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SMART GRID'S FUTURE:
EVALUATING POLICY OPPORTUNITIES AND CHALLENGES AFTER THE RECOVERY ACT

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The Business Realities of Smart Grid/Building the Business Case:

RICHARD NEWELL, Moderator
Administrator, Energy Information Administration
Department of Energy

JASON BORDOFF
Associate Director for Energy and Climate Change
White House Council on Environmental Quality

PETER FOX PENNER
Principal and Chairman Emeritus
Brattle Group

MATT TREVITHICK
Partner
Venrock

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P R O C E E D I N G S

MR. WEST: Thank you, George. Great job. And panelists, thank you very much. As soon as they come down we will ask our next panel to come up.

The next panel is going to address the business realities of the smart grid, building the business case. This session is going to be moderated by Jason Bordoff and feature a number of panelists. So, I will turn it over to Jason.

MR. BORDOFF: Okay, folks, if you'll take your seat we'll get started here with our third panel. Thank you.

Okay. So thanks to those of you who are still here. And I want to thank Brookings for hosting this really interesting discussion today on the smart grid. It's a pleasure for me to be back here. I spent four wonderful years here as a scholar prior to joining the administration, and it was a true privilege to work with such an exceptional group of colleagues here at an institution that places such a high value on rigorous analysis and objective scholarship not driven by ideology. And so I could say now that I'm in the administration how valuable we find it to have that sort of rigorous analysis and helping inform the tough policy decisions that we face every day.

So, given that -- my history here it's a special treat to be back here. And a special treat to participate in a conference organized by Darrell West, who is not only one of the nation's political scientists, but who also taught me political science when I was in college. I won't embarrass him by saying how many years ago that was. But it was one of the highlights of my time here at Brookings that I had the chance for a brief period to call him a colleague and to work with him.

So, we come together today to talk about policy opportunity that really is of utmost importance to the administration. President Obama has made that clear, he's committed to transitioning the U.S. to a clean energy economy, and we know that's smart grid. And we've heard today how smart grid can play a key role in getting us there.

We sort of heard today the elephant, right? The promise of the smart grid and how much it could be. It can help consumers save money and create jobs and reduce harmful

greenhouse gas emissions. It can help consumers manage their energy consumption more effectively, it can help us manage variable energy sources like renewables, where we want to move. Help us charge our cars one day, potentially. Help increase the reliability of the grid, reduce congestion. So, it sounds great.

So, why don't we have it yet? And who's going to pay for it? And so that's among some of the topics we're going to get this panel to talk about and it really is an extraordinary panel. I haven't -- I think people haven't sort of been walking through bios, I think people hopefully have those, so I'll just let them speak for themselves. But it really is a great group.

So, I think we're just going to jump right into it and kick it off. We'll try to make it a little dynamic and ask questions. And maybe rather than give everyone a chance to respond to every question -- which sort of limits the chance for questions -- I'll try to see who has something to contribute and if not, we'll sort of move on and try to make it a little interactive.

So Peter, let me start with you because you have a book -- and I don't get paid to do this, but I have it here and it really is quite worth reading. And one of the sections of your book is called, business models for the new utility industry. So you presumably know the answer to the question because you have a section in your book called, business models for the new utility industry. So, I guess the question for you is, what's the answer? Who is going to build the smart grid? And what incentives do utilities have to facilitate the development and deployment of this smart grid technology and innovation in the electricity power sector?

MR. PENNER: Well, thank you. I -- thank you very much for the plug for the book. Now I have to give the answer, and then no one will want to buy it. And that's probably just desserts for me.

So, when I go to the movie theater and I see previews for movies these days, by the time I've watched the preview I've pretty much figured out that I don't want to watch the movie. I got it -- and hopefully I can do that for the book and save you guys $27 on Amazon. (Laughter)

But I do say in the book that the smart grid -- but not only the smart grid. The

combination of the smart grid, the national imperative to improve our energy efficiency for security and climate reasons, and the impact of climate change limits on electric utilities together. Those three massive change drivers will make it essential that the electric utility industry change -- profoundly change its business model. And contrary to what Jason suggested, I don't know the answer. But I posit two visions of future business models that I point out will work and be sustainable only if they are married up with regulatory regimes that are acceptable to consumers and the political system and create financially viable outcomes. Or, in the case of co-ops, as Dave will talk about, the analog.

And the two sort of future end state visions -- business models, call them what you want -- are given, hopefully, clever titles in the book. One of them is called the smart integrator, and it's basically a utility that is largely pipes and wires, but smart pipes and wires. It really is almost a network service provider. It's a lot like a communications backbone provider, it needs the advanced billing systems the other questioner was talking about. And it's sort of a smart grid operator. And that -- under that business model it charges for connections to its grid, both -- in both directions. You want to plug your car in, you pay a connection charge. You want information, price signals, there's probably a charge for that. But it will be regulated, probably performance-based regulated. And it should be financially viable, but it puts the issues of who's going to pay for energy efficiency -- which is a very capital-intensive proposition -- and who is going to deal with decarbonizing generation and paying for that. It pretty much puts that in the marketplace or at least outside the responsibility set of the regulated utility.

The other vision is almost a mirror image of that, where energy efficiency and decarbonized generation become the responsibility of the regulated utility, and then I call that vision an energy service utility. And there I think that the business model becomes much more challenging, because we're going to need to invest a trillion dollars or more to decarbonizes generation. And another quarter-trillion in energy efficiency if we do it right. And so that calls for business model that really we have not yet invented.

And maybe I'll just leave it there. But if I could make one more point in -- as a kind of homage to this august gathering. It's just a little trivia observation, but I couldn't help

noticing that in the last panel you had not one but two, in a sense, true pioneers of the smart grid. Mike Davis was not only the assistant secretary for energy efficiency in DOE, prior to the Clinton administration -- and did many path-breaking advances -- is now at Pacific Northwest National Labs. Also, Steve Hauser who's now at NREL was at Pacific Northwest National Labs.

Reason I mention that is that the very first smart grid experiment was done through Pacific Northwest National Labs in 2005. Steve Hauser was involved in it, and it involved a tiny little public utility district in Sequim, Washington, which is best known as the "Lavender Capital of North America," where for the first time, customers were given the very first smart meters that they made by hand and hourly price signals. And they were able to use their home computers to control their -- Whirlpool made up, I think it was, 1,000 special washers and dryers with control switches on them. And that was the birth of the smart grid.

Thanks.

MR. BORDOFF: Thanks, Peter. Phil, let me turn to you next with sort of the same question. Who's going to do this and who's going to pay for it? What incentives do utilities have to deploy it themselves? What ability and incentives do they have to create business models that enable deployment by sort of other players? What role tech firms and others have?

MR. WEISER: So after speaking -- or speaking after the person who wrote the book I feel a fair bit of humility. Let me sort of riff off that in a couple ways.

First is, although we're up here speaking, someone in the last panel mentioned that many people in the audience knew more. And that's very true. We had a chance to see how many people in the audience are engaged and bring such expertise. And one of our goals in the administration is to tap into that. I think Bill Joy has said the smartest person on any given issue is generally not the one working for you, and so you have to figure out how to find that person.

So let me give you one way. There are several people in the audience here who are part of our inner agency government effort who both deserve acknowledgement and who you all should know so that if you want to talk to some of the people who can help tap your knowledge you know who they are.

So, from OSTP, Kevin Hurst over here. People probably know Kevin. He has

been to say laboring hard on this and long, it's an understatement. He's an enormous asset. From CEQ, sitting, I think, right behind him, Daniel Kildiff has also been an incredible workhorse on these efforts. We benefit from him.

And then a number of people at DOE, too, we should mention. Maureen McLaughlin at the back works with Scott Harris in the General Counsel's Office. And Doug McKeel works over in Pat Hoffman's office. They have put enormous effort into this. So to get a government-wide project and focus and thoughtfulness is not a small undertaking, and it shows how committed the administration is to this effort.

Having dodged the question for a couple minutes, let me come back to it. It's worth noting this 2005 date and acknowledging Steve Hauser's and others' good work in the Pacific Northwest, because think about other technologies. Cell phones -- the first cell phone started in 1975 or so, invented at Motorola -- the first modern cell phone, I would say. And 1980, '82, McKenzie did a study and said we'd only have a million cell phones by 2000. And that was a basis for AT&T deciding that they didn't need to keep any license to do cell phones when they divested that asset to the local Bells. Literally, that was off by a factor of 100, right? There was over 100 million cell phones in 2000, and AT&T later had to buy McCaw Cellular for $11 billion, really like 8 years after they had allowed the asset to elude its grasp.

So one really difficult challenge for policy is the basics of the technology in the business are, right now, hard to know. And one of the challenges I put out there -- and this is where we need all your thoughtful analysis suggestions -- the regulatory system hasn't necessarily been set up to facilitate innovation because it has been a fairly static technology and a fairly constant business model, with the major exception which has been adverted to has been some of the restructuring efforts that have happened. But other than that, utility industry has, you know, been built for and been viewed as a fairly stable business.

And so one of the challenges is how do you build in risk taking and experimentation into a framework that was in some sense premised on the opposite. And that cultural norms have developed on the opposite. This is not a small challenge, and having followed on the person who wrote the book having not answered the question, I'm not foolhardy

enough that I want to actually try to answer that question either. But that's all in the nature of what we're here for, which is to really get different ideas.

I think the best I can say is, you know, if we're like 1980 with the cell phone was on the smart grid, based on the timeline you've offered, we should have some humility. Some sort of view of the need for experimentation, and some ability to look at a emerging technology with great promise. And if this revolution of the smart grid can be like the cell phone -- which someone adverted to earlier -- that would pretty phenomenal way to change how we live our lives. And we'd be at a pretty critical part of our energy future.

So, a challenge for policymakers is to see where those opportunities are and to act in a way which is, you know, allowing different flowers to flourish and see where the best paths lead us.

MR. BORDOFF: So let me just ask you a follow-up. If you could say -- a couple more sentences about that last point. And so we talked about utilities, we talked about technology firms started by consumers. The role for government, both federal and state.

MR. WEISER: So let me -- yeah. Let me actually say something here which, you know, isn't always what you hear from the federal government. But in this electric utility -- electric industry ecosystem we have a virtue of what I'll call a cooperative federalism, which is, the states are going to take different experiments. And the challenge for that environment is how do you bound the experiments? How do you track what's happening? How do you provide a level of, you know, thoughtful, forward-looking analysis?

So, we shouldn't be afraid of the future. We should be seeking to move technology, which happens through, you know, government providing money for investment, helping set standards with NIST. And we should try to, then, create learning laboratories and enable best practices to be shared.

So I think the federal government could play a very constructive role and will benefit from a partnership with the states. So you know, this is an area for government leadership because in this industry, the investments are going to often come in the form of assets that are going to the rate base. And so the rate payers want to know that they're getting a return,

they want to know that they're protected. At the same time, we have this ongoing need to modernize the grid and it's not necessarily clear that there's one best solution so we have to have a way to understand what the different options are and make intelligent choices.

MR. BORDOFF: Does anyone else want to come in on sort of this question about the role for government and, in particular, what adjustments regulators need to make to facilitate effective deployment and development of the smart grid?

SPEAKER: I do, but I'd like to hold that and let the other panelists talk first.

MR. BORDOFF: Okay. So, well -- let's turn, Matt, to you next. From your perspective as an investor, your thoughts on kind of where you see the business opportunities here. What kind of firms do you think are going to lead the way in bringing us smart grid technology?

MR. TREVITHICK: Happy to. And first of all, I'd like to thank the Brookings Institution for convening this conference and the for the attention of all of you, and for inviting a variety of perspectives to participate. I always enjoy coming to Washington, D.C., because the conversation here is so radically different from the conversation in Silicon Valley, where I spend most of my time. I'm meeting with entrepreneurs, really, who I think have their ear to the ground. They're -- you know, Bill Joy's example of the smartest people out there not working, you know, for the big organizations. And that conversation is very much bottoms up, whereas I find the conversation in D.C. is very much top down. And I'd like to share that with you.

And the comments I'm going to make -- I'm going to restrict them to residential energy management. So the smart grid as applied to the residential market. That's about 40 percent of the U.S. market, so it's a big problem. And it's a problem that's actually really hard to address, and I think we all understand why industrial customers, commercial customers might have greater incentive. But residential customers much less so.

And really, the summary is it's the best of times, the worst of times scenario out there. On the best of times things, we have counted 108 startup companies formed over the last few years to address residential energy management. That's extraordinary. In Hollywood they say follow the talent? And we try to do the same thing in the VC industry. So a certain

percentage of the world's smartest and most driven people, for pure economic reasons, are deciding to start businesses in the space. That's the good news.

The bad news is, we often scratch our heads because they cannot articulate clearly how big their businesses can become. They, you know, are good, altruistic, you know, activities to pursue. And I think everyone understands kind of what we call the distributed benefits of the smart grid, and we've kind of talked about that here, kind of the soft benefits. But a question that we obsess about is, who wants the smart grid, really? And the more often I ask that, the mushier the answers become.

And in the residential energy management side, the honest answer is, there are very weak reasons for consumers to adopt the smart grid. So beyond a kind of early adopter niche of people that are really energy use zealots and find it personally fascinating to go after this -- I think this is probably a subset of people that play fantasy baseball -- you know, who really wants this? (Laughter) You know?

When we look historically at the adoption of technology, there's four reasons consumers buy something. Price -- it's going to save them money. Second, it's going to offer some extraordinary performance that they never had before. Third, it's going to make their life more convenient. And the fourth, which I've been criticized for calling it fashion, but it's really fashion. I'll call it social norms in polite company, but it's for social norms. And when we apply that to the smart grid, price, there is very weak economic drivers for price.

I have had now for nine months all of my office equipment plugged in to kilowatt, which is an energy meter. I am now up to $20 total energy use in 9 months and that includes my laptop charger, my cell phone charger, my computer monitor, and a backup disk drive. You know, that's about $30 a year. The expense of the equipment is about $1,000 a year into that thing. So it's .3 percent; it's really not an economic argument. And if you actually calculate residential demand response, you get similarly small numbers.

Performance. I am still skeptical that this smart grid is going to provide dramatically better performance than we have in today's electricity grid system. I -- you know, I quarrel with the analogy to wireless cell phones because that's an extraordinary capability that

didn't exist on my landline. But is my electricity going to be that much better? The convenience -- this one is a hands down no, right? The reality is, we have a pretty simple billing structure here, and if you make me now worry about my energy use or when I'm going to wash my dishes, you know, or if it's a peak load day, my life just got much more difficult.

And so the final thing is the social norms factor and this, I think, is the big maybe. And this is where we can really appeal to -- and I think your great entrepreneurs, to answer your question directly, are starting to go toward. The cultural legacy of energy use in the United States has been one about low cost, consistently low cost for the past 40 years according to EPRI, very simple pricing mechanisms -- tend to be, you know, flat, loose pricing -- and frankly, those have motivated a culture that does not aspire to energy efficiency. So it may seem maybe less interest to adopt.

But social norm, there are examples of change. In Northern California where I live, smoking is all but eliminated. You know, it's certainly eliminated in all public spaces, but it's just not widely practiced. Recycling, because of how they charge for garbage pickup versus not charging for recycling, in my home we recycle about twice the volume of material than the garbage. So, I believe that by addressing -- companies that address that space, the marketing aspects of residential energy use are the biggest opportunities. And I think inspiring political leadership can do something very similar as well.

And I just want to put a poll out here because this -- I get an answer, too. How many people in this room would consider their core skill consumer marketing. That's more than I usually see.

MR. BORDOFF: Just to follow-up on that, on the point about price not being a driver. So, do you think the response to that is dynamic pricing or carbon price signal, trying to fix that so it is a driver? Or more in the nature of, Barbara, you mentioned the consumerless efficiency program that we need to sort of accept that that's the case and maybe, Larry, that was your point? But sort of there's a low elasticity here and that's sort of the way it is?

I thought that's what I understood you to be saying, because where we've seen responsiveness -- you kind of indicated it was probably from a self-selection bias suggesting for

most people there probably isn't. So, you think we can get to a place where price is a driver? Or we're going to have to kind of build this accepting that it isn't?

MR. TREVITHICK: Well I think those are the A and B situations, okay? I think the easier thing to do would be to accept honestly that price is not going to be a driver. It's a very difficult challenge, then. How do you implement these benefits when you don't have the power of the purse to influence them.

The other approach -- and this has been done in some other countries -- has been to make price a very, very strong driver. This requires tremendous political will and I think education and basically the support of the voting public to make price a driver. And, you know, frankly, if you increase the electricity prices 10 percent, I don't think that's still -- they're off such a low base right now they're not going to really influence it. If you suddenly increase them, you know, 5 to 10 times that would dramatically change behavior.

I know they've done some experiments with pricing tobacco and gradual price increases really don't cause a change in tobacco prices, but dramatic ones do, and tobacco use. In, you know, motor fuel we saw that as well when motor fuels, you know, crept over $4 a barrel people really changed their behavior. As soon as it slipped below $4 a barrel -- I'm sorry, a gallon, consumer behavior very quickly gravitated back towards purchasing it, you know, the traditionally large vehicles.

Germany is an interesting country because, you know, for historical reasons they have made their electrical system, you know, increasingly dependent on natural gas, which they have to import from countries that, you know, are not necessarily benign to them. Their population is very supportive of heavily subsidizing alternative forms of electricity.

So, those are the A and B situations. But I think if we're going to kid ourselves that, you know, saving $15 a month on an electricity bill if it's a base of $150 is really going to cause someone to radically, you know, become a new IT specialist to network their homes and appliances, I think that's a weak driver.

MR. BORDOFF: Dave. So you, I think, have sort of a unique perspective on this because of the rural electric co-ops have sort of a different business model than traditional, you

know, vertically-integrated utilities. So can you say a little bit about what you see as the significant business case drivers for co-ops? And how have co-op consumers reacted to some of the smart grid and demand response programs you've been putting in place?

MR. OWENS: I'd be happy to. It's interesting that FERC, Federal Energy Regulatory Commission, came out with a report that -- actually two reports last year: One looked at AMI smart meters, and the other looked at demand response. And guess who was the leaders in both. The electric cooperatives. And the question I get a lot is, how did that happen? Okay. There was a great bit of skepticism, but how did that happen?

Well, in a very quick time I will tell you exactly how that happened because it has to do with our business model and our environment. And the business model is key to this panel, so I think both are rather interesting.

For those of you who do not know, cooperatives provide electricity about 83 percent of the counties in the United States -- all or parts, okay? We also supply about 75 percent of the land area of the United States, and most people have never heard of us, to be perfectly frank.

The co-ops -- the interesting background is that we have built about 50,000 megawatts of generating capacity to supply electricity. We've also built, interestingly enough, 43 percent of every model of distribution line in the country. Now there's an interesting statistic, but where am I going that?

MR. BORDOFF: And -- sorry, but what percent of Americans get their electricity from electric co-ops?

MR. OWENS: About 12.

MR. BORDOFF: Okay.

MR. OWENS: Okay? So we supply about 42 percent of -- excuse me, 42 million people.

The interesting thing is, two other statistics. One is, we have about 6 consumers per line model, on average and the average co-op is about 18,000 consumers. So even I can do the math. To supply 18,000 consumers we have to build enough distribution lines to go from New

York to California, all right? Three thousand to miles to supply 18,000 customers. So when you think about that, a couple things become very clear.

Number one, if you can substitute electrons and photons for reading a meter, making an outage call, locating a fault -- I mean, you're talking about a lot of savings in personnel time, truck rolls, you name it. To us, those economics are very clear. They're very clear drivers that it makes a lot of sense for us -- I'm not saying it does for everybody else, but for us it does.

The second thing is, you know, we do have 50,000 megawatts of generation. Viewed collectively it's -- we're the biggest generator in the country. Of course, individually we're not. Unfortunately, we sell 100,000 megawatts of generation, so where do we get the power? We buy it in the wholesale market. Now, you all realize what's going on in the wholesale market, and the markets have tended to be very volatile. Price goes up and down very, very quickly over time, particularly over peak periods. So for -- get this -- 30 years, cooperatives have been using various forms of demand response to hedge price risk in the wholesale market.

Now, how do we do that? We typically do -- and okay, Robert, you hit it on the -- nail on the head. We do it through direct load control, controlling devices that have inherent storage value, all right? We control water heaters, we control air conditioners, we control things that when we control them, the consumer doesn't know it's happening. What they do know is they get $15, $20, $25 a month credit on their bill. It's a very simple system, it doesn't cost very much.

So, we have those kind of reasons why in our business model this works very, very well. Now what about that business model? How are we different there? We're very different. And again, we're, you know -- I'm not saying this will apply to your business model, but our business model is we're consumer-owned, consumer-controlled, not-for-profit, private businesses, okay? The only thing we are interested in is reliable and affordable electricity to our consumer owners, all right? That's the business we're in.

So, we're not interested in gold-plating a rate base, we're not increased -- interested in maximizing profits. Guess why. If we make an extra buck, guess who gets it back? Our owners, the consumers. We are certainly not interested in what I'd like to call Buck Rodgers

toys, all right? And again, remember we're leaders in this field. We're not interested in transferring risks that should not be transferred to consumers to consumers. We handle those risks we can handle best ourselves, all right?

And excuse me, for the economists out there, we're not really beholden to economic theology. What we are beholden to are our owners, our consumer owners, and reliability and affordability. Those are the key. So, you wrap that all together and what do you learn? You learn that in certain circumstances this business case for smart grid is very definitive, very measurable, very identifiable, and very compelling, okay?

So, that's kind of our story about it. I will say that from the standpoint -- Pat Hoffman I think said it well this morning. What we're missing, vision is one thing. What we're missing is the measurability, the verification of the benefits that consumers need, okay? Need to understand before they'll buy in.

We have hundreds and hundreds of thousands of consumers who allow us to press a button in our office and turn off these devices. So, I was relatively amused when our friends at Accenture came out with a report recently that said no one will let a utility control their devices. Be as it may, we've been doing it for 30 years. We are a little different circumstances, it's easy to tell somebody who lives in the country your last outage was 5 hours, you let us put this meter in, it'll be 15 minutes. But because of the nature of our system, it's the truth and they understand it and they trust us. So put that all together, that's how we arrived at this.

MR. BORDOFF: Great, thanks.

Jeff, can you tell us a little about what Cisco is doing in this space? Where you see the business opportunities for your firm?

JEFF: Great, thanks. I'll just -- I want to start at 10,000 feet first just a bit to look at what some of the trends are that's going on that leads to the conclusion that we've come to about where we need to go in the smart grid space. And I think it's a number of things that are all happening at the same time that can either be addressed independently or collectively, and we think that addressing them collectively makes a lot of sense. All of which have been discussed today, so I won't go into any great detail on any of them.

But, you know, we have a world where it just makes sense -- I think Matt was saying something about follow the smart people? This is Washington, and I think here we all know to follow the money. And so let's follow the money a bit here. You know, the first is the long-term issue that we've always had about peak demand. And the fact that there's an enormous cost in meeting the very small number of peaks that are out there, and any method that can be used, as Dave was just discussing, to limit consumption during those peaks can save dramatic amounts of money. So, the ability to have a system that can control that and make that work well and more effectively is obviously going to save a lot of money in a long period of time.

The second thing that's going on at the same time is that we're moving into a world where renewables are going to be an increasing and important portion of our generating capacity. It's going to come about either via government activity, consumer preferences, or the overall economics. But one way or another it's going to happen in all these aspects. And there are a variety of things that happen when you bring significant amounts of renewables into the systems. You have increasing problems with variability of production and supply that have to be addressed on an ongoing basis, you know, minute-by-minute, hour-by-hour. You have increasing problems with maintaining voltage issues. I'm not an engineer on this stuff, but when you're generating large amounts from single stations it's much easier to maintain stability of the overall system. But when you're bringing in smaller amounts of sources from a wide variety of areas you have to do much more to do with measuring what is going on with oscillations and voltage and stuff that requires an entire system of synchrophasors throughout a network that can get that information and control the network in order to prevent any outage systems. As we have more and more renewables, this is going to be more and more critical to how we operate the network.

We're looking at the potential for a lot of electric vehicles in this system. If electric vehicles become a very large consumer choice dealing with the charging and potential storage capabilities of the electric vehicles is a huge opportunity, but it can also be a huge burden on the system. So having a system that can help control the charging of the electric vehicles or even, potentially, drawing from the electric vehicles during peak times can bring a whole lot of benefits.

The other thing that's happening that Matt was talking about is consumer interest in this. There is a lot of consumer interest in controlling their energy usage. I agree with Matt that I think a lot of it does not have to do with the actual savings of dollars on the consumer end. Although, I think we should discuss how we charge for electricity -- we're actually charging for electricity like a phone system except that the variable cost in the electricity system are nothing like the phone system. So we've -- we have to think about that. But the reality of the consumer interest in here is more like recycling. Some people recycle and as in your case, Matt, because there's some cost impact to them. But most people recycle because it's a societal norm. It's a good thing to do, people who do it do it because they want to do it. It's not that hard to do, and we can make it happen.

The same thing is true about controlling your own energy usage and making your energy use smarter, which is if it is easily done, if the technology enables it, consumers are going to want to do it for a variety of reasons, some of which are altruistic reasons.

So what all of this means is that we need a system that is capable of scaling to control all of these different varying systems that can be managed securely, and that can be future-proofed as the technology develops going forward. And that means we need to create some sort of, you know, communications control layer throughout the grid. And that clearly needs to be an IP-based system that can handle all these disparate sets of information and use them in a secure way to control these things with the consumer's permission when it's affecting the consumer, or as the utility needs to run it as they're running their own operations.

And that's where we see the big opportunity here. We think that building out such a system will create huge benefits, both for the utilities and for the consumers and the nation overall.

MR. BORDOFF: And so -- just as a follow-up. So, I mean, from the perspective of policymaker, you know -- the promise of and the opportunity of the smart grid, which the President has spoken about, is the extent to which it might ease the deployment of electric vehicles, the deployment of renewables.

From your perspective, investing in this -- and maybe Matt, you could speak to

this, too -- there's a lot of uncertainty around what that future looks like and how much will electric vehicles deploy, how much will they be the solution if we're effective in reducing oil consumption? What's happening on the Hill right now, what's going to happen in the years to come to address climate change and how much will we see renewables versus nuclear or CCS or some other technology? How much progress will we make against this problem?

How do you think about that uncertainty in terms of where you're putting your dollars?

JEFF: Well, look. We're in early stages in a lot of the activity in this area. But we believe that the overall average change in here is sort of inexorable. Now, exactly how much of this is going to be driven by electric vehicles, how much will be driven by solar or wind or other renewables? You know, are going to be variables that are going to change over time and I don't think anybody can accurately predict any of those things at this point in time. But the overall trend is heading there, and I think, you know, the reality of moving towards a carbonless or a lower carbon energy system is going to drive us towards this. And almost any one of those directions you go -- and I think we think all of them are going to go forward to significant extents -- is going to require a well-managed smart grid.

MR. TREVITHICK: Yeah, I guess I'd forgotten to say in my opening comments that I'm actually an optimist. (Laughter)

My father was an electrician, I worked with him through high school and college through an apprenticeship. I'm an electrical engineer by training. I invest in things that touch the grid, and I am an unabashed optimist at where we're going. I thought that was a given. Everyone in this room is probably, you know, a self-admitted optimist on this field. So that's why we can have this candid discussion about, you know, what could get in the way of this optimistic vision coming to pass.

A colleague of mine -- look. What would be the holy grail for venture capital is if we had a prescription of what would be great startup companies to invest in. So a colleague of mine actually studied this in some detail. And the broader question he was trying to answer was, what is the commonality of really big things -- when, you know -- when big things happen that are

technology driven, what is the combination of events that needs to kind of come together to make it happen?

And the data supported the conclusion that four factors really need to come together to make something happen in a really big way. The government has to get behind an initiative. Science and technology need to engage on it. Industry then rises to support it. But, very importantly, the public must be behind it because anything big is going to have to, you know, evolve over a period of time. And so all four of those factors working together and evolving together necessary to create something big.

A great example of success is the space program. 1957, *Sputnik* was launched. By 1969, the *Eagle* had landed. When you think about the technology we have today and the technology we had then, that's just an extraordinary feat. But, you know, it was obvious the government was behind it with Kennedy's vision. Science and technology, you know, emerged to address that hard problems -- industry came behind it. But the public, you know. We all wanted to be astronauts then. You back to the literature and the films of the day, you know it's all about everyone being part of this vision. Now, I still haven't been into space so, you know, maybe that dissipated but it was very successful for its time.

I think in the smart grid we really need to think about that public component, because it's not there today. And other attempts at energy efficiency programs -- notably, the '70s where you had those three other factors: government, science and technology, and industry. But without the public, they didn't go anywhere. And I look at the smart grid. We've got the government behind it, because they are declaring this nice vision. This is not really cutting the edge of any science and technology. Let's be honest, this is deploying yesterday's IT into the energy market. So I think that -- check the box, by default. Industry, like Cisco, are clearly motivated to do it. But again, it goes back to that public benefit.

So I think, you know, to answer your question specifically we've got all of these kind of soft reasons why this could come to pass. But something that really compels it into a vision and then starts to build those blocks as to why the public wants to become smart grid-enabled, you know -- I continue to go back to that as something we should really think about as

the key issue, not the afterthought or the side discussion.

Mr. BORDOFF: So, Dave talked about how, you know, rural electric co-op sort of had the right -- I don't want to say "right," but had, you know -- didn't have incentives to maximize throughput and electricity sales. And maybe that's why they deployed some of the technology they had.

So I just want to turn to you first, Peter, because you indicated before you had some thoughts about adjustments that regulators might make to facilitate effective deployment of the smart grid. I recall in your book you had sort of detailed discussion of some of the different mechanisms to do that -- decoupling or other approaches like shared savings. Do you have some thoughts on what -- where that needs to head?

MR. PENNER: Well, yes, certainly I compliment the co-ops for their leadership in this area. As some of you know, the idea of demand response or shifting load is really something that avoids the need to purchase during expensive periods doesn't reduce your overall use, you just change the timing of it.

Whereas energy efficiency is really -- the goal is to reduce your use. It's more expensive for consumers to do that, you have to invest capital in your house and get better windows and things like that. There is some interaction between the -- I call them cousins in my book, not clones. And so it's important to distinguish between those.

With respect to energy efficiency, I think for -- at least for regulated utilities who are -- who have regulated profits, we have been saying for -- since the 1980s that it's important for the regulation of these utilities to make energy efficiency roughly as profitable to them as building another power plant. And although that was a dream that we had in the 1980s, it is starting to become a reality today. Where regulators, I think, accept this idea and are now adopting incentive schemes that allow utilities to actually make profit off their own investments in energy efficiency.

Just to cite one example. In Nevada, if you do an energy efficiency investment that the regulators view as cost-effective, it's changing somebody's -- contributing to someone's more efficient air conditioner. The utility's contribution to that is put in their rate base just as if

they bought a power plant. And they earn a profit on it exactly if it was a power plant. And, in fact, you will see here, the CEO of Nevada Power say that is his preferred investment today. So, you do have a change there.

With respect to demand response and pricing, if I could say something in response to Matt's first set of comments. First of all, it was great to hear the more pessimistic Matt, because it's -- I was going to say, it's maybe the first Silicone Valley entrepreneur and venture capitalist in this space who was talking sense. (Laughter)

That was a little harsh, I take it back. But it was -- your realism was really well-grounded. But one thing I do want to point out as my colleagues and I at Brattle Group, we model the price response of consumers. And we have modeled it all over the world. We modeled it for years and years, we have a database of every experiment. And consumers do respond to prices; I don't want anyone to take from Matt's comments that they don't. What I agree with that he was saying is that it's a big, big cultural and economic change to put in what we call in the business "dynamic prices" or time-varying prices. Regulators are extremely hesitant to do that, they're very cautious about it, and there are some good reasons for that.

But -- and they shouldn't necessarily be put in for all customers at all time. There are a lot of customer groups that shouldn't, probably, have those time-varying prices. And it's not necessary. You get a huge amount of benefit out of a very small group of customers that are tech savvy and willing to shift their power use around. So that it's really -- as Phil suggested, we really need experimentation and evolution. And that is something that I'm convinced will take generations to change over time.

But there's -- but that's at the consumer or customer end of the smart grid. What I call in the book, the downstream smart grid. And there's a whole set of issues that are very important to work out slowly over time. It's also really important for everybody who thinks about the smart grid to recognize that the upstream portions of the smart grid -- the parts that are completely invisible to consumers and will be invisible pretty much and should be for almost forever, it's how the utility does its work. Those can be digitized and made much more efficient and effective without getting involved in lots of inter-generational and inter-customer issues. And

that upstream part of the smart grid, that's the part that Dave and his colleagues have implemented quite a lot, and it's really sort of a no-brainer.

It's an inevitability. It's nothing more than the electric utility industry updating its factories. I mean, its factories are power lines and power plants and substations. Updating them for the digital age -- it's like every factory used to be analog and now every factory in the country is digitally controlled and digitally sensored. And we just are a little lagging in doing that to the power grid, but it's -- the pacing factor there is regulators allowing those costs to be recovered, or in the case of Dave's, the decision by the board that they're going to put that money out and they're going to get the benefits of a more efficient operation back over time. It's really the same investment decision for the co-ops and utilities, except with the utilities you have regulators in the loop.

MR. BORDOFF: Does anyone else want to comment on this question and sort of what adjustments regulators need to make to facilitate deployment?

MR. OWENS: I'd like to reinforce something that Peter said. And it may have been lost, because I went quickly. And that is, to us, optimizing the production and distribution is incredibly valuable. It's incredibly valuable to our members, because it keeps the lights on and it keeps the rates low, okay?

The other part where you go and look them in the eye and said, when it gets 103 degrees we're going to charge you $1.20 a kilowatt hour, not so much. Okay? The fact of the matter is that's a really hard sell for reasons that have been mentioned by Matt and by Peter. So what -- I guess the best way to do this is tell a little story, okay?

We had -- because I'm here in Washington and been involved in smart grid and demand response since 1976 -- well, and it's a true story. Because I helped set up with EPRI, the first biodirectional communication control experiment when I was at ERDA, which is the predecessor agency to the Department of Energy. That's how far back it was or how old I am, depending on your sensibilities.

But you know, the fact of the matter is the goal in the short run, okay, is in the ability to understand what the customer is using and optimize that system. That's worth valuable

-- we have seen some of our co-ops can cut 10 percent of their cost, their total cost of service, simply by automating their distributions system. Through voltage optimization, through, again, AMR and things like automatic meter reading, through reduction in the amount of time and cost to go on a trouble call. You know, that 3,000 mile line, that's a long way for 18,000 customers. So, you know, by focusing on that, you know, I -- and nobody has any trouble selling that to consumers, all right? It's -- so I think we've made kind of a mistake to go in the rate thing so hard that that's the focus of all the smart grid.

I think that's really a mistake is -- as my friends -- I started to say, and I think complete story -- look, we were together with the vendors, the utilities, and everybody. And somebody -- I won't mention his name, but -- jumped up and said that we're all in agreement. Everybody is in agreement, but the consumers are not on board. And I went, oh, my god. You know? That's, I think, the problem we've got, okay?

MR. TREVITHICK: I do think that when we talk about, you know, the consumers not being on board or the regulators being concerned, these are serious things that have to be considered. But I also think we have to recognize that, you know, the math is the math -- I think that's Karl Rove. And at the end of the day, the consumers are going to pay for the costs of these services, and the operation. And when we talk about how they are charged for it is about, you know, may impact individuals differently. But in the aggregate, you're still looking at the same amount of money.

And hopefully, what we're looking to do is if you have an improved system of both production and consumption that overall consumption is going to decline, and that the very high costs of peak sources declines as well, which is going to create an overall savings for consumers. And I think, you know, getting used to something that's new and different is something that has to be worked on, there has to be a lot of education, a lot of discussion. But the notion that somehow this is just bad for consumers or that they're not going to like it I don't think is something that we should just assume going into it.

I mean, I'm old enough to remember when you waited until 11 o'clock at night to make a long-distance phone call because the rates went down. And you know, eventually the

costs of providing additional long-distance capacity went down so much that, you know, moving demand from day to night didn't matter that much in the telecommunications system, which is why we have a lot of flat-rate pricing now.

But in the world of electricity, that is not true, you know? Moving stuff around has enormous benefits. And so giving the consumer the incentive to save money by doing that and lowering the overall aggregate cost is a win-win for the consumers. So I think we should sell it as a win-win.

MR. BORDOFF: So, there's another piece to the consumer question that Jason averted to, no one's picked up on, which is, if people start buying electric plug-in cars that could sell back to the grid or buy from the grid at different times -- and if people start installing solar panels on their roofs and that becomes a social norm -- people I guess have called this sometimes the "Prius Effect," right? So you people like to be seen as being green. So if that starts to happen, how does that interface with drive, consumer awareness of, interest in, use of the smart grid?

MR. TREVITHICK: I have an opinion on that, because I also invest in vehicle technologies.

My personal view is that the electric vehicle -- the plug in hybrid electric vehicle may be a Trojan horse for much of the smart grid technology. Because that is such an extraordinary purchasing decision and behavior that I think it really accompanies a new relationship with the utility company.

So you buy an electric vehicle -- I don't think anyone that did -- first of all, they're going to be an early adopter. For the next decade, at least, you're going to be an early adopter. You will identify -- you know, all the quirks of your vehicle as part of your personality. The Prius Effect, to your point. And I think when you do that you will then, you know, appreciate that there are now going to be just a change of how you consume electricity. Very, very simply in PG&E territory, they want you to have a separate meter that would now have a different pricing system to other electricity use. And at that point, I think that the utility would be perfectly able to have the conversation. You charge that Prius at 5 o'clock in the evening on a peak pricing day, it's $2 a

kilowatt hour of electricity. And you'd say, hell no, I'm not going to do that. And I think with very simple technology you could defer that, you know, past 11 p.m.

So I'm actually really excited about those technologies. And that's kind of a point I want to make is, embrace the early adopters, right? If you try to -- you know, solve the entire problem at once it's an impossible challenge. But go after these people that have already accepted the complexity and, in fact, they not only accept the complexity, they embrace the complexity. It's part of who they become. So whether that's a, you know, a driver of electric vehicles, whether it's a rural cooperative -- and rural customers, I think, are unique class of customers -- or other niches. The islands of Hawaii, for example. Somebody mentioned storage earlier on. You have an island in Hawaii with a windmill. They are the world's leading, you know, market for storage because the microgrid is destabilized if that blade starts to turn.

So, embrace the early adopters. I think they are our Trojan horses.

MR. BORDOFF: So, and just a follow-up question on, Jeff, your point about sort of asking consumers to ultimately pay for this. I'll just throw this out for anyone. But, you know, the utilities are obviously facing pressure to invest in smart grid, but the standards for many pieces are not yet finalized. So, how do regulators charge with protecting consumers -- how can they be assured that the costs they're asking consumers to bear are not for technologies that may be rendered obsolete in the near term?

Anyone have any thoughts on that?

MR. PENNER: No, and I think that's a very important question. And it points to two factors. One is that, you know, the regulators should take an active role in investigating and intelligently assessing, you know, what they're being asked to support or to put into rate basis and whatnot. And that makes a lot of sense.

But it also highlights why it is important to look at a platform for smart grid that is ostensible and more future-proofed. And why we believe that running it on an IP-based platform gives the opportunity to interface with legacy systems that exist today that are both analog and digital systems that are out there. Interoperate with newer systems that come along, revisions of older systems, and operate as an intersection of all that information, which helps to future-proof

both the existing stuff that's out there or any future choices that you make as long as you have an ability for those things to communicate with each other, interoperate at some level. That's not going to be, you know, a gigantic problem that you're going to have stranded investment.

You may make -- not make the best technology choice in a particular situation, and that just -- that's the nature of the beast. That will always happen no matter what you do. The only alternative to that is to do nothing. But what you can do is operate it within a system that's based upon good communication protocol standards that will then allow for more future-proofing of what's going on.

MR. BORDOFF: Anyone else?

MR. OWENS: Let me mention -- and I couldn't agree with you more. We've dumped 7-, $8 million in our own research budget to develop an IP data standard called MultiSpeak to help do that. And we think that's a very critical thing, both to future-proof and to make sure that we don't waste legacy systems. That we get them to talk to each other and move forward. Again, it's keeping the focus on the cost containment.

You know, our rule of thumb, typically, is you can get 80 percent of the benefit with 20 percent of the cost. That's typically kind of the way the co-ops go. So, you know, we're always looking at that. Can -- how far can we go on how few dollars? Again, that's the pressure from having a publicly elected board. Regulators can be tough, neighbors with pitchforks and burning brooms can be really tough.

SPEAKER: I'll just try one with a very specific example of a line of technology development that we're very interested in. It's called energy use disambiguation. So, this is if you have -- I'm not -- I didn't realize that was so funny. Okay.

AUDIENCE: Don't use those words.

SPEAKER: The disambiguation. I'm in D.C. I have to use the big, big words.

SPEAKER: We're embracing the complexity.

SPEAKER: And so basically the idea here is -- and one always asks what is the resolution of energy data that you need to be able to extract useful information -- and let's say for the sake of this argument that useful information is going to be information about how you're using

your electricity or your gas and therefore better inform the customer about what changes they might do to alter that use of electricity.

You know, if we think about, you know, the ideal scenario, it would be you'd have a single data stream collected, you know, once per building -- let's take in -- take a residential home -- and by applying signal analysis to that you could extract the information that said, you know, this looks like your fridge turning on and off; this looks like your air-conditioning; this is your stove. We're incredibly encouraged that if you have about one second data resolution, you can extract with remarkable fidelity the major energy use -- you know, the energy uses in your home. And so what that means, it would allow somebody to say, you know, we've analyzed your home and it appears you have a refrigerator that is operating at one-third the efficiency of a modern refrigerator. And then you could do an ROI calculation to, you know, figure out that if you bought a new refrigerator you might pay for it in 12 months. Now, that's something I think consumers could get behind, right? Let's get new appliances in this, and it also adds, obviously, follow-on effects for the economy.

Where I'm going with this is we're deploying all these smart meters. We now know that if you have energy data at about one second resolution, you can do all these wonderful things. If those smart meters were enabled with open standards -- I agree completely the IP-based open home system -- certain consumers can say hey, I'd like to turn that on; I'd like to have access to that data. And of course we'd want it to be, you know, secure and private, but again to be consumer opt in. I think we could find out relatively quickly, you know, certainly within the two- to three-year period of time -- just have a far greater visibility into how the American population is actually using its energy, and I think that would have the spill-on effects into other areas. But, again, that only happens if you have these open standards.

To complete the story, so I've had a smart meter installed in my home for about two years now. I can go on to the Pacific Gas and Electric website and see my energy usage and hourly resolutions from the day before. The technology is in that smart meter for me to see the data every seven seconds, but I have no ability to turn it on. PG&E won't let me turn it on.

So, that's -- you know, I think we're kind of, you know, almost wrestling with

ourselves in some of this, and I think just for a decision we made to open the standards that that do future-proof this a little, but I think it's completely possible.

MR. BORDOFF: So, I've gone on a bit long. I don't want to go too much over, and as Bill said, many of you know more about this we. So, I want to open it up and take a couple of questions for our panel before we wrap up.

Yes. Right, yeah, in the front. Oh, we're waiting for a microphone, sorry.

MS. WERTHEIM: I'm Mitzi Wertheim of the Naval Postgraduate School. I thought one of the arguments for trying to reduce the amount of energy we're using, certainly at peak times, is that with the increase in demand for energy what we do is we postpone the need for having to build new power plants. Is that not a part of this conversation? It seems to me that has to be told. I mean, that has to be part of the story you are trying to tell the public.

I started this energy conversation, and I went and got from Don Rumsfeld's office the poster he had all over the Pentagon, which was Uncle Sam, and it said "We're at War, are you doing all you can?" And I picked it up, took it back to my office, and had the language changed, and it reads, "The energy smart, are you doing your part," and when Obama got elected, I had the red and blue changed to green. I used that, because I created this energy program in the military back in '06, and we had to make sure that it was macho and patriotic, and I think I will send you guys at the White House my poster and you can decide to use it if you want.

But I think you have to make -- well, I grew up during the second world war, and we all felt we were helping to win the war, and my own view is the leadership has to make all of us feel a sense of responsibility about both energy and climate, and what's so interesting to me is the Defense Department's new view is the destination is sustainability. Their language is changing. And sustainability is not only having a country that works but having resources that are available for all of us to use. So, I think you have to work on your story and have it coming from many parts of the government so you get us all caring. At the moment we only care about ourselves. You need to have us care about something beyond ourselves. And all this discussion is about money and how much money am I going to make, am I going to save a little. Think about something beyond that.

SPEAKER: Respond to that. Respectfully I disagree a little bit in the sense that one of the new nuggets that I got was recycling is a metaphor, and that is something that I had not been reflecting on and bears a lot of reflection. I don't know who here knows the story of how recycling has taken off as a movement, but it's an interesting way to think about this and about social consciousness and about public spiritedness. It's different than the cell phone metaphor, which I don't disavow entirely. Someone else suggested it. I think there's something to that. Part of it is we don't know where this is going, because there's of lots of intersecting trajectories. But I also think wherever it's going it's going to go there because we are as a country having to grapple with energy security, and that's going to be a critical motivation, and it's only going to work, and it goes, as you said, Matt, if the public gets it, embraces it the way the public did recycling. And I have to say that the amount of money you're saving is (inaudible). I don't know how big the incentives are there, but most people aren't recycling for the money; they're recycling because they believe that our country can't afford to keep dumping, you know, materials in essentially landfills that are obviously getting filled up. So, I think there is something there, and again I don't know who has reverse engineered that recycling story and then tried to provide a roadmap for smart grid, but whoever has, we need it.

MR. BORDOFF: I understand one thing, which -- I mean, we were sort of asked to focus on a fairly narrow set of in-the-weeds questions here. I hope it doesn't escape people's notice that the task force the administration has set up, the Subcommittee of the NSTC, to look into smart grid. You know, you have White House sponsors of that from the National Economic Council, the Office of Science and Technology Policy, and the White House Council on Environmental Quality. And there's a reason that it's an EQ we've committed to devote significant amount of resources toward the smart grid, and I don't think you can listen to the President talk about the smart grid without hearing exactly the sort of message that you're talking about.

MS. WERTHEIM: This is a story that you have to have everybody engaged in.

MR. BORDOFF: Yeah. No, I understand that.

MR. SHANER: Brad Shaner from Mitre. I'm interested in businesses' perspective on security. I get the economic portions, but I'd like to hear what business has to think about grid

and grid security, particularly Jeff and Matt, if you'd be willing to step up I'd appreciate it.

SPEAKER: Security has to be a core aspect to anything we do with respect to the grid itself and with respect to smart grid systems and has to be baked in from the beginning and must be, you know, it will likely succeed well if we base it on existing standards and existing processes so that we have for securing communications infrastructure going forward. And so, you know, it's -- you know, it doesn't get talked about as much as it should get talked about, but part of that is that I think if we think about this systemically and design it in from the beginning as a base part of every system that we're putting forward, then we're not likely to have significant security problems. If we do it later as add-ons or we start thinking about it after we have designed everything else that is out there, we're going to have significant problems.

MR. TREVITHICK: Venrock has a very healthy practice investing in security software, so this is part of our discussion about the grid, and my partner leading that effort jokes that the benefit of a dumgrade is it's really hard to hack. There's not many point to address. And so, you know, we should be very mindful of getting what we wish for, which is now a grid with multiple nodes, all of which are now connected to the internet and susceptible to some degree of malfeasance. Probably that's a world we'll just -- you know, we'll have to deal with, but I think the honest answer is it is now an increased complexity that the smart grid provides.

I also want to touch on another issue that's been mentioned a couple of times about privacy, because I think the two things are separate -- security and privacy.

Privacy is a very interesting thing, because when we look at the evolution of our own just use of technology, there has been this relentless path of actually decreasing security and decreasing privacy but dramatically increasing convenience. I just think the banking system now. We all put out credit cards or at least probably most of us put our credit cards over there now fairly freely and the business model of credit card payments now provide some level of insurance, but as a result, you know, we have e-commerce and it's much simpler. I think this goes back to messaging to the public. I think if we're willing to compromise some degree of privacy, some degree of security, again hopefully as little as possible, you know, to compromise it both, I think we could achieve a much greater level of convenience, you know, and benefit.

MR. BORDOFF: Questions? Yes, please.

SPEAKER: Hi, Medi Shu from the Science and Technology Policy Institute. I'm really curious about if you could contrast more co-ops versus industrial and utilities, and I'm wondering is it because co-ops just -- you know, people pay higher rates in general, that it's more sensible to deploy smart meters, or what can you teach, you know industrial and utilities, what you do to I guess make that business case.

SPEAKER: We don't think we can -- we should teach them anything, and it's not because our members pay higher rates; it's the focus on keeping the rates down. You've heard three or four speakers already today say no matter what happens, electricity costs are going up, take it to the bank. Okay, what we're trying to do is mitigate those cost increases as much as we can by optimizing the production, transmission, and delivery system using bidirectional communication and control, i.e., smart grid concepts, so we're trying to keep the rates as low as possible by optimizing the use of our existing assets and optimizing the use of the current assets.

You're exactly right, ma'am, the fact of the matter is, part of this is so we don't have to build new power plants, okay? But that's not the only part of it; it's optimization in real time.

So, we're not trying to teach anybody, and we do it differently. Making a buck -- that's the way most of America runs. We just don't happen to be that way. We're not saying everybody should change to us. We're just saying in our circumstance, this is why we became leaders in the smart grid.

Can I just say one thing I forgot to say. I thank the administration for the ARRA funding. We are out in front, no question about it, but because of that funding we're investing totally almost three quarters of a billion more dollars in the smart grid, so thank you, guys.

MR. BORDOFF: So, I think we're almost on time, maybe a minute or two over, so let's end it there, and I'll turn it back over to Darrell. Thanks, everyone.

MR. WEST: Thank you, Jason, and thank you to our panelists. Our last session, which will start in a couple of minutes will be a closing session with George, Jason, and Phil giving their closing observations on this.