THE BROOKINGS INSTITUTION

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

Washington, D.C.
Wednesday, July 14, 2010

The Evolution of Smart Grid Technology/Optimizing Tech Architecture to Use Case:

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P R O C E E D I N G S

MR WEST: I think we are about ready to reconvene, so our next panel is going to look at the evolution of smart grid technology, optimizing tech architecture to use of the case. The moderator for this session is George Arnold of the National Institute of Standards and technology, so, George; I will turn it over to you.

MR. ARNOLD: Okay, thank you very much, Darrell, and I'd like to welcome you back. So we're going to circle around again to the topic that we started the morning with which is technology. And as several people observed, technology is really a key driving force that's enabling what we're doing with the smart grid, but as we've learned through other technology transformations, the course of technology is often hard to predict. Some technologies don't pan out in the way that you've thought they did; other technologies that you didn't even think about, you know, wind up really having a profound effect on the market.

And so we've assembled in this panel some really stellar people with a strong technology background. We've got two national laboratories; we've got two technology providers; we've got a syndicated research organization. So it's my pleasure to welcome Larry Makovich, Vice-President and Senior Advisor, The Global Power Group at Cambridge Energy Research Associates; Dada Gudbolade, Director of R&D for Honeywell Automation and Control Solutions; Steve Hauser, who's Vice-President with the National Renewable Energy Laboratory; Rob Conant, Senior Vice-President of Product Management at Trilliant , Incorporated, and Mike Davis, who's Associate Laboratory Director for the Energy and Environment Directorate at the Pacific Northwest National Laboratory.

Their bios are in your handouts, so I won't read them. But what I'd like to do in lieu of having with the one-hour sort of time limit that we have, we're not going to have presentations per se, but what I'd like to do to start the conversation going is to pose some questions to the panel and ask them to respond, and at some point I'll open the floor up to you all to direct questions in areas that are that you would like to.

The first question I'd like to discuss is, well, some people characterize the smart grid as a bit like the blind man feeling the elephant. Now, I believe that there's no one on this

panel who's blind, but, you know, the fact is that the smart grid as an end-to-end concept going from generation all the way through to devices has many, many aspects and different communities, different localities have different priorities, and so everyone sees this in a slightly different way.

So what I'd like to do is to ask each of our panelists here to spend a few minutes and paint a picture for us. Let's, you know, look out in time. What I'd like to ask you to do is to paint a picture on what is your vision for what the grid is going to look like in five to ten years, and how do we get from where we are today to your concept of this future vision?

So I'd like to maybe start with one of our national labs and ask Mike Davis to paint your picture for us. Mike?

MR. DAVIS: Thanks, George, and I hope this panel can do as well as the last one. That was a great panel, so, but I think before I talk a little bit about the future, I'd like the level set in terms of how I -- a way to think about the grid today. And I actually think about it from a technological point of view as a whole bunch of assets, big assets on the supply side, owned, operated by utilities, and we pay for that, and an incredibly large number of assets on the demand side which we own, operate, and pay for largely individually. And what I think we're talking about in terms of smart grid is essentially that combination of assets, supply and demand, and the reality of what we're trying to do is essentially apply communication and intelligence into that network. And the question is, where do you put the communication and where do you put the intelligence? What's the cost and benefit? Who get it? When?

Now, there's also some other important distinctions, I think, in terms of what the future might be. That supply side asset is really organized in 3,200, give or take, service territories. Every service territory has a geographic boundary, regulatory boundary, and a financial boundary. But there's 3,200 of them, and they're out there working really fine today. As to supply side, it's highly regulated, and it moves at the rate of regulation.

Now, that supply side has done an amazing, amazing job over the years because it has met all the demands, if you will, of the demand side. But the demand side is essentially, you could think of it as one big service territory. And what we've done is we've created a great,

great big market that we've served with an average price that we've never disaggregated in terms of benefit.

So I'm thinking that there is potential of a revolution here that was talked about in the last panel, but the question is is it going to happen on the supply side, regulated and slow for good reason every 200 entities? Or might it happen on the demand side? It's essentially one big area that's unregulated that, in fact, could evolve at the rate of the entrepreneurial spirit. I'm convinced that there will be service providers that will disaggregate that demand market and have an awful lot of the infrastructure in place to already do it

I don't know how many portals you have in your home, but I've got three in mine, and the people that have actually put those portals there really do understand service. They actually treat me as a customer as opposed to a meter. Now, some of them are better at it than others, but if I had to score service providers relative to utilities, and I had to look at slow in terms of evolution versus fast, I think the evolution, or potentially the revolution, it will benefit us all. It will occur on the demand side of the equation.

I think there will be service providers that will disaggregate that market, that will provide certain values to certain entities that can actually benefit from those, and essentially allow individual customers to get benefits they couldn't on their own but can, if you can aggregate them to the point of having sufficient demand capacity that you can then actually dispatch back against or with the utility for benefits in both sides.

Now that's the future I see, and I see that future changing dramatically. I think it will affect business models. I think it will affect regulatory structures. So let's take a very careful look at what happens on the demand side. We've got an amazing opportunity to really get in to this -- and Pat and others are going to have a lot to do with this whole issue of smart grid demonstrations. We're fortunate to be involved in three, one in the Northwest where we have Bonneyville Power Administration and 12 additional utilities, one with American Electric Power and one with National Electric Cooperative Association, the point being that we've designed experiments around these functionalities. We've designed experiments to figure out where to put intelligence and communication through this whole collective set of assets.

The data that's going to come out of that in the ones that we're involved in all come to us. That data, I guarantee you, is going to get analyzed very carefully because our objective is to find out what the value proposition really is and how you get it, and who gets it, and when they get it in terms of this new intelligence and communication that we're spreading out throughout this infrastructure.

So I think the revolution will occur on the demand side. I think it's going to have some real challenges for the supply side.

MR. ARNOLD: Okay, thanks, Mike.

So, Dada, you represent a company that provides a lot of innovative technology on the demand side of things. So I would assume you agree with that. But tell us a little bit more. You know, paint a picture for us of where you see the technology and capability heading on the demand side. And what are the implications of that for the supply side of the grid?

MS. GUDBOLADE: Okay. I would like to carry on with the course that Michael was mentioning. The demand side is pretty much not yet advanced to the level as the supply side. The supply and D&D infrastructure has a lot more automation, a lot more reliability improvement elements. The demand side is pretty much open: You must get electricity, they use it, and they get a bill. So on the demand side, but then on the other hand it was also mentioned in the morning that the large industrial customers and the large commercial customers, they already have a lot of technology for doing demand side management. They understand that the energy management, energy efficiency is a big deal on their bottom line.

So you take a look at, say, Walmart or Office Depot, or Home Depot, are original. Some of these large retail chains, they have technologies where first of all they already have interwall meters, and they have even submeters. They have installed many of these meters, submeters, on their own, and they're collecting information and analyzing it. And analyzing it and then using it to provide feedback to their employees to change their behavior.

And so what they're doing is three things: one is collect information, analyze it, change behavior; and, finally, there aren't any employees that are actually looking at how to manage energy. They have automatic second forget controllers. So you have automated control

system that takes into account the things like, you know, when at night your Home Depot store is closed, you don't need lights. You don't need air-conditioning, so on and so forth. I mean we need to spend energy when it is needed by the people that are in there for comfort, for safety, for efficiency. So they're trying to match the energy used with the context, with automation and control.

So if we can now take the same analogy and can we take it all the way down to the consumer level, to the smaller commercial businesses to the smaller strip malls, to individual buildings like this, and all the way to the homeowners, if they could have a simple-to-use second forget-type control system, it could be a, you know, appliances becoming smart and saying, you know, I can run my defrost cycle when the pricing is lower. It could be, you know, changing your air-conditioning or cool from behavior and so on. So all we need is some information about pricing. This could be a simple time-of-use pricing, or maybe demand response, and just a simple way to input their preferences. Consumers need preferences and consumers need automation.

That's sort of what we have learned from various research that other industry blephs have done, we have done, and with that I can paint a picture of that, you know, you could have a simple enough appliance, a automation appliance. It could be your iPhone, it could be your smart phone, it could be a dashboard in your home, it could be your thermostat. You know, what have you. Delivery could be multiple ways, but there is a choice for the consumers to input their actions and then enable the system to save, to save energy. That might be all the time or that might be during peak-end introduction. But that's what bringing what Walmart is doing today to save energy aggressively all the way down to individual customers.

MR. ARNOLD: Okay. Thank you, Dada. So we've talked about, you know, the demand side and, you know, using or saving energy. Let's talk about generating energy and renewable energy. Steve, paint a picture for us from your perspective on what the future grid will look like.

MR. HAUSER: Sure, George, I'd be happy to. And I want to add my thanks that Mike mentioned. The sessions this morning I thought were really excellent, and I applaud the

organizers for bringing together such a good group of folks both this morning and this afternoon.

This is a great, a great day for understanding the smart grid better.

My remarks are going to align a lot with both Mike's and Dada's, I suspect. You know, we've had this implied contract with consumers, and I think Calvin mentioned that in an earlier session that we are to provide power any time, anywhere, and in any amount they want. If they turn a light switch on, if we turn a switch on in this room, we expect the electricity to be there. That paradigm has fed our economy and, in fact, was essential to the growth in our economy over the last three or four decades, but we've outgrown that model. Unfortunately, our policy and our business models have all grown up around that, that contract with consumers.

What we've got to do looking forward is to change the paradigm. We've got to change how we design, build, and operate the system in a way that is much more highly integrated, much more complex system that certainly captures the value, as was talked about also this morning. What becomes important is diversity. What becomes important is consumer, the ability for consumers to participate in the system. What becomes important is innovation which, again, was mentioned this morning, but innovation that brings us a new suite of technologies that tend to be much cleaner, much more reliable. They tend to be distributed as well, and I think we're going to talk a little bit more about some specific technology, so I won't get into the details of that.

What's important to understand is we can no longer provide electricity anytime, anywhere, and in any amount, and we've got to change the way the system is organized, and that means a couple of things: It means changing policies and business models -- that's the though thing -- and that was alluded to a little bit in the last panel. It also means changing the technology, the integration technology, the ability to understand where, how and how much electricity is being used for what purpose and how to manage that in a much more proactive way.

Certainly, as George mentioned, renewable technology is going to be a key part of that. I think Pat this morning mentioned the variability issue the more we adopt renewable technologies that bring a new set of characteristics which tend to be variable, tend to bed time of day, tend to be fast ramp rates up and down quickly. The system hasn't been designed to

accommodate those easily. It doesn't mean it can't, but it's not an easy thing to do. And so we've got sort of some challenges from the technology side to look at what are the integration issues? How do we understand what the value is? How do we capture that value for consumers and for utilities and create new business models that are really sustainable.

MR. ARNOLD: Thanks, Steve. So I'd like to next turn to Rob. Rob, I believe your company is in the business of providing communications for the smart grids. And that's clearly a key aspect. Paint for us a picture from your perspective on what the grid if going to look like.

MR. CONANT: Sure. Thanks, George. Thanks for the invitation also to be here.

So I'll paint a picture of what I think the smart grid will look like in five years, and one thing I want to touch on that hasn't really been the focus of conversation today, but there's a tremendous amount of operational benefit for the utilities in rolling out smart grid that is a core part of their business case.

If you look at the transmission system at the highest level, it's highly automated, there's a lot of communication systems already deployed at that level, tightly controlled, but at the distribution level between the substations and the homes, there's not nearly as much communications technology because it hasn't been technically viable, traditionally. And so one piece of the smart grid is instrumenting the distribution that worked with the same kind of intelligence that already exists at the transmission network.

Now, that doesn't require any new fundamental science, it doesn't require any fundamental new technologies to be brought to market; what it requires is taking the economics of the improvement of communications technologies and deploying them on the distribution network. And there are real tangible benefits for the utilities in doing that, and so some of those are metering, being able to remotely connect and disconnect customers, voltage management which allows a utility to more -- to potentially reduce the overall load on their system without an impact on the customers, theft detection, so a lot of, in some areas, theft is a pretty significant problem, and in some places in Canada.

I was amazed to learn that in some places in Canada, there are some substations where 85 percent of the electricity is stolen. Not 85 percent is bought, 85 percent is stolen. It's absurd. So there are a lot of real operational benefits that can be captured by the utilities.

Now, there is another -- something else that is happening in the market is there are some regulatory and policy constraints that are being placed on utilities because of things that we and the public are interested in. And so one of those is integration of renewables: electrification of transportation, electric vehicles, generation constraints as someone earlier mentioned, that it's very difficult to build a new coal plant in the United States today.

These are regulatory constraints that we are imposing on utilities. And utilities are looking for ways to allow them to deal with those constraints and in, to some extent, the smart grid is the way that they can find to reasonably deal with those constraints. So utilities are proposing smart grid programs that allow them to integrate renewables, allow them to embrace electric vehicles, allow them to reduce peak loads so that they don't have to bring a lot of new generation allied over the course of the next 10 years.

The recession has been a real benefit in some ways because it's pushed -- it's reduced the increasing rate of electricity consumption to sort of push that out a little bit in to the future. It's given us a little bit of breathing room but not very much.

So those three regulatory constraints that I mentioned are really addressed by the demand side, managing demand more effectively. And so that's really what people are focused here on today. And I'm a technology guy as well, and what we're doing in the industry today is really defining what this market will look like for the next 20 years. And there are some key decisions that are being made in the industry today that will determine whether utilities are the ones that are managing demand inside consumers' homes, or whether it's other companies that are providing that technology to manage demand inside consumers' homes.

We heard Aneesh talk this morning about creating open and competitive markets: clear, timely information about energy consumption pricing, frictionless markets, innovation. I cam out last night, I'd -- working in Silicon Valley, and there's a tremendous of

excitement about the opportunities for managing people's energy demands inside their homes. And the regulatory structures that we put in place will determine whether -- whether companies, if it's small companies, small innovative companies are going to be doing that work, or whether it's going to be done by utilities in a more regulated environment.

And that's a critical question that, you know, as policy setters, those questions really need to be answered. If we, I think if we answer them in the way that gives the power to the consumer and allows free and unfettered access to that information about energy consumption within the home, then you'll see just a wealth of different kinds of, new different kinds of companies coming to the market with products that help consumers manage their energy consumption.

So we talked about prepayment. We talked a little bit earlier; we talked about the ability for consumers to be able to set the amount of energy they want to spend on their bill. You know, these things are all possible, and the questions that we're facing are going to determine whether these things are done through regulatory processes, or whether they're done through market innovation. And that's not so much a technology question but really a policy question, and that we will end up with two dramatically different futures depending on which one of those paths we choose.

MR. ARNOLD: Okay, thanks, Rob.

So, Larry, let me ask you to speak next. Your role with a snicketed research organization, presumably gives you very broad visibility into a lot of, a lot of things. So what is it your crystal ball tell you on what the smart grid is going to look like in five to ten years?

MR. MAKOVICH: Well, George, you set us up well with your example of the PC and the Internet, and how difficult it was for people to envision how it actually played out. And right now we've got a number of people together to do a study of how will this smart grid play out, because it does look complicated and there's this history that it's very difficult to predict where it's going.

So I'm going to share with you some of the preliminary research we've got as to where we think smart grid is evolving, and I wanted to point out this is what we think is going to

happen, not necessarily what we would hope would happen. But it looks like over the next five years we're going to be on a pace of tens of billions of dollars being invested in smart grid. That being the case, I think in five years' time, it's going to be pretty clear that the killer application of all this smart grid investment is not going to be real-time pricing.

I think it's very interesting as we dig in with our research here how our customers are very different one to another. There are a small set of people that are innovators, early adopters that really like the idea of real-time pricing and control. The trick here is all the pilots that we've looked at have all been voluntary. And what we're afraid of is they suffer a very serious self-selection bias. The people that participate in all this real-time pricing are these innovators.

We've got a lot of very compelling evidence that the vast majority of residential and commercial customers don't want real-time pricing; they want stable and predictable prices. We've got two states where they've actually had this customer preference worked through the political system, and they've passed laws saying you can't mandate real-time pricing.

What I do think in five years' time will emerge as the killer application instead is that smart grid is going to be very critical for the measurement verification and settlement of utility-run efficiency programs and third-party aggregator programs. And this is large part because I think the smart grid will result in a little bit of time differentiated pricing, but nothing close to real-time pricing. There's going to be this opportunity for third parties and utilities to get the efficiency investments done that we're not giving people the signals to do.

In five years, I think it will be pretty obvious that the technologies we're talking about -- sensoring, metering, communications, databases optimization -- are going to have their biggest impact in the high-voltage transmission end of this business, not the distribution end. I think that's going to be later.

So as we get 10 years out what do we expect? I think we're still going to be far short of full-scale deployment of a mature smart grid. I think we need a lot more experimentation, a lot more pilot projects. I think that in 10 years' time people will look back and say this has really evolved much differently from what people thought it would 10 years ago. I think it tends to be

strengthening the central generating station power grid model rather than leading to a distributed generation industry structure.

I think that 10 years from now the grid through-put will be 15 percent higher. I think we're going to have a very minimal impact on electricity use with the implementation of smart grid. I think most of it will be targeted towards trying to attack peak because I think the background trend here is peak is growing faster than energy use. Markets will be tightening up in the next five years. That's where the real value is going to be.

I think demand response is going to be a small and secondary part of renewables integration. I don't think it's going to have a big role there or even in 10 years' time, and I think with -- it's going to be a key enabling technology for electric vehicles, but as we dig into that our research is telling us that's not likely to be where most people think which is urban. Because implementing smart grid with plugs to recharge cars in urban environments doesn't look like the most likely place. The economics say suburban is much more likely.

So that's just kind of a rough picture of what we think in the next five and ten years is likely to play out.

MR. ARNOLD: Okay, thanks, Larry. That's a very interesting perspective, and certainly your comment about more central generation, I wonder if some of the panelists would like to -- how do you see this? What do you think the balance is going to be on central versus distributed generation? Anybody like to comment?

SPEAKER: I kind of picked on the demand side to start with, but that's not to say there isn't a great deal of benefit that we can get with communication intelligence on the supply side. I do think the ability to generate commodity electrons and the ability to do that efficiently, we're forcing new forms of generation into the system. That's a social policy we're doing and that prevents or presents certain challenges, but it, in facts, can happen.

One of the things that enables that is transmission and where and how do we build transmission, and who pays for it, and how does that get resolved? That's a set of challenges that we're going to have to work out. That's going to take some time.

One of the things that I haven't heard mentioned that I think is also usually important; it would be wonderful if we could put some inventory in this system somewhere called storage. And the difference between transmission and storage is really quite important to the things like renewables. Transmission is what I call a directional build that typically involves a whole bunch of service territories. Storage is a point build. I can probably build storage a whole lot faster if I had storage technology than I can transmission technology.

So adding some inventory to this system as we start to accommodate intermittence, and adding some inventory to this system as we start to take on the transportation load, those will be important things to consider. People have pointed to the efficiencies that we can get in the distribution system. There's important efficiencies, absolutely important efficiencies that we can get with adding what we already know and can do to the distribution system that we've done in some cases in the transmission system.

So I do think there will be continuing important progress that, quote, "smart grid technologies" will enable on the supply side, but I think we're going to have to somehow come to some fundamental questions about what we do with transmission, how that gets resolved, and what we do in terms of adding inventory or storage into the supply side of the equation.

MR. ARNOLD: Steve?

MR. HAUSER: I see central versus distributed as largely a business model question. So in the five-year time frame, are we going to really change our business models? No, probably not. But in 10 years, 15 years, absolutely. And I think the business model change will definitely drive towards more distributed, and I was trying to think of a good example, but the earlier panel talked about the importance of demand response. And the more demand response tends to be distributed, not central, and the more demand response we do, the more we attack things like reserve margin which is traditionally a central generation sort of requirement to operate the system.

I think easily within 10 years, maybe sooner than that, we could consider eliminating reserve margin requirements that would reduce the drive towards central generation as one example of the changes.

MR. ARNOLD: So there's an issue here I'd like to explore with the panel, which is the difference in sort of the traditional assumptions used by the industry on how long technologies will be deployed versus the short life cycle of the electronics and IT technologies that are at the core of much of the automation going into the grid.

What -- how do you see this dichotomy, you know, playing out where, you know, in terms of, you know, rate regulation and so forth. You assume decades, assets get depreciated over decades when, in fact, you want to deploy new technologies on a much more frequent basis because of the improved functionality and performance and cost effectiveness.

Who'd like to take that one on? Rob?

MR. CONANT: There was -- I think there was a comment earlier about the reliability of electronics components, and I'd -- I'll address that, that specific point first before moving on to the broader point. Electronics are actually much more reliable than traditional solid state meters so the physical meters that people are deploying today will have lifetimes that well exceed the 20-year depreciation cycle that they're planning.

But the real challenge in this industry is that the utility product life cycle is something like 10, 20 years. The consumer product life cycle is 18-24 months I think it's a disaster that I have to wait two years to get a new phone. So, and what we're talking about with the home area networking is an intersection between an industry that is used to a 20=year product life cycle, and people and consumers or customers, they're interested in an 18-month product life cycle. And the intersection between those two is tricky. It has to be very well defined and very stable because it has to support the 20-year product life cycle, and it also has to be very, very simple so that it can support the 18-month product life cycle.

And an example of this is the plug, right? So a plug is a great interface between the utility and the consumer, and, luckily, the regulation hasn't had to drive what's on the downstream side of the plug very much. So consumer electronics companies can innovate as long as they're using power coming out of that same plug. They can do whatever they want, and the product life cycle of the things on the in-home side of the plug can be, you know, a week if you want them to be.

But that plug is going to be in that house for 50 years, you know, maybe more than that. So it's that intersection point that really becomes the critical interface between the life cycles on the utility side, the regulated side versus the life cycles on the consumer side, the unregulated side.

MR. ARNOLD: Thanks, Rob. Datta?

MS. GUDBOLADE: Yes. I would like to follow on, on that plug analogy and, as everybody has mentioned, smart grid is really overlay of communications and IP technologies on power. Power technologies would like to extend an analogy to the demarcation point between the utility and the consumer for the communication and IP infrastructures. So not only the power plug, but if there is a standard way to interface the data from the utility in the consumer premises, customer premises, so a standard clear demarcation point, then what will happen is the consumer electronics industry can utilize innovation and can develop new technologies.

I mean it could be the metering company, it could be consumer electronics companies; they are already in market right now. There are ways -- there are Wi-Fi TVs, there are Wi-Fi Blu-Ray players, there are ways to control your security from your iPhone. You have, you know, iPhone aps to control your own security. You can control lighting from anywhere, and there are ways to advance technology regardless of how the communication happens, so as long as, you know, IP-based communication between multiple parties so if you look at Internet protocol that has the Y-40 years plus, evolution both on the utility side, the telecom community side as well as the consumer electronic side.

So if we have a clear demarcation point between where the utility comes to your house, maybe at the meter and just, you know, for wider plugs for communication just like a plug for power. And from that plug you get information from the utility, whether it is consumption information, whether it is pricing, demand, response, you know, a standard way to define it, then we can use the revolution in broadband.

For example, you know, FCC is looking at broadband evolution. Broadband reaches 90-plus percent people already in 60-plus person people's homes where the smart meters are maybe 10 percent. So we can actually start accruing some of the early benefits that

don't depend necessarily on smart meter right away. And so I will say, you know, that demarcation point between the utility and the consumer premises, whether it is industrial, residential, or commercial, that's the critical point.

MR. ARNOLD: Okay, thanks. Larry?

MR. MAKOVICH: Yeah, I think most of these technology, we're talking about expected lives in this five-to-ten-year kind of time frame. So, you know, when people make an investment in advance meters or communication, or the software or optimization algorithms behind it, there is a real technology risk here because this is changing quickly.

And it really, I think, questions the whole idea that there's a race on here and there's a first-mover advantage. It looks like there'd be a considerable advantage to waiting and see what configuration works given the capabilities you want and the functionality which is evolving. So I really question what's in the conventional wisdom now that there's this first-mover advantage and big race on to be in the lead here.

I think it also in the environment that we expect in the year ahead of escalating real prices for electricity, if you make a mistake in deploying some technology on smart grid, there's going to be a very big risk that the regulatory process is going to lead to a prudency review, and you're going to have to eat part of it.

And so, you know, when you think of the life of these assets, you know, the Bakersfield, California, example came up earlier where they're running the new meters alongside the old ones to prove the accuracy of the new ones if they line up with the old ones. Well, I think anybody asks the question, well, then, why are you replacing my old one if it's just as accurate? And I think who's in the forefront of deploying advance meters, you look to Europe, you look to Italy, which has done more of this than anybody else, and ask why.

And it wasn't vision and good public policy to push it, it was that in Italy they had a really crummy They metering system They had really poor billing, and they had huge unaccounted for amounts of electricity which is, I think, you know, Latin for theft. And so the very direct benefits of taking state of the art technology and deploying it where the meters you've got

aren't doing the job is, I think, a really important thing to recognize. That's why they were on the forefront of this, and it wasn't that they had an earlier vision of the future.

MR. ARNOLD: Okay. Well, that raises for me an interesting question which is, if you look at the transformation that's occurred in the telecommunications industry over the last 30 years, which has really been technology driven, it has resulted in a complete restructure of the industry and completely different regulatory -- I mean it's basically to a large degree a nonregulated industry now with competition at all levels, and, you know, customer choice -- you know, almost infinite customer choice in many aspects.

How do we see this playing out with the electrical system? Are the technology changes, discontinuities here of sufficient magnitude and impact, are they going to result in the same kind of radical change in the structure of the industry and the regulatory framework? What are our panelists' views on that?

MR. HAUSER: I believe it will, but it's driven by value, right? So as someone recently said, there's three main drivers of this, and it's value, value, value. You know, my own experience just recently, my utility went to a two-tier rate this summer, so they're charging 50 percent more for most of my electricity this summer than they ever have before.

Prior to June 1st, I didn't really care that I had an old electric mechanical meter on my house, but now I do. And, in fact, I'd probably pay a hundred bucks out of my own pocket, maybe more, to have a smart meter on my house so that I could understand what my consumption is. It's because it's a much higher value to me now than it was six weeks ago.

I think we're going to see those kinds of value propositions sort of propagate throughout the industry in somewhat unexpected and uncontrollable ways. So this is not a top-down change management plan; this is really going to be, I think, a ground-up change that's driven by all these different value streams that we start to understand better and be able to capture.

MR. ARNOLD: Okay, thank you, Steve.

Would anybody else like to comment? Rob.

MR. CONANT: A quick comment. I'm not a regulatory expert, but when I visit our customers in the U.K., you know, you watch TV in the U.K. for a couple hours you're likely to see advertisements from energy retailers like you would have seen advertisements from long-distance carriers in the U.S. back in the '90s. And the way they're differentiating themselves from a business perspective now is around auxiliary services that they can offer that help you reduce your overall energy bill or some kind of, you know, differentiated electricity service in one way or another.

There's actually, you know, their primary relationship now is with the customer rather than with the regulator. And that does open up a lot of new possibilities. You know, they construct a segment to market by different customer types the same way the cell phone companies do. One company will go after the prepay customers; another will go after the ones who have sort of an environmental bent. And I think that it's that sort of segmentation and customer relationship that ultimately will lead to innovation and that does require some new regulatory structures.

And I think one -- and, you know, one of the good things about having 50 different regulatory -- 50 or more different regulatory bodies in the United States is that there probably would be some experimentation on that front again once people forget about what happened in California.

MR. ARNOLD: Interesting. Mike?

MR. DAVIS: Maybe just a little bit of what's behind what happened to Steve. I mean wire utility is doing that. I think the numbers, roughly, are that the system in peak, if you will, peak demand or peak service about two percent of the time, give or take. But that two percent of the time cost utilities 15 percent of the -- 15 percent of their annual costs are in that two percent of the time.

So there clearly is an incentive to address peak demands. And the process of doing that is working its way out through the system. Industrial customers are probably most able to deal with that, but that can't be done just on the backs of industrial customers, so those price signals are beginning to be sent to the broader customer set.

Now, my question is, if you solve the peak demand thing, then somebody ought to be just paying an average price. If you actually charge the people that are the peak the right amount and recover it, then somebody that's getting an average price ought to pay less.

So the pricing ought to work really both ways to the benefit of customers.

MR. ARNOLD: Larry?

MR. MAKOVICH: Yeah, the telecom's an interesting industry to try to get some lessons from, and, but you have to be careful, because, if you remember when people went forward with liberalizing or deregulating the power business, everybody thought it would go the same way that the gas business did, and it didn't.

But when we looked at telecom, there were two things that we thought were interesting lessons that we thought were very applicable to power. One is when cell phones became available and service options became available, lots of variety and so forth, but originally there was a lot more time differentiated telephone service and distance differentiated pricing on phone services. And it looks like the customer preference for a stable and predictable price led to what is now more common, which is a fixed fee for unlimited calling. And I think that the underlying structure of providing telecom is probably not a constant cost picture of through time or across distance, but, you know, I think there's a lesson there about the power of customer preference on pricing and how competition kind of drives you to that.

And then the other thing is -- and this came up with the earlier group -- which is the privacy issue. And if you knew where people were making all their cell phone calls from and so forth, that's really valuable information. That the fertile Communications Commission early on put very heavy limits on what you could do with cell phone information. You know it's out there if you watch CSI, you know, because they know where they have made a call at 12:04, and it was to here and there and everywhere. But there's heavy limits on the commercial exploitation of that information.

And I think the same thing is going to be very likely here. Smart grid information is incredibly detailed on what people do in the most private part of their lives, which is what they

do in their homes. And there's a lot of people that think IT companies are going to come in here and do all sorts of things with all this data and, you know, exploit it commercially. And I think that it's going to be much more limited like what we saw on the telecom side.

MR. ARNOLD: Okay, thanks, Larry.

So at this point I'd like to give you all an opportunity to ask questions, and please raise your hand and somebody has a microphone, I hope. Who's got the mic? I'll start down here.

SPEAKER: Do you all agree that connecting a person's device that they have in their home to be utilities and meter needs to be regulated in the sense that the meter is the gateway to the grid, and that the cyber security requirements will make -- will have to ensure that the device -- I don't mean that the utility owns the device, don't get me wrong -- that the device will have to meet certain criteria and be certified as safe to connect to the grid and the meter. Don't you agree with that?

MR. ARNOLD: Good question. Who would like to respond? Dada?

MS. GUDBOLADE: Not necessarily is my answer. This is the same issue like with AT&T, you know, decades ago. The meter is capturing the usage information, and if you simply have a one-way connection to the meter, so some device in your home can get the meter reading in a secure fashion, then that need not be registered with the utility. I mean it depends on the architecture you design for the smart grid. If the meter is doing a lot more than consumption information, but it's also controlling your home, it's taking data back, then you're talking about, you know, what kind of security you required. But it all depends on -- you know, right now today you have thermostats. You mentioned that, you know, which are being controlled by utilities for demand response, and they don't go through meters and --

SPEAKER: Right. But those thermostats are not now connected to the meter as such.

MR. MAKOVICH: Right. Right.

SPEAKER: They're connected to the -- you have separate communications.

MR. MAKOVICH: Exactly so.

SPEAKER: Maybe you have -- I (inaudible).

SPEAKER: Yeah, I have an opinion on this as well.

SPEAKER: I have a different opinion than you, sir.

SPEAKER: I believe that -- I believe that those, those consumer, those consumer-owned devices, the utility, if the devices are owned and managed by the consumer, I don't even think that the utility should have visibility as to what those devices are. I think that's one-way information from the meter into the home, period, in which case the consumer can do whatever they want with that information. I believe that it has to be secure, but that one-way communication ensures privacy for the consumer. I think that's an important piece of it. And we haven't talked to you more, more about that.

MR. ARNOLD: Okay, so I would like to move on to another question, but I do want to sort of interject that, I mean from my perspective cyber security of the system is absolutely critical, you know, aspect. And if there's one thing we've learned in the IT and telecom world, unless you have the right architecture you have an inherently insecure system. So in the -- at least the efforts that DOE and (inaudible) are, you know, involved in, in terms of setting the standards, making sure that we've got the right architecture and requirements, and standards is an absolutely critical aspect of the program.

So other questions? You, sir.

MR. HAUPFNER : Ken Haupfner of MIDO. Let me put my consumer hat on. I love the smart super grid concept. Let me put my consumer hat on, and I -- the best technology that I've gotten in my house was a controller before the Internet in my basement that would shut off my water heater and my air-conditioner for a half hour. They paid me four bucks a month to shut off my water heater. They said they'd be back for my air-conditioner which is really the peak saving, real avoided cost opportunity, and I'm still waitin'.

And now I hear about all this technology, smart appliances they're going to have to pay for, third-party aggregators, other technology. When am I going to get my four bucks?

MR. ARNOLD: Mike?

MR. DAVIS: How old are you now, sir?

MR. HAUPFNER; Twenty-nine.

MR. DAVIS: Well, that's a great question because it's a challenge as to who's going to provide you any kind of incentive. And the idea on aggregators is sort of fundamental, is that as an aggregator could I offer you something, and could I offer it to you now that you actually can't get for yourself even though you asked for it from the utility? And it is about who can provide benefits, who can define the value associated with those benefits, do it in a way that is secure, and do it quickly in terms of actually making it a business and a profit. And I continue to believe that the opportunity for that lies in the hands of those that truly understands services.

If I was a utility, I would probably be contracting with people that truly understand services to do that. This does not have to come at the expense of the utilities, and hopefully it won't. Incredibly well-served.

But there is value in a market, and it's a huge electric market, and we charge an average price for all that value, but it is an average value. And, as we get closer to this, and we understand what that value is, somebody's going to be able to deliver that value and monetize that value, and I just don't think that it's going to be done individual consumer by individual consumer.

I think it will be done in some form of aggregation. And I think good marketing and good services will find folks like you and others, and find a way to deliver that, and it'll probably happen more quickly than some of the things we're talking about evolving from the normal utility business model side.

MR. ARNOLD: Okay, thanks. Let's take another question down here.

MS. REZLAC : Hi. This is Laury Rezlac. I'm with Currents Group, and Barbara mentioned Ray Gogol earlier. He's actually my boss as Current, and he was the ex-CIO and CAO of Excel. So my question is for Larry. I'm kind of confused by one of the things he said and would like a little bit more clarification.

And you were talking about your read that distribution and automatization won't have immediate value in the next five years. You know, our technologies are fully deployed in Boulder, the entire city right now. And when we take a look at the power of salt detection,

isolation, things like that, the ability for the distribution, the utility to have a full year of their distribution network, right now the field operators are asking for that view in their hand-held devices. The amount of truck rolls that they have to send out into the field are drastically reduced.

And Ray was telling a story about how, you know, the utility runs blind, and the customer has to call in when they don't have power. And for the first time because they could sense all this, the utility picked it up before the customer did, and the customer called and said, "I lost my power. Oh, thanks for restoring it," before, you know, she even hung up the phone.

So they had this big party that, you know, this intelligence is allowing them to move into a real-time response capacity today right here and now. And then when you make that stuff smart, and you get that three to five percent shavings, that's a big benefit as well. So I'm curious what your assumptions were in making that claim.

MR. MAKOVICH: Well, when you look at the filings that people have put forward on cost benefits of deploying this technology, what you'll find is that deploying the smart grid technology's advanced meters and communication and software, what you end up with is you do create some savings, and it is, you can reduce truck roll -- it was mentioned earlier. You reduce the number of people you have employed in the metering end of business. You do reduce the cost of allergies because you are able to find out when the faults are sooner, and have better intelligence as to what's going on.

But what we're finding is, as we survey what's been done out there, those direct benefits that you can quantify can probably offset 60 to 70 percent of the cost of the smart grid deployment. And Boulder is a good example. Smart grid city they deployed all this technology, and what they found out was within two years the cost estimate doubled. So much so that they've had to spread the costs of the smart grid experiment in Boulder across the entire state.

So when I say in five years, (inaudible), so when I say in five years I expect that we're still going to have a rather modest deployment here, it's going to be very uneven state to state. I think what's going to pace it is people's tolerance for price increases, and in the next five years we've got some very tough real price increases happening with or without smart grid. So I

do not expect within 10 years smart grid is ubiquitous across every place fully implemented and mature.

MR. ARNOLD: Okay. Another question. You, sir, in the back.

MR. D'SINC: Thank you very much. I'm Rahja D'sinc from Welbrink . I have just two really small questions that if utilities are getting into two (inaudible) communication from consumer premises try to put a utility, why not they get into the telecom domain and offer the broadband services also using the broadband on-power line?

The second question is relating to the storage what Mike mentioned. With the introduction of the smart grid, and with all kind of intelligence right from generation to transmission distribution, do you still think that there is a need of a storage of electricity? Because if that's the point, then I think a smart grid is not really meeting the requirement. Thank you.

MR. ARNOLD: Who on the panel would like to respond? Mike?

MR. DAVIS: Well, with respect to storage there is a certain amount of control you can provide, even if you know what the system's actually doing dynamically. And today we don't know what it's doing dynamically. We manage it passively. So we're not anywhere close to real-time dynamic management on the supply side. We watch it, but that isn't management.

Now, as you introduce more loads of their emittance and whether they're coming from the supply side or the demand side, that's an integration problem with the system we currently have built. And the question is how best to do that integration? I'm not just talking about the storage of bulk electrons, I'm talking about being able to manage ramp rates with renewables; I'm talking about being able to eliminate spinning reserve. There's various we do it now, and the question is, can storage technology develop and be a better value associated with managing supply and demand interaction?

MR. ARNOLD: There was a second question on utilities getting into --

MR. HAUSEN: Broadband?

MR. ARNOLD: Steve?

MR. HAUSEN: There's probably experts in the room that could answer this much better than I could or maybe any of us could up here, but, you know, my simple answer is that one consumer is not the same as the other consumer, so different business models are going to apply in different parts of the country, certainly from urban to rural.

If you look at rural co-ops, they've done a very successful job of deploying satellite TV services, right, and that probably makes a right of sense in those markets. So I don't think there'll be a one-size-fits-all solution, and I think there probably will be examples where utilities do get into the communication side of this smart grid market.

MS. GUDBOLADE: Just one small comment on this communications topic. I can also ask the same questions slightly differently, can the electric utilities use the existing communication infrastructure so they don't have to build new ones is yet another different way to look at the problem and say, you know, if I already have, you know, three different providers providing me service at my home, you know, cellular, maybe municipal Wi-Fi, maybe cable, maybe DSL, do I need yet another fourth coming through meters. So it's all cost-benefit analysis, right?

I mean if it is a rural community it's a different story, which are one different stories about one. So it depends, but needs to look at if from all angles.

MR. ARNOLD: Okay, thank you. We have time for one more question. Yes, ma'am?

MS. DODGE: Hi. Nina Dodge again. I'm with the Civic Climate Action Group here in D.C. And I think many of you probably know that there are some utilities that are actually, have designed their smart grid over broadband, and exactly that addressing either a scattered population over a large geographical area. There is one of the Texas utilities -- I can't remember which one right now.

But at any rate, my question is a more picky micro one which has to do with billing software and for the utilities. And that is, involved a business model change largely from in-house software programming for billing, and relatively they use standard and very old systems to buying, really, from the specialized software platforms out there.

Has anybody tracked with the error of rollout how many of the utilities are actually buying this New Age software? It's one of the, I guess, legs at the table for propping up smart grid and also might indicate, even if there's resistance by utilities, to roll out smart grid that they're in fact building it into their future business model.

MR. ARNOLD: Anyone address that? Mike?

MR. DAVIS: There's no uniformity here, but we actually have participants in some of our demonstration programs where not only are we dealing with operational issues, we're dealing with billing issues. And we're finding ways to buy off-the-shelf software that actually saved utilities money, and being able to do a far more sophisticated job of billing customers.

MR. CONANT: Maybe I can add just a little bit. This isn't specifically about the topic of billing, but one of the big -- one of the challenges for utilities, and actually this turns out to be a surprisingly large portion of the price of a lot of the smart grid rollouts, is all the IT infrastructure at the head end required to actually store all that data.

As people look forward 10 years, you know, we've talked about the vision largely from a physical perspective of what physically gets deployed, but the utilities have a lot of innovative ways to be able to use that data to improve their own operations, but it requires them to store data for a long time.

In a lot of places they get, they'll get one meter read per month, and now as they roll out the smart grid they're often getting hour or 15-minute interval data. So they're getting data every 15 minutes instead of every month, so that's a huge change in the volume of data they have to manage.

Most of the large utilities, the big investor-owned utilities, have, you know, big IT staff that's capable of dealing with that. A lot of the smaller munis and co-ops, you know, their IT department is like a PC under somebody's desk, and that has to totally change when they move to smart grid. And so that is one of the sort of unsung challenges of the smart grid.

MR. ARNOLD: Okay, thank you, Rob.

I see that our time is up, and so please join me in thanking our panelists.

(Applause)