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Well, thank you, both Jason and David. The enthusiasm of those introductions proves that there's less than a hundred days left in this administration. (Laughter.)

But it really is good to be back here at Columbia. As Jason said, I was here in August of 2013 and some water over the dam in the meantime, and in fact particularly in two areas that I will touch on briefly, so that we can get to a conversation. But it's more to tee up things, I would say.

Clearly one is what I would call actually the linked issues of climate change, energy security and the clean energy transformation that is central to both. I'll touch on that. And then I'll touch on our responsibilities in nuclear security, in particular preventing the spread of nuclear weapons and reduction of nuclear materials at risk across the world. So again, I'll touch on just some of key the events and outcomes in these areas, so that we can move on to our discussion.

So first, on climate – well, Brian Deese was there; I'm not going to hopefully repeat too much of what he said – but the first point is that it is remarkable that an agreement of this type, with essentially every country in the world engaged, has gone from negotiation and agreement to implementation in less than a year. This is really remarkable, and I think it's one of the indications that we are headed to a low-carbon economy.

One of my CEO friends in the utility business says – who has a lot of coal plants and other things – you can't keep the waves off the beach. That's where we're going. The country is going there. And that's really important.

The Paris Agreement itself is a big first step, and I want to emphasize "big," and I want to emphasize "first." It's big because these commitments to a low-carbon future, again, across the globe put us, with their commitments in the 2025 to 2030 timeframe, typically with 25 percent or so reductions of CO2 – they put us on a trajectory that will get us to the deep decarbonization that we need to be looking at in midcentury and beyond.

But it's only putting us on the trajectory, and ambition is going to have to keep increasing as we move forward to reach this kind of deep decarbonization. And that's where another very important part of the Paris discussions – very important especially, in our view, at DOE – was what happened on the first day of Paris, which was the announcement by President Obama and the leaders of 19 other countries on something called Mission Innovation, which is a commitment to double roughly a $15 billion base of

energy technology R&D to roughly $30 billion over a five-year time period. So the idea is to really open up the innovation pipeline. Certainly in the United States we believe that we have lots of unexercised innovation capacity.

The innovation has therefore been put at the core of a solution to climate change – I want to emphasize not in place of policy but synergistically with policy, and I'll come back to that in a second – but also, at the same time, Bill Gates was there, representing 28 international investors with deep pockets, committing billions of dollars to invest in the fruits of that innovation and to do it with patience – which was a failure, frankly, of Tech 1.0, Clean Tech 1.0 – to do it with high risk tolerance and to be prepared to make the large capital investments that are needed in the energy sector to begin the scale-up to real commercial introduction.

So it was a very big deal and, I'd say, a deal we certainly spent 2015 building up to this and noting, again, how innovation was central.

Now there has been an argument put forward. On the one hand, Bill Gates, for example, is often quoted as saying we need an energy miracle to address our climate needs. The comeback by many is that no, we don't. We have everything we need today. We've just got to get it out there.

And certainly when I'm asked my view on that, my answer is yes.

It's false dichotomy, and in particular if we look at timescales – and I'll just pick arbitrarily, say, 2030, because that's kind of the date when most of the Paris commitments were made – can we meet our goals in the United States in 2020 and 2025 for carbon reductions with what we have today and kind of what I would call continued innovation and cost reduction? Absolutely. We need to get the right policies, especially as we go farther down the road, but absolutely.

However, if we are talking about deep decarbonization, what you are often shown is the electricity sector, and it looks great. We can get 80 percent decarbonization. But we also need the transportation sector, we also need the industrial sector, and those are much more challenging to do.

In fact, that leads me to think that we also need yet another stream, which is – I would call it large-scale carbon management, big-scale use of CO2, for example, converting CO2 and water and sunlight to drop-in fuels. We could go on as to what many of these – we could use Bill Gates' word or not, but big transformative technologies could be. I believe they will be a crucial adjunct to the kinds of technologies that we work on, and we are having success in driving cost down.

So that's really the goal. And what we have found at the department in doing some modeling is a tremendous synergy between success in the innovation agenda and policy, because, again, if you think it's only policy – let's use as a stand-in for policy generically a carbon price. There's many ways of getting there, but let's say a carbon price – nice, easy way to talk about it. And the thought is that, well, if we just crank up the carbon price higher and higher and higher, we'll get to whatever goal we want. The trouble is – I would say, number one, is the impact of that is – becomes very inelastic as the prices get very high and consequently are not politically very easy to reach.

On the other hand, when we look at innovation without policy, the time constants are too long for the introduction. But when you put them together, they tend to be nonlinear and amplify each other. And so at a much lower carbon price, for example, the innovation agenda leads to much, much faster introduction.

So that's kind of the picture that I wanted to lay out there, and of course we can talk about it more. But that's been, I think, a very, very major step forward over this last couple of years.

I might also say that the innovation agenda in Congress does have very strong bipartisan support. That bipartisan support over the next five years needs to be transformed into numbers to get R&D budgets up, for example, to link to the private sector for investments, to get an accelerated transformation. But we start out, I think, with good bipartisan support.

We start out with very strong support for one of the ideas that we have put forward, the Obama administration, in terms of executing Mission Innovation. And that is to use part of those resources to fund regional innovation partnerships, recognizing that the regional needs in our country are very, very different and let's use the innovation resources in different ways in different parts of the country.

And third, internationally, there remains – there is very, very strong interest. I mentioned the 20 countries, but beyond that, in fact, in the meeting just last week in London, there was interesting discussion about ways in which, while each country will pursue its own portfolio, how they can work together to create the opportunities and new – including possibly new ideas like international collaboration on prize approaches to stimulating innovation.

So there's a lot happening, and innovation will be at the core of the agenda going forward.

I'll just make one other aside on climate change, and that is, we are hoping tomorrow in Rwanda there will be success in amending the Montreal Protocol to address hydrofluorocarbons. So that's the replacement for chlorofluorocarbons, which are solving the ozone hole problem but are generating climate problems. And tomorrow we hope to get international agreement on that. Let's cross our fingers that that will work.

Let me turn to – briefly to energy security – I mentioned that as well – something that has undergone quite some evolution, I would say, in the last nearly three years. Basically I say "nearly three years" because for the starting point I take the Russian incursion into Crimea and Ukraine, which set off probably an accelerated rethinking about energy security because of the concerns about natural gas in Europe and being so heavily dependent on Russia.

So in the G-7 context, plus the EU, very shortly after those events in early 2014, we came together in Rome, the energy ministers of the G-7, plus EU, and really came forward with what I would call a modern set of principles about energy security, as opposed to the very narrow traditional focus on oil supply, which comes out of the 1970s oil shocks. And I just want to say, without going through it in

detail, that the principles include things, for example, like functioning global markets as a very important component of energy security.

Of course the issue of diversity of sources and routes of supply is important, but then when you're talking about diversity of routes of supply, you are inherently talking about fossil fuels, which is why clean energy comes into this equation as well. You don't worry about your fuel supply with renewables or nuclear, for example. So that's also part of it.

The questions of infrastructure improvements – in fact, that's almost part and parcel of well-functioning markets. You need to have the infrastructure to support it. That infrastructure has to recognize modern threats. Sure, there are geopolitical threats, but there's also extreme weather threats, going back to our climate discussion. There are cyber threats. There are physical threats. We need an infrastructure that supports clean energy but is also resilient to a more and evolving threat spectrum. And we need emergency response when the preventive measures don't work. So that's all put together in kind of a, you know, modern view of energy security.

And some things have really happened, even in that short time. For example, the evolution of global natural gas markets through LNG exports has really happened a lot faster than people expected. That's an element of security for us and our allies and friends. In Europe we still do struggle with routes, as there's a tension between new routes of more Russian supply versus genuinely new routes like the so-called Southern Corridor to bring gas from the Caspian, maybe eventually the Eastern Mediterranean, but those are the kinds of discussions that have been joined in a very, very serious way in these last three years especially.

In terms of infrastructure and resilience, at the department our Energy Policy and Systems Analysis Office, whose director is here, last year produced what's called the Quadrennial Energy Review 1.1, which was specifically on energy infrastructure in the United States, not a wholly pretty picture in many, many ways. We really need a big move forward. And I'll just give you a couple of examples which combine the infrastructure and – issues and emergency response. For example, just last week – actually, we're still in the throes of Hurricane Matthew. Hurricane Matthew knocked out about 3 million electricity customers, for example, and Hurricane – Superstorm Sandy of a few years ago, of course, here had almost 9 million people, customers, knocked out.

In Superstorm Sandy you got a very good lesson in this region about the interconnectedness of infrastructures, because without electricity for a long time you couldn't get fuel either, even though the fuel was there. It was an important lesson.

Lessons were learned, and so I'll just give the example of Florida Power & Light, where I visited there about six months ago, obviously Florida is often in the crosshairs of tropical storms and damaged energy infrastructure. They were really walking the talk. They had some ARRA, some federal recovery money, from 2009 – I think David knows about that – but they also invested their own $2 billion in

everything from simple stuff, like concrete poles rather than wooden poles, to making the grid smarter and harder with IT.

Now we don't know yet the final audit of how this happened, how this played out, but their estimate is, Hurricane Matthew would have had a lot of customers out for 10 to 15 days. Over 98 percent of their customers were back on line with three days, and they think that this hardening and smartening was a big deal. They're going to invest another $2 billion over the next three years on this.

And some of this, by the way, I mean, applies there, but it applies elsewhere. Some of it is smart meters, enormous deployment of smart meters. "Smart meters" tends to invoke the image of how you're going to pay your bill. What's critical here: It tells the utility immediately when you have an outage, and they know where to go and what to address.

So this infrastructure and in particular the integration of infrastructure with IT is really going to pay big dividends, but we're only just scratching the surface going forward. So this is one thing.

And then I'll just say, in terms of emergency response, again, I won't go into great, great detail, but because of this evolving threat spectrum, the Congress, for example, in December of last year, both in the highway – in the highway bill – it's called the FAST ACT – and in their budget bill acknowledged the increasing role of the government and of DOE in particular to have the authorities to address these energy infrastructure emergencies. So we are doing that.

But I will tell you, once again, this is work in progress, because we still haven't figured out how to align resources with responsibilities. And one of the things that I think we need to think about, the next administration needs to think about, is the possibility of a fundamental reorganization within the Department of Energy in terms of how all the emergency response activities are carried out. So we're leaving a few things for the next administration to look at.

The last thing I'll say there, actually, is in December as well the Congress did take one of the very resource-heavy recommendations of our Quadrennial Energy Review and provided $2 billion of funding to modernize the Strategic Petroleum Reserve. I'm going to end this part of the discussion with this, saying that going back to the earlier discussion about a modern way of looking at energy security versus the 1970s, the petroleum reserve was funded – was established in the 1970s, late 1970s, and people still think about it as, well, how many days of imports do I have to cover? No, what we're saying is, look, no matter how much oil we produce in the United States – and we are producing more, a lot more; we still import a lot, but we're producing a lot more – we will not be independent of the global oil price. And so a major disruption anywhere is going to affect our consumers, our economy, and that's why we still need to do – to have things like a petroleum reserve, to be able to manage that. And we can get into a longer discussion about authorities, but that's a different question.

Anyway, so that's some of the stuff that's been happening, certainly, since I was here last, in terms of the energy and climate space.

Let me just switch now to nuclear security and end there. The president established a very aggressive agenda on nuclear security in his Prague speech in March 2009, shortly after he took office.

And the Prague speech, the Prague Agenda laid out a broad agenda in terms of nuclear deterrence, nuclear nonproliferation, nuclear materials control, et cetera.

Now a centerpiece of what has evolved in the nuclear security space is the Iran agreement. I'm not going to go into detail on that, but let me just say that the fundamental architecture of the Iran agreement, which is focused specifically on the nuclear weapon threat possibility – the fundamental structure is, for 15 years Iran has significant constraints on what it can do in a civilian peaceful nuclear program. But transparency and verification measures are put in place – quote – "forever." So that's the basic architecture. For 15 years constrain the program as they reestablish international confidence and trust in the peaceful nature of their program and then have, from the start to forever, verification measures. In a nutshell, it's working, certainly so far.

Now we're only nine months into this, and nine months is only a few percent of 15 years. But the fact is, the IAEA, the international inspectors, have now published three reports that Iran is complying with its nuclear responsibilities. I do note the agreement came into force, into implementation, January 16th of this year, only after the IAE (sic) verified that Iran had fulfilled its obligations. And they were considerable.

Now one does hear from Iran the story that, well, we're not fulfilling our side. I'll make it very clear: We are completely fulfilling our side of the agreement. The fact that they may not be realizing the pace of economic impact that they had hoped for is due to many, many complex factors, which do not include our impeding business that is allowed within the current sanctions regime in Iran, because, I want to remind you, the agreement is not criticized for what it is. Now any criticism of it is for what it's not: Well, why didn't it solve the missile problem? Why didn't it solve the Hezbollah problem? Well, the reason is, that was not part of the negotiation, just as when Reagan negotiated arms control in the '80s, it wasn't to solve all the problems we had with the Soviet Union: Jewish emigration or their proxy wars, et cetera, et cetera.

The other side of that coin is, since it's only addressing the nuclear problem, only the nuclear sanctions were lifted. There are many other sanctions on Iran involving human rights and terrorism and the like and missiles. And so for international banks and international business, they have to sort out what entities they are dealing with in a country that has not had strong banking relationships now for quite a few years.

So anyway, it's moving. It's happening. Their oil production, their oil exports are very, very close to what they were pre-sanctions, for example. So that's adding to the economy, et cetera. So it's the pace of change, and hopefully these things will all come together and proceed as we all hope over the next one and two decades.

Now the nuclear security agenda's got much more to it. I won't spend too much time, but I mentioned earlier Russia in stimulating some additional thinking on energy security. They've also stimulated some additional thinking on nuclear security issues, unfortunately, and the reality is, the next administration is going to have to face some difficult choices because there is – even though the president has, in my view, certainly, the right vision of hoping for a world or working towards a world without

nuclear weapons, there is no reason today to think that that's not going to be a multidecadal activity. And so a lot of money's going to have to be spent on modernizing the nuclear deterrent and rethinking exactly how it's used.

I'll just end by saying another very important part of the agenda that very much involves DOE as well is, I'm hoping that in the next administration there will be the opportunity to return to the Comprehensive Test Ban Treaty. We've now maintained our deterrent – shrinking, but maintained it, without testing. And it's all based upon innovation, and that's the word I wanted to end with. Innovation in nuclear security, innovation in the energy space is what we at DOE are all about and what I think is going to be critical to addressing these priority issues.

So thank you … (applause).

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