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2 DEPARTMENT OF ENERGY

3 QUADRENNIAL TECHNOLOGY REVIEW

4 BUILDING AND INDUSTRIAL EFFICIENCY WORKSHOP

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6 Radisson Hotel
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7 Green Tree, PA 15205
May 17, 2011
8 8:30 a.m. - 4:45 p.m.

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10 DAYTIME SESSION

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12 TRANSCRIPT OF PROCEEDINGS

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14 Reported by:

15 Tricia M. Clegg
Court Reporter
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P R O C E E D I N G S

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XXX: Good morning, everybody. Thanks for coming to Pittsburgh for us. Appreciate it. And for those of you who are local, thanks for getting up early and coming over here. So I have the task of going through the boring stuff before I turn things over to the Under-Secretary to the interesting stuff.

So a couple of legal-type stuff. So those of you who are attending this workshop are not members of a federal advisory committee, nor do we intend to use this group as a federal advisory committee. We're not seeking group decisions or consensus views with respect to the issues before you or as any action the federal government should take. We welcome your individual recommendations and advice and are looking for a productive day.

Also, we know that participants in this workshop should bear in mind antitrust laws and restrictions. So check with your counsel before engaging in certain activity

such as collecting or discussing nonpublic data, evaluating public data about future prices or costs or discussing topics whose legality you are unsure. We ask that you refrain from disclosing any proprietary company cost, supply, or price information, or any proprietary company information.

Lastly, we want to stress we do not intend this workshop to encourage any specific cooperative activity among participating companies that is not clearly authorized by current law. So one of the commitments that we made as part of the Quadrennial Technology Review process is to gain an amount of transparency and openness. We have committed to engaging with folks from all different points-of-view. Part of that involves having a publicly website which hopefully all of you have visited, energy.gov/qtr.

We are releasing all Ex Parte communications that come into our QTR team for anyone outside of the government. We published a request for information on the framing document, which hopefully you have all read and

received over 60 comments on that document which we are in the process of reading carefully and making sure we take those all into account, and we're running a series of focus groups and workshops starting in late April and running through June which this is the third.

One thing to note for you is that we have a court reporter here who will be taking down a transcript and assigning names for our purposes so we know who said what. When we publish the transcript of this workshop on the web, we will anonymize all the names. So it's sort of a modified Chatham House rule in the sense of you can speak and hopefully speak freely, but your words will be there without your name.

So as I said, this is the third of five workshops. We did two workshops in the transportation sector a couple weeks ago, stationary efficiency, buildings, and industry today, the electrical grid next -- well, that date is actually next Monday in Arizona, and then clean electricity supply in Denver in

early June.

So that's our agenda for today. I'll turn things over to XXX in a moment. He'll kick things off and give a little bit of background and then lead into discussion with the panel. XXX has agreed to step in in his place. Then basically some Q&A with the panel. We'll take a break, and basically we'll continue the same discussion on the similar topics in breakout sessions in the tables in the back, or if the tables in the back are a little too close for audio isolation, the groups can meet in the front portions of the room.

We'll take a break in the afternoon. The tech leads for the buildings and industry will give short presentations on roadmaps and such out there, programs in looking at those potential for efficiency in those areas, and then we'll have breakouts that really dive into those technical roadmaps, and then we'll come back after a break for some report-backs and final discussing.

So with that, I will turn things

over to XXX.

XXX: Thanks for coming and helping us out in what is, I think, an interesting and important process. Energy is very much on both the public's and administration's minds these days, and sorting out exactly what the Department of Energy does in energy is something that's been long overdue, and we're taking a crack at doing that, and we need the help of all sorts of people including the diversity of folks in the room this morning.

As XXX outlined, I think we'll have a good day. We're learning how to structure these so as to get the maximum benefit from the participants, and this morning's discussion is really focused on principles and structure for the government's involvement with energy and particularly with the efficiency sector for this workshop, and then this afternoon we will get a bit more into various technologies with presentations from the tech teams.

So let me start out and try to outline for you what it is we're trying to do

and a bit of the process of how we're doing it. What we're hoping to do is to go through a process, a Quadrennial Technology Review that provides the context and a robust framework. That's important. You know, what is the Department doing? Why does it do what it does in its energy programs? What should it be doing? And also, the principles by which to establish throughout the year plans and budgets.

If you look at another function that the government is supposed to be doing, defense, for example, we have put in elaborate organizational mechanisms and processes that makes sure that the defense mail gets answered no matter what the politics involve. We have a uniform service. We have a professional acquisition core. We have an Office of the Secretary of Defense that extends across the whole Department.

We have a Quadrennial Defense Review that is issued in the second year of every four-year administration that outlines a five-year perspective on the national security

picture. What forces are you going to need? What do you have to buy? Et cetera. And then we have particular congressional committees that have unusual structures that manage national security -- I mean, national security council, of course. Contrast that with what we have in energy, and I think it's clear that we have got some work to do if we want to get some coherence in productivity out of what the government does in energy.

So the focus is to, first of all, frame the energy challenges. We're going to produce a document, although this is a process more than it is a document. The document will talk about what all the energy challenges. A discussion has relevant roles and diverse roles of government industry, national universities in trying to move the energy system in response to national goals.

Some roadmaps for moving key energy technologies forward. The principles by which the Department can judge the priority of various technology efforts. Our discussion of how do we do demonstration projects which are

important for some of the technologies we do, and then a connection between energy technology innovation and energy policy, although this is explicitly not about energy policy.

So that probably -- I should say a word about that. This is a little of the timeline, and the whole thing started with a PCAST report that was chaired by Ernie Moniz and Maxine Savitz who in November when the report was released said government, you should do a QER, Quadrennial Energy Review analogous to the Quadrennial Defense Review.

But they recognized also that that would be a significant undertaking involving many agencies. It's tantamount to a national energy strategy of QER, much discussed but rarely executed. And they said instead, well, DOE, you should go practice and do one yourself, and that will be good groundwork for a QER, perhaps, to be executed in a couple of years.

So after some back and forth, the Secretary finally turned to me in January and said, okay, go do it. Some discussion with OMB

and other folks in the administration of exactly what the scope was, and we decided to confine it to technologies and the policies that bare on technology development and demonstration.

So we're not going to get into what the ethanol tariff should or should not be, but we will certainly talk about the potential for third-generation nuclear reactors, things of that sort. We issued in mid March a framing document which, I believe, you have all seen a copy of, if not have read or committed to memory, and opened up for public comment for about a month. Three weeks ago the comment period closed, and the first batch of comments are up on the website. I assume the website is accessible from here, if anyone wants to read it as the proceedings proceed and you get bored or want to refer to it.

We are, as XXX said, in the midst of all of these workshops to talk about the strategies, and our goal is to submit by the end of July a report on this process to the White House for approval to be released before

the end of the year. And, again, this is expected to be the beginning of an ongoing process that will lead to broader conversations within the administration and then ultimately to an energy review.

I want to talk a little bit about the logic flow and where the discussions today should be fitting in. So there are, as we have outlined it, three strands that will come together to produce a set of principles and a portfolio of work. One is, well, what is the system that exists and what are the challenges that we're trying to address. Three in particular we have called out; the oil problem for shorthand, U.S. competitiveness, and environmental impacts, most problematically greenhouse gases.

You have seen that document -- or that discussion in the framing document and lead into the six strategies as a way of organizing and thinking about what needs to be done. We have the strategies next up. I guess I'm supposed to talk about that. Let me just talk for a minute. At the same time we have

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inaugurated a set of 14 technology teams, several of which are led by people in the room and we'll hear about this afternoon, that are meant to make assessments of various technologies, the way I like to say it, at kind of the one-and-a-half digit level, not in great detail of what the precise plans, roadmaps should be, but to say, you know, this looks like it's got a lot of potential and with a modest amount of research funding within the private sector we could really realize X, Y, or Z.

And then those are supposed to fold together, I guess -- oh, I was supposed to talk about the challenges, but I'm not going to. Time is running on. Those are supposed to fold together with a discussion in the middle column which as, I think, where we will spend the morning. What are the roles of the various players, private sector versus government, academia versus national labs versus the private sector, the relative levers of economic policy, technology, the roles of various agencies within the government to produce a set

of principles, principles like you shouldn't work on things that are too close to the market, perhaps, or you should concentrate on longer term versus shorter term or should only look at technologies that have the equivalent impact of a quad a year, in 10 years, 20 years, 50 years, so on.

All right. So that kind of discussion I would like to have. Ideally then we will combine the principles with the problems and the technologies and come up with a set of priorities in the portfolio at which the DOE should be working. That will inform but is not the department's budgeting process. That's going on. Those of you who have been in government know this is the time where you start to get serious about the FY-13 budget within the Department. That's going on, and this process will inform. We're in close touch with the CFO and other folks who are putting the nitty-gritty together of the budget.

As I like to say, this paints the big picture and identifies the priorities within the budget that will then get realized

in specific programs. Why are we doing this? I think probably for three reasons. One is to help with the priorities inside the DOE, to set -- I think secondly, to help tell the DOE's story to other folks. People are very confused about what the Department of Energy does. That confusion is also true inside the Department frankly. We saw that when we went through the strategic plan.

I mean, just for context of those of you who you don't know, the Department of Energy is 26 billion dollars roughly of spending. 40 percent of that goes to nuclear security. So that's about 10 billion, 11 billion a year. That's the stockpile of nonproliferation activities.

Another 6 billion goes to environmental management, cleanup of the waste sites. Another 5 billion goes to basic research, high-performance computing facilities, research and chemistry, biology, material science, climate, fusion, nuclear particle physics, and about 4.3 billion go to energy technologies which is really what this

whole discussion is about. So -- gee. I can't remember what prompted me to recite the budget, but that's what it is. So it's how do we spend that 4-some odd billion. Should it be more or less, questions like that. I'm not going to go through the challenges.

These are the strategies, and we have split them up into transportation. And stationary, we had a good set of workshops the last couple weeks on the transportation line, and this is the first of the workshops on the stationary line, and we will see what happens.

What has been interesting in all these workshops is we get together folks from very diverse perspectives and have a really good conversation often with great insights.

As we go through the technology discussions this afternoon, these are the kinds of things that we're interested in, interested in your expert opinion on why is the technology there at all? What's the technical headroom? How much better could you imagine technologies doing? What would be their impacts? What's the current state of play in terms of the

industry, other players and what they're doing? What's the DOE history and accomplishments in this field, if any? What does the technology development roadmap look like? What are the steps? How can you imagine staging things? What are the milestones, off-ramps in a research environment?

Very important, I think, for this discussion is what's the policy context and what are the barriers to deployment of the technologies and then other tech specific things. These are the documents that the technology assessment teams will produce and, again, something we would like very much to discuss with you all during the afternoon part of the day.

We talked about that. We have talked about what we would like to cover this morning, roles of players, principles, and connections between technology innovation and energy policy. There are some comments that have come in already relative to building and industrial efficiency. I'm not going to read through them, but I think -- did people get

this either electronically or -- well, maybe it's just making -- reading a bit to you. Here is ACEEE saying, we recommend the DOE work on developing cost reductions, strategies for monitoring large numbers of buildings of all important types. So a plea for data collection. Newer-term industrial efficiency activities complimented with longer-term activities to develop processes, materials, and products undertaken in coordination with this DOD.

ASHRAE, the DOE should invest resources into R&D to understand energy flows in buildings to stimulate development and deployment in lower-cost building and equipment-monitoring technology. So a lot about data collection. Sort of interesting. Work with the private sector to identify nontechnical barriers that are many with successful deployment. And then OLED Association said, the program has been very successful in fostering U.S. leadership, and DOE has to continue to invest in this area.

So I think all the comments are up

there. Again, you can browse on the website if interested.

So a couple of questions that we have put up for the panel which, I guess, we're about to start in a moment. Let me just go through them for you with a little bit of commentary. There are lots of ways to reduce energy use, and we get -- we, the DOE, spend some fraction of the research money in this business. How do we decide? Should we spend more time working and defining the nontechnical barriers or should we spend it on doing technology R&D? When I say we, again, I mean it's the things the Department funds whether in the universities or the private sector.

How do we balance the short-term versus the long-term? Some people say the government's most effective role is in the long-term. Other people clearly in a more political sense also would like to see short-term impacts and support for short-term organizations.

How do we balance depth versus breadth? Do we pick a few things and go really

deep in the programs, or do we spread the money around or support many different technologies? And then widgets versus systems. One of the things that the Department has been criticized for, particularly in the discussions we have been having over the last two months, is the Department is a geek shop that does widgets, and we have a poor appreciation for the system's contexts or the business contexts or the human contexts in which these things get deployed, and we should pay a lot more attention to that in deciding which widgets to work on.

Specific questions, again, you know, for all of you who have had experience with the DOE. Has it been good? How has it helped you or not helped you? Have you seen the benefits? A broader question beyond just efficiency is how do we balance our efforts across the six boxes, particularly in the stationary line between regeneration -- I'm sorry -- grid generation and efficiency. What's the relative potency of those levers and where might the DOE find maximum impacts? Is efficiency always a

win? I have learned about XXX a long time ago, and he keeps whispering in the back of my head. So we could have that discussion, if you'd like.

How do we decide when things come into the portfolio the DOE supports? When do they get out? We can't subsidize forever. We can't subsidize to scale. What are -- you know, have we done enough on lighting, for example, having reduced the cost by a factor of 10 or whatever the number is. Do we really want to go another factor of 10 relative to other things we could imagine investing in?

How should our involvement change as the technology matures? How do we integrate deployment with R&D? This one is particularly important for efficiency. We have been the steward of billions of dollars in weatherization, other smaller amounts of money to encourage efficiency on grants and so on. How does that connect with our R&D programs? Should it connect with the R&D programs?

And then policies that might -- incentive turnover rates in the hardware, and

what is the proper role, if any, for DOE here, or is this something that the government shouldn't be doing at all? So these are, I think, some of the questions that we're interested in exploring this morning which are not technology-specific but certainly germane to how the Department builds its portfolio and what it does.

So we have got a panel that is going to come up and have a discussion among themselves and with me for about a half an hour, and then we're going to throw the discussion open in a primary sense to the room as a whole. Let me ask XXX, XXX, and XXX to just come up, and they'll introduce themselves. We'll sit up here and have a discussion.

Why don't we just start from right to left, a couple words about yourself and what you do and maybe some initial reactions to some of the questions.

XXX: Good morning. I'm XXX. I work for XXX . We are a deployment

operation, deployment policy operation. So I'll try to bring that perspective to this discussion and how we see the need -- how technology drives the work we do and how the work that we do creates a need for additional technologies, and particularly, the various types of barriers that will come therein.

XXX: Hi. Good morning. My name is XXX. As you can see from my agenda, I'm a stand-in for -- XXX couldn't make it the last minute. I work for XXX. XXX is XXX. I'm a technical executive in the energy-efficiency area. So I focus a lot on energy-efficiency in buildings and industries. So that's really my key role.

For those of you who do not know XXX, it is a nonprofit 501(c)3 type of R&D organization working for the benefit of the public related to efficiency in the electricity industry. So everything from the electricity industry. So that's really our role. We are funded mainly by the electric utility industry. So that's XXX. You know, this is -- a lot of

interesting questions have been put forth in here. So we'll leave it at that and answer the questions that come up.

XXX: I'm XXX.

I'm the director of XXX.

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We are part of XXX.

It's very unusual to find an applied R&D center that's part of a community college, but we are. We're a team of engineers and scientists working on primarily energy issues currently, but we also are heavily involved in process heating and training for various audiences including -- we're doing a project right now for development of interactive training for Best Practices software for DOE on process heating assessment and the survey tool. You know, we have also done one for steam working with Oak Ridge.

So we have a lot of varied interests, and questions are being raised here today. Some of them are very difficult to answer but certainly worthwhile addressing.

XXX: So I'm happy to throw the floor open first to any reactions you may have had to anything I said. Otherwise, I have got a list of specific questions that we can talk about. Why don't we get started and at least -- let's go back up. So how might we think about balancing the Department between working on widgets versus training activities as you discussed versus just outright block grants of money to people who promote efficiency of buying down efficiency in various ways.

I mean, do you have a sense of where the biggest levers are for federal funding? Are there other people doing the training and, hence, we can back off and spend it elsewhere? Widgets. Some thoughts about that balance?

XXX: Yes. You know, these are -- like XXX just said a minute ago, these are very good questions, kind of difficult to answer. My opinion at least from our institute's opinion is that there should be investment in DOE in all the areas that you just mentioned, but the real portion is really

what should be the balance between them. Should it be more in one versus less in another research? I think, you know, you mentioned -- you said, XXX, in your opening remarks about some of the comments we've received, and you're right. There are a lot of people dabbling with widgets. That seems to be a lot of focus. So let me just talk about our own industry.

There is a focus on energy-efficient equipment to be deployed in the market. For example, the California utilities have 3 billion dollars for their efficiency programs over the next three years. So this is quite a bit of money to deploy in efficient technologies. And if you go look at the -- and the document in California is called Energy Strategies for the Future. That's a lot of money and a lot of focus on widgets.

Okay. What we do not see is a more focus on integrated systems, looking at both buildings and industry as integrated systems because, you know, you could have efficiency improvement in one and, whereas, an inefficiency builds up in another part of the

building. So one could be offsetting the other, and you really may not have overall efficiency. So I think a whole lot more focus should be on the system's aspect of it and what it does to the system in terms of all efficiency. That's one area I would recommend.

XXX: I would really second that. What I would offer is that where we are within my view at least right now with efficiency is that deployment is actually tracing well behind technology, and I think it's for lack of the broader context. So we're good at creating widgets. We're good at creating training programs. We can even in some places in the country find the dollars to do pretty deep efficiency, but it's the broader construct that that all fits within that, to me, is not enabling us to really get to where we need to get with efficiency.

XXX: Well, I think that the systems are very important. I also think that at times widgets are important. It depends on what it is we're trying to accomplish. Systems, I agree, especially in

industrial systems, we see improvements in one area that get offset someplace else, and, therefore, the net result is that we haven't increased efficiency. Aging equipment changes in process. There's lots of things that go on, and we don't look at it from the system standpoint. We look at it technology-by-technology, and that's good because we have to be able to delve into those areas in order to identify the opportunities, but it's not a system's approach which is, I agree, one of the things we really need to do.

XXX: One of the things I think is important, as a scientist, I resonate with data, and, you know, I think we're data poor in this business. I just draw your attention to the Sancti diagram. I think it's true that the inefficiency in each of the residential, commercial, and industrial has been assigned .2 in each of these numbers, and that strikes me as not a data-driven thing at all, but you just multiply by .2. And just being able to instrument better, now we can do that pretty cheap to put out sensors. Somebody

said we should do it for a lot of buildings at once, find the ways of doing that. Knowing just the quantitative landscape, I think, would help a lot.

XXX: A lot of the work we do is data-driven, especially even in the efficiency arena. Lots of instrumentation is taken out in the field to be able to measure what's going on, and one of the things I rely on DOE for is data, data that I don't have. And you're right, there are a lot of places where that data is either very old or nonexistent, and we have an opportunity to collect that information and give us a better feel for what the system is doing. And I think you're right. Somebody just multiplied by .2.

XXX: Yeah.

XXX: I can absolutely comment. What we have heard at the last summer study of buildings where Cathy Zoi made a presentation, and the overwhelming comments from, you know, 1,000 plus professionals in the buildings industry was that we need field data. Okay. It's just not

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data.

XXX: Free data?

XXX: Field data.

XXX: Oh. Field data.

XXX: Data that is actually in use. You know, so this -- the data from the field, whether it's this building or in industry, wherever, data from the field needs to be used to feed back into the policy-making mechanism. You know, just for example, you know, we have -- just for one example, the water heating for domestic water heating. We have certain test protocols that are by the DOE under which efficiency factors or energy factors are measured.

Does this really show the field data? Take another example of the SEER Rating we have for air-conditioning. Does it really show the actual field data? (Inaudible). So getting the field data and incorporating the field data in the policy-making is very, very good.

Let me just add one more point. XXX and I used to work together in the

industry area. So let me add a point on the industrial side. Many years ago the DOE sponsored work at Drexel University that looked at process flow diagrams for the so-called 108 processes.

XXX: Harry Brown.

XXX: Harry Brown.

Yeah. And, you know, data like that in terms of unit operations in these 108 industrial processes -- now the industry has changed. So maybe it will be different. But that taking of that data of energy flowing, somewhat similar to that, but specifically for unit operations in industry, that would be an exceedingly useful work so that --

XXX: In industry?

XXX: In industry in each one of these processes when you want to make, let's say, a plastic coming out at the very end, and, you know, in each one of the unit processes, how much does the energy flow in and energy flow out. You know, that sort of data is very important, you know, for the industry.

XXX: I would just add that then I think there also has to be standards on the data collection and how we're going to get it together. Just in Vermont we've got 11 years worth of experience, and on all the industrial sides, the way we do the follow-up to make sure that the efficiency measures actually panned out is we do pre- and post-analysis measure-by-measure, and we do it the way that serves us to make sure that we're able to characterize correctly. Other jurisdictions might do it differently.

So I actually think there's a fair amount of data if we find it and pull it together. And then the question is, is it all put together the same way so it's meaningful? And soon when it's marketed within a couple years, we'll actually be able to get that hour-by-hour, and, you know, meter-by-meter we have got 20 years worth of data meter-by-meter and property-by-property and.

XXX: So there's been a lot of pushback on the spot metering about privacy issues and stay out of my grid,

et cetera, et cetera. Do you think that that's a real barrier, we start to get into heating issues and so on? People are, perhaps, going to get their backs up.

XXX: It's a barrier today in part because one of the barriers we have to it, a broader adoption is that there's still mistrust on the consumer side. You know, it's largely viewed as a way to lower utility costs, not as a way to serve consumers from the consumers' perspective. I don't mean that disrespectfully, but anybody in that piece of business, utilities need to be able to lower their cost.

But that's part of where the challenge comes from, and, of course, there's a big broader piece of that. At the end of the day, there are plenty of examples where through confidentiality agreements and various other methodologies, we've had access to that type of data, and then when you combine that with good customer support to really help people make meaningful change and work on the demand side, lowering the demand side, I think we can break

through that barrier.

XXX: So that raises a broader issue of the interaction of social science with the technologies development. The DOE has been noted as notoriously deficient in social science dimensions, at least in previous incarnations in the EEC and so on.

Many people feel we don't do a very good job even now, particularly in this area which is so much about behavior. Can you imagine programs where they're executed within the Department or with partner agencies where we could bring more useful social science perspective research programs to do -- mix the technology and the human behavior together and what would they look like?

XXX: Well, I guess I would suggest, I think, as part of that overall systems approach that we talked about, I'm not sure that DOE reaching all the way to the customer and that interface is the right space for it. I think you have -- you know, you're going to have jurisdictionally lots of different entities doing that work. If you do

a good job, I think, with all of your products, the customer-basing products being easy to read and consumerable, but I think that piece of the work really falls in the cooperation between the folks doing the deployment and the DOE as a partnership.

XXX: Some were to suggest, for example, that for every demonstration we do a deploying, whether it's on meters or electric cars or whatever, that we take some small amount of the funding and devote it to data collection and social science issues.

XXX: Yes. Let me make a comment on the social sciences. Again, you know, we believe that human behavior plays an exceedingly important part in efficiency gains, especially for taking efficiency in the building space, not so much in the industry space. At least in the building space, there is a huge amount of focus on social sciences.

So an investment in -- not to a large extent, but an investment in the behavioral aspect of end-use efficiency would

be very useful. For example, XXX has funded a few projects. One I can think of is the work being done currently by Stanford University under a contract looking at behavior issues, and that's what universities like Stanford try to focus on.

So the DOE is involved to some extent in that, but I would urge the DOE to put a little bit more focus in that area because, you know, you can have the best widgets in the world, but like was just mentioned, if the person thinks that the market is hurting them or, you know, putting the radiofrequency into their house or whatever it is, the perceptions will not go away.

In fact, just as in California there was a big blast of PG&E pipeline, and some people started to blame it on Smart meters, some sort of signals from the meters. I mean, you know, you have people doing -- a focus on behavioral would be interesting, too, but not as a high extent, at least in our opinion.

XXX: I think that even in the industrial space, there is some

behavioral issues that need to be looked at. Why don't plant managers, plant engineers, process engineers deploy things that they already know are going to improve efficiency or reduce cost? And a lot of that has to do with mindsets, and in some cases, organizational rigidity that prevents them from deploying those kinds of things.

So there is some of that that goes on industrially, but industrial is directly pointed out. It's really driven more by the process of profitability and commercial-ability to a residential space.

XXX: So then actions will be determined more by the availability funds, cost of capital.

XXX: That's correct.

XXX: Payback time and so on.

XXX: And one of the big problems, talking about data in industrial, is that it's amazing how many industrial plants don't have good metering data. They have good data on the process, temperatures, pressures,

but not on the energy. They may have one gas meter which is for billing and one electric meter for billing, and that's all they know, and until somebody goes in there and actually takes measurements, they really don't have an idea where their energy is going, what they're spending.

XXX: Do you find that when they know that data, are they willing to share it more broadly?

XXX: Yes. Yes. To the extent that it doesn't present a competitive disadvantage for them. A lot of energy use as viewed industrially as part of the proprietary process is good. I used to do it myself. A good engineer or analyst can go in and look at that information and determine to some degree of accuracy what their costs are of production. So you have to be careful, but that doesn't end up in a competitor's hands.

XXX: Yeah. How do we integrate or should we integrate our R&D activities with deployment? And, again, just to take an example, you know, stimulus money

was about 5 billion dollars of weatherization activity that went out. I don't know that it was connected at all to the R&D, whether it was instrumented in any way, thought through what projects we would do. I think, you know, you can argue the stimulus money had a different purpose and was necessarily done in a rush. But nevertheless, it's an example of how we might have capitalized under deployment to advance the R&D.

So you have other experience where we have done a good job or missed opportunities between deployment and R&D. Anybody else?

XXX: My name is XXX (inaudible). XXX. From XXX. My background is the manufacturing, R&D at XXX. At the end of the day, looking at it from the industry point-of-view, it is competitiveness and the cost. I try very hard to just single-handedly emphasize efficiency but don't go too far unless energy-efficiency is -- it is a big part of the cost and competitiveness of our business.

The reason a lot of companies does

not have adequate instrumentation for the process is nothing but cost. We face very rigorous competitiveness from other countries, and the reason, manufacturing in U.S. was overseas because we just cannot be competitive. It is a cost.

So from the DOE and R&D point-of-view, I think from the industry point-of-view, we look at it two aspects of the industry from technology point-of-view. Whereas, the kind of step-up break-through technology can bring U.S. manufacturing into other countries.

The other one is more how do we make us more cost-effective and competitiveness. Energy-efficient has been integrated in that data, being (inaudible) otherwise, you will not add attraction in the industry because at the end of the day no matter what we say, energy, how much we spend or we not spend if our cost is great if we don't have to do anything.

However, if our cost has a big part contributed from energy-efficiency, the industry will have the full power to move

forward. So I think I don't see the technology in the energy-efficiency has been driven to the cost-effectiveness of everything.

XXX: I think we have started the more public part of this discussion. So I'm happy to open the floor up to other people who might wish to comment on what they've heard or some of the other questions we haven't touched yet.

XXX: XXX.

And I'm also XXX.

So

XXX, a couple things. One, you were talking about the Quadrennial Review and comparing it to DOD. And I thought that was interesting. And you were also talking about perception of DOE and then on through from basic research to deployment.

I thought back to DOD and our experience with DOD at XXX where one of the things that's so valuable and easy to work with in having the DOD's side is the fact they label their money, and you know this because --

XXX: 61 Research.

XXX: Exactly. So I know that 61 Research, it's basic research, and I can explain it to someone, if it's 62 Research, it's becoming more applied. By the time it gets to 63, we're trying to build a protocol type, and beyond that, they're going out and seeking industrial support to actually manufacture.

I've often wondered if DOE could follow a pattern like that. Maybe it doesn't need to be numerical, but maybe it could be something else. It tends to drive a pipeline of innovation in DOD which is quite impressive when you think about it. You know, whether it's Drone technology that we see or Stealth technology which started with widgetized kinds of things coming out of academic labs, meta-materials, things of that sort which drove Stealth or not.

It just seems that there is a pipeline of flow that I think works very well in DOD and might serve DOE better in the future.

XXX: Should I try to

comment on that or do you want to finish?

XXX: Sure. I have got three things I wanted to say. Otherwise, I'll stop.

XXX: One of the departments, we have started to discuss and categorize our activities by TRLs, the technology readiness levels, which is a finer grain discussion than DOD does.

One of the advantages in DOD is that there are -- there's one organization that's enduring DDR&E that in principle can shepherd and steward things along from 61 to 62, 63, shifting money is appropriate. In the Department we have got the Office of Science, basic research, a whole separate funding line and organization from the energy technologies which would naturally be the 62, 63, and moving things across is difficult, not impossible, but much more difficult than it would be just from culture and funding lines and so on, and there's nobody permanent who is holding both reigns, so to speak.

XXX: The principal

difference though between DOD and, let's say, industry is the fact that what DOE develops -- let's assume we had followed the DOD model -- DOE is not the ultimate purchaser or deployer of the technology. DOD is. I mean, they're actually developing something they're going to purchase and deploy. Whereas, in DOE's case, they're developing something that industry is going to deploy, and they are not part of DOE.

So there's an issue of getting the information out, understanding how it fits in, economics driven from their perspective, not from DOE's perspective.

XXX: And, by the way, industry is also driven by regulation for which DOE does not necessarily have much or any control over because it's other parts of the government or the states.

XXX: Right. And the barriers, the nontechnical barriers are a lot different from the DOD. I'm not saying you can't deploy some of the thinking from that process, but I think you can, but you have to be careful in that the end product is not

something that DOE is going to be the primary procurer of.

XXX: That's right.

And DOD is cost-driven, but it's not driven by the relentless economics that the private sector is.

XXX: One of the things I like about the idea though, if we can figure out the logistics, is that in the efficiency sector, one of the things I think we have been challenged with is that when we look at what's possible with efficiency, we almost always get constrained by what's technologically available today.

There's no kind of -- very rarely are you allowed to forecast in the emerging technologies when you do potential studies, when you develop three- and five- and 20-year analyses about how much of our energy nut can we sell with efficiency going forward.

This type of approach begins to categorize technologies in a way we can start applying some sort of discount factor to the likelihood of emergence that would allow us to

do a better job of really understanding what the possibilities are with efficiency going forward. So I like it from that perspective very much.

XXX: I think it might make it easier for appropriators to understand what you're trying to sell to them. And you're point is well taken that DOD is a real customer, but, you know, up to about 6.3, the relevancy of the idea, I think, and the analogy works.

XXX: I agree. I think you've got to find a way to make that happen.

XXX: XXX, I know you had a couple other points.

XXX: I did. I can get back to them any time.

XXX: XXX, from XXX.

And just to follow up on the comment you made about DOD being their own customer at the end. I think the federal government themselves owns probably about 3 billion, 4 billion square

feet --

XXX: That's right.

XXX: -- of space, building space. And so in a certain sense, they kind of could be their own customer, if they wanted to.

XXX: That's why I said industrial.

XXX: Well --

XXX: Buildings are a different entity, I think, because --

XXX: Sure. Sure. And it wasn't -- sorry. It was more a point that potentially there could be an opportunity when you talk about headroom --

XXX: Right.

XXX: -- if there was the same type of knowledge that I'm going to have to own this and a lot of the DOD principles are done. As a matter of fact, even if it was done by DOD, they're starting to go through the efficiency department, use a lot of their processes to drive that ownership and on base at FOBs, they might actually be able to

drive a lot of these early adopter types of things that then others coming afterwards and capitalize on.

XXX: The base is a wonderful test base for some of the building technologies.

XXX: Absolutely. And the privacy issues you were talking about, those tend to go away.

XXX: That's right. That's for sure.

XXX: Then, of course, DOD has its own unique tactical efficiency or operational efficiency needs which are somewhat separate from the civilian sector.

XXX: XXX, could I just make a comment coming back to you, the bullet before the last one we talked, deployment versus R&D. If you look at the pipeline we have been talking about in our technology, readiness levels, and DOD and in technologies. Look at the pipeline of technologies, energy technologies all the way from incubation to the use of the technology.

The many players that come sort of in the middle, the windows for developing products, there's a lot of university research that is happening that, you know, leads to products.

So I believe, at least we believe that one of -- a good work for the role for the DOE would be to focus on, you know, the front end of the technologies that sort of are being incubated to being brought back, but at the same time, make sure that the technologies are pushed through the pipeline because eventually it has to be used by the end-user, and one way to do it is just what was mentioned is to try the technologies in DOE building, perhaps.

So there should be a mixture of everything, but it will be good to see the technologies that are being incubated, especially, you know, from your Office of Science all the way to the end-use deployment and to bring it all the way to deployment, but then, again, feed the pipeline of projects.

XXX: Let me push back a little bit just to get things maybe a bit more stirred up. If we have already got

technologies now in some efficiency arena that are cost-effective and are twice as good as what we have got but still not getting them deployed, is developing technologies at four times more effective really going to help the problem?

We've got a rate-limiting step in deployment some way. Maybe that's the thing we should be trying to keep bottlenecked to use the chemical term.

XXX: XXX from XXX. I would like to -- I think this is a key point, and I would just make one preliminary point because we don't need so much more effective technology as we need cheaper technologies for buildings. More to the point, linking DOE deployment programs with R&D programs, I think, it's certainly something to be pursued.

The point I want to make is that we don't know much about how that deployment process or commercialization process really works. There are a lot of case studies, a lot of books on innovation. There are scholars around the

country who study the innovation process and has put some money into this. I don't think there's much at the federal level in terms of what agencies are doing that are good models. The states are doing some things, but, you know, the answer is elusive.

I guess the point I want to make is if this is a direction that DOE wants to go in doing it in a rigorous -- intellectually rigorous way is very important, and --

XXX: I would draw, again, a contrast with defense where there's a whole scholar body of work on defense and how the Pentagon works and geoproto-tactics for structure, et cetera. There's a national defense university. There's no such thing in energy at all.

XXX: I would argue a bit on all of the above though. I think that we definitely need to push through the barriers to market transformation and bring those products' prices down, and I think that's part of the deployment challenge and knock the barriers out. And the minute that they are

actually cost-effective, we should pull our dollars out and move to the next thing.

We do need the next sweep of more efficient products. So if we're going to continue the cycle and actually get to where we can turn off those negatives so there's room for electric vehicles and all the other deployments we need to do, and, you know, there's buildings that we have been to three times in 11 years, and every project was cost-effective, and every project was the next level of that product's evolution life, and each one has lowered the operating cost for the businessman and became more cost-effective in their industry.

So we do need some of each. We need the next technologies being developed while we drive the cost-effectiveness to a better space and get them deployed now.

XXX: I think you need a real balance between the breakthrough technology which we have now given the Next-Generation technology in the next 10, 20 years, but at the same time we need to have cost-

effective technology to support current industry to become competitiveness and safe energy for the nation.

In the past from my perspective, looking at it from XXX, I think we haven't seen DOE support breakthrough technology more than cost-effective technology. Recently I think there is a change on a level XXX participated in the GP program which I think is a very good program. It drives the real issue in the short-term and long-term.

And in nation energy efficiencies, energy is not like a defense. Energy is a massive technology. It's a private commercial space. So how to make any efficiency become an incentive for the industry in a very competitive manufacturing industry, I think we need the DOE to build a program how you collaborate to commercialize the technology in this space. That's where I think it's missing. We have a lot of good commercial space to do the DOE projects or nation projects much less industry collaborations, how to transfer the technology industry, and then you have the

impact to the nation.

XXX: We are interested in collecting little stories, vignettes, either positive or negative where DOE has helped forced or breakthrough technology that's been useful out in industry. We would like to hear about that.

XXX: If you look at the challenge today in the commodity, manufacturers' industry in the U.S., to be quite honest with you, we have much less R&D than 20 years ago. The industry alone, particularly chemical industries, I mean glass and chemical industries, it has become more and more difficult to develop such technology that can make our manufacturing process more efficient operating.

So how do we then learn to help the (inaudible) of technology environment to do more effective program to address that area?

XXX: So there's at least half of Washington who will say that that's an entirely inappropriate role for government, and that the private sector knows

best, you guys have the cash, if you want to do it and --

XXX: Take our manufacturing to China.

XXX: That's the answer, right. That's good. I like that answer.

XXX: And for profit-based industries, at the end of the day, it is money-makings, not technology-making.

XXX: Right. Exactly. Good.

XXX: But I would like to comment on that point because we have certainly faced it in the Hub already with some people who asked us if we aren't trying to pick pointers and the marketplace, and I think we can argue back on that. Go back to defense for a minute and look at the fact that in defense there are certain things everyone agrees you simply need to do. Once you get to that point, then you don't worry so much about market factors. The beauty of it is that you need to do it. Government does it. They buy their own

dog food, if you will, and eat it. But then at the end of the day, once those materials and other things get produced for DOD, they roll out into the marketplace in very, very nice ways.

So on the energy side, there has to be a similar sense of urgency, and somehow we have to tie, I think, energy to national security because at least half of Washington doesn't believe in Global Warming or carbon dioxide and things of that sort being an issue.

So you really do have to tie it to other issues, and then maybe using government to be the place, government bases, DOD, and so forth as the first customer because you do feel the urgency is a really nice pipeline approach that mimics DOD and eventually rolls into the marketplace, and there are some things that are appropriately done by the market. Defense is not one of them, per se. At least I don't think it is. And there are other things that aren't appropriately done by the market because there are market failures, and in this case, what is our percent GDP on energy research?

.01 percent according to the Savitz report. Our GDP is so below -- sorry. Our expenditures in energy research are so below, even Japan and Korea and others. It's remarkable.

XXX: Two things. Let me just address the energy research number having been in the energy business for five years on the supply side. When people cite those numbers, I think what they don't understand is that the supply side, at least which is a good fraction of the total business, is a commodity business.

XXX: Absolutely.

XXX: And you can add up total sales and divide research to get a percentage, but research is only one and often the most feeble of the levers that you pull for business success in a commodity business. It's about your operations. It's about the market, positioning, et cetera, et cetera.

And so that's why you don't see technology get developed. It's a commodity. It's like chemicals. Right? It's the same thing. And so, again, maybe in the case of

business actually knows the best. On the demand side, it's a different story, but on the supply side that's why the numbers are off.

We have tried to frame the energy problems as three, oil first on the left. I think you can get everybody in Washington to agree that's a problem. The problem is you can't get them to agree on what the solutions are. Anybody who knows anything about oil and economics will know that domestic drilling does not solve the problem. It may address other issues like jobs and balance of payments, but it still keeps you coupled to prices.

Competitiveness which we touched on already a little bit. My own sense is that the problems there are deeper than just developing more energy-efficient technologies. Businesses decide where to be on the basis of financial regimes, regulatory regimes, and cost of labor as well as energy costs and then the environmental issues. We are now talking about the more or less in this order.

XXX: Yes.

XXX: But if someone

has a better framing of these or thinks there should be other things on the list, we would like to hear about it, again, to be able to tell the story to many people in the government and the public about why the energy business is important.

XXX: XXX, real quick. Maybe an easier one. You talk about competitiveness -- you talk about competitiveness for -- is the battery on? I can be loud. Do we have a sense of, again, square footage that we have in the U.S. that we have to deal with? We can't really offshore the Pentagon. We can't send that over to China and operate over there.

UNKOWN SPEAKER: Maybe we can.

XXX: It could be a challenge. We're going to have a certain number of square footage that we're going to have in the U.S. to operate.

XXX: Building space.

XXX: Building space.

XXX: Commercial, residential, all of the above.

XXX: Exactly. As a fraction of the global operations, what does that type of competitiveness look like?

XXX: Well, you know, it's a proportion of the population. Let's start with that. And we're 4 percent of the world's population, 4 and a half percent.

XXX: But we have to have more square footage, I think, than India.

XXX: So there's probably within maybe 8 percent. I don't know what exact numbers are. Somebody may know.

XXX: But five million buildings that are 40,000 square feet or more. So five million --

XXX: Right. But that doesn't count houses.

XXX: No. That's just commercial buildings. And then on top of that, we have got what, 60 million --

XXX: The point being that there's a stock we have to manage whether we like it or not. We can't move it around based on margins. We're going to have to deal

with this. And when you start talking about the competitiveness picture, somebody in Washington might say that's a market problem, I don't have to deal with that.

If you add it up, there's a certain number of square feet you're going to have to do whether you like it or not. That's not what we need to back away from.

XXX: If you look at these three charts, I think it tells a compelling story about energy-efficiency. From an energy security perspective, this happens at home. It's energy we're not using. So there's no negative energy security implications.

From a competitive perspective, program-to-program is different, but our experience is we have never been anywhere we couldn't pull off efficiency for less than three cents a kilowatt hour. That competes with any energy source out there straight up, and we can do as much of it as people want and create all kinds of space. And on the environmental side, you're directly -- whether people believe in climate change or not, it's

addressing it. It's dealing with particulates. It's dealing with all of those in a positive way. It's an incredibly compelling story that aligns energy policy with other national policies which is the way we ought to be lining up our technology programs. After all, let's actually accomplish the policies of DOE and our country. So I think it's really compelling in the case on the chart.

XXX: Other comments?

XXX: I would just add to the last bullet point about the environment, you know, and say, yes, you know, in Washington, D.C. there is a lot of debate about greenhouse gases and Global Warming. But irrespective of that, we know that efficiency is in the right direction.

So as long as we can say the story that by being more efficient, we are not only cost-competitive but environmentally more cleaner. That's a good story to say. I don't see that story come that often in terms of linking efficiency with the environment. We try to do that, and a lot of industries around

the country trying to do that primarily because from the production perspective. They credit by having efficiency, but we don't see that a whole lot from Washington or other states.

XXX: You might add just one fourth bullet, by the way, on this chart which in today's world there's a lot -- which is local economy and jobs, and efficiency plays so directly into that. You know, I haven't seen good national studies on this, but the work that we have done suggests that 80 cents of every dollar in efficiency stays in the local economy and creates jobs.

Whereas, we are now starting to see jurisdictions around the nation start adding actual job creation metrics to contract for efficiency. We just started work down for the District of Columbia for creating an energy utility down there, and we actually have to deliver green jobs as an actual measured outcome of energy-efficiency work which I think is a positive direction and helps make the story more complete.

XXX: Same thing is

true industrially in, I think, the fact that that efficient plant, looking at it as a system, if they are more efficient, they are lower cost, and, therefore, they're maybe one of the low-cost producers. That keeps the jobs. That keeps the plant open, makes it competitive with other plants within the same company.

XXX: My name is XXX . I'm with Train Corporation. I have been in the industry about 25 years, possibly not as long as some other folks. However, one of the things that's really a passion on my part is mentoring and developing new engineers, hiring interns, and developing into the energy career.

My question to the universities represented here, is there a -- in DOE is there a focus on the next-generation energy engineer professionals that could tie in with the green jobs, the greening of the jobs, energy conservation and from a grassroots level attack it from an educational/professional standpoint so when these young folks grow up, mature into

the business realm that we have a culture of energy-efficiency behavioral sciences that impact the energy picture overall.

You know, when I was a little child, I remember standing in the gas lines with my parents of the Oil Embargo of '73, give or take, and I look back, and I share this with my family who my kids are college-age now, what did we learn? What did we really grasp from those tough decisions back then? And I think it's a harsh challenge. There's not a direct answer, but I think if we see $10 a gallon of gas, that's going to impact behavioral change.

So to close, I'm just looking at from universities, Penn State University had an energy program that I took advantage of. And I was just wondering from across the country if that could be grassroots level, that DOE can maybe help fund some of the sponsoring of scholarships and so on? Thank you.

XXX: The industrial assessment centers at the universities, there are what, 26 of them, I believe, have a valuable role in that regard. We have at XXX

every summer I get two or three IAC students, students who are part of the industrial assessment centers either at West Virginia or at Lehigh University to work there.

And what's interesting is the fact that by coming there, I have had -- out of the six or seven mechanical engineering students that I have had from Lehigh, I have gotten -- there's like three of those engineers that have gone into the energy industry as a result of their involvement in the IAC or as a result of the involvement with us working on industrial issues.

So I would like to see the IACs expand. I would like to see a bigger role for the community colleges. I think that that's how you get that type of involvement because that's hands-on. That's hands-on activity for these students. They can really see what the impact of what they're doing is.

XXX: To answer that question -- where did he go? Students tend to vote with their feet, and what we have seen over the last, I'd probably say six years, is

there was -- 10 years ago there was -- so maybe 10 years ago, 11 years ago, there's a big rampup.com. There were a lot of students that went there. The boom went away, busted. We saw sort of a scattering from CS away from that into some of the other areas, mechanical, took a big swing-up.

What we've seen over the last four years -- I serve as the associate dean for research in college engineering. So we have to see all the figures, and you get the trends. The environmental and the energy space, nuclear took a big bump as an impulse response, and it started staying out at a higher level than it was pre-crisis.

So I think we're seeing a lot of the students voting with their feet and moving a little more towards the energy sector. Oil, being as expensive as it is and energy being as expensive as it is, people see a future for themselves as engineers in that space, and so they tend to gravitate more towards that. So I think what you're asking for, we're starting to see a lot of that market-driven, students

voting with their feet, and I'll ask XXX to --

XXX: So I can just pick up on that and say I agree. Through the 1990's at XXX when engineering programs were, frankly, in decline around the country, ours continued to grow. You're right. Between '95 and 2000, everyone including chemical engineers wanted to be in IT. That went away pretty quickly around 2001.

We have seen steady growth in mechanical engineering. Mechanical engineering grew so fast that we actually had to cap it a number of years ago. Now, in those programs, there is a huge amount of energy-related education. So you can have traps that are involved in taking chemical engineers into the energy industry.

And then we also have upstream programs, so that people do that, natural gas, petroleum, mining, and drilling engineering, and energy engineering. We have got all of those basis covered, and the flux of students into those programs just as it is in Illinois is incredibly strong. Could I say a word about

the Hubs, just the type --

XXX: Yeah.

XXX: So I'm probably going to end up saying the Hubs are the answer of all problems today. I'm going to try not to say that. One of the things I really liked about the Hub though is that rather than simply working in sort of a Ph.D. level with students or even BS level with students or working across the board.

So part of our Hub, because we're an innovation cluster as well as a DOE Hub, part of our mission, in fact, is to go out there in the workforce development, and that means working with tradespeople who are right now technicians who are working on electrical systems, lighting systems, and upgrading their skill-sets with certification. That's part of what we're doing.

We're also working then with a variety of organizations including the community colleges to put people into the pipeline to get at more advanced securities, whether it's an associate's degree or what have

you. And a lot of studies show that if you do two years for an associate's degree, you're more likely to go on for two more years to get a bachelor's degree and maybe even two more years to get a master's degree.

So we're seeing people coming into these programs at a tremendous amount of interest in that. And the last thing I would say is that I think a lot of these issues over time will nullify themselves even in Washington because the younger generation of people coming up with very few exceptions buy all this. They like it, and they want to work on it. They'd like to see the United States be more energy-efficient, and they believe in it.

So I want to come back to the whole issue of not just deployment, but adoption which is the other side of that coin.

XXX: XXX,

. I came to the national lab from the oil business, and I do Aspen process design and economics. So I really like the system's approach and linking that back into the widgets. It doesn't always

make you friends. Okay. But it really helps -- it really helps the program.

Leaving that aside, let me introduce some controversy because I am critical of the energy programs in general at the universities, but I'll be targeting a specific university that's preeminent, and that's XXX. I had an excellent -- it's a wonderful place. But you can get a -- and I'm a consumer because we get the summer interns coming through the national lab system, and I have only one question. You know, you are producing really well-informed citizens through these energy programs is what I see. But I have only one question for the university programs.

Do you require thermal dynamics? Do you require thermal dynamics? XXX does not to get one of their degrees in the, you know, area of environmental science. And I said this is the basic bookkeeping of nature. I know. You're --

XXX: Of course.

XXX: And what I'm finding is very well-informed citizens, but I

can't actually get them to do anything because they don't --

XXX: For the record, XXX will not appear in the transcript. It will be X-something. Anyway, that's a challenge to some academic folks. Do your programs require that they know something about thermal dynamics.

XXX: In 2006, to that point, Penn State as opposed to XXX was trying to get its house in order with respect to energy. My boss at that time who is now Under-Secretary of science at Smithsonian said to start a task force in this area, and in that task force, we didn't just look at research, we also asked ourselves what about outreach and education for undergrads.

We make the recommendation at Penn State, we felt strongly enough that every undergrad in Penn State should come away with a basic understanding of the first and second of thermal dynamics even if it were only conceptual, even a poet should understand it. Unfortunately we were shot down. But on the

engineering and science, absolutely. But on the liberal end side, we have to learn a lot of -- our students have to learn about literature, sociology. We have all sorts of general education requirements that they must go through. Unfortunately, the ancillary of that is not true, and it should be true. I think you made a great point.

XXX: Somebody else is getting up. Please do. But I have kind of a question. I have reviewed this document, and we have been talking about what -- our opinion, that is a very, very important part is whether it is put into a market disciplinary approach among different, you know, branches of engineering in colleges, whether it's community colleges or in the state universities or whatever it is, but that's very important.

I might have missed it, but I didn't see a specific focus in this document on workforce development. Is that -- was I the only one who missed or is that not in this document?

XXX: So I will ask my

team to -- we have seen so many documents in this exercise. I don't know. I don't believe there's much in there about that at all. So you're correct. Let me just say a word about training more generally within the Department.

In the Office of Science which does basic research, we support many thousands of graduate students, summer interns, and so on. That has not at all been the tradition in the energy programs with one outstanding exception in nuclear engineering, and we in the Department believe that it is important to do that. We had a program called Reenergize, you may remember, that did in the end make it through.

Let me just say that there are other people in the government who believe that education should occur elsewhere and not necessarily in the Department of Energy, and so this is an ongoing discussion.

XXX: Just to add to that comment. Again, I come back to California's initiatives because that's where I'm from. The State of California issued this

big board energy-efficiency initiative in terms of money going into that. If you read those documents coming from the State of California, from the California Public Utility Commission, there is specific areas focusing on workforce development.

So specific strategies are put in place for workforce development either in colleges or other places. So after this document was released, you know, we have seen infusion of this happening throughout the university sector.

Let me just give a couple of examples. The University of California Davis has now got an energy-efficiency center, multidisciplinary center focusing on (inaudible), lighting, and third, on systems. So they have got that. The University of California in Santa Barbara, a conference which DOE has funded already institutes energy-efficiency that DOE has funded, a pretty large institute. San Diego has a center. Stanford, there's a center. So there are a lot of centers that have developed not primarily

because of this document, but this document has really provided that ammunition for centers to develop, and we see a lot of youngsters in the workforce today coming to the workforce today who want to work in the energy center, and that is really good news.

So I would urge a specific mention of workforce development, to put some of it predominantly in the document because that is a key part in the energy.

XXX: I'm XXX from XXX. I taught at architecture schools for the last 30 years at Berkley, Boulder, Cornell, MIT, and Yale. If you look to the innovative building and engineering firms that are in the energy sector, there are firms like TRANSSOLAR, Baroque and (inaudible). They're firms that all started in Europe. They're firms that today in New York City, for example, Baroque happening in New York City which that division has been there for, I don't know, 25 years. The young energy engineers that are dealing with buildings, most of them are not U.S.

citizens. Most of them are Europeans, New Zealanders, some Australians.

So one has to look and ask why has this happened. I mean, the changes that we see are very, very positive, but if you take a longer historical point-of-view which because of my age, I can, but if you realize that at the end of World War II, Europe had to rebuild its buildings, the U.S. did not have to rebuild its buildings.

Architectural engineering programs were dropped from many U.S. colleges, universities across this country, and they disappeared. They have reemerged, but if I ask everyone in this room if you want to be a building energy engineer, if you want a good education in building technology, most of you will have a hard time naming more than three or four schools. Penn State is one of them, of course.

So we have this kind of fundamental problem in just building science education. That's not really offered as widely as it is in Europe. Architectural education in Europe and

Korea, not Japan so much, New Zealand, Australia, Canada, the energy knowledge required of architects in those countries is at a much, much higher level than in the U.S.

XXX: What about China? A great spurt in building that's going on.

XXX: Yeah. In China there is clearly a much higher -- the architecture students are required to have what we would consider an engineering background. It's very, very different. I have had, you know, only limited experience through research collaborations in Hong Kong.

But there's this fundamental educational difference. There's also a difference in the way that the business model for delivering architecture. In the U.K., for example, the architect is often not the primary design, building designer. They are just one of several consultants that are working on the project, and also, in the U.K., but it's probably true in Scandinavia, probably in Germany, maybe less so in France. There's more upfront money put into building analysis and

preliminary design of which simply can happen here, especially in the residential sector.

So there's these different educational expectations, different educational traditions. The historical reasons for them are clear, but, you know, this is a moment where DOE can step in and move this trend that's moving in the right direction a little bit faster. I'm not sure how.

XXX: Thank you.

XXX: If you look at the difference of opinion in the U.S. and China, in particularly, in building industries, China built all kind of new buildings. There are opportunities to design fancy style and efficiencies. You look at a -- compared to U.S., mature countries has maturer buildings.

So you look at it. What I wish the Department of Energy can do is using the policy and the technology, R&D department to create a market, business opportunities in the United States so that we can use our technology and policy to retrofit in all -- in the buildings or in other areas. I think that's our

challenge. We all talking about how this technology go outside out of United States, but how we create business opportunities first in United States, then you can drive not only the profitability of the industry, but also an educational opportunity, too.

The reason we do not have a lot of students in these areas is because simply they can't find a job. So that's a fundamental reason, because we do not have the business opportunity.

XXX: I'll give XXX the last word, and then we're going to have to break.

XXX: I just wanted to tie those two together into a question that might be part of the breakout. XXX, thanks for the comment. One of the things we thought a lot about is that much of what we do in DOE money and what has been done with DOE money falls in the category of technological push. We're pushing technology. We're talking about deploying technology. One of the things as Hub director that I worried a lot about and have

not been able to solve is that of market pool. And, XXX, here I turn to the architects, and I haven't been able to get much of an answer or help, but what I have tried to say is that, you know, people do understand behavioral economics at some level.

And if we did, in fact, create some architectural designs in the like which somehow much spoke to people and made it, I would say, obvious that a certain building that had been renovated was one of these new kinds of buildings, and if that became somewhat more prestigious, early adopters might do it.

XXX, I'm wondering, you must deal with this problem all the time, but that side of the equation, this energy thing we're talking about, energy-efficiency kind of lies at the nexus of people. It lies at the nexus of people with technology and people with information, I think, which goes back to the whole database thing. And I'm wondering how we get that market-pool piece. I think the Hub should do some of that. I haven't figured out how to get the architects to play with me yet.

XXX: This is getting really interesting.

XXX: Can I respond? In response to -- you suggested the notion of putting out demonstration buildings, buildings that are conspicuous buildings.

XXX: And beautiful.

XXX: Yeah. Of course. XXX, we have a new building we think is a conspicuous, beautiful building and a very low-energy building. It was designed by Sir Michael Hopkins in association with -- but let me turn to the more general point. Across Scandinavia and in, perhaps, Germany and also France, U.K., buildings often come out of competition. Royal supported buildings are competitive ventures.

We don't see that very much in this country. We did see it in the late '70s when the State of California had the State Office Building competitions, produced, I don't know, a half a dozen buildings at that time. Those were very conspicuous efforts. Architecture schools looked at those with very great

interests and had a big, very short-lived impact. So the whole idea of putting -- the idea of DOE sponsoring competitions is a very, I think, healthy approach.

XXX: Good. We're going to have to take a break, but it's clear we have gotten the discussion rolling and the juices flowing a bit. I want to thank the panel for helping us get to that point. I guess we have coffee for a bit and then breakouts. So I don't know what the logistics are.

XXX: 50 minutes or so. You have a number on your name tag. We'd just like one, two, three -- four round tables in the back. If the tables are a little close, we'll pull them apart so we can have separate conversations. We'll reconvene in about 15 minutes.

(At this juncture, breakout sessions took place.)

(Short recess taken.)

XXX: Okay. We have an hour to give four presentations. We would

like to get started. The rough structure here, two of the folks from the buildings program are going to talk about different aspects of technology related to buildings, and then two of the industrial folks will talk, and this will take us until about 2:00, and we'll go into breakouts on those topics. First is XXX .

XXX: Earlier on, there was some discussions about widgets. I would say this is the widget presentation, not the system, a presentation that's going to follow right after this presentation.

DOE employs energy-efficiency using three strategies that build a self-reinforcing Ecosystem, and I'm going to go into greater details about it, and it's research and developing new technologies, priming the market for technology adoption using codes, and standards to clean up or propagating new standards.

Buildings accounts for -- and this is the boilerplate. Building accounts 40 percent of the energy consumption in buildings.

So they present a great opportunity. We're going to present three -- we're going to view these opportunities on four horizons. The points; today's technology, researching emerging technologies, advance cross-cutting components, and exploring not-in-kind advances.

Not-in-kind technology isn't technology that wasn't kind to you. It's a paradigm shift. It's moving from one technology to another. Pretty much like if you were to look at when we transitioned from horse to steam, from steam to the internal combustion engine, moving from conventional lighting to solid-state lighting.

When we talk about not-in-kind, those are the type of technologies that we're addressing. As you can see, this is the three strategies. We have codes and standards, and one of my co-workers is going to go into greater details, but that's mostly those activities are putting minimum-efficiency standards or working with energy codes for buildings. Then you have the R&D. When we develop new technologies, new projects, new

products, new widgets like they were talked about in market-priming, and that's when we use other mechanisms by which we introduce products into the marketplace and create that pool.

I'll give you a very good example. The DOE in developing the heat pump water heater did some R&D working with the national labs and the private sector to bring that product into the marketplace. So you had the R&D component. At the same time we created a market-priming aspect to it. We worked with the Energy Star Program to make sure that we had standards in place that were voluntary criteria. So there was an Energy Star criteria for heat pump water heater.

At the same time, there's the code-and-standards component. When the DOE was setting a minimum-efficiency standards for heat pump water heaters, even though the Department did not set a standard at that level for the residential, they did evaluate it and did go for a heat pump water-heating standard for the commercial-type units, and that cycle continues, and it's very important to do the

R&D because the effectiveness, they are all tied together. The effectiveness of the codes-and-standards program relies on new products being developed that are more efficient and economically justified.

So one of our roles is to repopulate that field. As that curve shifts, you know, in the number of units, we keep populating that curve. Otherwise, that curve gets truncated, and you run out of products to move to.

So there's an important role to be played in developing these new equipment. There are some advantages. One thing to keep into perspective is that over time energy use has been growing, and we were very effective in trying to make sure we do see that growth. The growth is still there, and we do have new technologies that can help flatten that curve as you can see, but that rate over time has been reducing. It's just that the number of components have been increasing. The number of units that most of the residential products use -- like if you were to look at a home -- this is where data comes in. If you were to

look at a home 10 years ago, and you were to count the number of small transformers that would fall under miscellaneous electric loads, there weren't that many of them. But if you look at today, if I were to take inventory of your home, you probably have -- for every single cell phone, you probably have one of those, for every single Game Boy, Play Station portable, I-Pad, I-pod, all those other products, you probably have a little transformer there. So that growth is there.

We do have one advantage to say, that 75 percent of today's energy consumption, you can sum it up by four major end-uses, and being the technology development manager for HVAC, I know that I'm a big contributor to that area. HVAC, miscellaneous electric loads, that goes under MELs, lighting and water heating. Well, they represent 75 of today's building energy use. So we are focused -- we have a lot of activities that will go into -- when we had the challenge of presenting this QTR and developing, you know, the areas of focus and dividing that universe, that space into certain

bins, you know, we tried to focus on some major end-uses to be able to communicate where we would be focusing on.

Buildings over the past couple of years, we have seen some major increases in our budget, you know, and I won't go into a lot of details, but it sort of tells you some idea of what the order of magnitude -- you know, what are we talking about. We're not talking about billions of dollars related in the buildings program or in the federal energy management program or the residential program, but we are talking like in the buildings in the 200-plus area.

One thing to consider that these charts do not show, the down-payment that we made through the Recovery Act into energy-efficiency products. We made a major down-payment through the Recovery Act, and that doesn't show up in these charts. If you look at the four horizons that we talked about, standards and market-priming, emerging technology, cross-cutting, if you look at that major bar as being the total energy that's

being consumed, we know we can drive, you know, a certain percentage by standards for market-priming. We know we can drive it down into merging technology and cross-cutting technologies that I'll talk about next and not-in-kind technologies.

Using all those three, four parts. We know there's a little bit of a remaining part for future consumption that will have to be addressed, but all those four areas have a major part that we're able to address. If you look at the four horizons that we looked at, there was earlier talk this morning about the technology maturity areas aspects.

We're in the buildings technology program, and we're mostly focused on the zero to 10. Later on you can look at RPE. That takes a little bit of higher risk that we talk about DOD, the areas, the technologies that you work on. The high-risk aspects are the Office of Science. Those are the areas that are -- those are events they participate in. And we are in the applied engineering science aspect of it. So the first horizon is the deploying

today's technology. We know that if we're able to deploy today's technology, we can make some big improvements. It isn't all about the Building Technologies Program. We have the Office of Weatherization into government, FEM, Federal Energy Managing Program, and other activities that represent significant benefits. That would only take you so much.

Then we have research through emerging technologies when we develop the Next-Generation and also feed into the applied standards, but that will only take you so much. Then the next horizon where you get over the 10 years, that's when RPE and to a lesser extent BTP, Building Technologies Program will be able to participate, even though you could consider solid-state lighting to be in that bin.

And in some aspects in the next exploring, not-in-kind technologies, building technologies, you know, RPE, the Office of Science could contribute a lot in those particular areas. And if you look at the whole space, one of the challenges that we had earlier was dividing up those little bins, the

end-uses that we're going to be addressing. When I talked about HVAC, water heating, lighting and refrigeration and MELs, you know some of those aspects being 75 percent, you know, these are -- if you look at where the different activities are for horizons, where they can participate, the standards, the market priming, the near-term, emerging technologies, the cross-cutting technologies, you know, where they can go in, you'll be able to see from our chart.

And the not-in-kind research and development opportunities, that list has -- there's less -- we know that these are the current concepts or ideas that are known, but there's always a greater opportunity that there are activities that we're not aware that will present themselves through research since they are radical departments.

One of the things that if you look at the energy consumption in buildings, 45 quads of primary energy and residential and commercial. If you looked at initially when I had that graph, you could see how much energy

could actually be able to drive it down for both the residential and commercial using existing technologies, savings with advanced technologies, and then the remaining consumption that would have to be addressed to more advanced.

So if you look at it, existing technologies only takes you so much. You can couple it with advanced technologies, and you still have a remaining of 10 quads of energy, 10 quads being 10 quadrillion BTUs.

Okay. The deployment, assistance standards and market-priming. One of the most important effective programs that we have in the Building Technologies Program is rulemakings. If you look how effective it is, they save 1.8 quads per year, per year in 2030 and saved consumers 264 billion cumulatively from 2013. This is not a small number. This is major activity. This is a major part of our program, and the emerging technologies program supports this activity making sure that we're able to supply the next standards. It's an effective program. It's only effective if

you're able to repopulate if that technology stays with more advanced products in itself.

The other part is market-priming takes another part. The applied standards, remove the low -- the products that are not performing as high as efficiently as they should. The other part is using the existing residential -- addressing the existing residential buildings, and we have programs through OWEB program and the better buildings that are going to deploy commercially-available, energy-efficiency measures that are available today into the marketplace, and DOE has a goal to support retrofitting one million homes between now from 2010 to 2013. So we want to be able to touch those homes.

The other part on market-priming, we do have going after the existing commercial buildings. The better buildings initiative seeks to reduce commercial building consumption by 20 percent by 2020. We also are addressing new buildings. That includes developing through the Building America Program that goes after residential buildings and developing

advanced energy design guides that improve new buildings. There was talk about in our breakout session how effective having case studies are, and the advance energy design guides that are an important part of that aspect, at least for commercial buildings.

So one of the goals is a 50 percent savings in the model building codes by 2015 and enabling Net-Zero energy buildings by 2030. Going back to the original slide when you have the major bins. There was a lot of talk about what is the capability, what is the potential savings. So emerging technologies can offer a 50 to 90 percent savings in major end-uses, and some of this technology is currently available. You have for HVAC, heat pump combustion, heating, cold climate heat pumps, integrated heat pumps, and ground-source heat pumps.

These are activities currently being undertaken by the Building Technologies Program. For lighting, we have requirements that was talked about somewhat earlier relayed about solid-state lighting and LEDs, and we have criteria or goals for -- by 2020 to have a

requirement for a 210 means per watt as a requirement. We are also focusing on outdoor lighting advances, sensors, and controls, and that has a potential of 5.4 quads of primary consumption.

And for water heating, you have the heat pump water heater that offers great energy savings, roughly around 60 percent. You also have other opportunities with gas absorption, heat pump water heating, solar water heating, and demand reductions that could move into more of a systems approach.

And miscellaneous electric loads, significantly reductions are possible. They are a little bit more challenging because they're not -- they're more fragmented, and it's harder. You know, the program is addressing some of those through rulemakings and some other parts through research, and the systems team could also address how to handle these miscellaneous electric loads. There are other opportunities, too, not as great, but there still are important opportunities and potential energy savings, and we broke them

out. Refrigeration has 2.6 quads of primary energy consumption, and there's the possibility of a 20 to 40 plus reduction processes possible. Laundry, cooking, dishwashing, they have major ranges, up to a 50 percent energy reduction possibility in those areas, too.

But if you look at those end-uses, sometimes you'll see that there's some common technologies that are cross-cutting across. So insulation, heat exchangers, motors, DC, direct current and off-grid and working fluids are important components that impact -- that play an important role in water heating, lighting, HVAC, cooking, laundry, dishwashing, HVAC, and miscellaneous, electric loads. These are cross-cutting technologies that are everywhere.

Improving the insulation can impact water heaters, can impact refrigerators. Heat exchanger are a major part of HVAC equipment. They also play a part in water heating. They also play an important part in maybe future heat pump dryers. DC, direct current, being able to use renewable energy directly without inverters potentially. Working fluids are

expanding as we move to heat pump water heaters. They were limited in refrigeration and HVAC equipment, but now they're moving into heat pump water heaters, but then there's the external factors internationally related to low global warming refrigerant and how to address those issues.

So those are more of the cross-cutting opportunities that working on one area will impact the other and give you extra benefits. Not-in-kind technologies offer the potential for dramatic breakthroughs in some areas. One thing to understand is that these not-in-kind technologies are moving from one technology base to another. So there are sometimes some higher risk and will require more R&D, a longer-term perspective as we move from conventional lighting to solid-state lighting.

Some people may complain about the quality of light. So the Department is addressing those issues as we move from vapor compression, HVAC pieces of equipment to solid-state. We know those are going to be

challenges in maintaining the same efficiency requirements we have for vapor compression, also require more investment, and RPE has a very strong program for first solid-state technologies on the HVAC system.

There's also the opportunities to move not only beyond the technology but from one cycle to a different cycle in vapor compression. We also have multi-photon phasers for solid-state lighting, and LED lighting is evolving from reducing the cost from these small super-expensive displays to larger ones, and, you know, one of the advantages, if you go even today with LED TVs, just a couple years ago they were super expensive, but now the price keeps going down, and, you know, consumers are accepting as the price goes down, and we hope in the future that that technology will repeat itself, the mechanisms to regular lighting.

And there are other technologies, not only technologies that could be applied in the HVAC space to and from others using advanced materials in the building technology

space.

And this is the executive summary, same slide that is on slide 2. So mostly we talked about the three strategies, the research and development, priming the market for technology adoption, using codes and standards to clean up, and we talked about those strategies and how they feed into each other and the opportunities and the four horizons that we're using to deploy new technologies in our research, R&D. And that's it.

XXX: Rather than take questions, I think we're going to go into technical breakouts. Folks who would like to ask questions will probably end up talking about it in breakout anyway. So in the interest of time, we should just move on and plow through the rest of the presentations.

XXX: Good afternoon. I'm XXX. My position is XXX is my official position, but at present I am helping out in the emerging-technology research area.

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So my presentation is going to look very similar in many regards to XXX's. We're in the same group. And I'm going to be focusing on buildings as a system.

The executive summary, what XXX and the equipment area and the systems area, we're working to try to accomplish the same thing. We're working in the R&D area, looking at market introduction technologies. We're looking at regulation in order to mandate or, as we say, clean up the area.

This slide XXX had presented. I think one thing to focus on was looking in the 1960's, 1970's. The major growth was the introduction to the marketplace and a significant way of commercial air-conditioning. So that large growth in the late '60s, early '70s is a shift of the market both residentially, but principally commercially into air-conditioning products.

I would like to touch a little bit on this very simple slide to indicate a major difference between the Building Technologies Program and the other programs in the energy-

efficiency removable energy area, Isaac's industrial technology which he's going to be talking about, but also other parts of DOE. And the Building Technologies Program is the one program area that has a major regulatory activity. There are minor regulatory activities scattered throughout the Department.

But in the buildings program, roughly a quarter of our activities, at least measured by budget, is regulatory. We are responsible for managing the applied standards program. We're responsible for managing the building code activities. The applied standards are mandatory standards that we regulate what manufacturers are able to produce and sell in this market.

The building codes, while at a local perspective, building codes are mandatory, our activities in the building code arena is to support the development of model energy codes through code organizations, professional societies such as the international energy conservation code managed by the international code council as well as the ASHRAE, American

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Society of Heating and Refrigeration and Air-Conditioning Engineers. In the case of the codes, we are promoting the codes and helping provide technical leadership.

But what makes the regulatory activities significant is that it brings -- it helps bring the R&D product into the marketplace by mandating it so that the market planning or the deployment activities such as Energy Star and in between the research and the regulatory and that there's an opportunity and a time for the market to absorb and adopt some of these advanced product designs, but by the time they get mature, they are still not widely adopted. The regulatory program can make it happen.

Tony showed you this slide. I would like to focus on the bottom slide. The buildings activities, both the Building Technologies Program and the Federal Energy Management Program at the present is roughly a 250 million dollar program. 50 million of that roughly goes into the Federal Energy Management Program which there was some discussion earlier

today about why not use the federal buildings, the federal system as a deployment vehicle. We, in fact, are doing that and looking to do that more. And buildings in the federal sector is a major area. We're in the process of developing some joint programs with FEMP, Federal Energy Management Program.

I would like to focus on the rest of this graph. If you take FEMP out of the budget, the Building Technology's Program budget is roughly 200 million dollars. The appliance -- the regulatory program is roughly a quarter of that budget. The deployment activities is roughly an eighth of that budget. The research is the balance, roughly five-eighths.

One of our challenges is how to take those three legs of the stool and divide it up as far as for budget for activities. We're to prioritize, and we have struggled with that for years. One thinks, which makes this complicated, is when you look at the regulatory programs, the legislation is very specific as to what rulemakings we have to undertake, what

code determinations we have to undertake. We don't always meet those schedules, and as a result, we have had instances where interested parties have gone to court and got a court order, and that gives us direction as to exactly when we have to come out with an applied standards rule.

So our budget for the regulatory programs is pretty much driven by legislative requirements given that we have limited resources, prioritizing and how to -- whether or not to focus on lighting, focus on envelope, focus on HVAC equipment is something we continuously look for some feedback and some guidance and always encourage more.

We started out by looking at the energy pie, looking where energy is being used in residential and commercial sectors to early on prioritizing our area, residential buildings, new buildings. Now we're shifting to existing buildings and retrofitting, but looking forward to some assistance in furthering the planning process. Systems approach. Why do it? Tony talked about

building components and making it more efficient, water heater, more efficient, heating and air-conditioning system. You're going to reduce.

As we all know, you're going to reduce the energy use through efficiency, but when you start getting to the limits as to what's economically viable within a piece of equipment, there's still an awful lot left on the table that can be saved by looking at how that air-conditioner or that furnace is designed, how the ductwork is designed, how the ductwork is installed, treating that as a system, whether or not looking at a commercial sector, looking at having controls to automate some of the on/off and directing heating and air-conditioning throughout a building so a systems approach in taking an efficient piece of equipment along with the controls can significantly reduce the energy savings -- significantly reduce energy use. Excuse me.

Envelope. We've got a major area when we look at envelope as far as whether or not it's more efficient windows, more efficient

walls, more efficient roof systems, and taking together also with reducing the other impacts such as moisture that you can make a building more efficient as well as healthier for the occupants.

We talked briefly about sensors and taking that in with equipment, XXX's equipment can further energy savings. Modeling. We talked about some data earlier today as far as understanding where energy is going. We found it is a significant factor for building designers to understand where the energy is being used and some of the modeling tools that we are -- that we have developed such as the older window 2, EnergyPlus being developed for building designers, building constructors in order to model the building before it being built in order to design it as well as some of the similar tools being used to evaluate the buildings' performance to be able to do continuous commissioning of the building because, I think, building professionals have found that many times valves are put in incorrectly, in opposite so that they're not

controlling the flow as they should be.

The controls, you can have thermostats that can be put -- a great thermostat, occupant-sensitive and put in the worst place possible because it happens to have a HVAC control it. It can be put right above a return register, right about the supply register, and you lose all the benefits. So lighting control, if you try to get occupancy sensors, you put it right next to a hallway, and you get the people walk by triggering it. So information about the system and being able to model it as a focus.

I'll spend a little bit more time here in talking about some of the major activities and design guides. While we have a major regulatory program, there needs to -- we need to prime the pump. We have been working with ASHRAE in developing some commercial building guidelines. We started working with them on what we call the 30 percent guidelines on how to design a building, commercial buildings and 30 percent better than what the ASHRAE standard called for. We worked not only

with ASHRAE but the American Institute of Architects, some of the other building organizations to put together these guidelines and made available through the ASHRAE process.

What we found is that having a partnership with working with multiple stakeholders who have a delivery mechanism in place rather than us taking the Kevin Costner view of The Field Of Dreams, "You build it and they'll come," 20, 30 years ago much of our work -- we completed the study, put it on the bookshelf, and it did not get into the marketplace.

So a key to our current activity is define those parties who are working with the professionals who have delivery mechanisms and taking advantage of those. So the 30 percent guidelines with ASHRAE we have completed. Now we're at the 50 percent level. And what we hope and expect that will be coming out of this is that as these guidelines get into the marketplace before any of the codes are updated, that the building professionals will be using this information before it is being

considered in the regulatory forum. In our most recent working with ASHRAE on the 90.1, that last 90.1 standard update, they adopted levels that were 30 percent better than the previous requirement.

So having the design guidelines play the key role in being able to get the changes in the ASHRAE standard. We're now working on the 50 percent guidelines, and our code activities are also working towards that 50 percent improvement level. That is one-half the amount of energy that will be required by the 2006 ASHRAE guidelines.

So we're taking that work, and that goes into our building code activities. All that also is going to be wrapped up into work which we are doing with the EPA on building energy labeling in order to provide the information on the energy use of the building as a system, to the homeowner of the building so they know what they are, in theory, purchasing because, again, going back to that valve isn't always put in correctly, the controlled system isn't always put in

correctly. So what actually is being used by the building, whether or not it's commercial or residential, isn't always what it is represented to be.

The building codes and the regulatory programs, we are finding that they're reducing energy, reducing greenhouse gas emissions, and that the consumers are seeing savings. There have been many -- a lot of pushback over the years about increasing in efficiency and how it's going to cost, and in many cases it does cost, but as the industry becomes familiar with it, as the research and our residential building systems research, we are looking at it as a system.

And so we are able to identify framing techniques that can reduce the cost of framing, accomplish more efficient shell, and at the same time with that more efficient shell, provide the builders information on about downsizing the furnace, eliminating -- going with a high-efficiency furnace, eliminating the chimney for that, and what we are finding for in the case of residential

building systems is if you treat it as a system at the 30 percent level, that you could actually construct a residential building that does not cost any more to construct than the baseline unit.

If you treat it, the design and the construction as a system, yes, the furnace is going to be more efficient. The furnace is going to be more expensive, but the insulation is going to be more expensive, but by properly framing it, you're using less lumber. A savings there. You're going to be eliminating other systems and be able to reduce the cost and still deliver the quality product to the consumer.

I'll quickly touch on our goals for the building code arena. I talked about 50 percent better, more efficient code. We're also working with states and localities to promote the code for adoption. So code adoption is state-by-state or a locality prerogative. It's not a federal mandate. So we're working with the states to encourage and facilitate the states to adopt the more recent

versions of the code. In some cases, it's home rule issues. It's the counties and cities who are adopting it. So we're working through the states to get to the counties.

Also, we're working with compliance. We're working through the states to provide some of the tools to help builders and designers on designing a structure that will comply with the code so that it does not become a barrier. The envelope is a system taking into account with much of our systems research the orientation of the building, the ease of where they come in, the envelope, the occupant, moisture and the like, and trying to treat it working with the individual component research, the envelope research, the windows research.

Some of the envelope research activities we have -- advanced roofing designs which gives the highly reflective roofs, the white roofs as well as highly reflective colored surfaces other than white. Highly insulating dynamic windows. We have a deployment program where we are working with volume -- establishing volume purchase program

for R10 -- excuse me -- R5 windows. Our research is focusing on R10 windows. R5 windows, double-pane windows are highly more efficient, are in the marketplace, but there isn't a coalition coalescing a demand around that.

So we are working on purchasing guidelines and trying to get with a number of parties together to focus on buying those in order to more rapidly introduce those products to the marketplace.

The dynamic windows is something we have been working on for about 20 years. It's questionable as whether or not that's something that will ever get into the marketplace with, whether or not will be ready for the marketplace, and through our roadmapping, trying to get some input from stakeholders about that technology.

Wall and basement retrofits. Highly insulated walls. Looking at ways not only to improve the efficiency of the walls, reduce moisture problems, and reduce costs. We have talked about some of the automation tools we're

looking at in order to improve further improvements on equipment as a system by not only having the more efficient equipment that Tony is working on, but to take the controls and integrate it to the system to further reduce the energy demand requirements.

Improved data use is something which we talked on the breakout session. It's been talked about a number of different levels. We need -- when we look regularly to improve the data that we have available to us in order to make our decisions about how to prioritize what the focus is on as far as the research areas, but it's also given the nature of the program, talking about the regulatory activities. It's very -- data is something that's a very key to our regulatory activities in order to analyze the cost and benefits of increased efficiency on the nation, on consumers.

So data is a major driver and a need for our program. We have also found that some of the work product, particularly the technical support documents for our applied standards program have ended up in academia, and that a

number of graduate students have approached us about how they've used our TSDs in some of their work. We're able through our engineer economic analysis on the water heaters to have collected a lot of substantial information.

The last thing we talked about on this slide is we touched on retro-commissioning. Some of these tools that we're working on developing, but also just to go to good business practices is to get the building owner, the building professionals out there on a regular basis to review and update the performance of the buildings.

Because I know that we have all seen cases where just looking at light fixtures where you have got your Edison A socket might have been designed to have a screw-in CFL to go into it, but over the years somebody has -- it's burned out. Somebody has replaced it with an incandescent. It might be a very simple way to say how a building might be designed and constructed, but over time it is modified by people whether or not it's the homeowner, the building maintenance staff, and how its

performance is two, three, years after it's been put into the market is different, and so the continuous commissioning, looking at the building, how it's being used and modified we find is the key in order to continue to maintain the energy performance of that building.

We've touched on some of this. The building commissioning, both designing the building, looking at the design, working with the builder as it's being built after the building is being completed, going and testing it to determine, verify that it's been installed, and then following up afterwards multiple times a year after it's been gone into the market to ensure it continues to operate.

Just a quick one as far as various -- some of the analysis being done, looking at buildings, where some of the opportunities are and what commissioning can look at, recommissioning. It's just looking at the ducts. How many times have you heard people where somebody has added, modified the layout of a building, modified the design of

the home, particularly the commercial building, and they have cut into a duct and put a trunk on it, and it just is not designed for that, and as a result, it throws the whole system off. It's done poorly. So you have got significant -- that's probably the largest region loss area.

But also some very simple things. Just the space controls, you know, not being used. Occupancy sensors might be there for lighting, but they're overridden. So the lights are left on 24/7. HVAC is left on when the building isn't being occupied.

So there are multiple opportunities. So recommissioning, we can focus on these and be able to retune the building. Asa was up here for about three minutes. So I touched on that. Thank you.

XXX: Let's switch gears to the industrial side.

XXX: I'm XXX. I'm XXX . What I'll do is I'll cover mostly the existing industrial

sector and the energy opportunities, and then I'll turn it over to my colleague, XXX. He'll cover the fun stuff. He'll cover the Next-Generation materials and manufacturing opportunities. So he gets all the fun stuff.

I'll use a couple more slides than his because it provides the context of the industrial landscape and the energy opportunities. I'll start with this one. The industry consumes about 30 percent about roughly one-third of the energy in the U.S. Industry sector improves the manufacturing which is a major share, plus like construction, agriculture, mining, fishing, that stuff.

U.S. manufacturing is essentially an economic engine of the nation and employs 12 million people, more than one half of U.S. exports, all the engines and airplane that we ship overseas, and we're still the big brother of manufacturing. It accounts for 20 percent of the global manufacturing output. This is the BC energy landscape of industrial sector. I'll walk you through quickly. Starting from the left side. The industrial sector, based on

the 2006, that's 32.5 quads of energy. Of that, that's the breakdown of the energy for the industrial sector. 39 percent petroleum. 31 percent natural gas. And 14 percent in electricity. That is what is being metered at the plant gate. So it includes generation and transmission loss of the electricity. That's another 7.5 quad there. So the total energy consumption by the industrial sector is 32.5 quad.

The next column, where they go to different industrial sectors. The lower ones are the big ones. Chemicals, 21 percent of the 32 quads. Petroleum, you'll find to be 27 percent, and then forest products, 11 percent. The top 16 percent is what we call non-manufacturing. That's the mining, construction, those things.

So of the 32.5 plus 25 quads go into the traditional manufacturing. Then the next column shows where and how energy is used. That 25 quads in manufacturing sector. Starting from the top. Feedstock, 28 percent. That's the feedstock like natural gas going

into different chemical products. So feedstock, that goes into the actual products. And then subtracting the 28 percent in the lower part shows like 29 percent of that 21 quad go into like fire heaters, furnace. 25 percent go into steam systems, boilers, paper heating. So that shows the major use points of the energy initial sector.

So the arrows. Feedstock, what we want to show is that could be some opportunities there to address the feedstock, alternative feedstock to reduce the column for energy requirements.

Of all the process energy used in the industrial sector, manufacturing process, roughly 30 to 60 percent, depending on quad process is basically lost, and only about 40 to 70 percent of that energy actual into the product. For example, if we need to heat up a steel slab to 2,300 degrees before we roll it down the strips for a car part, that, you know, requires roughly about .7 BTU for a ton of steel to get the temperature -- raise the temperature up so you can roll it. So that's

the 40 to 70 percent of -- that green arrow. That's where the energy is -- got to be there to make that product. So it just shows where energy is used in the industrial sector.

This is another way to look into how -- where energy goes within the industrial sector. This is the overall energy landscape of industrial sector. That box there, by the way, the X is the energy consumption in the box scale. Trillion BTU per year.

So that point about 1,000 trillion BTU per year, that's 1 quad of energy, 1 percent of U.S. energy consumption. So anything on the right side of 1,000 point, that's 1 percent and above of the U.S. energy consumption for the industrial sector.

The Y, X shows energy intensity, how much energy is used per product. So that little box on the upper right corner shows what is traditionally called energy-intensive industries, petroleum, chemicals, steel, and glass. So that's where the energy -- they produce the basic materials. The point is savings here can translate into reduced energy

of all the products. It reduces the energy used for steel, translating down all the way down the stream to what did you do with the steel.

We did a wider use of State-of-the-Art technologies and best energy management practice could drive energy and cost-savings. There are significant near-term opportunities that I'll just touch on. Industrial energy systems is like pumps, boilers, steam distribution systems, combined heat and power, and energy-intensive industrial processes or actual process that you mix stuff

This is another table. This is developed from our energy analysis for the several most energy-intensive industries; chemicals, petroleum, steel. The top row in industry average, that's the -- those numbers are BTU per dollar shipped for those industries. That's the industry average. That means that they are companies' plants that have numbers that are way above that line as just average, and they are companies at the State-of-the-Art plant. So it shows the bend,

and that number, percentage numbers shows the potential savings we can drive down based on what money can buy compared to the State-of-the-Art to the industry average. That doesn't mean that they all cost-effective. It just shows that if people are willing to spend money to get the most efficient plan, the most efficient technology, that's the potential savings, State-of-the-Art level

So what is R&D, the role of R&D in terms of driving this industry -- industrial efficiency is it can bring down the cost so that there's broader implementation of the most energy-efficient technology. R&D can also drive down the State-of-the-Art line that we can push that State-of-the-Art level to more and more efficient, to lower that level.

And practical minimum shows that with the current technology, current facilities, that's how much that's the potential savings that we can drive down to from R&D and drive down to the level. Theoretical minimum is just a theoretical ideal production based on the thermal dynamic and

chemistry limit. That's the absolute minimum for energy required for those products

So what this is showing is it shows the boundaries of -- with the best practice with reducing the cost, how far we can improve in the current energy-intensive process; with R&D, how far we can drive down to the practical minimum based on the current production scheme. And that lowest record there is from new science, and we can develop some game-changing technologies.

For example, you seen different feedstock, different materials to produce the same thing of different things. That could actually get into that bracket to really game-changing way to make new products. So it just shows some potential boundaries of how far we get in production for energy-efficiency

This one I won't get into too much, but it just shows the landscape of like where energy is used by this energy-intensive industries and by what equipment, steam process, heating, and machine drive systems. So those are the three major ones. Combined

heat and power. Some people feel combined heat and power is a very mature technology, and some people feel we are still in the early growing curve of -- not the curve -- depends on what application, what technology we use.

Oak Ridge National Lab published this report in December 2008. What they get into was -- would examine the 20 percent CHP scenario. What are the different tools and market implication and the benefits. Under 20 percent CHP scenario for U.S.-generating capacity by 2030.

So that report is looking into what are the technology needs, what are the policy needs. Basically it's not saying that we can reach it, but it shows the potential and what it is to get us there to 20 percent scenario. Basically it takes the whole village to get us there, requires from technology investment, the market into what do you put in major investment to get there. But the bottom line is 20 percent compared to the current 9 percent CHP. That's a huge benefit to the nation. And that little box on the lower left side shows the

potential -- the impact, what does it mean by 20 percent. Major energy savings by quad per year savings.

The lower right chart is showing the growth curve. In 2007, that is 85 -- that was 85 megawatt. That is 9 percent CHP in the U.S. based on straight line projection, that's business as usual, lower one. That is a straight line projection. That's roughly about 13, 14 percent.

McKenzie look at the CHP potential. They feel that we can get up to that, probably 15 percent, 160 gigawatt level. The whole Oak Ridge analysis, given the right investment, technology, policy, and the market investments. All those tools pulled together, can we bend the market penetration curve and bring it up to 20 percent by 2030.

Would he pursue the CHP opportunities, the different barriers, regulatory market, and technology means? So I won't get into that. Energy intensive process opportunities. To address the major opportunities to save energy that shows -- we

can get away from these four areas.

Reaction and separation. That's where all those manufacturing processes, chemical industries on how to separate things and add things. That's essentially reaction and separation. Major energy-savings opportunities.

High-temperature process. A lot of the industrial processes require high-temperature process like melting glass, melting steel. You have to raise it into -- form and shape it. Waste heat recovery, enormous energy loss there. So there's a lot of potential waste heat recovery opportunities.

SMART and sustainable manufacturing. SMART is basically how can we utilize all the information, communication technologies, process automation technologies to make things smarter and more efficient. Sustainable manufacturing. How can we -- we move energy for print in the product. How can we reduce the steps in the final products. So these are the major areas.

In 2007, October 2007 we had a study

that was led by Batelle Institute, pulled together several national labs in the industry and the community basically to examine these opportunities within the industrial sectors. One of the potential big savings there, and that's what they analyzed on, in these four areas.

Our strategy for technology deployment, what we have been focusing on is to drive the corporate culture. That's where we think that is required, and that's to start at the top of the wall to drive the corporate culture, how energy is measured, provide a lot of tools, training, and resources to support the manufacturers.

We also put together some pledge and recognition programs to increase the winners and commitment from corporate wall because sometimes the recognition programs can reach to the top management within the company because these things don't require a lot of money, but you are getting a lot of quality from them. So we have a number of pledge and recognition programs to challenge corporate officers to

make a commitment for the company to set targets to save energy.

We are starting a new program that's called superior energy performance. It's a certification program that would help to set a standard, and they can make that goal to reach -- and it's continuous goal-setting for the corporate wall for energy-efficiency. That was discussed about the training of the energy workforce of industrial assessment centers.

We are also working with the state. We have something called action network -- state efficiency -- state energy-efficiency action network, action network. State utilities, associations, and other federal agencies such as Department of Labor, EPA to provide analytical tools and reach out to the industry. What states drive energy- efficiencies in the planned level. So that's all I have, and then we'll have XXX to come up to talk about some of the Next-Generation manufacturing process opportunities.

XXX: Thank you, XXX. My name is XXX, and I support the

Department of Energy - QTR

XXX

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This presentation transitions directly from XXX's presentation. And the way XXX presented the industrial space is a somewhat traditional approach for DOE to look at and do analysis and understand the opportunity space for the specific industrial sub-sectors.

DOE and the industrial technologies program has been starting to look at a more wholistic and integrated approach to understand the full opportunity space, and in particular, looking at Next-Generation materials and Next-Generation processes.

So the traditional approach of looking at energy-intensive industries makes a lot of sense. There's large chunks -- as Isaac showed in some of the data, there's large chunks of energy that are concentrated in certain parts of the industrial sector. But we can also begin -- because we're dealing with a system-of-systems, we can miss some of the

opportunities, and we're trying to address all the levers to improve our industrial manufacturing space. That includes energy-intensity, carbon-intensity, and even pushing into things like use-intensity, and by that, we mean, how can we achieve the same or better results or utility for materials and products by either new materials, Next-Generation materials, and new processes and ways to make those materials.

So the approach looking forward, and what I want to emphasize is that in some ways this is a very exemplar approach, and we're looking for feedback with respect to some of the things that we're proposing today, and what we're -- from sort of a vision perspective, this Next-Generation industry could consider the innovation of new materials that not only, you know, provide lower energy use, lower carbon footprints, but new applications, new utility. Novel manufacturing methods to produce these materials is going to be required. If we're developing Next-Generation materials, we want to concurrently develop Next-

Generation processes that are as efficient as possible. So we don't have to start from ground zero and continue to develop new methods of manufacture over time. We're trying to develop the best materials and the best ways to make them now.

The goal is, of course, to ultimately revitalize the manufacturing sector. Developing rapid manufacturing processes continuously drive innovation, reduce the product life, development of lifecycle.

Some of the goals from this ultimately reducing primary energy usage and ultimately driving lower carbon and energy -- embodied energy in products. Some of the framing by which DOE and ITP has been looking at the material space comes from some studies that have been performed by TMS, The Minerals, Metals & Materials Society that convened a panel of experts. And the output of some of those workshops include a number of thematic areas, themes that TMS has identified as potentially high impact with respect to energy and carbon. These include functional service

materials, things like catalysts, coatings, enhanced surfaces, things like super-hydrophobic coatings, for example, high-performance coatings for stream environments, ways of driving to high-temperature alloys, electric materials, very lightweight and high-strength materials

Materials integration in clean energy systems. So things like low-cost carbon fibers, joining technologies, fuel cell catalysts, low-cost battery cathodes, and an area that was originally defined as sustainable manufacturing and is being discussed now as sort of the new paradigm materials manufacturing process, things like near-shape processing of structural materials and low-cost composites.

So some examples of specific Next-Generation materials opportunities, again, looking at things like cost, energy, reduction in pollution, improved product quality performance. So some of these potential areas include things like low-cost titanium, how to improve the performance and the life in energy-

intensive applications. So you can imagine things like in heat exchangers, heat transfer materials to improve process heating technologies and power generation and other applications. Of course, traditional applications in aircraft, geothermal applications, and with low-cost production and forming and fabricating of titanium, pushing into even areas like automotive applications.

So things like lightweight metallic materials, magnesiums, aluminums, and a number of structural applications and vehicles, they are already underway, but to fully utilize these materials, the Next-Generation process is driving towards very low-cost methods for production are required.

In addition, things like SMART coatings and thin films, electrochemicals for functional surfaces, and ultimately getting to things like very inexpensive and high-performance lightweight materials like carbon fibers have not only applications in clean energy technologies but light-weighting of vehicles. This approach, sort of systems-of-

system approach has benefits throughout the supply chain and ultimately to the use phase.

You can imagine highly light-weighted Vehicles being able to be a key factor in driving up the energy-efficiency in the transportation sector. But to be able to achieve that with minimum impacts on the embodied energy is going to require very robust manufacturing and processes not only to produce the carbon fibers, perhaps, from renewable sources, but to form and fabricate these into composites and deploy them in a cost-effective manner.

Here is one example. Graphic from some work recently been done by Oak Ridge National Labs looking at the potential -- this is a Bottoms-Up engineering analysis looking at the potential application of carbon fiber in a number of industries.

And so traditional applications in aerospace, there is a modest but continuing growth. Other industrial applications are large, but in things like wind generation, they see very large potential. Automotive parts,

things like hydrogen storage tanks, for example, a significant use of these types of materials.

We'll focus on -- make a comment about we were talking earlier today about the Penn State buildings innovation. Assuming funding going forward comes through, there is a proposed energy innovation Hub on critical materials as an example.

And the focus on this Hub would bring together the expertise of scientists to reduce the reliance with respect to clean energy technologies on these things like critical materials, rare earth materials that are either rare or difficult to acquire, expensive and often -- currently at least mined outside of the United States.

And the approach from a strategic perspective is the reduction of materials. So ways of reducing the use of those materials in existing components, material substitutes. That is new materials and compositions and approaches that would replace those critical materials, recycling technologies that lower

the cost of separations of critical elements from the recycle stream. So design for reuse and recycling technologies that would enable greater utility and reuse of these materials.

So I'll just kind of touch on a couple of Next-Generation manufacturing opportunities. And, again, thinking about the systems and the systems-of-systems approach, looking at new production systems, for example, innovative bioprocessing systems.

The goal here is to reduce fossil-based feedstocks of chemicals and materials. We know on the one hand that driving efficiency as Isaac showed in some of the studies is very, very important to reducing energy use in the near-term as rapidly as possible. But to achieve our really longer-term objectives over the next 20 to 30 years, it's going to be important to see somewhat of a substantial shift from petrochemical-based feedstocks, for example, to bio-based feedstocks.

Things like advanced forming and fabrication technology, by driving towards absolute minimum use of materials in near

Net-Shape processing we can significantly reduce the amount of energy that's utilized to form a product.

So if we end up in a situation making titanium parts, for example, for aircraft, and we both form them and machine them down and have to machine away 90 percent of the massive part, that's a very inefficient way of doing that, making these parts. So by being able to produce in near final form with materials -- minimal materials use is a critical approach.

Things like nonthermal-based chemical conversion processes, as Isaac showed, there's a significant amount of our industrial energy use that goes to thermal processing approaches. And moving towards producing products by nonthermal-based chemical conversions can significantly reduce that energy.

XXX mentioned high-performance separations. There's a significant amount of energy used there and savings across a wide variety of sectors from chemicals, papers,

fuels production, et cetera.

A number of other areas. I'll just mention them briefly. Nanoscale manufacturing and processing. Single minimal-stage conversion pathways. Again, reducing energy to finish parts compared with today's State-of-the-Art. And I think there's an important aspect of thinking about the energy Danwood studies and pushing towards practical minimum levels of energy.

If we can really produce something that's game-changing and a different material that replaces that existing material, we can essentially begin to break beyond those practical and theoretical thermodynamic limits because we're beginning to shift towards something needing substantially lower energy required to get there.

So this approach is to -- is a really, you know, not only unique approach with respect to changing the materials that we use and the way we make those materials. Ultimately things like SMART manufacturing system are being driven in some aspects, in

some sectors of the manufacturing system today, but with the increasing availability of low-cost sensors, wireless sensors systems, et cetera, we can optimize all the way throughout the value chain, everything from process control technology to RFID tags through tracking through the supply chain. I think we'll wrap it up with that.

XXX: So we will now spend about an hour or so, maybe until 3:15 or so in breakouts, again, back in the back of the room. Roughly speaking, we have designed these basically to breakout along the lines of the four presentations you have just seen. Roughly speaking, I think the distribution of folks in the crowd is such that we should be able to get a reasonably even numbers of people at the different tables. It's not a popularity contest.

So roughly speaking, these topics correspond to the four presentations we just saw. Let's do the same table numbering as we did before. Again, ignore the number on your name tag now. Go to whichever one matches your

interest and expertise that you would like to share with us.

XXX: Is it possible to ask one or two questions of the speakers before we breakout just real quick?

XXX: Really fast.

XXX: One thing that DOE used to talk a lot about in this context, it seems to me 10 years or so ago was tribology and the whole issue of energy conservation through better vorticity, if you will, throughout the whole manufacturing processes and the like. And I don't hear anybody talking about it anymore. But the numbers were huge at one time, the tribologist claimed. Does anybody know what happened to those --

XXX: XXX, XXX. Actually numbers are still remaining huge, and also, it's not only friction. I mean, I talk a lot to transportation area. It's not only energy savings by reduction of friction, but also enabling some unique designs. So the materials, we can enable unique designs. In

fuel injections, for example, you look at the engines. They work with temperatures are increasing. Look at the fuel injectors. Pressures are going high. And on the -- at the same time I look at the lubricants, the additives are not good for the environment.

So there's a demand for, you know, pressures to reduce those additives. Those additives, the material liability becomes an issue. So, you know, we are still working on it, but it is very difficult to penetrate that industry. That's another challenge. You may have a very, you know, magical product, but as long as it is -- I mean, it is depended by the consumers, the industry will not implement those technologies.

XXX: You talk about (inaudible).

THE COURT REPORTER: I'm sorry. I can't hear you.

XXX: Well, I mean, there are several technologies related to low friction, but as I said, it is difficult to penetrate in the automatist industry because

there are price concerns, and there are -- this is a huge mass market. So the companies concern about the recalls also.

So as long as they don't have any problem right now, they will not implement in technology. So there should be a push from the consumers to end-users which is us to then to get high-efficient automatists.

XXX: In the interest of time, can we -- happy to have folks corner the speakers as we transition into the breakouts, but, perhaps, if you have particular interest that you might well just fit into the breakouts with the speakers and work with them there. So we'll try to breakout for about an hour, and then we'll have a little break after that.

(At this juncture, breakout sessions took place.)

(Short recess taken.)

XXX: I'm going to start with a short report-back of the compliances and equipment breakout session. Given all the wonderful conversations we have

been having, we're now dramatically behind schedule. But that's good because the point of this thing is to hear from everybody. So we're going to try to do these report-backs as quickly as possible so that we can get back to good conversation with the rest of you.

So I participated in the compliances and equipment breakout session based on XXX's presentation. I'm just going to hit a couple of quick key points and pass the mic, and we'll go on from there.

One of the main real things that came through is the importance of roadmaps, milestones, and setting targets, and a good bit about the process for these for roadmap creation differences between sort of roadmaps for really sort of not-in-kind technologies and step-function technologies and how that's different with different levels of manufacturer interests and input on those types of transformative technologies versus incremental improvements in existing technologies, but a real emphasis heard from various individuals around the table on the importance of those

roadmaps and really setting out targets of having something for the programs to work towards.

Because this is the area where there's this real deregulatory hammer with compliance standards, we had a really interesting conversation around how that affects the dynamic with the industry and also what are the various drivers for innovation and how much of it is DOE and R&D, how much of it is competition between different folks trying to push the limits on what's possible and get the marketing edge for those, and how much of it is the standards program.

And then also some good discussion on the importance of reliability and lifetime and how that plays into the economics of consumer payback and really being able to be sure that if you're promising someone payback in five years, and then it's going to make money after that if the product dies in six, you didn't really deliver. So the importance of those kinds of metrics in addition to shear energy performance out of the box.

With that, I will let XXX go for the manufacturing side.

XXX: So I was in group 4 which was manufacturing materials R&D which ended up being less about Next-Generation materials and more about -- more finding cross-cutting technologies for existing material industries. And one thing that seemed to be common was instead of looking at, you know, big-step changes in the Next-Generation materials, for these industries, we can look at things in terms of the processes that are common to all the industries.

So finding new ways for furnace efficiency and finding big problems with getting new furnaces or capturing waste heat as it is capital intensive, and the payback time is a major barrier there. Another cross-cutting thing for existing materials is recycling. We talked a lot about recycling of materials. For example, one kilogram aluminum from ore, it takes about 13 to 14 kilowatt hours to process, and it's about one-and-a-half if you recycle materials. So it's about a

tenfold energy-intensity difference. And so figuring out better ways to kind of collect and identify and sort materials for recycling seemed to be a cross-cutting approach and could have a big impact for DOE.

And there's another issue that identified with the cost of catalyst and oil catalysts and how that's a big challenge both for existing industries and will be for processing of biomaterials in the future. And it was also identified that we need to have better tools to optimize processes, more mathematical modeling.

And on the kind of modeling side, we also -- or I heard that lifecycle analysis and kind of understanding how any new vague technology breakthrough would ripple through the economy needs to be better understood, and for those reasons, it's hard to identify the head route for any of these big-step change in technology for the materials side. And with that quick little update, I don't know who is going third.

XXX: So this is a very

rapid report on the building of systems discussion. And, you know, well-known to all of you, commonly said, buildings are 40 percent of energy use. I concluded that they are much less well understood than, say, transport systems which are 30 percent of energy use.

The modeling tools are not what they need to be. They're not validated. There's still a great uncertainty about whether we should be doing data-driven modeling or lump-system modeling for detail, physical modeling. All in all, it struck me as a rather primitive state-of-affairs and something we need to do much better on.

There was some discussion about who the users are, and in the end, the ultimate users are either the consumers or the design folks and the need to make the tools friendly enough to do that. Some discussion of should it be open-source or proprietary, and there was a reference to Aspen as, perhaps, one way of the ways going about things. Again, more admiring the problem than solutions. Most buildings are prototypes, and they tend to be

custom-built, put together by a series of different experts with no integration between HVAC, et cetera. What else?

Contrast that with vehicles, for example, were designed to a tightly integrated design of all the different systems, and then you go out and build a couple million of them. There was some discussion of control and sensor systems. The man on the target issue was raised where the lights go out in the restroom because the motion sensors have not detected anything for a while. How do we fix problems of that sort as we try to automate buildings.

Someone mentioned the big box source was starting to grow out retrofit solutions so that there are, perhaps, some learnings there. As to what the DOE can do, one is modeling data collection. There's some opportunistic data collection going on, but serious controlled experiments or large scale assembly of data on energy use with the design and the behavior and so on. It sounds like something one really needs to do. And then finally, to articulate as it says here in the notes, the sexiness of

building systems design. Most people around the table, of course, are experts in it, but there was a sense that as you go out and talk to other people in science and technology, there is a realization that this is an actually pretty interesting problem from both an academic perspective and a real-world impact, and just getting more people trained would be a very good thing to Hub. With that, I think that's what I heard. No consensus is what I heard. Mike, you're the last.

XXX: So I'll do the technology deployment and market activities breakout group. First, let's see -- given the competing demands on capital, industrial-efficiency opportunities needs to have a much clearer value proposition, value propositions that yell at you, so to speak, merely being technically better isn't enough.

There were observations that DOE isn't necessarily good at engaging at the level of the corporate decision-makers who may be more concerned with the risk incurred as they are with the return on investment that the

program -- or the Department may be better at engaging with the engineering level in the firm.

The Department wasn't necessarily seen as being proactive in its communications and outreach as to the opportunities and what that value proposition was. There was a sense that we developed something, we write it up, we post it, and then we move on.

We had a lot of discussion on combined heat and power. We were seen as not necessarily having a consistency of approach, that some of the hurdles to implementation may be as much political as technical, and that in some cases, that the technical data through the technical capability of the technology was less important than in convincing firms of the breadth of the applicability.

When discussing how to think about or how to evaluate the program and our activities, the standard that we should be striving towards is evaluating our programs on the basis of whether the technologies are implemented rather than merely developed or

whether they can achieve a cost or a savings, a BTU savings target. So much more diffusion, adoption-oriented measure of success.

And then regardless of what we were doing in the program, there was a hope that the Department doesn't lose its focus or appreciation for a domestic manufacturing base. So that was the summary of the technical breakout.

And then I took all of the comments from the morning's cross-cutting discussion, and so these are sort of everybody's morning breakout session sort of interwoven. And so some of the commentary that we had there, I think we -- there was a point made that we need to create -- we need to spend as much time thinking about how to create a culture of energy-efficiency as we do about the technologies surrounding that in the sense of drawing an analogy to public health issues like smoking or something like that. So trying to align our messaging, our policy, our technology, and that it's not just relying on the self-evident superiority of the technology.

The Department needs greater integration of technology and policy, and there was some discussion in various groups of the need for greater investment in policy studies as opposed to just technology development or deployment activities, that we really need to put some resources behind that.

The Department also needs to think about greater integration of disparate technologies into systems. So some of that is looking at opportunities for retrofit as well as building new. Given the residential, commercial, and industrial infrastructure, DOE thinks too much sort of inside each of those separate buildings rather than the communications or the interactions between the buildings.

One of the examples was, I guess, heat, where you can use industrial process heat to heat homes, that -- and again, we also think of -- or don't put a lot of effort into the policy hurdles associated with implementing a solution like that. We need to think about greater integration of technology into these

real-world situations and understanding how a technology performs in that system's context.

One of the things that came up was the potential for DOE as an integrator or convener of industry academia, non-profits, other agencies, and that we should play a more significant role in convening discussions of the DOE role also. Continued with saying that we should prove out cost-effectiveness of various technologies, that we should try to connect that cost-effectiveness to labeling programs like Energy Star and try to provide some sort of incentives, either purely informational or try to incentivize customers in making energy-efficient choices, and then back-step that with regulation.

As happened in all the other previous workshops, we got the polar-opposite views. Some said we should work on breakthroughs rather than incremental technologies, and then we also had the opposite comment, that we should work on incremental technologies rather than breakthroughs. There was a comment that systems engineering, system

approaches needed to be implemented more broadly.

We were seen as under-utilizing our bully pulpit in this role of convening industry, presenting energy-efficiency propositions, and persuading firms to arise at the challenge of making those investments. And some of those are things that already have positive cost-benefit ratios already.

In terms of how we ought to think of the mode we operate in or whatever, with respect to market pool, the consensus -- or the opinion was that, you know, they are well-identified, well-known creators of market pool high-energy prices, regulation standards, that kind of thing.

Another market pool would be the provision of new services, either additional control opportunities, choices that would be enabled by information technology. Then there was -- I guess people observed that we should try to think whether there's some middle ground between this technology push model or technology push mode and that regulatory

posture where we could try to create new opportunities for changing things.

As to the time scales of our portfolios in this arena, obviously the issue of balance comes up, but even though we do have -- there's, I guess, a need for short-term deliverables. The observation was that the Department -- the government can look at longer time frames than most private sectors.

One time scale came up for how we should prioritize or manage the portfolio was sort of two or more iterations of the product cycle of the technology ahead of the current practice that was offered as one of the three-part tests for entry into the portfolio. That is that a technology should be on the critical path to a policy goal. It should be two or more iterations of a technology ahead of the current practice. Some people put that in sort of the 5-to-10-year period, and then consideration of class equity in the sense that either small -- there would be a technology that would be an opportunity for a small, medium-sized business, but they may not have

the deep pockets to make that adoption easy or that the economically disadvantaged households might be able to adopt technologies, but then they have to think about how we enable their adoption of those technologies.

A couple of notes on choosing the two or so cycles out would allow industry then to optimally position itself for the common product cycles, and the time that horizon -- sort of the technology with the widget-based time horizon, and that our system's view ought to be several technologies further ahead of that. So a 15-year look or more for the system's view.

Comments on data. The Department has a role in a collection of accurate impartial data and making sure that the use of that data is done. There was an observation that the Department is the only institution that it could aggregate information from competing industrial players. So we should think of ways to do that usefully, that industry and the Department should think about what kind of information consumers want and

need given that some -- that IT is becoming an area or sensors are becoming cheaper and more pervasive, that we will soon be a washing data, and the Department should be looking ahead and trying to figure out how to best use that to accomplish energy-efficiency outcomes.

Some of the metrics that were proposed for looking at our portfolios. Cost analysis is expensive and inaccurate. So cost predictions shouldn't necessarily be a metrics to what their Department uses. Obviously we hear the conflicting viewpoint that you can't make decisions without knowledge of cost.

One of the other metrics that was proposed was energy optimization rather than price. Workforce discussions were a significant part of some of the morning breakout sessions. So the Department's role in workforce development should be focused on curriculum development, best practices, distribution, that we should not have as active a role in training, in the actual training, leave that to partners. That the Department may want to engage the Department of Labor in

job definition tasks to make the energy content or the connection to the energy challenge more clear.

In the information technology human interface arena, there were comments that human factors and consumer behavior should receive more attention from the Department. There was an observation about some of our technology push failures. Equest and EnergyPlus got stuck in huge markets, and DOE is now working on user interfaces to facilitate more development.

There was a comment on sort of the fashion and favored mechanisms among the departmental period where maybe entering a phase where Hubs are seen as the solution, and I don't know if people had a very strong opinion whether that was good or bad.

And then international competitiveness, we have a lot more to learn from international collaboration. So we should lean towards international cooperation. And then the Department working on technologies that meat environmental goals but that have no clear domestic market should be prioritized

lower than those that will be deployed both domestically and internationally.

So with that, I will -- but those are sort of the broad comments from the cross-cutting group. I'll turn it over to XXX.

XXX: So our intention in this last session is to have some free-flowing wrap-up on anything you may have heard today. We will finish no later than 4:45 since there's a shuttle that goes to the airport at 5:00 that I know some people are trying to catch. So the floor is open. As usual, I'm prepared to provoke, if nobody does. Yes, XXX.

XXX: What's the next step?

XXX: So what's the next step is the question?

XXX: Yes.

XXX: As part of the process of generating a document, we will be working with the technology assessment teams to produce a section for the QTR. The feedback input from this discussion today are certainly

an important part of modulating that.

Exactly what we will do with that section beyond circulating it within the Department remains to be seen. Frankly, again, compared to the defense situation, energy is intrinsically everywhere in society, and figuring out how we involve everybody in the final thing that gets written is something that we're still kind of making up right now.

My suspicion is it gets circulated broadly within the Department. We will have the capstone session which this will be a piece of that in July. But beyond that, I don't know exactly what -- we're making it up right now. If you have suggestions, that would be great.

XXX: Will it be integrated with the other --

XXX: Of course. Of course. I mean, the final report will have 14 probably appendices and then summaries somewhere in the text that have all of this built into it.

XXX: What would be the national (inaudible) physical situation impact

to this project?

XXX: Sir, I --

XXX: Given to me for the certain situations with the national data and other things, how much impact that physical environment could have impacts upon that?

XXX: Our oversight committee are the folks who live in the big white building with the dome on it, and I think we're very much affected by anything that goes on there, at least in terms of the funds we have available, and to some extent, in terms of the character of the programs that we do.

I'm going into -- I have gone into this exercise, the QTR figuring that at least from a techno-economic point-of-view, let us put down what seems to be rational defendable energy research program, which those six strategies and so on, which anyone can look at and say, yeah, I can see how you got there. What happens with that beyond the rational technical economic analysis in the protocol sphere, I don't know. But unless somebody writes down what should be, that's not going to

have much impact on what will be. So we're going to try. Again, it will depend on put it on dynamics over the next year. Do we do a QER. What happens in the 2012 election, et cetera, et cetera.

But let's at least try to put that in one place, what we think we should be doing as technical folks, and then we'll go from there. Nobody has ever -- as near as I can tell, have done that before.

All right. Let me try to provoke a little bit. I want to bring back the level discussion. XXX who was mentioned this morning briefly. I guess I did. And made the following anecdotal story and then a bigger point. We are in a different part of the Department trying very hard to accelerate the Next-Generation of computer systems and to go from the current class to the 15th FLOPS to an Exaflop class, 10 and 18 FLOPS. So factor of 1,000, we think it could be done in about a decade, and we have money, 126 million dollars in the FY12 request in order to get this started.

To go another factor of 1,000 is really a very complicated systems issue. You will have -- order 100 million processors working. You will have memory that needs communicated with the processors very rapidly, what happens when a processor glitches, and so on, so forth, plus the operating system programming models. We've got a program that we've -- that starts to get to it.

But one of the other big issues is power consumption. And if you took today's biggest machines are running at 7 megawatts or so -- Jaguar at Oak Ridge is about 7 megawatts. And if you took that machine and scaled it to Exaflop class, you're looking at a good fraction of a gigawatt, no more than half of a gigawatt. So that's clearly impractical, we're not going to do that.

And so one of the big pushes in the technology development program is to reduce the power consumption of computing per FLOP. People who don't understand the business say, oh, we're going to make computing green and use less energy. And, of course, that's absolutely

not the case. If we succeed in cracking the power problem, and we think we can, then we're just going to use more power in total because we're going to build a number of these systems, and you'll be able to put out more systems of a lesser class than you've got now.

So that's a good example of more or less direct rebound effect. Then you've got issues with a broader level, now not in computing, but nationally, if you look nationally, we talk about energy-efficiency, if you part energy use as a function of GDP, energy use per capita. I'm sorry. I don't have that chart, but that's the one I use often when I talk about energy.

As near as I can tell, there are no negative slopes on that chart. Everybody -- nobody has used less energy as they have gotten richer. And, yes, individual energy technologies have certainly gotten more efficient, but somehow there seems to be -- I won't say insatiable because as you get richer as we are, at least a constant use of energy.

And so for some things, of course,

energy-efficiency, absolutely important, get the most out of every jewel, but some of our problems like greenhouse gases depend on the absolute amount of energy you use. So it's not obvious to me that efficiency is all that it's cracked up to be in dealing with that particular problem. Comments.

XXX: Well, you're right obviously. I mean, absolute energy is a critical ultimate first order of issue, and efficiency is the second order of issue by comparison, but it does allow you if you can get energy efficiencies in one part of the economy to slow the ropes of that absolute, and to shift energy from one sector into another, and that can be advantageous.

But I think absolutely energy-efficiency problem is a huge one, and particularly, in computing. I mean, I jokingly said to you this morning that we need a better way to push electrons around. It's just too expensive. There's just much drag in all these models and semiconductors and stuff, you know, but --

XXX: Keep everything cold. Keep it cold.

XXX: Keep it cold. But it costs money. Put it in Antarctica or something like that. Something originally where you take advantage of where it's already born.

XXX: I think we have two examples where new energy services have come on line and are driving increased use. The air-conditioning chart somebody showed this afternoon. Right? I mean, suddenly it became economic to deploy air-conditioning, and you saw an increase in energy use as a result of it. Right?

And then I think the second probably to a lesser extent is the personal electronics or all of the electronic gizmos we have now. Again, a new service that you didn't have before driving increased energy use for that reason.

XXX: And other

efficiencies, air-conditioning is a new value-deliberated function, but if you --

XXX: Right. It's not an efficiency.

XXX: Maybe you can go back and look at the first building design in 1982 on energy-efficiency for years outlook. When we look at it (inaudible).

THE COURT REPORTER: I'm sorry. I can't hear. I'm trying to make a record.

XXX: Both of these cases are areas where you have new types of technologies coming in that deliver values. They are not energy-efficiency. They're innovation. Right? So when they talk about innovation as a policy, you know, this whole energy thing is not really entering -- we're talking about energy-efficiency. It's like in rebound, it takes away the benefits even more so. It doesn't really apply.

XXX: Good. Anybody else on anything else?

XXX: I'd just like to

say thank you. As Hub director, this was really helpful to me, listening to everyone kind of trying to converge on what's the optimum of what Hub should be, to be honest with you, and it continues to sort of iterate to get to where we want to go, and today helped a lot, I think, and it confirmed and reconfirmed some of the things we're doing because I heard you saying things that sound a lot like what we're doing.

But it also scared me how many times I would say, yeah, we're going to do that knowing what the budget is and so forth. I would just like to say thank you. And if we could get any of you more information about the Hub in Philadelphia, please let us know. You've got our card, our contact information. We have the Hub's website, and we'd love to host you there as well and show you around. Thank you.

XXX: Good thought. Of course, my thanks to all of you. This is, I believe, a very important exercise. I'm devoting a good fraction of my time to it.

It's been for me personally really interesting, not only at this workshop, but the several others we have held as well to really get this kind of synoptic view of what's going on in energy and all the problems we have got. Again, many technical opportunities, but also a confirmation, particularly here that many of the barriers are in the policy and economic arena rather than in developing widgets, and also, here I think the system's message has come through loud and clear.

So, you know, you all know how to reach us by E-mail or phone. We look forward to any further comments you might have, and we're, again, figuring out how to engage you all further as we go through the rest of this exercise. So thanks. Travel well.

(At this juncture, the meeting was in recess at 4:35 p.m.)

C E R T I F I C A T E

I hereby certify that the proceedings and evidence are contained fully and accurately to the best of my ability in the stenographic notes taken by me on the meeting of the within cause and that this is a correct transcript of the same.

S/Tricia M. Clegg