DEPARTMENT OF ENERGY

QUADRENNIAL TECHNOLOGY REVIEW

GRID MODERNIZATION WORKSHOP

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XXX: Okay. Why don't we call ourselves to order. Probably useful again for our recording lady to just go around the table and names and institutional affiliations would be good.

XXX, you want to start?

XXX: Sure. XXX. I'm a professor of law at the Sandra Day O'Connor College of Law at Arizona State University. And prior to that I was an Arizona Corporation Commissioner, which is Arizona's public utilities commission.

XXX: XXX, Office of Electricity, and I do storage.

XXX: XXX. I'm XXX's staff director.

XXX: XXX. ISO New England. I head R&D (inaudible).

XXX: XXX. I'm on XXX's staff.

XXX: XXX. I'm on XXX's staff.

XXX: XXX, also on XXX's staff.

XXX: XXX.

XXX: XXX. Salt River Project. I manage our transmission and generation operations.

XXX: XXX, with EPRI. I manage our power delivery and utilization resource.

XXX: XXX. I'm director of the Energy Institute at the University of Southern California.

XXX: I'm XXX, with the Office of Electricity in DOE.

XXX: XXX, Bonneville Power Administration. And I head up the research and development there.

XXX: XXX, a fellow in the Office of Electricity.

XXX: XXX, Department of Energy.

XXX: Okay. So I think the goal this morning is to have a deeper look, second thoughts, delayed reactions to what we all heard yesterday. In previous workshops, it's proven as useful as the workshop itself. People have had a chance to think, they can speak a bit more freely, we can have a good conversation.

We have a number of questions that we can use to prime the discussion, but probably the best way to start is to just open the floor for any great thoughts people have had overnight. I will also, while we're

talking, just circulate around for your interest two pages of pie charts that show according to the six strategies that we're talking about in the QTR how much money in both FY budget proposal and in the stimulus money has been spent in the various boxes. And it is kind of interesting.

It does not, of course, include any R&D money that might be spent in the private sector or spent internationally, but it nevertheless gives one a sense of where the Department is investing its resources. So I'll send that around.

XXX: It doesn't include any R&D tax credits or anything like that. Just R&D DOE expenditure.

XXX: And the scale of the recovery act is four times larger than the scale.

XXX: Can I ask a framing question? One is did yesterday meet your expectations? And along with that is there an expectation that we're going to find or need to find a killer app for this area or for any area under the QTR?

XXX: A killer app in the sense that --

XXX: A SunShot equivalent.

XXX: Well, can you find a killer app equivalent to it? It's not obvious.

XXX: It's not obvious.

XXX: Well, okay. Let's talk about that a minute. The grid is largely invisible. It wasn't until I got into the business I even started noticing substations. What would it be?

XXX: Well, so it's not invisible when your lights went out. Boy, I was amazed at the number of stories around.

XXX: It was invisible when his light was out, actually.

XXX: See, it was not visible.

XXX: You know, that in the simplest, most basic terms, people's lights do go out a lot, despite our statistics that we take some comfort from. And in most parts of the country, not quite all, how the utility knows that the lights went out is the customer called them and said my lights are out.

XXX: If you can get through to a human, yes.

XXX: You know, there was one -- if there was a moon shot that would -- SunShot that would, you know, make a difference to a consumer, probably not without undergrounding everything make -- keep the lights from ever going out, but fast restoration and I don't have to call the utility to tell them. It's fundamental.

XXX: So I'll give you one. We, the government, and whether it's the state, local, fed, will guarantee that your lights will never go out for more than five minutes ever. And if they do, we owe you restitution, something like that. Right? Really quantify a level of reliability and then guarantee it. Would people get excited about that? How much would it cost?

XXX: No. And I didn't think that's what we were here for. I mean, I thought we were talking about, you know, all of the money that you're spending to create a clean energy economy. And that's all well and good, but that's what the utilities have to do under their requirements by state public utilities commissions anyway. And that's what they -- I would assume Rob would say they're doing that right now.

And let me just -- so I would say what's the -- what the killer app is -- it's an interesting formulation. I like that. I would go after the -- I think the biggest barriers and maybe my biases that I think the biggest barrier to a dramatic expansion of clean energy is transmission.

And if we can't get new transmission built, then making it more efficient or making it -- or rehabbing it in a way that allows us to get more renewables on those lines and to load. That's the biggest problem, that's the

No. 1 issue that western regulators are facing, and probably eastern regulators.

And then, two, I would say, you know, what is going -- if we -- you know, if we think about what our utilities are going to look like or what -- if we think about what a utility would look like if it was Apple running the utility, what would it be, it would be clean, efficient, seamless, responsive to consumers. And I think that's where we want the utility of the future to get to. So then you ask yourself the question from a grid standpoint, a smart grid standpoint, how do we get there and what's the killer app for that.

XXX: And it's -- the complexity makes it hard to think on transmission on one side and moving green electrons and the distribution system in the same breath, kind of. So it's hard to find a single solution set that might -- that we could frame that under.

XXX: But one solution set, one place to start is how do we allow consumers and utilities to start having the transformational conversation about energy that we're going to have to have. And I think that's the -- I'm not smart enough to know the answer to this question completely, but part of the -- we start with smart meters that allow consumers to get information about their energy use, that allow a much more seamless

relationship between the utility and the consumer and allows the consumer to become much more in control of energy provisioning. Now, utilities aren't going to like that very much, but that's where I personally feel we're going.

XXX: My feeling is most consumers don't want to have that. That's just --

XXX: Too much information again.

XXX: The utilities don't have any problem with that.

XXX: What about when it gets put on their iPod or iPad?

XXX: Again, I'll say this as a data savvy guy and I love data, just one more data stream I've got to deal with. And I'm not sure I want to be that involved.

XXX: The majority wouldn't go for it.

XXX: It's interesting. When you started with the demonstration with the Department of Water & Power in Los Angeles -- and Los Angeles is a special case except that it does vary some, super diverse community. But the one recurrent theme is I have power, I have lights, I can afford the bill. What are you doing to me? I mean, what are you doing to me?

Electricity is the one thing when -- in the face of the world, with 100 emails a day and everything else, it's the one thing I didn't have to put any effort into.

XXX: What happens, though, when we reach grid parity for solar and tens of thousands and hundreds of thousands of people are putting solar on their roof tops and become much more engaged with their energy provisioning and care about it?

XXX: For the high-end consumers that can afford that --

XXX: No. When solar reaches grid parity it's not going to matter.

XXX: In many places in the country it is right now competitive with retail.

XXX: It's absolutely taking off. I mean, it's absolutely taking off in Arizona.

XXX: But Arizona may be a special case for solar.

XXX: No, not really.

XXX: I think they actually don't feel that they --

XXX: California is, with their rates.

XXX: They want to know they got a savings in the net meter if they get a deal. But they

don't want to pay attention beyond that. Bragging rights for a month or two, but that's it.

XXX: I think it's an interesting question how you change the interface.

The other space that we are not talking about here when we talk about necessity is the other part of the economy, the income-generating part of the economy, industries, commercial, all of them. And some of those are already starting to say -- well, the technology may allow them to take it into their own hands and just I'm not going to worry about the utility. I don't want to worry about whatever battle they have with the residential, and to the extent I can I'm just going to manage my own energy. So I think it's not -- this is why I think it's hard to have some kind of integrated, uniform policy, because it just doesn't look the same. And it doesn't look the same, for example, for the auto plants in South Carolina as it does in Arizona, either, where they want nickel an hour -- they went nickel a kilowatt hour coal car plants.

XXX: And they're getting that.

XXX: And they'll get it because that's what keeps people building auto plants.

XXX: So we have just opened up a second theme, which is the regional differences. But I

would like to stick on this consumer thing for a minute.

XXX: So going back to the original framed question, is there a killer app out there, I think the discussion almost always tends to lean towards there's probably not a silver bullet out there. It's going to be a whole spectrum of things to be managed and then managing expectations along with the technology along with the rollout.

I do tend to agree that it's going to have to be targeted. Because some of the consumers will want more and some are not going to want more, and I think we have to address both of those options. I mean, if we have a lot of our population, and I don't know what the percentage is, who tend to be less tech savvy, we can't force them into it. We found that out with the Internet. We still do a lot of manual billing because not everyone wants to do electronic billing.

XXX: I agree with you. But in a practical sense it's really hard to package a federal program like that.

XXX: I know. But I think it's going to be just like when we talk about carbon reduction that there's no one way to achieve carbon reduction. It's going to have to be a whole --

XXX: And no resolution.

XXX: No universal. It's going to be a whole spectrum of things. I think the same thing here is on the grid. If we want to transform this grid, it's going to be a whole lot of issues to deal with.

XXX: So what if we try not to bite the whole thing at once and say can we take a significant chunk out of this thing without even --

XXX: What's the most important thing? Is it transmission?

XXX: Is it -- maybe it's energy storage or maybe it's -- maybe we go after this routable power idea. Maybe we say we will do a 300X increase using available lines in the power link and transfer because we will route that power. Now let's talk about all the technologies under that we need to make that happen. But now you are going to get your access to your renewables, you will get your access to your T&D side. But let's say that existing system, we will boost it like crazy and figure out how to use it.

XXX: What do you think transmission would do to consumers? Why do you think you need to build a lot of transmission?

XXX: Because it's really cheap relative to everything else.

XXX: So what you're saying is

you're going to deliver cheap energy to consumers? What is the benefit?

XXX: Are we after cheap energy, or are we after affordable energy that's clean and preserves our world?

XXX: So we build tons of transmission in Connecticut that now their bill is flipped. It's for the first time I have ever seen the energy part of the bill is lower than transmission. Now we produce and process that so we're actually as business should be, to buy cheaper electricity.

Why would we always try to bring cheaper electricity to the consumers? Because you want actually the system to be able to show where the best place to be. And you've seen businesses moving around, moving to the places where the price is lower. Building transmission is not necessarily the best alternative always. And if we have certain backbone, you have now a lot of opportunities for people building --

XXX: So we could build wrong. If we built out too strong, we could build it wrong. (Inaudible) will move if you build it?

XXX: I would just argue --

XXX: I'm not talking residential customers. I'm really talking about major --

XXX: I'm not talking about gratuitous transmission. I'm just talking about transmission that would be designed to get renewables to the places that need it. And if California has the 33 percent RPS or if we ever had a carbon policy in this country or if every state in the west had a slightly higher RPS than they had -- and that doesn't even matter; the California RPS is driving this -- then we would build a little more transmission. We're not getting that done. Or we would make our transmission system more efficient such that we could get more renewables, more ATC into those lines.

And I will tell you there's -- we've certificated four projects in Arizona that -- I think I said this yesterday -- are stranded. They're ready to go, the developers need to get that energy to California. I can't tell you how many others. Rob's done a chart that shows all the interconnection requests in Arizona that's stranded. It's a massive amount of renewables that's stranded in Arizona that needs to get to load in California. Because guess what. They can't build anything in California. Sorry. No offense.

XXX: I'm not in California.

XXX: You're not? Okay.

But they're having trouble getting stuff built.

XXX: I could argue, just for the sake of argument, that if you left -- if you have stranded plants you didn't do your total planning well enough. Because we saw what happened in Texas. You know, Austin Energy, they built the wind plants and then three years later they built the transmission. So we knew that. We knew those kind of things. So why wasn't there a holistic look at how do we move all of it at the same time so we don't build the plants and leave them stranded?

XXX: Well, I think the answer would be our commission while I was there and before and after is one of the most efficient in the country at citing generation and went ahead and did it, hoping that our utilities would be responsive. Well, they haven't been. They haven't -- we don't have -- we don't have a policy in any state that says that we're going to build transmission based on our renewable energy policies. It's based on the need of the service territory and the need of energy in the state, and it has nothing to do with these larger policies.

XXX: So you are trying to sell in California?

XXX: Yeah. So our laws -- one could argue that the laws don't allow us to make decisions based on California's needs. But I -- but one can also argue

that we can.

XXX: Wouldn't California have to build something locally because they have their own requirements?

XXX: Well, they're not going to be able to build locally.

XXX: Well, there are projects, but it's a battle.

XXX: California isn't always reasonable in their goals.

XXX: In the context of this, I think there are going to be some regional differences, especially between the eastern interconnection and the western interconnection. And at least in the west we've had the advantage of understanding some of these issues over a long period of time. The distances are large, we know where, one, the renewable resources are, we know where the load pockets are. That's not going to change.

For example, there's additional expansion needed between the northwest and California and the northwest and the desert southwest, and it's not moving forward. There also needs to be transmission expansion between the Rocky Mountains and the desert southwest, and it's all bogged down. So I think the transmission would allow the regional diversification. It would provide the

renewable resource opportunity.

And ultimately I think if you want to take a look at routable power, right now I have a hard time imagining we could get there unless we also have transmission expansion to go with that. Because you're familiar, Bill, we got a lot of (inaudible) transformers on the west and to do that exact thing, and we're already saturated at that point.

XXX: So the transmission story, sounds to me as you're talking, that's not technology by and large. This is citing, permitting, politics, economics, so forth.

XXX: I think as building the optimum transmission grid, then it's a combination of building some transmission but also dynamic circuit rating, advanced conductors, FACTS devices, power electronics to get the most out of the existing resources. It should be a holistic view to that. So I think the technology question is still there, but even no matter what you do with technology there's some building of new lines that's probably required for the optimum.

XXX: But we are at heart supposedly a technology organization. I'd like to understand what the technologies are we need to be working on in order to make these things happen.

XXX: I would argue so if we don't think there are technology improvements on the transmission side -- I think there could be, and I actually think there actually have been, and Rob's probably a much bigger expert in this, the technology improvements made in transmission that are not even being deployed by the utilities right now.

But, secondly, XXX, I would say storage. Storage, storage, storage. I mean, one of the things that's going to get us to grid parity and going to get us to a scenario in which customers are able to provide their own energy is commercialized storage.

XXX: So $100 kilowatt hour target, let's go get it. Let's just chase it.

XXX: Storage shot.

XXX: I would chase storage.

XXX: And I agree we are not fully utilizing resources. For example, voltage profile optimization on the line would save us some capital investment for transmission, but you'd have to have certain incentives for commissioning companies to do that, and we don't have that.

We also have jurisdictional barriers. For example, on the transmission side they want to move other transformers that are under subsequent transmission

jurisdiction. You cannot do that. They don't want us to, for example, move their old transformers. So you have to come up with new ways of coordinating between transmission and (inaudible) substation distribution as well. We don't have at the moment very good coordination between the energy management systems and (inaudible). And I foresee all DMF coming with -- because not many distribution companies today use SKADA. They all mostly JAS based. So it's really -- they are not aware of the transmission (inaudible) and network model. We have that coordination, it will increase the efficiency of existing grid control quite a bit.

And you have to make sure that certain incentives exist that people do that, plus with very tight NERT standards and trying to squeeze more out of transmission, you're risking huge penalties and that really creates a lot of reluctance in people implementing even if you prove that.

XXX: I guess what's the relative value -- or I guess in the current, how much policy studies, policy analysis do you guys support? I mean, it sounds like the earlier conversation was it was a lot more potential in the analytics than there was in a new technology.

XXX: We don't spend a lot of money,

but we spend some pretty important money in that space. And I think -- Gil's probably better to answer this, but the two things that ARRA money had a tremendous stimulus effect on is the interconnection planning effort, opportunity. But historically we've worked with states, the NASDIA (phonetic), NARUC, NCSL on seeding specific studies on demand response in a region, those kind of things. And those have not been high dollar but they've been very, very effective at managing the debate in the country about those things.

XXX: I guess the amount of money that you've spent on it, are you saturated?

XXX: Not by any means.

XXX: Sounds like that's where the biggest return on the federal dollar would be, or your dollar would be, on change -- discussing the balance between policy studies versus technology development.

XXX: So we've only done a couple of cuts that were deep. I did it in Hawaii. We spent a couple million dollars a year and we set a percent clean energy goal, and we're on target. Three and a half years in we're on target actually to reach that. And we -- energy bills, open dockets for fit, for decoupling the utility, that kind of thing. And it was the order of or $ million a year that was moving that

space.

So if you target that throughout every state and region, you know, in a concentrated way and say if you deliver one, two, three, here is the money kind of thing, you would have a tremendous impact. My belief.

XXX: We are doing some work in supporting the states as well under ARRA for the regional interconnection planning process. That came up several times yesterday, really trying to say we don't want to dictate a solution but we want to facilitate the dialogue on a regional level so that you can start understanding how your needs could be balanced against some of the regional resource desires as well.

XXX: Because you have got to bring along not a consensus necessarily, but you have to bring along the states involved, the region. And so if you look at the eastern 39 states -- and head of New York ISO said that's the first time I've sat down with all these states ever. So that's a nice starting point, a nice benchmark, but think about how far it has to go in order to make that.

My concern will be -- and, again, XXX knows this far better than I do. My concern will be what happens two years out when our money is gone and is there enough of a structure in place to continue the movement.

XXX: You know, we talked and certainly was on the slides, but distributed generation. If you think about the fact that you've got something that's driving it, if you are going to have DG you have to have storage. I mean, I think that's one of the -- and scaleable storage. And the other part to DG, but again is scaleable, end-use technologies for natural gas. That's the other thing where you've already got the backbone infrastructures already developed. So is DG as a -- in other words, if you really -- if DG really moved, it would change the pressures a little on the rest of the distribution system. Not solve them, but it would change them.

XXX: People mean different things by DG. We've been there a long time. But in your case you're talking small gas and solar?

XXX: Small gas, solar, and storage.

XXX: I have no idea; some of you may know. So I live in a house in Chevy Chase, I'm on the grid, and I also have natural gas of course coming into the house. If I disconnected from the grid and put panels on my roof, I still need natural gas as a backup.

XXX: And storage.

XXX: Both. Can I run my electricity on my natural gas line? Do I have enough capacity in the

gas to be able to do that?

XXX: Yes.

XXX: Yes; it's not a problem?

XXX: It's a pressure issue.

XXX: If you ignore cost.

(Multiple conversations concurrently.)

XXX: If you could have a kilowatt fuel cell and screw it in, it would be the size of your washer --

XXX: A diesel unit, the cheapest thing.

XXX: I don't want to have to deal with diesel fuel, too. I'd rather run it on the --

XXX: No. But the thing about that one is the storage is in the grid.

(Multiple conversations concurrently.)

XXX: Guys, the court reporter --

XXX: Sorry.

XXX: I can only get one of you at a time; I'll just throw that out there.

XXX: It's only natural with question and answer.

XXX: But the DG question, I mean, part of the value of that is not about just electricity production. But several times yesterday we heard about

32 percent for the efficiency of the system. And the way to change that is to really start thinking about how -- if you bring the production onsite, micro grids, et cetera, how can you capture some of those other efficiency losses in terms of heat and others. So I would say the argument extends beyond just electricity production into the value that you can obtain further from those resources.

XXX: I guess what I would say is if you could produce a viable -- from an economic point of view really get the cost down, just like you're trying to do with SunShot, if you get the cost down at a range, you've created a whole new set of options for people. The system will diversify the way that it adapts itself. You're seeing it on the commercial end already. I'm saying if you scale that down to where individuals or communities or developments are interested to do that --

XXX: We put money into that. The six-pack the UTC has, we helped develop that. The ATS small gas turbine stuff, we did that, too.

You know, market timing is everything. So we've pushed the natural gas technologies to a higher efficiency, CHP-based systems kind of thing. I would argue that there's a lot in the market right now based on that and was just waiting for gas prices to come back down.

The question that comes back to me is how many people do it, what does this natural gas bubble look like, are we after another silver bullet yet again. And the utilities were badly burned in the '90s with the natural gas push that they did, forming companies like Moran. Stranded assets sold 10 cents on the dollar five years later. So the lesson learned is how far do you push that. Without a portfolio approach, you're in danger of anything. And if the U.S. natural gas resources go to the international market, that price is not going to stay where it is.

XXX: If you don't mind, I would like to comment on this issue of the efficiency of the system, because it has been brought up a number of times.

EPRI put a lot of work in on this issue. And the most efficient part of energy is the delivery portion. And, you know, if you really want to improve the overall energy use, resources and loads is where the area is.

I do think, though, that utilities have a role to play in this and this is as they continue to build out the system and replace equipment, you want to go to low-loss development and low-loss conductors, low-loss transformers, et cetera. But I don't think that's where the killer app is going to be in that part of it.

If I could frame --

XXX: Could I just ask is that separation of generation, transmission, load still valid in the paradigm in which you have got both power and information flowing in both directions? Seems to me some of the thrust of the conversation yesterday and this morning is the blurring of those things. I mean, that's what smart grid is about.

XXX: From a loss point of view, though, the losses on the --

XXX: The physical losses --

XXX: -- (inaudible) don't matter in that equation because they're so low in the big picture. But what matters is making the end-use loads more efficient, making generation more efficient regardless of where it is, because the transport is already pretty efficient. We make -- we can make incremental changes in that with conductors and compensation and things like that, but it's small in the big picture.

But I do think that -- going back to the killer apps and we talked about transmission, I think that the prescription for the active distribution system is still a big challenge that we have in front of us. The distribution system that can integrate as much solar as

you want to put out there and that can manage the voltage so that -- you know, PNNL's report came out and agreed with EPRI's results that we can save percent of the energy use in the country just by managing the voltage on the distribution system. And one of the most dollars per kilowatt hour saved, probably the best thing that we can do across the whole country is just do voltage regulation better. And -- but we want to do it so that when we make that investment it's not going to also defeat our ability to integrate PV and to charge electric vehicles.

So it's a big picture. It's the active distribution system. Voltage regulation is -- that conservation voltage reduction function is happening in a bunch of the ARRA projects. And we're learning about load response to the voltage, but we're also figuring out what the limits are about how much PV we can put on the system unless we do smart inverters, you know, and another great project for storage and PV.

But if we kind of put it all in this active distribution system target and work on GridLAB-D for simulation, make it a model-based system, active control, integration of distributed resources, don't sell it to consumers as you're going to get all these benefits. It's just you're going to be able to do stuff that you might not be able to do otherwise, but it's something that we

have to do to make it all work.

XXX: I agree, and it's part of the whole system approach. Our problem I think is that we can't sell that. It's too complicated to sell on the Hill or to OMB or people that want a simple dollar-a-watt equivalent kind of thing. So without the simple story, we don't get any mileage for a systems approach.

XXX: Maybe the simple story is CVR and we just bury everything in there. Because that percent savings, you can bury everything in that percent savings. Just make sure you do it all.

XXX: But the people you are talking about have no idea what CVR is.

XXX: Do they want to save percent energy for the least amount of dollars that you can possibly spend? That's a pretty simple message.

XXX: It's a good thing, but it will not resonate. I mean, that's not going -- you're not going to be able to tell the story with that.

XXX: And consumers don't have to do anything.

XXX: I know it's great, and I say we should do it.

XXX: But it doesn't get us past the hurdles.

XXX: And we have to say trust us.

XXX: And we haven't figured it out.

XXX: It's a lot of hurdles for regulators, a lot of hurdles on the Hill and --

XXX: If I could just -- going back to the pie charts, I was just noticing, when you look at what DOE is proposing to spend, an enormous amount of money on stationary efficiency. A lot of that is targeted at consumers, right? An enormous amount, much more than before on solar. That will be -- a lot of that will be probably on DG technology, also consumer focused.

So I guess maybe on the grid side then maybe what you should be asking yourself is how much money should we be spending on grid applications that are consumer focused, that are designed to help us take all the advances we're going to make on the efficiency side and the renewables side that are consumer focused and do that also on the grid. And I think some of that could be storage, but also smart meters that allow, like I said, the sort of conversation to start happening, this transformative conversation to start happening between -- I know there's some skeptics in the room between -- that say that the consumers don't want that conversation. Maybe even you, XXX. But I personally believe they are, and I believe it's going to happen sooner than we

think.

XXX: DOE doesn't have to do anything. Advance meters will be on every house. It will just happen.

XXX: Okay. But utilities aren't terribly interested in having that information flow back and forth. I can tell you that. Huge, huge --

XXX: Utilities want to make sure they're not liable. They want to make sure they protect the information. But they don't have any problem giving customers the information about the energy.

XXX: But do you acknowledge there are going to be huge fights coming on this issue over who owns the data and whether the customers can have access from the -- I mean, one of the --

XXX: I don't think that's a fight.

XXX: Let me tell you one of the things that frustrated the hell out of me as a regulator was the fact that our utilities are deploying all the smart metering technology and we will charge the consumers through rates, but they have no access whatsoever to that data. And I can guarantee you that regulators in the future are not going to accept that answer.

XXX: Can we take a step back. If we

had a distribution focus, say in the distribution, so there's 6 percent losses, six quads in the distribution --

XXX: No. No. It's 6 percent of the electricity, not 6 percent of the --

XXX: Okay. Four quads is being doubled.

XXX: Loss between the resource.

XXX: No. It's less than a quad. We have 14 quads of electricity a year in the country, and 6 percent of that is whatever, .8. That's my understanding.

XXX: Say that again.

XXX: 6 percent of the electricity, not 6 percent of the primary energy.

XXX: Right. Electricity, I mean, our system --

XXX: We are damn efficient.

XXX: If you weren't losing that electricity, you wouldn't have to generate it in the first place. So you go back on the losses, also.

XXX: That 6 percent is an important number, but it's very difficult to increase the load 6 percent. It could help if you do distributed generation --

XXX: Whatever the number is, it may

be bigger than a quad. Except if it's a quad, a quad is worth chasing, right? But target on the distribution, all the other things that it gives you and gives you quad savings, how can you get smart distribution systems kind of thing and what are the technologies needed to do that. That would be one way to go after what you're after.

XXX: And a distribution system is close enough to the consumer that it can be tangible.

XXX: They can see the result.

XXX: And also reliability kind of falls out as a benefit when you spend the money on that infrastructure anyway. So whether you make a promise about it or not, reliability kind of comes as a bonus once you have -- once you have justified generation and storage, then things like micro grids for reliability improvement get -- they're more reasonable to put in the same sentence. They're not really -- they don't really belong in the same sentence until we figure out a way to justify the generation some other way. But all of that kind of flows once you get the ball rolling down that direction.

XXX: And as we electrify transport, the weakest link initially is the distribution part?

XXX: By far.

XXX: Yes.

XXX: If I could go back to your original quest, which is what's the technology perspective, I think we need things to address regulating reserves. Right now the approach that most utilities are taking is as you have more variable energy resources you're using gas to do the regulation. Some of us have access to hydro. But as you lose that -- I know if we were to lose our hydro we would be using gas to regulate. So what are the types of technologies that will help reduce the use of gas for regulating? Storage would be a component and an approach that would help. There could be other types of things out there, too.

Dealing with continued reserves is going to be another big issue as we deal with variable energy resources. The technology on the PV and wind is improving, but it doesn't allow us to adequately respond to the loss of a large stationary generator and rely on any of those variable energy resources. So technology related towards how we can improve our contingency responses for contingency reserves would be very helpful.

The whole issue of capacity is going to be another issue. If we rely on distributed generation, if we rely on large amounts of variable energy resources, we need to have technology to figure out what happens when we have a bad combination of lack of those resources.

And then lastly -- Mark, this is one you touched on, which is the voltage or reactive power. I want to specifically focus on the reactive portion of it. Because the PV won't allow us to run the pumps. And so if people in the desert southwest want to move water and if they want to have air-conditioning, PV is not going to get it done. And so devices which support the reactor power without having to use large stationary generators will be the area which we really have to overcome.

XXX: Storage and power electronics.

XXX: Those types of devices will make a difference, because otherwise we rely on running the large coal-fired units or the large gas-fired units.

XXX: So once again you're talking about distribution flexibility of how the system --

XXX: Yeah.

XXX: That's No. 1 electrical challenge we are facing. We are going that route that many of us included, regardless -- somewhat regardless of the economics of it. If you decided you want to decarbonize, you want to build system that is very different, then we are changing (inaudible).

XXX: Getting back to the budget thing that you were bringing up just a little while ago, if we're successful at the solar for PV, developing solar

where we make the SunShot, if we're successful at electric vehicles, what's going to be the impact?

XXX: That's an excellent way to phrase it.

XXX: I mean, the Department's role is really looking in the future. So how do we assure ourselves we can intersect that future?

XXX: We need a grid commiserate with our aspirations in these other directions.

XXX: Exactly. And I'm not sure that's being looked at yet.

XXX: No. And what --

XXX: What if you succeed?

XXX: Yes. Right. We catch the bus.

XXX: What if you catch the bus.

XXX: As Wayne Gretzky says --

XXX: What do you need to do to the grid currently, what are the coordinated programs in the grid we need to match, either SunShot or electrification or both. I don't know. But that sounds like a nice way to phrase the question.

XXX: That's a challenge for the distribution side rather than (inaudible). Not so much for both.

XXX: Although -- well, yes and no.

I mean, you want to put up lots of grid scale PV in the southwest, I've still got to move that bulk power to LA.

XXX: What I would say, though, it's going to be -- I think that whole issue is going to be a much bigger issue where you have areas of the country which don't rely on air-conditioning. Those parts of the country which rely heavily on air-conditioning I don't think are going to see much of an impact from the large-scale implementation of charging cars, only because the system was set up for large amounts of amps and flows to run air conditioners. And I think I mentioned this before. When you take a look at every house here in Phoenix, it's set up for 100 or 200 amp service or more. Having a plug-in vehicle is just not going to have much of an impact. It's going to be when you charge and the rates and so on. But I think if you go to an area of the country which doesn't have a lot of air-conditioning and you start having a large saturation of cars charging, you're going to see an impact.

XXX: XXX, it could have -- you guys talk about the cul-de-sac phenomenon, don't you, where it could have an impact on substations, like individual --

XXX: It could have local transformer impacts, not even substations. Local transformers. And you can watch that just with your

advance metering system.

XXX: But you could map that and you could still map that and --

XXX: But there are a lot of locations in that category, the whole country of Ireland and the whole coastal regions where the car is a big part of the load. So, you know, it makes a difference.

XXX: Because they didn't have to do much.

XXX: But, XXX, to XXX's point and -- I'm sorry. Your name?

XXX: XXX.

XXX: To their point, I mean, wouldn't it have an impact on you guys if there was large-scale adoption of distributed solar and large-scale adoption of energy efficiency?

XXX: Depends on --

XXX: What will that do to your system? If everybody turns into my brother who just completely solarized so now his electric bill is $ a month --

XXX: The whole issue of the distributed PV won't be in the wires. It's going to be back into the regulation of that power.

XXX: Doesn't that go to storage?

XXX: That's what I said. One of my four was with the regulation of the energy is the wire size out here is not going to be an issue. It's going to be this fluctuation in how you manage it. So the lower the voltage that you interconnect these types of devices, the harder it is to manage; whereas, the larger voltage that we interconnect these things into the easier it is to smooth and mute that. So, yes, that is a key thing.

XXX: Can we make statements like at the level of, I don't know, pick a number, 5 percent PV penetration the grid's going to break as current, or at the level of 8? I don't know what the number is.

XXX: There's some circuits in California approaching 100 percent and they're not broken. Some approaching 25 percent and they're broken.

XXX: So you can't generate a crisis for me?

XXX: Some circuits, you put five PV -- five electric vehicles on, they won't handle that.

XXX: So what about EVs? Can you generate a crisis for me with EVs?

XXX: Maybe.

XXX: The cul-de-sac scenario, right?

XXX: Localized for sure. If you have

percent EVs, that's a lot of EVs. That's 30 million of them.

XXX: But they're not going to be evenly distributed.

XXX: No, they won't be, and that's the issue. A big clump of them in Berkeley and Brentwood and Santa Monica, and there will be zero in Kansas City. I mean, you know --

XXX: The crisis --

XXX: But you could upside the equipment or you can put in better controls.

XXX: There will be a number of circuits next to each other all at 70 percent. That's where the crisis will be with PV. Because what happens is you have a problem and now where do you go for solution sets. So it's the integration of side-by-side systems looping back in and getting -- making sure you have adequate flow.

XXX: So we've had a lot of conversations about the role of power quality, conditioning and reliability and these new types of technologies on the distribution circuits. But I'd like to understand how you envision that being controlled. We have a centrally controlled system now. These technologies that you're talking about deploying, are you

talking about deploying them on the distribution side? And so would these technologies have to be automatic, self-healing, what have you? Or are we -- and completely disbanding the centrally controlled paradigm? Or how would the interplay work? How do you envision it?

XXX: We have a centrally controlled paradigm on the distribution system, usually. That varies from company to company, but, you know, for the most part it's very distributed already.

XXX: We've also done projects with PV and distributed agents that have very localized control. So there's different ways to do it.

XXX: The point is you have to push more control awareness downstream. That's the solution to it. So you will have to think about, okay, what do I have at the 12 PV level and lower that I've got visibility into my system that I know it's happening. The smart meters are going to give you an aspect of that, but then you want to think about what else do I have to do at the substation level or whatever, at the transformer level to get that communication that you don't have.

XXX: The smart meters alone don't really make a smart grid.

XXX: So can one write down -- I want to come back to the sort of requirements driver from the

other things that the Department is trying to do.

Can you lay down a roadmap sequence, some sense of what needs to happen, not necessarily the how but the what, on a, say, 20-year time scale? Take some assumed penetration of EVs, some assumed penetration of DGs, that sets a set of requirements for the grid. Does such a discussion exist anywhere?

XXX: Yes. There are research and papers done, but they're done solely based on specific forecasts.

XXX: But there's no plan after that.

XXX: Then the plan is how do you meet those requirements, and it's some combination of policy and technology.

XXX: Different scenarios.

But I also want to go back to the way we control today distribution system. It's different. I think Mark was trying to get to this, is that it's pretty much not the same way as the bulk side. It's mostly controlled on a time base. You would put a set in for specific time of the day and then change rather than doing adoptive (inaudible). If you want to control voltage, it's not really reacting on current condition; it's all precalculated. And the bulk side there's a lot more sophisticated. So if you move toward that more

sophisticated controlling solution side you could save a lot.

XXX: But you can do that. I mean, the technology exists I would think.

XXX: You just have to start working on it. You have to set a number and go.

XXX: The ARRA projects, you have probably a dozen good examples of different advanced distribution management technology because that's where we are right now, is experimenting with all different approaches.

XXX: And we have maybe a dozen utilities that do that. But the rest of them are still sitting in a very old age, if you will.

XXX: We have a challenge just in lessons learned from the projects that are going on now. And then -- the nice thing about distribution systems is you can have 20 different ways of doing it and it's okay. Because every distribution system is independent and there's -- you know, we have 60,000 substations, we have whatever, a couple hundred thousand feeders, it's enough that if 40,000 of those support one technology the vendors can continue to build that and support that and 40,000 support another one. There's enough out there that we can have multiple ways of doing

that and that's okay, as long as they're all kind of standard and they all -- as they boil up to the transmission, the EMS systems, they provide the same interface at that point. So lots of visibility to demand management and resources that might be applicable if we are going to do frequency regulation, if we are going to do things that affect the transmission system. That has to boil up in a standard way.

But other than that, they can be done different ways, and there's a lot of work to be done there. There's a lot of work to be done there. DOE has a role there. Modeling is a business aspect of that. The PNNL work is right on target for that and needs a big --

XXX: But it needs hard technology, too. I mean, you've got to have real things.

XXX: It needs hard technology. When we put storage out there, there's 20 different ways we might manage that storage, and the distribution management system has to represent that. It's probably a distributed control that's doing something, shaving peaks or controlling -- providing frequency regulation or providing a micro grid support for local customer, whatever. But we have to know what it's trying to do because it affects the whole system.

XXX: But every control center has

a near miss, not every distribution system has a scale (inaudible). And I might think one of the things you can do, it's an easy goal, to put the goal in front or at least create some kind of incentive to do it, because that could by itself save a lot of money in controls.

XXX: CVR gets that into the substation.

XXX: As we go back up the grid, where in the power does D stop and T start? Distribution system handles a megawatt power or less?

XXX: Substations could be -- like Con Ed substations are 3000 megawatts, but that's unusual.

XXX: That's unusual.

XXX: 15 megawatt.

XXX: You're talking 50, 60 megawatts --

XXX: Is where D starts and T ends? All right.

XXX: Could we go back to the Under Secretary's question about the 20-year timeline. So you said there is some -- there are some studies being done? Who did them?

And then I would ask the utility guys in the room, maybe Rob, is this being discussed in board rooms?

I mean, seems to me you have a fiduciary duty and a duty to your ratepayers to be making this kind of an analysis. So which utilities are making that 20-year analysis of what would be needed if all of this stuff happens?

XXX: I'll speak for our utility. And I don't know if we are unusual. Yes, we have a -- she already knows the answer.

XXX: That's why she asked the question.

XXX: With the court reporter in the room.

XXX: We need to take a look at a very long-term totally saturated system. So we look out 40, 50 years, and then we have a 20-year and a 10-year look, and we take a look at technology. And most of our technology on our distribution side has been in collaboration with every -- we do have a distribution automation system going on and we have experimented with different ways of doing that. You know, so we hear about the self-healing grid, we wonder how you can really do it on the transmission side so much.

The distribution side has more opportunities for us right now, and that's where the design is different from distribution utility to distribution utility. For example, we have a complete redundancy at every voltage

level. So at every voltage level we have a redundancy so in case there's a loss there is another line that can provide the capacity into the area.

Well, distribution level, right now most of those areas rely on a switch which is manually controlled. So if there is a car accident, there's a power outage, we send out a troubleshooter. He goes in there, he isolates it, he hits the switch and then we can provide energy.

The automation portion looks at controlling that remotely through our EMS, and we have that. And so the question is although it's not easy to tailor the entire system and put all of the equipment to make that work and that's where we are experimenting with what technology is going to make that work properly. And so we've got two areas which we're doing that.

I know the utilities out here do this long-term look. I don't know, though, if it's common across the country. It is common in Arizona for utilities to do these things.

XXX: Rob, are you looking, though -- I mean, does that look include, you know, high penetrations of EVs and DG solar and what would happen and what you would need, to the Under Secretary's question, to -- for that to happen?

XXX: I would say that's in its

infancy. We have done some. Have we done it to the scale in which the Under Secretary had suggested may be done? No. I'm certain that APS has done more than, let's say, SRP and TEP have done, and they've got a better feel for that. And that's something that ultimately has to be done because I think it would be interesting on the combination of both the electric vehicles and the PV, which will tend to be prevalent in the entire southern belt of the U.S.

XXX: A lot of that is part of the set of utilities benchmarks with nonutilities, and one of our conversations was with a major manufacturer of electrical equipment. And they had an interesting sort of speculation that I think applies to this circumstance. They were saying, well, when you have a lot of electric vehicles and you have a lot of PV and you have a lot of distributed generation, the current thinking of how safety works at the distribution level may not work. You may end up with an utterly unstable system with generation coming on and falling off and all kinds of weird things.

We haven't really imagined what does it take to actually have a safe operating grid with power flows going in a bunch of directions at the distribution level.

XXX: There's a study in Hawaii, two-year study, and it's three months old, looking at exactly the problem.

XXX: This is true for the bulk side, too, by the way, how is that behavior going to affect the bulk side. We can't ignore anymore what's going on in distribution.

XXX: So those things, low voltage ride-through, all those kinds of things that you expect of generation may be new features that you need to expect in distribution.

XXX: But the study I was referring to was mostly done not by utilities but by academia and some other companies --

XXX: By who?

XXX: -- trying to use -- academia and some other research organizations that try to use real data or real regions, but not specifically targeted.

There are different studies in Europe, studying together the social behavior of vehicles charging and finding out if we have smart charging versus not having smart charging what is the effect on distribution. And if you'd like, I can probably pull several of these studies.

XXX: That would be useful.

So let me again continue on the progression here. If there is some electric future out there and there's some planning that's starting to go on at the

utility level and maybe then at the regional level, what is the DOE's role in that? What do we do, we, the DOE?

We can facilitate the conversation, obviously, and that sounds like one of the very important things we do. There's probably a technology piece, there's an informing the regulator piece. I'm looking for what is it we do.

XXX: One thing we've done, very effectively in some places, has been kind of the technical basis. Because what we find is very few of the people that want to sell wind farm, or whatever their gadget, have done the analysis behind how does it impact the system and that kind of thing. And we have expertise in that. So we bring an honest broker kind of --

XXX: Do we do it in a kind of consulting mode?

XXX: To the state, actually. To the states.

And then we have to do the like solar collection and the wind collection behind that. We have to do the modeling behind that and all of that to have that basis. But usually very few companies have the technical depth to come after this, some of the questions, and so they make it up. And so you end up with, frankly, at the PUC a lot of liar's poker kind of thing. And we

can be the honest broker in that, and that's a very valuable tool.

XXX: So why hasn't somebody started a business to do that? I mean, that sounds like an obvious private sector thing.

XXX: Well, companies like KEMA do do that.

XXX: There's companies that offer those services as well, and they build on results that DOE has.

XXX: I see.

XXX: So DOE providing a foundation for the private sector to build on.

XXX: The point is they do the near-term work, and DOE I still think needs to be looking out further on these types of items and -- because we team up with EPRI on a lot of things. And I have to admit our focus can never be out as far as EPRI would like us to be. And EPRI does allocate some funds for this very futuristic type of research, but it's probably never enough. Whereas I do think DOE has a role in looking out further than everybody else is.

XXX: There's really no tools to allow to some good strategic planning and assimilation. I think we desperately lack that kind of tool.

XXX: So is that one of our roles, to create those tools?

XXX: I think it would be a great thing to do, because it's just -- even ISO today is facing uncertainty in generation. And so I think there's no adequate tools.

EPRI does have one tool; I forgot the name of it. It does some long-term simulation. But it's very rudimentary. There's no focused effort. Also ability to simulate new technologies. And so that's something that if done properly would greatly benefit everybody.

XXX: We were talking about that at the beginning. I think that if you look at the complexity of the system and especially if you are starting to look at the ability to model not just point simulations but what people are doing in the rest of the world, which is to -- with the advancement of advanced simulators and advanced computers now, actually compute probabilistic outcomes and all of that, I think one could argue that if you look at the system and include all of the effects that we've been talking about with the -- not only the infrastructure you have but the invention of new aspects into that, new research and new technologies, very large nonlinear systems, the ability to simulate them, who has that simulator?

I think I would argue that most people would say there isn't anything even approaching that. And there isn't a simulator for grid-based systems that's anywhere nearly as complex as we see in some other industries where they have developed that. People can design a whole aircraft from scratch. Those are not trivial things to develop. These are hundred -- multi-hundred-person-year developments of people who know what they're doing.

But who is going to do it if it isn't DOE? Individual utilities simply are incapable of that. They don't have the competencies.

XXX: It may not be that --

XXX: The universities themselves are -- can contribute, but they're not --

XXX: I'll give you an example. My CO wanted me to create what he called advance (inaudible) simulator to do just what you're talking about. I spent two, three months' time frame effort to try to just narrow down the scope of that. And it was very tough. And I still don't think I have succeeded to -- I have some features. Because you have to really balance between what we have today in simulation and what you want to do. It's really specifically dedicated to strategic planning. You have to be very carefully balanced between the complexity (inaudible) whenever you need it, because not necessarily

you need all the detailed models. It's just a matter of how you do it and how quickly you simulate alternative future.

XXX: So that's one way. I mean, another is to have the same software that actually does the control doing the simulation at the same time.

XXX: Which may or may not --

XXX: Down the road that's exactly what you would want.

XXX: That would be tough.

XXX: We talked at Cornell about this.

XXX: Is it the changing physical characteristics of both the technologies on the system and the system itself which can no longer mask or hide these nonlinearities and complexities? Is that part of the issue of why we need such a dramatic leap in capability? The system has been managed for half a century using similar type --

XXX: I don't think that's the issue. I think the issue is the flexibility of changing the future and how you simulate that and also how you present that simulation in some way. Because what you just talked, we do have that software. If I want to run very detailed analysis of making commitment for every

hour -- it's not even production cost, it's -- (inaudible) the sort of production software that we have. It's a very different process. You have to be able to model things and technologies that don't exist.

Now, if you have a simulator that each time you have a new technology you have to create a new program, of course it's a very, very tough thing to do.

XXX: Just think of a scenario where we really adopt dynamic pricing across the whole grid. And now we're going to rely on high prices to manage demand and reduce demand at critical times. How do we simulate that from a reliability point of view in terms of consumer behavior?

XXX: How would you understand the consumer behavior well enough to --

XXX: That has to be part of it.

XXX: How do you put that into a reliability simulation? Those are the kinds of questions that we need to start attacking under this umbrella of what's the reliability of this smart grid and how do we access it.

XXX: I agree with you. The simulators like this are really actually a whole information architecture. They have simulation, they have data, they have -- they can increase -- like some of the combat

operation simulators actually simulate behavioral effects. All of this stuff is there. It could be done. I don't know of any entity that has the capabilities of doing it or the money.

XXX: Or the desire.

XXX: As you're familiar --

XXX: They need a project to do the requirements definition --

XXX: Just the design work. But as you know from your experience at DOD, I mean, in a more specific but nonetheless complex simulation process, these are a hundred million dollar simulators to develop. And nobody -- no utility is going to do that. And they really are built around -- and even if you have them, you need an organization to maintain them, to keep them going. You need expertise to do consulting projects. You need -- it's a whole entity.

Now, national labs have done this for the weapons program. So there is a model.

XXX: And also systems in defense.

XXX: All the defense systems. So there actually is a model, but it does require -- I would argue if you go down this pathway it's a commitment to an organizational capability, not just a technology, or you can't get anywhere.

XXX: So why couldn't -- why isn't -- maybe IBM in the back room, this is what they're going to do.

XXX: It's not clear you can ever pay for these things.

XXX: We're a terrible market for software. We're just not big enough. So electric utility industry does not support the development. We use -- the good software that we use has -- cuts across many markets, like Historians, like PI Historian, that work in the industrial market and chemical industry and everything else. We'll adopt it and use it. But in terms of supporting large-scale software development like that, we're just -- actually, we're not a big enough industry.

XXX: And you don't have the historical competencies. You don't have people that have done -- developing such systems is not -- this is not an amateur's game. These are people that know how to build complex simulation operations systems.

XXX: I would still argue that it is more important to understand what you're trying to do rather than how to do it. We know how to do it. And my major problem was I actually met probably ten times with my boss just to find out what they want, what they mean by this. It's not a simple definition.

Another problem, I have been peer-reviewing some of the large-scale models that EPA (inaudible). The problem is validating that model. Because it's really not a very easy way to say whether the simulated is actually --

XXX: But on the short time, we were talking in one of the -- the short time scales you get validated continuously, right?

XXX: Yes. But in the -- not all of it. For example, the planning model.

XXX: No. The planning models are much harder to validate.

XXX: Even in the very short term, you really don't have enough statistics.

XXX: And you might argue that the planning models are really only tools anyway and don't --

XXX: I have another idea for example for the DOE. You created these research centers and hubs, innovation hubs. Why can't we pick up a couple of teams, give each team an alternative future. Because we argue here, one way to build transmission, another way to build more micro grids, assume centralized or decentralized control. And certainly we have to find one of the key features we want and let them analyze that future, create a human simulator versus software that

could take long to do, and then let this, each team, defend their own. Like relaxing today's (inaudible) amp constraints, whatever.

We have today different reliability rules both in distribution and bulk side. Different metrics. Completely different metrics. Even though the line is blurring, we still --

XXX: So now we're into the how, which is one dimension. But I think we're --

XXX: That's what I think you want.

XXX: It's a neat idea. I guess where I would stumble is who gets to judge that? Who gets to pick what's the winning solution set?

XXX: You have to create a group of experts and have the other groups to do that. We do economic experiments, experimental economics, simulating market behavior. I gave an example yesterday about Y K. You tell people that everything is going to go down the drain in 2000, and people started buying the backup generation and things like this. They wouldn't do it otherwise.

So if you say in four years we are going to change frequency regulation by that amount, and so some people say, oh, well, our computers wouldn't be ready, the quality is bad. They will find the technology to deal

with that. And so it's just a matter of scaring enough people to come up with new technology.

XXX: So there are many ways to run this kind of exercise, and that's great. Somebody will figure that out if we decide to go ahead.

Let me turn to the data a little bit. To build models you need the data. And what I learned yesterday is that there are barriers, legal, business, others, to collecting enough data in one place to do that. Is that going to -- is that an issue? What time scales? Where? Who owns the data? How do we --

XXX: Actually, XXX, you dealt with that when we built Verde.

XXX: Yeah. I hear from the group. But at least based on even past experience where even as DOE where we were concerned about having data to support recovery efforts after Katrina and Rita, just so we can prove our situational awareness so we could say, hey, help us understand where there's critical infrastructure down that we can be able to support you in ways that -- I mean, that became even, well, sorry, we can't do that. And it took probably two years of just legal discussion, working with --

XXX: But the point is it took a long time but you got it.

XXX: We did. But I think part of the question is how do you -- I mean, that was on an -- I mean, it came back to an earlier conversation yesterday, and maybe, XXX, you were mentioning this one, but talking about, well, the only way we can get you data on the ISO or TO is if we get every single stakeholder involved. And I think that's part of the question, is how do we start -- if data becomes an issue, how do we start getting a framework that allows sort of access to it but doesn't violate the trust responsibility that is occurring.

XXX: Policy that I think was created just specifically not to give it out.

But what kind of data are you talking about? Let's find out exactly what data. If we are -- there are two things that are protected by this critical infrastructure. One is network modeling data and another one is markets data. That's what ISO is. Doesn't give away easily.

My question is who needs that data? So, for example, if it's just DOE, it's one thing. If you give it away to somebody else who is going to work on this, that's different. Because if it's just DOE, I think you can probably strike a deal with FERC. FERC -- whatever FERC wants it gets. And so when I talk to our lawyers, they say if FERC asks for any kind of modeling --

XXX: This is DOE and its laboratories in the end.

XXX: Even labs may be questionable.

XXX: The question is can DOE in general keep confidential data confidential?

XXX: I think we've got a pretty good but not perfect record of that.

XXX: So I would say that as long as DOE can come to the understanding that it will not be releasing confidential information, I think we can get the information to you.

XXX: Also, do you need -- I mean, you don't need it from every ISO. If you are building a model at least at the beginning all you want is one ISO's data because that's what you want to get started on.

XXX: It depends. For example, with wind penetration and wind data, you may want to go for California or Washington --

XXX: But most of the work will be done by starting with one ISO.

XXX: In theory you could compartmentalize based upon the questions you were trying to answer, sort of the unique characteristics you were trying to capture of that system.

XXX: In fact, it's a good predictive exercise to build the model for one system and then see how well it does applying on another system.

XXX: It's largely self-inflicted. You seek standards when they are created --

XXX: But the note is FERC to go after to unlock this?

XXX: FERC orders. It's different FERC orders on this topic.

XXX: There will be lawyers going against it. It's going to be against distinct standards from NERT. And so it's going to be a legal fight.

XXX: Is it interstate transmission you're trying to deal with? Which would be FERC. Does it involve states? Then you've got to deal with the states that are involved as well if you're going into that activity.

So Hawaii's an island. We did that. We modeled the grids in Hawaii. A little system, megawatts within percent reproducibility, a year's worth of data. It's doable. A lot more complicated on the local.

XXX: That's interesting.

XXX: And here you are talking more the distribution system, right? So that's a state

jurisdictional issue.

XXX: Distribution system models are -- utilities, generally you can clean them up to the point where they're shareable. We've had a number of utility -- we've developed test cases that we can give to IEEE, critical mass, names are changed and they have all the details.

XXX: The distribution system using GridLAB-D, a number of 27 different architectures I think.

XXX: We're getting to have a pretty good library of distribution circuits that represent a cross-section that we can play with and continue.

To me the models of the individual elements are the big unknown, that we need to develop the library of that then plug into those systems. As we develop storage models and we develop smart inverters for PV and we develop power electronic transformers and we develop pricing systems that customers are going to respond to and we plug that into a distribution model, those are -- all those elements are not there. They're in our heads and with examples, but they're being played with in example cases.

But they're not out there in the public for

all the universities to try and model and evaluate the impacts and things like that. So test cases are there, but all the technologies that we have to integrate in those test cases are not there. So there's a lot of modeling work to be done from that respect.

XXX: And some of those models are manufactured for proprietary --

XXX: That gets even more complicated, how to generalize the manufacturer's proprietary model.

XXX: Interconnections are very difficult because every company uses their own private model. And there is no real agreed-upon model to do that. There's no --

XXX: Even all the way up to wind turbines. We worked on that for many years, but in the end you want that wind turbine model in your transmission model, the actual vendor's model. You can do your planning studies with generalized models, but there's all kinds of idiosyncracies in terms of how they respond to voltage regs and things like that that are only in the vendor model.

XXX: I don't think there's a rush at the moment that (inaudible) laboratory. I don't think we need specifically a big push for that. It's happening.

XXX: It's happening.

XXX: It is happening for creating models that (inaudible) -- to do Internet, mostly trained us to do simulation. All the wind turbine models are being -- some of them that we can't get from the vendors, EPRI is actually having an effort with IEEE creating a reusable model that we can plug in. (Inaudible) with different areas are meeting together and making sure what's being used now and be able to try to calibrate some of these models. This is well on its way. I don't think that's something that has to be pushed by DOE to start happening.

The network models, again we have certain standards that allow us to exchange. It's not perfect. It's far from perfect. But, again, between the utilities, not that bad.

But with academia, when we want to exchange market data with neighboring markets or a nonmarkets, it's really a matter of -- when you talk about the data availability, it's data for research and ability to use that. I think at the moment with some of the security goals it's going to be more and more difficult. It used to be always published it with FERC. Now it's not as accessible.

XXX: Is there something more on

the consumer behavior side that -- in terms of understanding it, education, how -- what the response will look like for different scenarios in the future that DOE should be doing? I actually don't know the -- I mean, there's a lot of studies going on. In my opinion they're somewhat limited in scope in terms of what we will learn from them because we can't look ahead to an automated response, which is a big factor. We've got to actually have that to see how consumers will respond to that. But putting the science on to the consumer response question and then migrating that information into models as well.

XXX: So how important is the human dimension in all of this and should we be studying it? And if so, what does the research program look like?

XXX: I know we're starting a program next year on integrating the customer, because our end utilities of -- that's a big issue for all utilities, is understanding the customer, and if nothing else from just an energy efficiency point of view: how do we interact with the customers and help them become more efficient and provide education and -- but there's a lot of science to put around that, so it has not been an area that utilities typically have put a lot of science in.

XXX: I think most sociologists would look at it and say that the efforts today are very simple

and don't account for a very diverse set of responses to things, demographic issues, cultural issues. So I think you have a starting point. But I think the idea of expanding that to look at, you know, kind of the diversity that you see and how do they respond --

XXX: We just said it's happening already, too.

XXX: I wonder if we need to do more, because it is happening.

XXX: I think it's already that everybody realizes we need to do that. And if DOE (inaudible) from FERC triggered a lot of need for that kind of study because it's not quite economic and people don't really know how loads will behave. And so there are several efforts already right now including EPRI trying to address that, simulate what's going to happen and how people are going to behave with that specific order. Because it's at least next four, five years. Again, I think it's already happening. There is a need for this. The industry realizes the need.

I think where we all are diverging is what is the future going to look like. So we are going around and around about this, and we really don't have a very good picture. And that's I think -- it would be a great thing to focus the efforts to try to figure out what --

XXX: And the dimensions of that are what the generation will look like?

XXX: Actually even the --

XXX: The loads?

XXX: Picture wise.

XXX: Architecture, just physically architecture?

XXX: Not necessarily there's only one right direction to go. If we feel that this is the reasonable direction, it's just we have to start going. Because we are going like this instead of going like this. I mean, there is no one solution that would be perfect for everybody.

XXX: It's kind of like is there a way to customize the delivery to each and every customer. Because we talked about a vision with the smart grid, some of the studies we're doing, so that a new family moves into the home in wherever, say Arkansas, and the electricity company can say, okay, we know for your family size of four and your income and your sociological background this is the best pricing model, the best home interface, the best way for you to save energy. So they would start with that, but it's customizable based on the needs.

XXX: It's like with markets. We

have learned that there are certain -- there is very common principles in design that should be in every market. But then it turns out that every region has its own specifics, and you can't really build one market that fits everybody. So -- and you have to have that skeleton of the future where we want to go, and then everybody will customize it. But if it's fully customizable you will be in the same place.

XXX: So everyone needs electricity, but how to get it, how to use it, how they manage their behavior at the interface, it's different.

XXX: But FERC gave a standard market design, I think we have to have a standard decision that we will go that way and start going.

XXX: So I have a friend who works at the forefront of biology and genomics, and he talks about a medicine that's personalized, predictive, preventive, and participatory. And there may be another "p" in there. Those are the kinds of things you would probably like for the grid as well.

XXX: I think that's what people are going to demand from their -- not just from the utilities, but they will begin to be exposed to options from vendors that are already doing many of these things, vendors that are going to come in and offer to consumers, well, we'll

set up a personalized energy delivery system for you inside your home and it will allow you to close your blinds before you get home and it will allow you to know what you're using on a real-time basis. And all of these things are going to happen. I think it's going to be very consumer driven.

XXX: That's already happening. I know in Nevada with the smart grid project we've got there, the representative came to NV Energy and said with the awnings up and down automatically at certain times of day, they wanted to add that feature and they wanted to partner with NV Energy. So it's already starting to happen.

XXX: AT&T is developing an app that will allow people to do that. So this is happening. And whether the utilities are ready for it or want it, it is happening. And I think --

XXX: The thing is can we jump-start it. Can we make it a holistic thing, not just a piecemeal kind of activity that is being tried.

XXX: Or should we? Maybe you just let it happen. I don't know.

XXX: It's a question of how much value is there in the time saved of a targeted approach versus letting an evolution happen. What's the value of

that to other markets, to other activities, to the consumer.

XXX: Can we meet our goals in the time frame that we need to?

XXX: The driver is money. So if the price of electricity goes up enough that people will be concerned about it, they're going to start doing it. If not, it's very difficult. Only people that are environmentally concerned and -- they would do things like this. But otherwise, unless I really have -- I see the effect of it and how much I pay for it --

XXX: Well, it's money or regulation. I mean, you can say thou shalt.

XXX: Yeah. But you can't really probably --

XXX: It's just from a different source.

XXX: Mandating something like this you won't. But certain things, yes, you can mandate.

XXX: But I think once you get there, this conversion where it has -- that the energy system has a significant information attachment, that's what the consumers are going to be drawn to. I mean, I agree with you a hundred percent. And history shows that all kinds of things are going to happen then, once that happens.

And there may be the need underneath this for some fundamental understandings about it.

So DOE's role of providing knowledge and expertise to parties that can use that information to develop commercial activities, I think it's very possible in this thing that the interface between the -- literally the delivery of the electrons and the use by the customer will get occupied by some other kind of entity. It won't be the utilities. And I think utilities have not historically had the competencies to do that and the companies that have are already showing up. Whether the ones that show up now will be the winners, we don't know that. But they know how to take information and make it relevant to customers.

XXX: And to be integrated with many other things.

XXX: Many other things. It will be part of your information infrastructure of your home. It will have all the other stuff --

XXX: Pool pumps and --

XXX: So utilities could just back off and be basically infrastructure.

XXX: But the impact on utilities is a major issue inherently.

XXX: So that's where I think the

knowledge question --

XXX: And that just goes back to what will consumers do with all that information that comes from Cisco and Global and AT&T and everything else.

XXX: So do we have other examples of where there's been this kind of information overlay on it, either historical or happening now? You know, the phone system, a phone is much more than a phone now, of course. So that's happened. Transportation, starting.

XXX: It is starting.

XXX: It is starting. Digitization of your automobile.

XXX: Financial management dominates. Now it dominates. IT dominates financial management.

XXX: Entertainment is the same.

XXX: Actually, that's all -- financial management now is an information system.

XXX: Used to be pencil and paper.

XXX: Construction industry. The whole FIATECH collaboration is really all about digitizing the creation of buildings, all the way through permitting and building them and as-builts. So you got the big players sitting around trying to say, hey, how do we not have to do this. And I think it was last year they developed the entire architecture and system far enough

that they realized that the building permit departments had been left out of the whole thing and were expecting a damn roll of paper.

XXX: That's the planned manufacturing, also. You go watch them build an airplane, it's all digital, right, everything from the parts to the manufacture to the operation. But those are not consumer things. I mean, this is different.

XXX: But one that is --

XXX: Healthcare.

XXX: Healthcare is coming.

One that is is supply and logistics. The U.S. -- in part the reason the U.S. has by far the most efficient supply and logistical system, FedEx and all of that, people now take that for granted. They can get anything from A to B by logging on and doing it. That's all they have to do. They don't have to do anything else. So that's been completely transformed.

XXX: So this is the vision of what the grid might look like, right?

XXX: Probably already possible if you have a massive storage penetration on some level so you can actually distribute -- make the effort (inaudible) in some way. You don't need for very long period of time. It becomes closer to the Internet. We talked a little bit

about this. But if you have that capability you can actually -- we never thought that you would be getting from Internet a movie, which is package of discrete messages, but you don't really see the discrete. You see it as streaming. So streaming technology today in IT is very different from what it initially was. And if you have storage everywhere and the storage could talk to each other, I can dream up an interesting model. But that requires a lot of push for storage, to build more economically.

XXX: Napster of storage? I mean, storage sharing basically.

XXX: You actually can make a system of storage talks to a couple of tiers away from this. And if you need to balance, you can borrow. I mean, I can think of a model --

XXX: Yes. Right.

XXX: -- and then come up with some idea. But you need that kind of leap in the storage cost.

XXX: I like to use the word ubiquitous for storage as a goal.

XXX: Why not?

XXX: That takes the current --

XXX: As the customers get control of this, which is I think where you're going, and the fact

that the one thing you can count on in this, the complexity for the energy system, is the underlying IT technology is going to plunge on into the future regardless of what any one industry does. And its rate of change is so vastly faster than the infrastructure, that's going to cause something else to happen. I mean, in five years -- five years is a huge leap in IT. That's almost nothing for somebody who's building out a power system. So one of the questions is as that gets latched on, as customers start to be the driver of that interface, what then is forced upon the infrastructure to manage it. That was your question. And I don't think that's clear.

And you shouldn't underestimate -- the IT system will be so unbelievably different in ten years, that's the one thing you can count on. The evolution of the power system, it will be evolving, but it will still have substantively -- most of its components are there today. So how does that happen? So what happens here?

XXX: You've got the same problem. You know, a car lasts 10 or 20 years and the software changes a lot faster than that. And so how do you match those two time scales?

XXX: I think that's a general question about the evolution of the system shouldn't be underestimated. Because I agree with you a hundred

percent. Once consumers get used to -- because they're used to it now. They're going to say, hey, I've got control. I want A, B, C.

XXX: I really think that's where DOE comes in, is to help the utilities make this transition and to solve some of those -- I really like the way you put that, solve some of those demands and problems that are going to be hoisted upon utilities that have to be solved.

XXX: Well, they'll either be hoisted on to the utilities by them or by an intermediary that says we'll aggregate a thousand of you and then we'll really take on the utilities, which is what's happening in logistics.

XXX: And can we make a fully digitized grid hack-proof?

XXX: That's a whole other class of problems.

XXX: Talking about nightmares.

XXX: That's a whole other class of problems. That's true for banking as well.

XXX: And the answer is you can't there, so you tolerate whatever losses you're having.

XXX: Localize it, isolate it, all those kind of things.

XXX: Exactly. You have to make a --

XXX: I would like to take five, ten minutes just for break. So why don't we reconvene at quarter after, and we'll keep going in perhaps a different direction.

(Break taken.)

XXX: There was a sense -- discussion among some of us over the last couple minutes that perhaps the conversation had gotten a bit too high level and not really focused on what the DOE could, should be doing over the next five years or so to realize, to use the political phraseology, to win the clean energy future. And, you know, how do we fit in relative to FERC, utilities, technology providers, where is the highest leverage or appropriate role, whatever you want to call it.

So maybe I would like to try to bring the conversation back to the nearer time frame and more specifically on where the DOE's niche, highest leverage is. So just with that I've got my own thoughts, but I think I'll just put the question on the table.

XXX: It would generally be helpful for me if I understand what you can. For example, are you talking funding?

XXX: Yes. So assume the money is

not the issue at the moment and whatever the budget is right now --

XXX: Besides funding certain efforts, what else can DOE do? Maybe I'm the only one who doesn't know exactly what you --

XXX: When you say funding certain efforts, which efforts?

XXX: That's what I think we are here to find out, which efforts should be funded. But besides this, anything else that the DOE -- I mean, what other options are there?

XXX: So we heard that we operate in I don't want to call it consulting mode, but maybe that is the right word for various --

XXX: Facilitation mode.

XXX: We convene, we get people talking to one another. We try to promulgate best practice, so, hey, it worked over there and we think you should look at it because it works over there. We are involved in setting standards in some things, right, certainly down at the demand end, both at the charging for vehicles and things of that sort. And then we work on the underlying technologies, whether it's storage, power, electronics, simulation, and so on.

So I think at some modest level of

resolution that's what we do. Did I miss anything?

XXX: I think one of the things that cuts across it and one of the things we struggle with a lot is the communications of what we do and the communications of the best practices and the results of some of the work that's been done in Wyoming.

XXX: Because people don't want to hear or we don't work at it hard enough?

XXX: Both.

XXX: Probably I think a little bit of all of that, really.

XXX: Prior to smart grid we really -- OMB kind of slapped our hands for doing so, thought it's not DOE's role. We are technology in the organization.

XXX: Let me turn it around a little bit. It's too bad Mark left because it had an application in our discussion with EPRI. EPRI, recall back in the '70s and '80s, were fundamentally just pure research and they produced a lot of great reports. I can't tell you -- bookshelves of great reports. I wish I would've read them all.

And then they started transforming themselves into doing more things and branching out. And just as this conversation turned before what the customer is, if you are asking what are the customers of DOE

looking for and how do you become more responsive to that, it's how you communicate on these different levels now. And although the reports are necessary still, I would venture to say that that is not the end product any longer. The end product is not developing a great report that really answers all the questions that nobody reads or very few people read or people just don't go about and implement in some fashion. So it's going to have to be in a new perspective as probably more interactive, more engaging, and tying things together better.

XXX: I do think that this is a problem for DOE. And, you know, you've got to get better at communicating the story. Because you are about to have a profound impact on individual lives with this money. And you already are. I mean, the money that's going out through ARRA, you are touching so many people, and yet I don't think those people know that it's DOE.

I'll give you an example. When I was a commissioner, I visited the home of a woman who was having her home weatherized. I climbed up on her roof, looked in the attic, it was really cool. I was wearing these heels, so that was probably a little stupid. But, you know, got back down and she said -- I said, well, you know -- she said to me, Well, Commissioner, you know, I'm going to be able to take the money that I'm saving from these

retrofits that I would've sent to SRP and I'm going to be able to buy my kids textbooks and shoes for the first time in a long, long time. And so it's a profound individual impact on these people. And I don't think she had a clue that the federal government was involved in that.

XXX: That's interesting.

XXX: So I don't know if it's -- it is -- at bottom, I mean, I'm a former communications director to a governor and a former reporter, so this is not rocket science.

XXX: Who did she give credit to, by the way?

XXX: Who did she think was responsible?

XXX: I don't know. Probably maybe more to the utility and to the state and maybe the community action agency that was actually deploying it.

XXX: Or coordinating it.

XXX: So might be interesting to go back and look. Because I think that, you know, the Environmental Protection Agency enjoys much more of a positive image in the public's consciousness than you guys do.

XXX: Look at ENERGY STAR, anyway.

XXX: The appliance rebates, who

got those last year? I mean, I got some of them. I mean, I put in a high efficiency heat pump. Nowhere did it say that this was from the Department of Energy.

XXX: And EPA has ENERGY STAR -- we invented a lot of the ENERGY STAR stuff. I mean, CHP, we actually did that program first. But their PR, they were allowed to hire PR firms to go out and market, and we were not allowed to do that.

XXX: I don't know. It's case specific, but certainly we don't do much of that. NASA, we often -- on the science side of DOE we often look at NASA. So the launch that just happened at the shuttle, the payload is a DOE, the big magnet, the AMS.

XXX: That's expensive, right?

XXX: Right. That's us. We did that for 15 years. Do you hear the word DOE mentioned once?

XXX: No. I had no idea. And this is not a trivial point.

XXX: 10 million out of 2 billion.

XXX: I would argue this is really not a trivial point. Because like I said yesterday, we are at -- we are at a pivot point in this country in terms of where the public is going, where Congress is going in terms of both EPA's funding and DOE's funding. So whether or not you can communicate this and get the public on our

side on this is nontrivial. And it could be -- could spell the difference between DOE being able to continue with this work in the future or not.

XXX: Particularly with a large part of the population convinced that public servants are drones that ought to be minimized.

XXX: So recognizing that engineers and scientists are particularly poor at communicating --

XXX: Some. Some.

XXX: Many.

XXX: Yeah, many.

XXX: -- communicating our impact in what it is that we do, is the appropriate answer to say that we just need to talk about what we do better? Or are there things that we should direct our focus to that we either have not done in the past or have not done at a sufficient level to have an impact?

XXX: I was going to say it's important to drive at this from a -- there is a fundamental reason. Set aside beating yourself up from whatever happened in the past because that doesn't make any difference, for one thing. The second thing is that for some people, just as a counterpoint before I make my main point, you know, people in the energy business don't have this problem with DOE. I mean, they've had lots of good interactions with

the companies.

Now, what's different is -- this is where I think you're going; this is important -- as the energy system gets more attached to individuals -- individuals historically, whether they bought gasoline or whether they got electrons from their local utility, were basically viewing themselves as generally victims of the system and lived with what they got. That's just the way life was. Or if the prices were low enough, they didn't care because it was invisible.

But if the system is actually -- I think with smart grid, if the system is going to start to materialize in a direct way with consumers, that's a communication problem you didn't have in the past which you now have. So there is the question about not getting enough credit for the science you do. But I would argue that many who understand -- will ultimately make that decision understand that, so you don't have that problem.

But if you are starting to engage and you believe that one of the hypotheses is that on the power grid for sure consumers are going to start to be a bigger driver in the system than they ever were before, then there is a communication gap, because that gap you don't cover. So I think you've done a good job with the industrial sector by and large.

XXX: But invisible to consumers.

XXX: I think you also have to make the -- start making some connection between what you're doing and what that is going to do for people. And, you know, so for -- and start to sort of connect on a visceral level with people in different -- maybe on a regional basis, because what's important in New England is going to be maybe very different than what's important in Arizona.

I can tell you two things to connect with people or people connect with viscerally here. One, water, so the water energy nexus; two, air quality. We have one of the highest rates of childhood asthma in Phoenix than anywhere in the country. And if DOE can go out there and spell out there to say this 304 million -- or billion dollars we're spending on energy efficiency is going to help clean up the air in Arizona, that's what people need to hear or want to hear, and that's where you can start to build popular support for what you're doing.

XXX: One of the, I'll have to say the ironies is just when the programs are starting to go out into the consumer base, it happened to be also a time where -- when I started at the Department 10 years ago, we had regional offices to cover just what you're talking about, New England, Boston slightly different than the southwest which is different than Chicago which is

different than the southeast. And DOE over the last five years or so has progressively pulled back from that local and regional presence. I would say along with that has been that connection to the programs and to the individuals. And I think in some ways that relationship not necessarily with industry but with the stakeholders from a consumer perspective has somewhat been lost.

XXX: That's right.

XXX: Interesting.

XXX: So I think there is that dynamic, and I think that's an important dynamic for DOE. This is -- and this is a trend that is not going to reverse itself I don't believe. I think it's going to go the other way. So at the very least there's a segment of your -- of interested constituents that is really going -- this new segment is going to show up. That doesn't mean you abandon the old one. But the old one works.

XXX: Most people have no idea what the Department does.

XXX: That's correct.

XXX: In fact, it is pretty heterogenous. We go from a diverse -- diverse is probably a better word. We go from the nuclear weapons to energy issues to cleanup.

XXX: Basic research, the university

community knows about that.

XXX: That's right. And they see us through that lens. I mean, no sense of the rest of it.

XXX: The nuclear impact is the thing that probably sticks most in the mind of the public. You are the guys who are...

XXX: Well, you know, the joke characterization which you know is that we're a waste removal company with an arsenal.

XXX: So the message that I'm hearing is that we are doing everything right; we just need to talk about it better. Is that the message I should take away from this meeting?

XXX: No. I think you have to realize you have a whole other set of constituencies that are going to be much more active. And this is what I think is the new dynamic. If you believe in the smart grid paradigm, once consumers start to interact they'll either like it, they'll hate it. This looks just like what you see across the rollout of smart grid. There's people that have embraced it, where things have gone well; there's people that are on the porch with the shot gun saying you move another foot and I'll kill you, which we have seen.

XXX: California.

XXX: So let's compare this with the

Internet, high-speed cable, which is another infrastructure that has sort of entered people's lives over the last couple decades, touches everyone. The FCC presumably --

XXX: We're not very entertaining.

XXX: But we make the entertainment possible.

So are there parallels there that are worth thinking about?

XXX: By and large the Internet came about on its own and regulated that.

XXX: Cable touches everybody's lives. You interact with it.

XXX: But the other is it delivers differentiated content. I mean, you know, we deliver electrons. There is a difference. I mean --

XXX: But we also have green electrons and regular electrons.

XXX: Really? Think the electrons know about whether they're green or not?

XXX: Spin up or spin down.

XXX: As people begin to understand and get more connected, I think there's going to be a communication issue. It needs -- but DOE, I would guess in your management thesis there's very little talk about

the fact that you're -- how you communicate to consumers. I think you talk about how you deal with state governments --

XXX: In fact, that's sort of --

XXX: -- maybe big industrial firms, but not --

XXX: Why? Why is that?

XXX: I think it's viewed in the political sphere as propaganda, mind control, you know.

XXX: This administration is pushing X. OMB especially has been very, very --

XXX: Yes, you're pushing X. Of course you are.

XXX: It's a good thing, too.

XXX: That's the challenge we're having with smart grid, is what should be our role in educating. We had this discussion yesterday. Should this be the Department's role, to educate end-users about smart grid? Would we be invading PUC state territory? Would we be invading utility's territory?

XXX: I think not if you partnered up with those PUCs. I mean, I think that's another thing that the DOE --

XXX: That's not how the last party saw it at all. If you were impacting the market in a

five- or ten-year horizon, you were not doing your job. You either were doing -- you really weren't supposed to do long-term effects on things like hydrogen and not be protecting the current market, the current budget.

XXX: You mean the last administration?

XXX: It's a great excuse for not doing anything.

XXX: But we are doing --

XXX: I'm not being political.

XXX: We are doing -- just to clarify one thing, it's not that -- I agree with you it's the partnership thing, which we are doing. We are working with PUCs and NCSL and NARUC in terms of educating on smart grid and the benefits and transmission primaries as an example. But again --

XXX: As Don was saying, down to the end user, the consumers.

XXX: But, again, I mean, the role is we -- if you look at all those publications, the reference to DOE or sort of the resources, it's like one sentence, thank you for your -- on like the fourth page, Thank you for your support. Which again it comes back to then -- and, again, what's our role? And I think that's the question.

XXX: I think the larger issue for the Department, from my perspective anyway, is the lack of a national energy policy. What are we promoting? What are we selling? That's really been like -- so no one knows how to go after it.

XXX: So, again, you can recite the national goals as well as I, right? At least in this administration that's what we're trying to do, fix the oil problem, U.S. competitiveness, and environmental impacts.

XXX: As you said yesterday, when was the last time we had a strategic plan?

XXX: Oh, right.

XXX: Are you talking Congress or the White House?

XXX: The White House.

XXX: It's ironic to me that, I mean, of all the federal agencies, you may have more touches on individual people than any other agency.

XXX: Well, that's interesting.

XXX: I mean, think about it. Think about just your energy efficiency alone how many touches you're getting into households, American households, and they have no idea what you're doing.

XXX: Everybody has a water heater.

XXX: Right. And that woman that had her house weatherized. And so I don't know. Something to really think along --

XXX: Even bulbs.

XXX: Maybe it comes down to whether that's palatable at the congressional level or not.

XXX: There was that famous exchange a couple months ago about light bulbs and flush toilets.

XXX: Exactly. That's exactly what I'm talking about.

XXX: So for the QTR, what is really needed to really relate back to that exercise and what goes into a broader DOE, longer term things we should try to impact?

XXX: Right. So we were talking during the break a little bit. Actually the conversation now would go sort of -- I mean, there is a story here to tell, and it's about making the grid commensurate with our expectations and plans and other dimensions. And it's got efficiency, it's got information, it's got all of the things we kind of talked about.

It's about an industry that is not as coherent as it needs to be to try to bring these things about in a government role, in some technology, in convening, in simulation. And, you know, that is the

rationale. And then you can descend into particular programs or programs that should be, whether it's in storage or simulation, power flow control I mean, the monitoring. And I think that's in the end what the document looks like, which provides a framework -- I think it tells a coherent story and then integrates well into the other pieces which we have not yet actually created.

So I don't know. Does that sound right? Again, it's a question of what goes into the resolution, what goes into the detail, you know. We don't want to get too specific because that's the budget exercise, but enough so you can explain to people why the DOE is involved with this and why it's important.

XXX: So part of modeling is also verification and validation. And there are a lot of perspectives on what V and V constitutes for the grid. You know, we have a facility that is going in at NREL called the Energy Systems Integration Facility that is fairly small and -- but it will enable validation of technology and systems components at some level. But I also heard yesterday people talking about using entire cities as test beds.

And so I guess from a technical perspective, what is needed from the Department to go beyond the we will create a model to we will make sure this model is

useful and used?

XXX: I think that's a really good point, Avi. I mean, ESIF is a really impressive accomplishment I think of DOE, and I think it's going to be -- I mean, I think it's going to be extraordinary and I hope the utilities will use it. And actually my university is discussing some possible partnerships between our Az SMART program and what we're doing in terms of mapping the distribution grid at Arizona State University. I mean, we're a small -- Az SMART has the participation of our utilities. We're a small grid unto ourselves. And so I think there's -- there would be real value to taking ESIF wherever, I'm not necessarily -- obviously it would be great if it was with ASU, but wherever you decide to do this to sort of pairing that with a real live example, sort of. And I think there's lots of different places you could do it. You could do it within the university setting, you could do it with -- pick a small city. But, yeah, I think that's something you should look at.

Again, I think that gives you also more sort of exposure, public exposure to what you're doing. Because ESIF is going to be fantastic. It will be an extraordinary tool for the utilities, but I'm not sure then how much exposure you are going to have to average

people, for average people.

Rob, what do you think?

XXX: Well, one is I do see it as a continual collaboration between NREL, the universities, and utilities. I never saw this as a one-time shot and then turn it over. It's going to start off a little more so it can be managed, and then once it has proven out then you can expand that and provide more applications of it.

But I think -- I tend to agree, but I see that as a long-term element that will see some initial pay back on it and then it can be expanded because we'll learn a lot. And it's like everything else here, there's just so much complexity to this.

XXX: Personally, I see it a little differently, because I think ESIF is just one of our tools that we have in the different labs. And we need to take advantage of networking and making sure that the labs are coordinating across the states. Because the tools set at PNNL is different at Sandia, is different at NREL. And if you take them collectively, it's pretty powerful. But let's make sure we're not building redundancies that we don't need.

XXX: How should we be managing these capabilities?

XXX: For the conversations we have

related to ESIF spending, I actually think that there is a movement among at least the working level to self manage that in terms of saying I at NREL recognize PNNL has this better capability, they will take the lead in this project and vice versa. I think there is an opportunity right now to give them a chance to do that. We're talking about exploring that with them on the --

XXX: I think -- I mean, from a different perspective, I mean, ESIF is a very clear example of a government-owned capability. How should we manage giving this capability to the nation? How should we manage access to it? How should we manage funding and opportunities?

There's been discussion of creating technology user facilities that actually came out in the last strategic plan. And there are advantages to that. When you go with the technology user facility model, you have government stewardship, you can have an open competition, you create name recognition, and you can pull in -- you can choose from the best science and technology development regardless of where it comes from. That being said, user facilities move pretty darn slow. They have annual competitions, business and utilities require much greater flexibility.

So how should these types of

government-owned capabilities be managed, funded, operated to have the greatest impact for the country?

XXX: We've done it before. And maybe Gil can talk about the Oak Ridge facility because we went through both the creation and the ending of that and what it did.

XXX: I guess the question I think is probably the seed of where you're going is there's going to be a desire to use the facilities in my opinion by the utilities, as an example. I don't care if it's an outdoor testing facility for the conductors or if it's at an ESIF facility. But how do you make sure it goes beyond just that laboratory-utility relationship in that particular project and that information and that understanding gets disseminated more broadly? And I think that's something that is a more difficult question. I think to create it and the ways to have projects and looking for sort of areas of mutual interest, that is something that will develop and will occur on its own.

Engaging universities, fellowships, exchange programs, teaching capabilities, that's another way to expand it. Having NARUC in summer sessions at the laboratory so they can get an understanding of what the technology is. And it's really about opening these up as vehicles for a broader dialogue on the clean energy issues

and how the grid and the technologies and the policies and the operations and the markets all are intersecting and helping people understand their individual roles in accomplishing the sort of the successful outcome.

XXX: To do that you have to have a core level of funding that's consistent, and that's been missing.

XXX: Because we lose -- part of it is we lose expertise. When we start -- there's the project-by-project basis, but I've seen it on a lot of the stuff I've worked on, in power electronics or Imre I'm sure in the storage in the past where you go out and you engage people who have the expertise in that area. The project blips or the utility just dies away from that perspective, they go on to something else. And regaining that capability and that expertise just is something that's very difficult to do. And it doesn't mean that we have to have a mortgage, but it does mean that I think we need to be thinking strategically of how to maintain that base so that broader body of users can --

XXX: Why did Congress zero you out in the '90s several times? I assume it was Congress.

XXX: Yeah, it was. Basically zeroed out in '95, '96, and '97.

XXX: Why was that?

XXX: They didn't like us getting in -- coming up with saying what the solution should be for some of the transmission issues, specific lines need to be built. So in the California crisis, blackouts happened, as an example. They were like, you know what? Some congressmen got upset because we said X is a better solution than Y type thing. And any time we got close to those kind of things it was like just zeroed it out because we don't want you in the space.

XXX: Interesting.

XXX: But a users facility doesn't have to do that, because people come and they do what they do and they make the decision, they go away and they do something.

XXX: But that's the question you have. Still a lot of issues you touch on just given the very nature of you're looking at a system that has jurisdictional and regulatory and all these other political sensitivities, it's how do you intersect with those communities in the way that appears as an asset to help their agenda and not a threat that goes against --

XXX: Look at the congestion study history of the past ten years. Congress ordered us, mandated us to go do national congestion studies. Congress zeroed -- you know, slapped us for doing it and

said not in my district, kind of thing, are you going to do something.

XXX: Well, some of us think that congestion study was flawed.

XXX: Is it the same Congress, or several years apart?

XXX: At least one senator who can remain unnamed but who had a large force in changing the scientific and engineering analysis.

XXX: But I understand the sensitivity. I'm sorry, Don.

I understand the sensitivity. I get that. I just don't know that you're going to have as much of a problem -- and I could be totally wrong -- with this, with ESIF, with some of the other initiatives because they are elective. I mean, the utilities can choose to go up there and test and do the research and do the testing. So you're not hoisting it on somebody.

XXX: But right now there is no -- in my opinion no adequate commitment to the funding base for ESIF. The same problem existed when we started the Oak Ridge facility. And industries loved that facility. It didn't matter. You know, it just didn't make the cutoffs when it came to the budget decisions in terms of being a critical piece. And, you know, and in a given year it

just was zeroed out.

XXX: Don.

XXX: Well, I think that's the key question. But having a capability and maintaining it over a long term that would allow parties who have the decision-making responsibility to come and do what they need to do, as opposed to saying we are going to decide what the program is, that's different. And the user facilities don't really do that. They may have -- in addition to that, there may be in fact the directive by Congress to engage in specific things, like the advantage computation facilities. But by and large it's the people who have the problems that show up and you enable them to do it. And the advantage that you have from such a facility is because after you engaged in a lot of these, you have been able to knit together leverageable knowledge and capability.

And so I think the question is can such a structure -- can such a facility be built around, whether it's one facility or network of them, around the system aspects, the understanding a system that's going to be significantly higher in digital intensity and have significantly higher dynamics, both temporal and spatial dynamics. And there is a system -- there is a modeling part to it and information management part to it. And

then also as we've talked before in the past I think there's a field validation part.

XXX: I hope so. I hope there can be.

XXX: But that would be a different picture of what you would do.

XXX: Maybe it's different.

XXX: Without judging whether you can get it through, I would argue that would be a highly valuable infrastructure to have.

XXX: It would be.

XXX: You're asking the right questions, though. I would imagine that before you did Oak Ridge you didn't -- maybe you didn't have this conversation and you weren't saying who do we -- what stakeholders do we need to engage --

XXX: We had a national --

XXX: -- and get invested in it.

XXX: -- technology roadmap for the grid.

XXX: But did you bring in PUC chairmen? Did you bring public utilities commissioners in?

XXX: FERC chairman, Pat Wood.

XXX: Well, so what? No.

XXX: There is the whole problem right

there.

XXX: But I would say -- and maybe you did do all this stuff before.

XXX: Did we do it well enough? Was there critical mass? You know, I can't speak --

XXX: There is a core problem with the way the Department talks about the technology programs. The number of announcements of funding per program dollar is like many orders of magnitude greater than for the science programs. We talk about ourselves as if we were an ATM machine. And so in the competition between check writing and provision of service, our energy programs undercut themselves every single day.

XXX: I agree with that. The other thing is Oak Ridge is a science lab. This kind of a facility, science lab, was not a top-tier activity. So, you know, things became more important for the director and that kind of thing. So do we have a dedicated place to do this kind of stuff? The answer is no.

XXX: But one thing hasn't been discussed really. Do you have the right program manager?

If you have the right people to actually run the program in an integrated way to deliver the services that you're talking about and deliver the value for that facility, it's not just the facility. I mean, it's the people, it's the capabilities, it's how it's put together, the portfolio, the mechanisms that are put together to make it attractive to industry and to value.

XXX: So on the science side of the house we do know how to run user facilities. We do that. But it's a different user base?

XXX: But this idea that -- I think this is an important part of the story. We discussed how distributed the grid is. It's management, it's highly regionalized interests that have different views. So part of the story is there is leverageable competencies that span all of those, but the user facility itself would not be driving the system but would provide useful facilities for a whole diverse range of interests.

In other words, you would explicitly acknowledge the regional differences, the utility differences, the -- so you wouldn't be saying this is the roadmap and we're going to charge down the road and are you interested in getting on the train. But you're more of a --

XXX: You open it up.

XXX: -- switching yard. You're willing to support all kinds of trains and stuff coming in and out.

XXX: That's exactly what we have done. I mean, yes, I totally agree. It's just -- and I'd love to think that we're successful the next time we go at it.

XXX: But XXX's problem --

XXX: But you get cross ways with these differences.

XXX: Bring all comers, bring collaboration. How do we get the most information? All that stuff should be embedded in it.

XXX: Something everybody in power can get along with.

XXX: This is another way of convening, right? Beyond information, it's facility, come test this.

XXX: Bridging the stakeholders.

XXX: But I think trying to put that in a budget that's got metrics that we will achieve this this year and that next year and this next year is like, ahhh. Doesn't even fit that model.

XXX: The metric could be establish a user facility for the next ten years.

XXX: Although, I do have to say as an ex-OMB guy the ability of the -- I mean, the reason that the examiners get away with what they get away with is that you guys never have a coherent story for what your program purpose is. There's nothing to judge against. And --

XXX: Respectfully, I disagree.

XXX: It's easy to clobber you guys.

XXX: It's easy when there are lots of people that want to go after us. But to say that we've not really actually -- frankly, I really object to it. We've done as well at planning on certain activities, not consistently across the board, as anybody else has. Some of the things that have sold have been on far less research than we've done to create our programs. So I don't think that --

XXX: It would be good for us to see and maybe it's already in the tech assessments, I mean, what are those stories' rationales that you give, we give for why we're in the grid space. So I'd like to get some of those documents if we could to see how you've been telling the story.

XXX: I mean, we -- wrong administration, but we had -- the early stories, we had a national energy plan, national transmission study, grid

2030 roadmap, technical pathways to all this all laid out systematically. Didn't sell. Didn't sell it. Blackout, blackout in the same time frame, 2003 time frame.

XXX: You would think, right?

XXX: Thirty days. Get above the fold, 31 days dead in Congress floor. Dead. Dead issue.

XXX: Shock and trends.

XXX: We'll talk more about why I think the plans --

XXX: If there's a way to solve it, great.

XXX: Those type -- that specific issue always tends to be a very emotional issue.

XXX: The lights went out.

XXX: How do you deal with the emotion? Blackout is easy because it has a lot of attention for a short period of time. But, for example, you know, what would it take to get acceptance of transmission facilities in the human and natural and regulatory environment?

XXX: We figured it out, but don't write this down.

(Indiscernible.)

XXX: One of our challenges in this country -- you know, we used the Internet before. We

talked about cellular phones before. When we went on the path of going to the cellular phones, tremendous money of infrastructure needed to be built to make them happen. Now, there were individual battles, but for the most part the population was fairly accepting with that new infrastructure going on.

XXX: Because it provided a service that everybody wanted and it was a new service. Right? There's no incumbency.

XXX: Right. And again --

XXX: Lots of new business opportunities.

XXX: Sure, new business opportunities. Now, again, I would say that most people want electricity.

XXX: They've already got it.

XXX: They already have it.

XXX: And this is something that we've dealt with a lot. I will go down that path just for a moment. And the same thing with the Internet, is they didn't have to see as much of that infrastructure to make all of that happen. What did they do? A lot of that got placed on the transmission infrastructure. And so in other words, all that infrastructure burden got placed on those transmission or subtransmission or distribution

facilities. But they wanted it.

Now, I know one of the biggest battles when you talk about a new transmission line and you've got any type of community saying, well, we already have service so why do we have to have a new transmission line and they keep forgetting that they're already burdening some other community for services. So the question then becomes what would it take, though, to have transmission facilities -- I'm talking substations, lines, all the things that go with it -- to help address the regulatory environment, the natural environment, and the human environment?

XXX: Consumer benefit packages. Can we do something for New Hampshire to get a line through New Hampshire right now? What's the benefit to the guys who are just going to watch the electric companies?

XXX: Buy them off.

XXX: It's very specific. It's not a universal outcome.

XXX: I would say it can be specific. I think there can be some very large generic issues and then there will be very tailored issues.

XXX: The issues are the question about how you address some of those. But every -- in a sense, for transmission every project is -- you're talking about a project at a time.

XXX: Just the spaghetti chart, you got to start somewhere at the top.

XXX: Maybe. But what if most people say no, we're not going to do it. I want to solve my problem, not your problem.

XXX: You're down to a project again.

XXX: The benefits have to look at the trade-offs and say what is -- anybody that's impacted by this, what's in it for them.

XXX: So getting people to think beyond a local level into a regional or national level, right? And that's very hard.

XXX: Right. If DOE, though, wants to help promote an energy policy that has very different characteristics than we have today, where does that need to be in the year 2030 or the year 2040, and then what's it going to take to make that happen? And one of those things is how do we go there, or whatever year you want to pick. But somehow if you see that changes in the transmission facility is going to be part of that goal, what do we do to make it acceptable?

XXX: I think the challenge with all of these is who is we? Is it you as the utility? Is it me as a consumer? Is it the nation as a whole? This is

always the battle. Because we don't make "we" decisions. Specific groups make decisions. And I may not -- I mean, some groups will say I don't like that. I'm not in your we. I quit. And that's what we see all the time.

XXX: Say at the very least it is the enhanced -- enhancing somehow the perception across the country that these are important, imminent issues as society develops, evolves, we electrify everything, and, hey, we had better do something about it or you are going to get caught, blackouts, brown-outs, whatever the issue.

XXX: We have learned to deal with it in other areas better. Every city knows that they have waste and so they have to find a way to deal with either landfills or some other type of process. It's the same thing with water facilities. It's the same thing with transportation. We have to find a way to manage what transportation needs are. When cellular phones were coming out, we had to find a way to deal with cellular structures, so on, so forth.

It seems like in almost every other industry we have done a much better job as compared to electricity. Take a look at the freeways here. How many of you have had a chance to drive around here? Freeways are desirable. In fact, the cities here now fight over the freeways coming into their area.

XXX: Right.

XXX: And I would argue to say that not far from here you could have a stretch of the freeway people love to visit. And this is the up through Scottsdale. In fact, they were crying over having some other freeway torn out for improvements because they liked the look of it so much. We don't have any of that when it comes with respect to transmission.

XXX: That's not true. Everything --

XXX: In fact, it's the opposite in --

XXX: Can't extend the 710 freeway in LA. We've been trying to do it for 40 years and can't get it done.

But I think the question is what is DOE supposed to do about this. Are they supposed to have a program that engages in these important studies that provide election capital, therefore, to others to make decisions?

XXX: Which DOE has been doing anyway for a long time.

If you don't mind, I'm a very technical person. I will bring up a couple of things that I feel DOE could do. Because DOE has a role that is different from any other because very few agencies here that could

actually combine many different organizations together in the industry. DOE and FERC. I mean, your people that -- in fact, most of the (inaudible). If somebody else says let's get together and dream up something, people -- like you said, somebody is going to join the we and somebody is not going to join the we.

So there are certain things that I think DOE could take a unique role in the industry that could bring together the right talents maybe. And I think what Gil had at Cornell is one of very good practice if you have a facilitating targeted discussion of the people from different industries bringing together people that usually don't meet together: IBM, Cisco, utility companies with our industry. I think that's definitely a very good thing that you could keep doing.

Another thing, I was talking about the future grid architecture. Again, if somebody says let's get together and think what the future grid architecture will be, there will be 15 more similar entities that will do the same thing. So there's no one in this area that groups try to steer this thing. FERC is actually trying to at the moment do that in markets domain. Dick O'Neal is scheduling this annual conference where we'll be discussing where the market is going to go, the electricity market. In the future what kind of software

tools are needed, where are we deficient.

So similar things in the grid I think is very important, very concrete. We need to push grid optimization technology as definitely something that emerges anywhere. Anywhere you go, talk to engineers and people that try to deal with future grid, we need new nondeterminant organization. Trying to boost it, bring people from outside our industry is important.

We talked about simulator. I think you're not doing very good job in advertising what you have. In fact, if you need to -- for example, Argonne has EMcast. We just talked about the simulating behavior of the consumers.

The EMcast simulator that Argonne developed already does that. But if somebody wants to do that, they are not going to believe that hiring some consultant that don't even have the tool, and then the reputation of somebody who can do that I don't think is there. I think you can do much better job in bringing out the labs as a source of that kind of consulting service.

I'm not sure if that should be -- how funded that service should be and so on. But that's not my strength. I actually try to steer away from things like this.

I also feel that anything that you do with

trying to work in the future production is policy forecast. Who is in better shape? I mean, it's the worst possible task or problem to solve, what the policy -- it's so much like four years discrete.

XXX: We don't get to do that. We can talk about the impacts of particular policy choices.

XXX: The problem is when we trying to do this kind of outlook in the future, that's the most difficult certainty we are facing. And how to deal with that, it's good to be silent here and demand different.

We talk about transmission to utilization. I think what we didn't touch on in these two days is high-performance computing. High-performance computing and how we actually could marry it with our needs in the industry is another thing that might require certain additional --

XXX: Are you talking about high-performance computing for planning, operation, both?

XXX: Both. I would say the operations is a higher need than planning, but we do have a need in planning to do certain things because of the -- not necessarily be in the interest of DOE, but new capacity marketers has brought up some new needs where you have to run massive amounts of reliability studies in a very short period of time.

I'll give you an example. When you have an option that has multi-round option, and each round within literally a couple of hours you have to run a tremendous amount of number of studies, not necessarily because it's the way it is, it's because sometimes we design markets not the best way. We do need some of these kind of things.

But in operations, definitely, especially with programming, you need multi-scenario analysis, you need much faster tool. When I talk to IBM they tell me we running these integrated surges, transient stability studies in minutes literally with huge systems, $300 million element. I said I can't really believe that is true. So we met with them. Turns out that they run a linear analysis. But they do have nonlinear analysis as well; it's much bigger system and their systems (inaudible). So it's definitely a cross-pollination that could be happening if we have a facilitator for that.

So we talked about transmission optimization. I think it's definitely a direction, because we are not running optimization except for in operations. And planning, planners don't even have a concept of optimization. When they try to run some how to make decisions, they run hundreds of power flows instead of running a couple of OPMs. And that's an education,

plus the lack of good software a little bit. In operations as well, if you run a lot of the optimization online you can utilize more optimization than we do today.

XXX: Is it a fair characterization to say that the majority of planning software is economically driven rather than operationally or functionally driven?

XXX: I wouldn't say that. Actually, very, very few planning organizations do least cost planning. And it's a problem, by the way. Not very easy to answer. Plus we don't have a good idea why we are running probabilistic analysis and then on top of it trying to do the (inaudible) analysis. There's really no clear framework for planning at the moment. We do some research.

One last thing is we talked -- not the least. We talked about the storage technology, trying to show what we could do with it even if it's not yet economically feasible. And some people do that kind of research. But just showing some very out-of-the-box solutions that could come with it I think is an excellent topic to do. Creating a lot more desire for people to push technology.

XXX: So that's your list of what the Department --

XXX: That's my list. I will stop there.

XXX: I'm curious as to how that lines up with what we are doing --

XXX: This is specifically --

XXX: Yeah, yeah.

-- what we are doing or what you think we should be doing. None of it sounds bad.

XXX: I hope not.

XXX: No. I mean, there have been discussions in terms of some of these computational. I think part of it is I would say as a Department one of the things we've realized over the last several years, more so than we have in the past, is the fact that no one division, no one area has complete ownership of all of this.

I think the high-performance computing, the computational research area is something where we're really saying we need to focus on how we can help Office of Science. And NSF and EERE and OE can come together collaborative to help address some of the industry's concerns in this area. Whereas before I would say -- and this is going back even six, seven years -- it was much more the stovepipes often prevented some of this forward, cross-disciplinary discussion.

And I think that's the other part of it is in the grid area it's no longer just an ASU research purpose, for example. It's no longer about just electrical engineers approaching this problem. What we've heard today, it's about the economics, it's about the policy, it's about the human factors, it's how to deal with the people, the electrical engineering. I mean, the entire field of what power systems is and what grid is about has changed dramatically.

And how we start creating programs that leverage this understanding -- because there's break-throughs that -- network theory. That was one of the things that came up at a meeting recently, the break-throughs in that. How does that apply to the grid and understanding the flows and the control architectures? It's just new concepts that I think we're just starting to cross pollinate and really starting to try to influence where some of these programs are going.

So I would say I think all the stuff that was there was exactly where I think as an office we've realized we needed to go. I say it's -- to accomplish it we need to think institutionally about how we need to change ourselves to be able to adapt and meet these needs.

XXX: I think we've seen that -- I know you took this off the table; I will put it back for a

second. But the funding issue really is critical. Just look at storage. This administration supports storage at 40 million. It came in at 20 million, half of what was planned and could be executed. So it's that uncertainty of that, how do we truly address that consistently.

XXX: Do you feel like you have enough easy communication across the Department so that you can talk to ASCR, EE about these things?

XXX: The answer is it's really mixed. And having spent a lot of time in the last year trying to do that, I mean, yeah. It gets into personalities, it gets into programs, how they say -- cultures.

XXX: Money.

XXX: Money issues. All of those things impact that. And so it's very inconsistent.

XXX: I would say there's -- a lot of the dialogue that's occurring at a working level is due to the personal relationships that individuals have. The program manager doing the algorithm development on the ASCR side. I think what is lack -- if I may be free in saying so, I think what is lacking is an institutional structure that allows that dialogue to occur on a more formal basis. And how the Department can start bridging that in a way that allows the leadership within those divisions to say, yes, this isn't something just about my

area but I see the value in working with these other organizations to my own organization, I think that's something that really hasn't been fully understood or appreciated or captured as we start thinking strategically about where individual organizations need to go.

XXX: Sometimes it's just lack of incentives.

XXX: In storage it works quite well. I mean, we have joint program reviews, we have joint planning exercises to develop strategic plans, we have joint projects, particularly with RP, but also with basic energy sciences and EERE. We work with hydro power folks. We work with the wind people and particularly the solar people because of the PV angle. I think at least for the last year or year and a half during which storage has become -- has moved toward the forefront we have created a very efficient and friendly system.

XXX: XXX, is that because storage is widgetized and it's very easy therefore to see the boundaries of both where it both intersects with and then overlaps other concerns?

XXX: No. And I wouldn't even say it's particularly widgetized because we have the entire gamut from the research, which is basically -- is applied research but it's fairly basic, through demonstrations,

which has to be cost shared with the states and others, through venture capital involvement, the loan guarantee office. I mean, it moves along that whole chain.

XXX: Right. But in the end the concept of storage is a battery or a case.

XXX: Okay. You're right.

XXX: So it's widgetized and you can understand --

XXX: We come with a product.

XXX: -- that versus the challenge for the grid is what is the product, what is the metric.

XXX: You're right.

XXX: I think it's -- maybe I look at it differently. We spent a lot of time on storage last year on TRO, what the roles were between organizations. We came up with a model structure that applied across the Department and included John Vetrano's work on the battery storage outfits and coming and kind of embraced all those things together. And Imre kept -- I mean, personal relationships go back to the transportation battery work kind of thing.

So I'm not sure how you -- the way you replicate it is you have enough critical mass and enough people to think -- you place the right buyers at the table and then you have a commitment. And there was a top-down

commitment, storage will be fixed because there were certain things on the Hill that were driving that activity.

XXX: Do you think that the structure across the Department now, and storage is as an example, will endure? I mean when the current political leadership changes out.

XXX: I think there's a good chance that storage will because the people involved in it are committed that it's a good idea. And we specifically spent a lot of time talking about what role do we want to be. For example, the cross storage team said we don't want to be a pod; we want to be a communication group between these entities. We think that's -- for this function is what we need. It's too broad to be a pod, single goal kind of activity, that coordination has value. And I think that will endure as long as the program managers that are in it and are committed to it are there.

XXX: It's a social network as well as a scientific network.

XXX: That's perhaps more important.

XXX: But so the one thing that I see in XXX's presentations and the corresponding presentations for the mobile platform energy storage is there are targets. Right? Dollars per kilowatt, dollars

per kilowatt hour. You have gravimetric targets, volumetric targets, all these other things.

What is the target for better grid models? And how can we then translate that to something that could be addressed via this successful model?

XXX: That's a great question.

XXX: Why does it have to be the same model?

XXX: Well, it hasn't been successful being unique.

XXX: So you --

XXX: Have we tried?

XXX: My understanding, how do we know we've improved the grid?

XXX: Yeah.

XXX: I don't think we have a very good understanding. I don't think we have a good answer to this.

XXX: We don't have a good answer.

XXX: You may not know until you -- I mean, you may never know. The answer is how do you know if you've been successful is if things don't implode on themselves.

XXX: The challenge requires a different approach.

XXX: Success is a ten-year dedicated effort to it. If you've got that and you've gone through eight years, you're feeling pretty good about it.

XXX: You need clear objectives, what your objective is. If you don't know then how do you manage it.

XXX: To get at the heart of what you want, I don't think we know how to do it in that area. I don't think we really know because it's not as simple to define I want $100 per kilowatt hour or I want a dollar a watt.

XXX: The light source. What are the objectives?

XXX: Which light source?

XXX: Any of the light sources.

XXX: You know, in other words, if you take one of the user facilities --

XXX: Fine. So the objective is so much brilliance. I mean, I can write you technical specs.

XXX: For the technical ones. But in terms of operating the facility and delivering --

XXX: Oh, service 30,000 users, stay up --

XXX: That's what I'm saying. That's a different type of metric, in other words, than saying I'm

going to fund this research and I will drive down. This says I'm going to be able to support activities of utilities or however many people show up. And they have the objectives.

XXX: But you've got to start with the technical specs, also. I will build a model that is validated to the 10 percent level against these benchmarks, et cetera.

XXX: Technical specs with the platform you're constructing. But the people that come and do things on the platform are the other -- that's the reason you do it.

XXX: That's right.

XXX: One is a matter of engineering the right platform. One is the reason you have it.

XXX: And a lot of the energy programs were lacking --

XXX: So a user facility doesn't have this "I'm going to drive component X to a certain performance level." That's not your objective. That's an objective that somebody comes and uses the facility.

XXX: -- were lacking the --

XXX: This is a high-performance computing it looks like.

XXX: But the problem is a lot of

the energy programs were lacking the policy clarity as to what the programs were there for. And the science -- Office of Science is trivial.

XXX: Well, we've got a problem with high-performance computing. I mean, you know, I can say we're going to try to build X system, but I can't tell you exactly what good that system is going to do for you. It's not, let's say, stockpile stewardship where you know that Seymour Sack is going to retire and you have to have Seymour's brain in the machine or something like that. So it's not -- the goals are not as crisp as you would like.

XXX: You are providing a capability.

XXX: Providing a capability. That's right.

XXX: We discussed two things. One is we have a new technology that hasn't been tried in the industry. And for me, for example, I bought two of these computers. I just -- even though I have them, I don't really have time or resources to conduct them on a fast pace. I'm talking, for example, GPU-based technology. We already have a package at the moment (inaudible) that deals with sparse (inaudible). Somebody could take it and say I have implemented the major power flow. Take couple of the major applications and say this is something worth pursuing. And then there will be people who will take it

from there.

XXX: Sort of just port these standard codes to parallel architecture.

XXX: So if nobody specifically at the moment maybe has either time, dedicated time or resources, even though I bought it but I don't have -- I thought I had, and then I got couple more things that my boss has given me and that becomes very low priority. Somebody could put it on their plate and say let's see if that works.

We talked about cloud computing, being able to use cloud computing again in the smart grid. They seem to be very conducive, but again there's huge barriers that have to be dealt with before you can actually apply because it's based on -- the economics of cloud computing are based on lower reliability of the actual information. Can we create a smart grid that doesn't require that kind of -- maybe we can. But we don't really have that. And so specifically somebody who is interested to do that, there's very few entities that could be doing this.

XXX: But would make it available broadly once it's done.

XXX: Right. Once you have certain directed effort, then you could say this is really worth pursuing. This is what we proved may be the concept

already. And the labs have the talent, they have the right timing and right priorities, that's something that could be done. Again, I'm saying that there's an entity like DOE has unique position where you don't really have to try to make it somebody so interested they would do it. You can just say let's do it.

XXX: But then there is the issue of maintaining it and so on.

XXX: Then how far you want to go, whether you want to create a commercial product or just I want to promote this rather than -- there will be people that will create commercial products. The vendors will be happy to do that. But the way the vendors today, their business models are such that they need up front, somebody to pay them to do the research. They just don't work differently. So nobody pays them.

XXX: Technical software as a product is not a business.

XXX: If I want to do something like this, my boss is telling me no, we don't. The way the market is designed, forget about it. So I really can't justify that work.

XXX: We're close to the appointed hour. Are there any things we have forgotten or need to revisit?

XXX: Just one thing we didn't talk about today but probably deserves an extended discussion in itself is the whole issue of cyber security, cyber --

XXX: Oh, yes.

XXX: -- for the grid and all the complexities of agencies it deals with.

XXX: How much is that really on people's mind? I mean, people bring it up all the time, but you look at what we're actually doing and trapping the confusion within the government about roles and responsibilities, you get a sense that people like to talk about this more than they like to actually do something about it.

XXX: I think if you get to the executive groups in the utilities and energy companies it's clearly broken through the waves, as has the emergence of this -- the APT, advanced persistent threat issue, state sponsored.

XXX: I agree.

XXX: The reason we have seen these things come through is because people have been at them for -- most people would think, I would believe they've been working on these for at least five years. I would argue that many systems are already infected; we just haven't -- the threat hasn't been turned on yet. So I

think this is a huge issue. And normal cyber defense and software do absolutely zero. I mean zero. They can't even find it. So this is an entirely different level of threat.

XXX: I think that's one of the big challenges we have like with the electric infrastructure and cyber security, is telling the story that the solution that we need for the power grid and the energy infrastructure are different than the solutions you need for desktop computing. And the government is spending billions on cyber security for desktop computing. But the only one that's really working on cyber security for the energy infrastructure and the cyber physical interfaces and how to do that is DOE and others, spotty places.

XXX: How much do we spend?

XXX: Thirty million.

XXX: Do we leverage the labs across for deep expertise in this? Do we leverage that?

XXX: They have deep expertise in IT.

XXX: Fine.

XXX: What's missing is that intersection of the power systems guys and the IT guys. And then the threat, the intelligence piece, you overlay

those three.

XXX: So we haven't put that together?

XXX: We've tried to put that together, but we haven't been successful.

XXX: How do you trade off between how much you put money into security and what the outcome is? Because if you let security people decide, they will --

XXX: Fine. That in the end is a pretty high level decision.

XXX: Very difficult.

XXX: We can give the cost trade, but in the end it's a policy decision about where you --

XXX: I think our role is -- what we're heading towards is trying to build resilient systems that can actually withstand, survive certain attacks and still keep on operating, some sort of resiliency. That's our longer term vision.

XXX: It is a very clever approach because you can't just brute force say we have to protect everything, because for every protection there is antiprotection.

XXX: Do we own that? Where is DHS in this? Where is --

XXX: We have partnered with DHS on some of these things. And actually Don, I know he has partnered with them, too. But we're funding a pretty significant effort, university effort, at University of Illinois, and DHS is putting some funds in as well. So we have a working group that oversees a lot of that.

XXX: We also put cyber security requirements into all our ARRA specs.

XXX: But this question of what requirements do any good, I mean, this is the real issue. But I think the question is more of how do you, DOE, contribute a capability and perhaps programatic funding to what is not a solvable problem; it's just an ongoing capability. Your ability to manage the level of threat, the level of threat will continue to get greater as the technology -- as IT gets better, the threat gets bigger.

XXX: There are commonalities with the other infrastructure systems.

XXX: Absolutely. I think if you think critical infrastructure, oil and gas, power, shipping, ports.

XXX: Chemical plants, refineries.

XXX: And each of them is different, but they all have the same characteristic. This is not solvable; it is only manageable. That's the first thing.

Most management teams when I talk to them, that's the first one they ask, they go, oh, gee, what do you mean you can't solve it? It's not solvable.

XXX: But you go to the defense world and everybody understands that. It's an evolving --

XXX: Yes. But that's the paradigm shift that they have to get across. This is a capability you have to have. So I think it gets back to the same thing, what is the DOE's role in helping. I think it's particularly true for utility management, which has historically been in a different place on IT than some of the other infrastructures that are much further along.

XXX: DOE's role should be not IT people make decision, but --

XXX: It's a business process. It's not -- that's the second thing they have to realize. They can't go to the CIO and say you fix it, because it's a business issue; it's not an IT issue. You have to have IT weapons, but that's not -- a strategy of the war can't be driven by IT.

XXX: That's the best thing you can do is make sure decisions are not made by IT.

XXX: But I think this is another area. I think this is a very fluid area and the kind of thing from a strategy point of view is when the first really bad

event happens -- which is an inevitable outcome here, I believe. In the next couple of years, there will be some major -- some major piece of the power system will get taken control of and then we can get some action.

XXX: It will get exciting when that happens, yes.

XXX: But as we try to intersect this future, as you were saying the grid needs to be more flexible and be more controllable, the challenges upon us continue to grow.

XXX: Robust.

XXX: More compartmentalized and the damage control.

XXX: So for the justification of a grid program, I was wondering would enabling an electrically serviced economy be a good goal or like an umbrella goal for all the research and work that we're doing? Just throwing it out there.

XXX: Comes down to the detailed choice of words, but I understand.

XXX: I think so. I mean, because I think that's where we're going. And so I think as you are all trying to figure out where to put your resources, I think that you should -- that you should formulate it that way, understand it that way, and target things that are

calibrated to support that future.

XXX: So DOE's role is a vision setting role? So if we have this vision --

XXX: Having an electrical economy --

XXX: Service economy, yeah.

XXX: Do you think that would change the business models of utilities and that would address some of the --

XXX: Enabling the utility of the future.

XXX: Clean utility of the future.

All right. Closing thoughts from anybody?

This has been great. Good discussion this morning, again building off of but different than yesterday's.

It was important to have had yesterday's conversation, I think, having been able to do this. As I said, we will engage you as we go forward with respect to reading text or participating in other meetings if you can make it. So thanks very much. Very good.

As we go through these, we can -- at least with my team I can see the pieces in my head of the whole thing coming together, and I think it will actually be really quite powerful when we get it done.

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