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Opening Plenary Session

Energy Secretary Steven Chu

Steven: Thank you, Richard, and congratulations to Duke, although I have to confess I was rooting for the underdog. Anyway, it's a great pleasure to be here today to talk about something I care deeply about. And the message, the take-home message, is the United States has an incredible opportunity before it. We will need a new industrial revolution, that is to say, a revolution that gives us the energy we like, the energy that creates prosperity but in a different way, and in order to do this, if we do this, and if we take to lead in this, it will ensure American competitors not only in the coming few years but in the coming decades. We also want to decrease our dependency on foreign oil and mitigate a climate change.

Let me say a few words about the EIA. As Richard said, its most important function is to create impartial, thorough, fair data that can be trusted and analysis that can be trusted. But the EIA is growing in its scope. It has begun to take data on, for example, energy demand. It used to be solely focused, for example, on the production of oil and gas in the early days. But it's going through tripling in size because of residential energy demand surveys.

And as we move towards energy efficiency in homes and buildings, we need this data to show how cost effective it would be and will be. It's also keeping up with changes in energy, in particular in the shale gas and smart grid alternative energy sources and technologies. And finally, it's looking at this constant, very complex view of what actually shapes our energy and prices. But again it's founded on hard data.

Now, in the near term, President Obama, with the help of Congress, has passed the Recovery Act. It's an $80-billion down payment on a clear energy economy. It was intended not only to immediately create jobs, but it was to invest in an energy infrastructure that would build for the future.

The Recovery Act is working. I think most economists now see hard data again. In the first quarter of 2009, we were losing an average of over 750,000 jobs per month. The last quarter was very encouraging, and the average, well, the last month was a high of 190,000 jobs that month, by over...the average over...is the full quarter of 54,000 jobs per month. There's a long way to go. The unemployment rate is still 9.7%. And as the President has said, this is just the beginning. It's just beginning to turn over. We still have much work ahead of us, but the first signs are encouraging.

The momentum of the Recovery Act has to be continued. And we, in particular, have to assume that global leadership in a clean energy economy. So, let me tell you something about what the Department of Energy is doing with regard to that. As in the previous years, we've been passing appliance standards. The rate has been fairly slow, 30 per year. We have been consistently falling behind on the *[inaudible]* for these standards, but when President Obama took the office, he said we want to increase this rate to double it. 30 a year, we are on pace for that, and our current plans are to keep on that pace.

Energy efficiency standards are very necessary because quite often the consumer doesn't really have a choice on things to buy. For example, when you buy a laptop computer, you don't really have a choice that the little power converter that you plug into the wall, the AC converter, is energy efficient, and there's no price signal that will ever tell you to make it energy efficient. So, efficiency standards are very important.

Homes. You can build a home now that uses three or four times less energy than homes built, for example, in the 50s and 60s. Again, the consumer doesn't really have a choice. It's the standard in the state, in the local area, that determines this. The

McKinsey report said, a thousand dollars invested when you build a new home in materials and labor, and it's mostly labor, and added insulation will pay for itself in one to two years. So, it's not even a question of do you pay a lot more for a warmer home, a cooler home in December, a warmer home in the winter? It will pay for itself in such a short period of time. It should be a no brainer, and yet we don't do this.

So what we're trying to do, we have 130 million homes in the United States. Perhaps, 70, 80 million homes could use an energy facelift, if you will. And what we're trying to do is we're trying to start programs. There's a $400-million initiative to fund building retrofit programs that reach whole neighborhoods. And the way this works is the following. People en bloc get together. And they say, well, if some of us are going and take this contractor and use this contractor to give us home energy audits and tighten the seals and duct work in our home, improve our insulation; we can get a huge quantity discount.

So, we're working with the people who might supply these services either large or small — Home Depot, Lowes, True Value syndicates — people like that, and try to get neighborhoods to do this. So you can take a lot of the leg work out of this. Otherwise, you'll be calling independent contractors yourself. And believe me, I do this and it is a real pain. It's much better to say, okay, these people I trust, and a quarter of the block goes in with this. You should have a much deeper discount because it's cost effective to the provider of this retrofit.

We're working on legislation, again, with Congress. Home Star legislation that would provide direct in-store rebates of building materials, also, if you want to use these providers for the services as well. We're working on that. We are open to all ideas in how to make energy money savings a norm. And we need to get it. So, when you're thinking you're ahead — the energy savings, don't think more expense. Think I'm saving money because it really is that. By saving energy, you will be saving money.

Now, we also need to enhance our security through responsible use of our energy resources. Probably, the hardest sector to decarbonize is the transportation sector, and let me tell you why. This is a plot of the energy density per unit volume on the Y axis and energy density per unit weight on the X axis. So, what that means is in the upper right hand corner, you have the highest energy per unit...volume per unit weight. That's good because if you're a mobile platform, you want to carry the energy in the most compact form as possible. And what leads the least is diesel fuel, gasoline, kerosene, or which is jet fuel essentially, and body fat. There's a reason why nature stores energy in a mobile platform in body fat rather than in carbohydrates; it's because it is the highest density.

Now down there, so close to zero, is the current technology of lithium ion batteries, best commercial batteries. And it's so close to zero and energy density that, I have numbers, it's about 80 times lower than diesel fuel.

However, don't despair. If a battery goes to where that store is…it's got to be about five times better in energy, per unit volume energy per unit weight. It's got to last; if you want to put it in a car, it's got to last 15 years of deep discharges. But if it does that because the electric motor is 95%, 90% efficient, because it's so much smaller than an internal combustion engine, you can actually start driving an electric car for 15 to 120 miles without a recharge, and so that would really electrify, so to speak, personal transportation in sort of range. And so that's one of the problems we're doing. We're improving the energy efficiency of automobiles, of trucks, of everything, really. But certainly, electrification of personal vehicles is a big deal.

The President has always said, since the end of his campaign, in the beginning of his Administration, that responsible expansion of oil and natural gas, as long as it's part of a comprehensive energy and climate program, is the way to go. And as we have been stressing, it's okay to look at the development of the outer continental shelf, but it has to be in a manner that protects communities and coastlines. And here's a picture of

the President behind...in front of rather, I think it's an F16, it's a hornet, the green hornet, because half of its fuel blend is made from biofuels.

The biofuels come from cover crop that alternates with wheat, so that you can have the soil rest in alternate years. The Secretary of Navy, Secretary Mabus, has made a pledge that in the next—within 10 years, the US Navy will decrease its use of fossil fuel by 50%, a very, very serious pledge. And they're taking steps to do that. The Department of Energy made investments that lead to massive increases in recoverable coalbed methane and shale gas. This program was started in the late 70s and I think it was in 1978, I believe. It was ended when it began to look as though there was enough viability that commercial interest began to take over. So, the methane coalbed program ended in 82, the shale gas program ended in 92. In 1991, *[inaudible]* began to use their vast resources for exploration of shale gas.

And as many of you know, this has been a very good success story. Roughly speaking, the reserves of gas in the United States have gone up by 30%, and they could have gone up — they might have doubled it. It's still yet to be proven actually how; the effect will be probably has doubled the gas reserves in the United States. That's a big deal because gas will be a transition fuel as we go to renewables. We're doing a very similar small program in methane hydrates again, and it's a long shot. But there are a lot of potential reserves there.

We're also developing technologies that will have significant impact. This is what it's called the learning curve. It's a Moore's law curve and what it shows is the price of silicon — not only silicon, thin-film photovoltaic — is going down over the years but not as a function of time, as in which you use with the Moore's law in integrated circuits, but it's a function of the amount of material deployed in the field. And that really drives down the learning curves. There's always incremental improvements that go over, span many decades.

And as beginning in 1980, the cost of photovoltaic modules has gone down by more than a factor of 10. Right now, the cost for the modules is $1.50 per watt for large installation modules, hundreds of kilowatts to megawatts.

The fuel costs now of fully installed low-cost is below $4 a watt, again, for large installations. Rooftop is unfortunately still higher and the issue is, how low will it go? Well, I'm pretty confident that it will go below $2 in installed watt. And at $1 in installed watt, everything, people put it everywhere with no subsidy.

And so somewhere between $1 to $2 or, say, $1 to $1.50, it becomes a no brainer. And so we are trying to accelerate the development of this. What about coal? Well, US, China, Russia, Australia, and India have three quarters of the known coal reserves in the world. The United States has a quarter of the known coal reserves in the world. So, is it possible to use coal in a much cleaner way? I believe it is. There's a debate; some people say no. Why don't we just turn our back in coal? And I would counter it by saying that even if the United States does this — I'm not advocating we do this — I think we can develop these resources in a clean way. China and India will not. And so we are investing significant amounts of money, $4 billion in clean coal technologies and also in investigating sequestration. And the good news is, it's being matched by $7 billion in the US private industry.

The other good news is other countries are taking on this challenge. And for the first time, China is beginning to take on this challenge. In fact, it's going to be hosting the clean coal forum a year and a half from now. And we are now in a bilateral agreement with China to try to develop clean-coal technologies, so things are changing. Our first target is to start to get deployment perhaps in eight or 10 years. But then there's a second round of generation of technologies. We're also developing, again, to continue to drive the prices down.

We think that nuclear reactors will be part of the future. We're particularly intrigued by what are called the small modular reactors defined to be less than 300

megawatts but can even be less than 100 megawatts. These things have advantages. You lose the advantage of the economy building a really big 1 to 1.5 gigawatts. But if you build a small one, you can mass produce them in a factory, and they could be shipped in its entirety on ship, truck, or rail. It actually makes a better investment if you're utility company; a full 1500-megawatt nuclear power plant could cost $8 billion or more. If you're a moderate-sized utility company, you'll think $8 billion, that's a fair fraction to my capital worth. It would be as if you were betting the entire company on this one power plant.

So, if you can put it in bite-sized pieces, one-tenth the cost, it makes it much more attractable. It also means that it could be a drop in replacement. So, if you want a 500-megawatt one, you put it in four or five of these or let's say four of them. And so it makes it...and that's what we do with coal plants. You know, the standard turbine...or the standard boiler is, let's say, 250 megawatts. So, you can put it and replace a power plant without upgrading the transmission infrastructure, without upgrading the cooling infrastructure. And so, there are a lot of reasons why this could be a good thing. The President's budget for 2011 requests $300 million for a new program on small nuclear reactors. Not much but already there's two or three or four US companies were very excited about this.

We also need rapid large-scale deployment of technology. That technology deployment requires investment. The investment flows towards opportunities for profit and market opportunities are structured by policy. So with the right policies, you can create investment forums. Right now we're kind of on hold, and because of that, a lot of capital investment is on hold.

We know many examples of policies in Denmark, in Germany, Spain, and now in China that foster the development of clean energy and energy efficiency. The United States has, to a certain extent, on again, off again policies. And because of this, and I want to stress this, because of long stable policies that tilt a particular country like

Denmark towards renewables, it was...that's the reason why Denmark developed its wind turbine industry. They had a long time to make this development. And they knew through tax policies, through *[inaudible]*, through production categories or whatever, they can develop that.

Now, as we start to turn up our wind industry, right now, on average, the worth of wind turbines being installed in the United States today is about 50...a little bit over — 50% of the total value. Including the installation, labor is about 63%, 60% to 63%, a number of studies are saying that.

Four years ago, in the United States when we installed wind turbines, the American value of it was only 25%. So, what has happened as we install more and more, companies will come here and create manufacturing factories over here and they establish domestic supply lines. Toward the *[inaudible]* factory in Boulder, Colorado; they've invested $600 million in an American manufacturing plant. If all goes well, they intend to invest $2 billion in American manufacturing plant. And they were telling me how their supply line chain will go through over 80% American parts. Okay. So, the value would be over 80%. So, this is a natural thing. That's what happened with Germany and its solar; it's a natural thing. The manufacturers, they don't want to be subject to currency fluctuations and they would rather have local suppliers.

So, the most important thing that we need in our comprehensive energy and climate legislation are long-term signals. In particular, we want to establish a cap on carbon emissions that will allow slow growth. And it's that long-term signal that tells the utility company what to invest in, in terms of a gas plant, a nuclear plant, a coal plant with carbon capture or not, and renewables. And it's that long-term signal, because when you make these investments, these are 50-, 60-year investments, and they're billions of dollars. So, that is probably, in my mind, one of the most important things in the comprehensive energy and climate legislation.

What about the costs? Everyone is worried about the cost, but let me remind you of something. In terms of the cost, when the American Clean Air Act was passed, about a quarter of the lakes and rivers in the eastern part of the United States could no longer support fish. It was so acidic that our lakes were dying. And so now you see, from 1989 to 1991 versus 2001 to 2003, the great decrease in the amount of acid rain; this acid rain program cost four times less than what was originally projected by the EPA and six times or more or less than what was originally projected by the power-generating companies.

And so this is one of many, many examples. Once a law has passed, once you say this is our goal and our target, innovation occurs much more rapidly than even the people who were pro law had thought it possible. It was through smart control and catalytic converters *[inaudible]*. See, that's true of many, many things. It's true over *[inaudible]* at appliance efficiency standards. And it just happens over and over again. Get moving. Innovation makes the cost much less. And speaking of innovation, I mean the United States still can be...is the world leader in innovation. If the United States invented solar cells and the first silicon photocell, the first transistor, the integrated circuit, the laser, satellite communication, GPS — all of those things were invented in the United States.

So, let me make a couple of predictions in closing. I think the cost of oil and other forms of energy will rise in the coming decades, strictly based on supply and demand. I think the risks of climate change are becoming increasingly apparent. Despite the last little flutter, the body of evidence on a yearly basis is making the fact that humans cause climate change much more compelling, and we're getting to know many more of the dangers that we potentially face.

So, if this is the way the world's going to be, we have a choice. We can say, well, maybe there's hope that the price of oil will go down into $30 a barrel again, or maybe everybody's mistaken and there is no threat to climate. But in my mind, it's a very high

probability that these two statements will be true. Now, China, European countries, and others who have seen the economics, they've seen that this is the future. And if this is the future, they're taking steps to lead in this future.

So, let me finish by saying, we still have the opportunity. With the right policies, they gently guide the industry and investments towards this new industrial revolution and to secure our future prosperity. But time is running out, and the train's leaving the station. Thank you.

Richard: Do you want to stand up here to answer questions or do you want to sit down?

Steven: I would sit here and *[inaudible]*.

Richard: So, we have a lot of questions that you all have put up. I'll pose them to the Secretary. To get us going, can you state a program or start a program under the Recovery Act to help reach end users directly? So, this person is giving example on their college campus wanting to build a...build a plant to be self-sufficient in energy, but can you give example?

Steven: Well, I don't know about any individuals building a plant. We give to individual companies. I think the best thing we're doing is in this energy retrofit, this energy recovery, we're for energy efficiency, we'll be giving direct...we're allowing direct rebates of individual's, individual's plants. I mean, we give grants but it's a slightly bigger deal.

Richard: Do you agree that energy and environmental affairs should be a matter of world integration and cooperation?

Steven: Yes. The sure answer to that is yes, this is an international problem. It's not a local problem that carbon and oxide mixes throughout the world. And the whole world will suffer the consequences if we don't do something about it, and it absolutely needs internship cooperation.

Richard: This is a question about energy and battery storage with renewables, is this particular daily outlook for?

Steven: Yes, energy storage is a very big deal to us. We're looking at both storage in the level of batteries that you could use for your laptops. We're not as concerned with laptops; they'll take care of themselves...but could you *[inaudible]* the automobiles. We're also looking at storage in a larger scale so that if a building like this one puts in photovoltaics or has access to wind, it can store locally on site. And so we're investing in a very innovative way of making totally new batteries that have a potential, and we'll known within just a few years whether you can decrease the cost of energy storage of these type of batteries by factor 5 or 10, and they can scale up to hundreds of megawatts of storage, and hundreds of megawatts of power, hundreds of megawatts of energy storage...megawatt hours of energy storage.

We're also looking at trying to integrate hydro sources of what's called pump storage, so that utility scale can also store energy. So, when the wind stops blowing for a day or three, you don't have to have a blackout.

Richard: There's a number of questions here related to natural gas ranging from, you know, why does the Administration favor electric vehicles over natural gas? What are the prospects for natural gas and transportation? Do you have any opinion about the best use of natural gas?

Steven: Okay, so well right now, as I said, the estimates vary but our reserves have gone by 30% to, perhaps, doubled. We are looking at transportation. We're piloting transportation mostly with vehicles that have essentially fueling stations, so you don't have to worry about the infrastructure and see how it goes. So, these are delivery trucks, for example, or in situations where, since natural gas burns a lot cleaner, it would be a good thing.

Now, having said that, we still think electrification is part of the strategy because natural gas right now is predominantly used for industrial purposes and for heating and

for power generation, and that's a very good use for it. You know, there's one automobile manufacturer, Honda, who makes a natural gas vehicle. And the range of that is about one quarter...compressed natural gas is about one quarter a gasoline...a normal gasoline car will give you.

So, we're looking at it, but it really depends again on the economics of the situation. Now, there is another role for natural gas. What many people don't realize is when you have renewable energy—sun, wind that can vary and can vary quite suddenly—once you're…I'll pick a number…50% wind and solar, it couldn't really be that the sun might stop shining or cause rollover, and we have in our records a very sudden...a quite often sudden displacement.

Now, if 50% of your energy is coming from this, there are two sources of energy that you can get going in a very short period of time. Hydro, and just how long it takes to spend up the turbine, and the other is natural gas that...you can bring up natural gas in a few hours. You cannot bring up a commercial nuclear power plant in a few hours. You don't want to. It stresses it, and nor do you actually want to bring up a coal plant in a few hours.

And so natural gas is actually one of the fastest response batteries, if you will, that we have. Now, natural gas also can serve another purpose as we look into large scale utility storage...compressed air storage where you take the excess of electricity from a nuclear power plant that ignites from renewables. You can actually compress air, put it in cave, seal the cave, and you can let the compressed air out to spin a turbine. Overall, round-trip efficiency can be as high as 70%. And this technology is now being developed, but you need gaining natural gas to give it a little boost to spin the turbine. So, that's what I mean that natural gas has a role as a transition fuel to renewables until we solve the transmission and storage problem.

Richard: Another question; we have time for a couple more. How do you see the future of nuclear power in the United States?

Steven: Well, we're trying to restart it. We're hoping that several initial loans to get seven, perhaps, as may as 10, reactors built so that you can show that you can build these reactors on time and on budget. And then after that, we hope that the United States just steps out of the game. And that once it's demonstrated to the investment community and to utility companies that can build on time and on budget, then the economic forces should take over. I think having a cap on carbon that ratchets down over a period of years would favor nuclear as well.

Now, there are two issues that are not, and I'll be quite honest, they're not completely solved. One is the nuclear waste issue. We have a very distinguished panel of experts including the next speaker, is it the next speaker? Yes, who is on a blue ribbon panel that will look, take a fresh look at the back-end of the fuel cycle and advise me, the President, and Congress, how we can make changes in our current statutes.

I think that's a solvable problem. I believe it's a solvable problem. The other is also a solvable problem, which is that the...as the world turns in nuclear, more of the world turns to nuclear, not all nuclear being partially. You have nuclear materials around and there's a proliferation problem. And that's a very important problem as well. And again, this is going to require international cooperation, but, yes, I think it's solvable.

Richard: And a final question here which speaks to the role focusing on innovation, the role that you see for the Department of Energy relative to the private sector in addressing energy and environmental challenge.

Steven: We see ourselves mostly doing the front-end stuff, the research and the development. The more it goes to development to piloting and certainly to deployment, the private sector should be taking over.

In certain areas, for example, the development of carbon capture and sequestration, the piloting of some of this is so expensive that we have decided to take a more active role. But as you saw, and you know, kind of minimum match to one-to-

one sort of thing is, we'd like the private sectors to say, okay, we're invested in this. Again, a long-term policy will help that investment.

The other issue is that in certain parts of the energy side of our house, there isn't a deep long-term, sort of, basis for technology, R&D investment if your utility company doesn't have the same attitude that a high technology company has towards R&D. If you're in a high technology company, like a computer company or something, or drug company, 20%, 30% of your gross revenues might be in R&D. If you had 20% of the primary energy creation industries, it's a trillion-dollar business in the US, and that R&D budget would be $200 to $300 billion a year. The federal investment in that R&D is a couple of billion, like $2 to $3 billion. Okay, so that gives you a scale of where we are.

Again, other countries are stepping this up. You know, if you're a utility company, you don't really see R&D as a major thing. If you look — and I'll just end this — Edison was a wonderful inventor. He invented a way of recording sound. He invented a way of generating light, the incandescent light bulb. He invented many other things. He produced the first electricity transmission distribution company in United States and in the world. If he came back — this is in the late 1800s, mid to late 1800s — if he came back today, what's this mp3 stuff? He wouldn't recognize it? What's this LED stuff? He wouldn't recognize it? He would recognize the power generation equipment. I feel right at home. So, I think the Federal Government has to step in and help with this one. Thank you.