget for R&D, you have to demonstrate a profit pool. And everyone's sort of talking around, you know, what's the economic incentive? And for private industry, it's quite simply, where's the money, and how do I make money off of it? And you know, Speaker 4 joked about it earlier, but you know, clarity of policy is important, because to spend on R&D today that will take one, two, three, five, seven, eight years to come to fruition, the policy has to be relatively stable. And you can't have shifts in the policy dramatically over that timeframe, or people are going to back off.

And my company has invested a lot of money in things that we thought policy's going to take us someplace, and we stop for that. We've spent a lot of money to make gas turbines a lot more efficient, because there were some policies in place that encouraged that, as well as high prices for gas. But before that, it was policies about, you know, NO_x emissions and things like that. So it comes back to policy being predictable over a long period of time, to create profit pools for people to put their money after. And you go through our R&D budget every year, and you go through the budgeting process, and the question is, where are we going to get paid for it?

Speaker 3: I would just note that I think CCS in the developing world is really hard, in contrast to some of the other mitigation options, because all the other mitigation options do something

that's important to something else, like local air quality. You know, if you could push out gas to displace some of the coal in China, you'd address a lot of the major local air pollution issues that CCS doesn't do. And so it is tough to think through, how are they going to finance it? How are they going to design policies that might actually create a private sector incentive to invest in these technologies?

It's hard to imagine, although, you know, I remember a conversation four or five years ago where I said, "Look, I think long-term, if we're going to be adequate to the challenge of climate change, we will have done one of two things. We either find some way to push CCS into all the coal that's in the developing world, or we're going to do geo-engineering." Given the kinds of demands on policy in the developing world, I just don't see how they're going to bear the cost otherwise.

And I think that's the real challenge, when we think about this long-term, not just how do we design effective policies here in the US. I mean, this is a developing world problem because of where all the emissions are going to occur this century. And they're the ones who are going to bear a lot of the damages in the near-term, or even the medium-term, more so than the developed world. (I think we could still bear quite substantial damages here in the US as well.)

But I think that's the real challenge, and I don't have a good answer for that. We're not going to come up with the kind of monies the developing world talks about. The money just isn't there, whether it's our treasury, in Europe's, in Japan, the money's not in the developed world to do the kinds of transfers the developing world is calling for. So I think it means at the end of the day we need to find some way to dramatically lower these costs. It does require promoting technology. But I just don't know how you do it, especially for a technology that, at the end of the day, lowers your CO₂, but reduces your power

output, and it doesn't have an impact on any other sort of local externality that might motivate its adoption. It's a challenge.

Question 9: I'd like to direct this question to Speaker 5. We've heard a lot from various speakers about Spain and the problems of Spain. And we've looked at that, and it's fairly obvious what happened there. But a lot of people hold out Germany as a be-all and end-all. And, for those of you who do not know, the electric rates for residents, electricity users in Germany, is 34 cents a kilowatt hour. They've developed a system that has poor people subsidizing rich people's rooftop solar collectors. It is a catastrophe, and now all of a sudden it's become an issue in Germany, if you've seen the media lately. Speaker 5, you've obviously looked at Spain. Have you looked at Germany, and do you have any thoughts?

Speaker 5: We actually had investments in Germany that we sold a few years ago. But we're looking at German investments today. And, frankly, one of our concerns is what you've raised. There seems to be a bit of a social discomfort with the price of electricity and the cost of electricity. It's also borne in Germany more by the residential customers than the industrial customers. They shelter the industrial consumers from those rates. The residential consumers pick it up, for the most part. I think the feed-in tariff in Germany for wind is about, what, 11.5, 12 cents? Something like that. In that ballpark. But they pay very high rates for all of that.

I mean, Germany rushed to do a lot of this. Talk about unintended consequences. They're a poor wind regime, you know, in terms of wind resources, compared to other places in the world. You know, many of the plants there operate at 20% or lower capacity factors, which is pretty bad. They have a lot of solar in a place where I think the solar is like Nome, Alaska.

You know, they jumped into it feet-first, I think trying to jump-start an industry, which really benefitted China, especially on the solar side, a lot more than Germany. But, yes, we are looking at Germany. We are somewhat concerned over what some of the issues could be in Germany. They are considered a success in terms of the amounts that they built out. I think the economic cost hasn't really been fully borne out. And strangely enough now, you see in Germany that the fastest-growing new investment in German power is coal. And so it's a little bit of a perplexing place.

Speaker 3: There's some recent research by Denny Ellerman, who used to be at MIT for a long time, showing that the German renewables policy for wind (and I think this is relevant when we think about second-best policies versus something like a carbon tax), in terms of displacing coal, it costs ballpark sort of 40 or 50 Euros per ton of CO₂. For solar, it's about 500 Euros per ton of CO₂.

And this is at a time in which the allowance prices within the emissions trading scheme are trading in the sort of five to ten Euros a ton CO₂ range. So while I agree with what Speaker 1 said about how the politics of something like a carbon tax high enough to really drive meaningful change is probably not politically tenable, I think it's important to recognize that we implement a number of these policies where, when we estimate what are effectively hidden costs, they seem really high on a per-ton basis.

Question 10a: It's hard to say how depressing I find all of this. And on the one hand, there's Speaker 3 talking about dreamers, and the fact that decades later we're still talking about dreaming. Tom Schelling once said, 20 years ago, that, you know, we can give ourselves a little bit of a break in the mid-90s when we hadn't really addressed this problem, because it's a very complex problem and so let's give ourselves some time. We're now decades later, and we still haven't addressed it.

And I'm also glad you threw out the geo-engineering card, because I think that that's something that needs to be put on the table. But I'm trying to be positive today. And so the one thing that has changed in the last decade or so which is positive is that we have seen the costs of several low-carbon technologies go down significantly. We've seen the costs of wind go down significantly. We've seen the costs of solar go down significantly. Now, have they gone down far enough to avoid the problem of sticker shock at some point, and the backlash that would come from that? I don't think we know.

But at least it's getting cheaper. One of the speakers yesterday made the point at lunch that we're underselling the benefits here, and we should lead with the benefits, maybe, and not the costs. But setting that aside, to what extent have the renewable portfolio standards had a role in driving down those costs? And two questions related to that. Does that mean, now that we've driven down the cost, that it's time to rely on them less? That we're not getting that innovation benefit anymore? And is there any learning from that, if we do believe they have had a role in driving down the costs for some of these other technologies we've thrown out?

An earlier question mentioned storage, which is very important. That could be a silver bullet. Carbon capture, a potential silver bullet. Some of the alternative nuke technologies that have been discussed, small-scale nukes, potential silver bullets. And we'd be putting a lot of money into driving diffusion of technologies, rather than driving innovation. I'm just wondering if we really want to just focus more on the innovation, because I think as Speaker 3 said, that affecting developing countries is really the only hope here.

Question 10b: I thought that was a great question, so I think I'll leave it at that, because I think it's a really great question, and mine was

sort of similar to that. I just wanted to say, if you're going to dream, don't dream about cap and trade, dream about the carbon tax, because it's a lot better. You'd solve so many more things, and it does the same thing if you can pick it. So carbon tax--the cap and trade would be really tricky with carbon across all the industries and everything.

Speaker 1: So just a quick comment. I've been working on these issues since 1970, and on climate specifically since the late '80s. And I'm still not depressed, and I'm going to keep working on it. So I hope that no one else will give up, either. On the production tax credit for renewables, yes, the case could be made from an economics standpoint that it's time to wean ourselves away from that. But I think it's important to look at the consequences for the energy mix.

If we took that credit away and replaced it with a carbon tax, you know, then we might avoid the perverse results. But if we take it away and don't have a carbon tax, I think the answer is predictable. We'll have much more gas new build than we otherwise would. And that will just worsen our carbon footprint, and that's not a good thing. So I think you've got to look at the recommendation in the context of what is going to happen politically, not what might happen theoretically, to solve the problem.

Speaker 4: Well, I think it's a great question also, and I haven't done an analysis of what's happened because of RPS. But my view is that state policy initiatives, taken broadly, have contributed to bringing down the costs of some of these technologies. An earlier comment talked about solar in New Jersey. I always say, I've lived there. I know it's not the second-sunniest state in the nation. But it has the second-most installed solar. And as they brought down the cost, first of all, they brought down the cost that it costs the public to put it in, by weaning people off the subsidies.

But also, the scale of the program has brought down the manufacturing cost, and it's built an infrastructure in the state. Here in Massachusetts, I know the early energy efficiency programs really brought down the cost of the insulation providers and all this infrastructure built on it, so we were able to wean people off the subsidies. If these programs didn't work at all, then there wouldn't be a difficult choice what to do about them in energy markets. What makes it so vexing is the fact that they have good benefits. I think one of the problems is that, because of the politics, a lot of times subsidies that are supposed to help a new technology last long after it's no longer needed, and an infrastructure, a bureaucracy builds around it, and they hang around.

In case this is the last time I have the mic, I want to say, I don't think people should be too depressed, because I think that, as someone said yesterday, there's a generational issue here. My impression of our kids is, they don't debate whether climate change is real. That's for the people our age in Congress. I think if we don't fix this--I hope we leave a better world to them because we address it--but I think they're ready to come along and do it.

Speaker 5: It's clear that the technology has gotten a lot better and cheaper because of this. You know, wind turbines today are far more efficient than they were 10 years ago, 15 years ago, which is due to tremendous economies of scale there. I think it raises kind of a policy question, though, because a lot of the sites where wind turbines were put five or ten years ago are better wind sites than sites where the latest generation of technology is being put today.

And the question is, should we find a way to pay to repower those older sites to take the maximum advantage of the technology and really drive some, you know, cheaper electricity prices out of those? Although there's a cost to repowering, it's a little perverse, because the places that the less-efficient technology went to

first were the best sites, and the worst sites, or the less-good sites, are being used by the better technology now. It's a little strange issue. But it's clear, we see PPAs being led today at 2.5 cents, you know, for wind. And it's economic to do a wind project at that. Now, that's with PTCs. But still, that's a good deal for a consumer.

Speaker 3: I would just say, I think it's complicated, because we have a mix of policies that have been targeting renewables to assess. How much is this the RPS versus the PTC, or, for solar, the ITC? I think it requires some fairly detailed and rigorous analysis. Having said that, you know, big picture, to try to leave it on a slightly more positive note (I know I started talking about dreaming and then I said some rather pessimistic things about the future of the planet and climate change), you know, I think that there's a lot of opportunity to learn what's going on in the states. I mean, we have 30 RPSs. Some of them I think are slightly crazy. But we learn from these. And I think that experience informs thinking like what Speaker 1 and his colleagues put together in NRDC. I mean, in some sense you could look at their proposal, and it has some similarities to ways a number of states implement RPS programs.

So I think that when we're talking about dreaming, part of it is that we can actually try to experiment or do some of what I think someone earlier called pilots in the states to figure out what could work as the next generation of policies. I mean, I talk about being a dreamer about a carbon tax, and I appreciate the enthusiasm for the dream.

I'm on a panel next month to talk about a carbon tax here in Mass. There's a bill under consideration on whether we should implement a statewide carbon tax. So there may be that opportunity. If those who make these decisions for the Commonwealth decide we're going to do a carbon tax, to learn from that, that might be useful for future debates when we think about a national and longer-term policy.