Center for Strategic and International Studies (CSIS) Global Security Forum 2012

Scenario 2030: Is the U.S. Nuclear Industry Dying?

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JOHN HAMRE: Thank you very much. My name is John Hamre. I'm the president here at CSIS, and I welcome all of you – delighted that we could have this conversation. Let me just make a couple of general announcements.

First of all, I do want to say thank you to our friends from Finmeccanica, who have made it possible for us to do this conference. Again, let me remind you – take your cell phone, pull it out; put silence, you know, silence on. No – no bell tones; I don't want to listen to anybody's fancy bell tones here.

We are tweeting live – and I'm saying this really for the audience that's outside, but I want you to know. We're tweeting live, and it's @CSIS_org. And we are using as the – as the hash line – it's #GSF2012. And we invite people to dial in. We are going to be taking questions from all of you, and it's a small enough and a most – intimate enough room where we can do it directly. And so I will simply, you know, make sure that the conversation flows. But this is really your dialogue with both Mayo and with Brent.

And then after the session, we will have lunch. You'll just have to pick up a brown bag as we go to the next place. Now, we've had two people on Twitter who have already written us questions. (Laughter.) And the first question is – and we're going to cover these. The first question is: After Fukushima disaster, does nuclear have a PR problem? I think we're probably going to talk about that.

And then the second question is: Why does it matter if the U.S. is no longer a global nuclear leader in the nuclear age? That also is something we're going to talk about. So I want to thank our friends in cyberspace, who actually framed this exceptionally well.

I'm going to give a little bit of an introduction just to ground all of us. And I apologize to my two speakers, because they really are the focus of this – but I think for all of us, to have just a little bit of a point of reference.

So let me go ahead, and talk about what is – we're going to talk about the history of nuclear energy very briefly. We're going to talk about nuclear energy production on a global basis, and then we're going to take a quick look at U.S. nuclear.

So let's take a look at the history of nuclear. Now of course, at the start of 1942, when we were – when they built the Chicago Pile – and of course this – in 1953, seminal time, when President Eisenhower gave the "Atoms for Peace" speech. If you think about it, it is still the policy framework for America. There's danger in nuclear and there's great promise in nuclear.

And we have to find a way to bring these together and to reconcile them and to have a policy framework that makes that work. I will argue, and we'll go through this today, that that probably still is a dominating landmark for all of us.

So now, as we go down, we see – it was in 1957 when the Price-Anderson Act was passed. Now, people – probably this audience knows Price-Anderson. You know, but most of Americans don't have a clue what Price-Anderson is. It is the foundation where we made it

possible for nuclear energy because we established a government framework for liability. And I would argue it's one of the most powerful things that shapes the effectiveness of this industry – something, frankly, that we've been trying to encourage Japan. They need a Price-Anderson Act.

OK, let's just march a little bit further in time. Of course, back in 1968 – just to give you a sense of where we were scale-wise – past the Non-Proliferation Treaty in '69, and then if you look at 1974, that's the last time we approved a power plant; 1974. It wasn't when we were building them but it was the last time that one was approved, and the reason for that of course was is we had Three Mile Island in 1979.

Now, as we go down in time, now obviously that reshaped the landscape. We passed a number of pieces of legislation – 1985 INPO was created, very important. And INPO is the driving force of efficiency in American nuclear power production – and Mayo is the head of INPO. INPO has an executive secretariat down in Atlanta, but they elect from among their midst a senior leader. And Mayo is here, and he's here in that capacity. He's with us here today. He's also the co-chair, with Brent, of our commission.

You see we hit the high water mark in 1990 for commercial nuclear power plants. We authorized Yucca, and I will show you soon we de-authorized Yucca. 2005, of course, is when we put in place this landscape for the so-called nuclear renaissance.

And very important; it's been a little bit slow on the uptake. We saw – but in 2007, is when we started seeing new licenses being submitted. And of course, the NRC had in many ways sort of collapsed and had to be rebuilt. So that's been part of this process that's going on now. And then as we go down in time, Yucca was terminated. And then, of course, in 2011, Fukushima.

Now, so we've just got a brief review. Let me take a look briefly and the global nuclear energy production. I think it's interesting to see this. And what I'm going to show – and just to orient you on this, the x-axis, the horizontal bar, this is the percent of nuclear inside these countries. And the y-axis is the amount of energy production in the country.

And what I'm going to do is to track various parts around the globe to give you a sense or where – what production is like. And now you can see where we are. OK, it's – we're going to go out to about 2010 here and stop for a second. This is – was the landscape pre-Fukushima. And you see, as a percent of nuclear, Europe was the largest, largely led by the French.

The United States, you see, we're 20 percent. Twenty percent of our electricity production is coming from nuclear power in America. And what you see – you may have seen the Asia thing moving a little bit; and it went over and it was closer to 14 percent, and by 2010 it's actually moved back. So it's about 8 percent.

The reason for that is China has been building so much commercial, non-nuclear plants. So it isn't that the percentage of nuclear – it isn't that the raw numbers of nuclear power plants

have gone down. It's that the percentage against the economy has gone down. But now I want you to see what happens.

We're going out into the future. OK, you know, so we're at 2030. If you will have noticed, Europe slipped to the left, and that reflects both Germany and Belgium and Switzerland saying they're not going to do nuclear anymore. They're going to start phasing out of nuclear. You see the United States is still fairly static – it's drifted a little bit; it's closer to 19 percent by 2030. But you see the skyrocketing performance of Asia, and it's because you're seeing dramatic increases in the production of power in China.

OK, let's take a look at just the reactor fleets, just to give you a sense of this on the national basis. And if we're looking here, the y-axis is just simply numbers of reactors and the x-axis doesn't mean anything. It's simply a way to spatially differentiate the countries.

But let's look at the pace of time of what's happening. Watch China's rise; Japan's decline. And this is in 2000. Now, we haven't seen anything yet happen for the United States, but now watch – and this is simply looking at retirement schedules for nuclear power plants. We only took it out to 2030.

So now, let me take a closer look now to the U.S. nuclear energy production.

This is – these are demography charts we're taken from population economists. And we're showing – I'm going to show you the demography profile of the nuclear power fleet. And these are numbers of reactors in each column. So if you look at the light green, it's 25 to 29 reactors that are – that are in – excuse me, in the age group – 25 years old to 29 years old. There are 30 reactors in that category.

We're going to just watch to see what happens to our current – and this is by current investment plans. You don't see anything on the left. We're getting out of the nuclear power business.

Now, one last look at this. And this is – again, I'm looking at the numbers of reactors that we have. And again, the x-axis is meaningless because it simply differentiates, so that we can show – this is states, states in the United States where we have nuclear reactors.

We have roughly 104 nuclear reactors; and we're going to watch the clock. Georgia's going up a little bit, because we still have production coming online.

That is what we're looking at.

OK, so let's have a conversation. (Laughter.) Let's have a conversation with – (off mic) – Mayo Shattuck and Brent Scowcroft. They are – kindly have agreed to co-chair a commission that we're doing on the future of commercial nuclear energy. And so it's in that capacity I've asked them to come. Now, Mayo is the executive chairman of Exelon. This is a product of the recent merger of Exelon and Constellation Energy. He had been with Constellation Energy and he is now the executive chairman of the combined firm. Exelon operates a quarter of all the

nuclear reactors in America. So they are the powerhouse, as it were, of the nuclear power industry.

Brent Scowcroft – everyone knows Brent and, you know, Brent, if I were to really go through his résumé, we would run out of time – (chuckles). So instead, let me say – I've asked him to be here not only because he's on this – on our commission, but he recently headed up a commission on behalf of the government, looking at fuel cycle. And, you know, we're going to shut down Yucca, what are we going to do – big, you know, important question. So in that capacity, both of them are deeply steeped and knowledgeable about this. So let's explore what you've just seen.

And Mayo, let me start with you. You know, America has this great blessing right now, and that is we're a North American island of cheap gas. When you think about it, it's a great thing for the country. I mean, all of a sudden we have this abundant fuel supply, but it's quite inexpensive and it's really doing – it has tremendous impact on the nuclear power industry.

So as a guy that has to make money, every day, selling power, what is cheap gas – and I don't mean that in a negative sense – inexpensive gas. What is inexpensive gas doing to the future of nuclear?

MAYO SHATTUCK: Well John, let me start off by saying you have the coolest slides I think that I've ever seen. (Laughter.) I'm going to – I'm thinking of how I may copy that. Now, I don't like anything about what they say but I thought they were very cool. Well, it's really interesting.

I listened a little bit to the conversation in this room just preceding this, and the ebullient, you know, excitement about natural gas was prevalent, and its applications and its, you know, probably infinite level of capacity and all these things that are very exciting on many dimensions.

And I must admit in being in a highly regulated industry, it's of some relief that our customers are in a period of time where they're benefiting from low natural gas prices, both on the actual use of natural gas in their homes but also from a(n) electricity standpoint. Prices are way down, and customers really suffered dramatically during that commodity run-up that coincided with the Hurricanes Katrina and Rita back in '05, such that natural gas prices got up close to $15 per MMBtu.

You contrast that to today's price, which is a little bit over 2 (dollars per MMBtu). And each day we see it keep inching down to levels that are really somewhat unprecedented. So all, sort of, good news for customers. We heard some things in the last session about what great news that is for the application of natural gas – whether it's for, you know, conversion to liquids or transportation industry or export.

And all of those things, you know, I would agree are great for America and great for the states. It is really not great for nuclear. And the reason being is that the price of power is in most regions in the country a function of where natural gas prices are. There are central clearing prices that are really a function of the marginal unit that's being turned on.

So nuclear plants, which are intended to be running all the time at very, very expensive, awkward – and there are safety-related issues associated with every time you actually bring down a nuclear plant. So they're really not designed to be cycled. And as a consequence, they're on all the time, and their marginal cost of operating is pretty low, and therefore they're at the bottom of the stack. Coal is a little bit higher.

Then you get into natural gas plants. So as natural gas plants – natural gas has gone down, there has been a gradual switching of where those gas plants are on this stack, to some degree, displacing coal and getting turned on before the coal plants get turned on. And that phenomenon also affects the level of profitability of the nuclear plants, because of the central clearing-price notion.

So right now, it would not be unusual to look at the 104 plants out there today and see that some of them are actually not making any money at all. In fact, they're losing money – particularly single units, smaller, older single units. And so even the existing fleet is feeling a little bit of the pressure in this kind of environment.

The next question would be, well, is there therefore any price signal that would lead you to believe that you should build a new plant. And we'll probably get into this a little bit more.

But when we examined that ourselves – and this is during my Constellation days – and Joe Turnage is here, and some others – Mike Wallace, who's very involved with this commission with John, really were leading the charge to examine whether, you know, in a new world can we start building the fleet.

And I think the conventional wisdom at the time was, number one, we needed carbon policy and probably carbon pricing in the neighborhood of $20, sort of added to the stack of a power cost. And we needed natural gas prices probably in the neighborhood of $7 per MMBtu.

So when you think about the fact that we have no carbon policy, and gas is at two (dollars per MMBtu), is you can imagine – you run through the economics and it's not a very good picture in creating the price signal for entities that are making not only decisions for assets that will last 60 years but for assets that take 10 years to generate any revenue.

So what a lot of this is about is – you know, we're in a business of making very long-term decisions and requiring price signals that are enduring. And since the carbon debate has, you know, died on the vine recently – it will come back – and gas has gone through this massive paradigm shift, it does raise very serious questions about whether new nuclear can – particularly in the merchant market –

And there are some states that might be willing to – like Georgia, which might be willing to support new nuclear in order to have a more balanced footprint. But that requires the sovereign support of that state, which really means it's on the backs of the ratepayers, not the backs of the shareholders. And in a company like Exelon, you know, we're making all of our decisions in the merchant world as an investor. So I'll stop there and let you –

MR. HAMRE: I think you've shaped it. I think what – to summarize, you've said, really, there are no price signals that would lead us to build new nuclear in this country. And as long as natural gas is going to be as inexpensive as it is, that's a long-term, durable phenomenon that we're going to have to deal with. So Brent, I come to the question that our friend in cyberspace asked, which is, is there still a reason for America to be a nuclear power company – country?

LIEUTENANT GENERAL BRENT SCOWCROFT: Well, I think there is. But it depends on what your calculations are. You know, eventually fossil fuel is going to run out. That's a certainty. We don't know exactly when. We thought it was going to be earlier than it is, with the new gas extraction methods. The second thing is that energy demand in the world is going to grow geometrically.

We take it for granted. But much of the world is really not heavily dependent on energy. As they modernize, as they get cars, T.V.s, electricity on, lights on all the time – all of these things. For the globe, energy consumption is going to grow dramatically. Now, these two questions need to be answered. You know, how long can we depend on fossil fuel, and what happens after we can't depend on fossil fuel.

Well, the people who I run into who are dead against nuclear – and there's a psychological aversion to nuclear energy, which I have discovered – say, well, we can use solar and we can use wind, and they're renewable and so on. Well, nothing I have seen indicates that the growing demand for energy can without some revolutionary developments in solar energy fill that gap. Nuclear is the only thing that we can count on that is, but it has these disagreeable features which are salient in nuclear and not in the other. You know, you breathe polluted air, but you don't care about breathing polluted air very much because it only shows when you get lung cancer. But gee, nuclear stuff – Fukushima, look at all the people who died, who were driven from their homes, and so on and so forth.

And Three Mile Island was one of the most significant events in our history because it really, simply stopped the development of nuclear power in the United States. And so there are certain questions that need to be answered, and that is, what is the – how long can we subsist on natural gas? And when we've fracked everything we can, then what? And we go from there.

MR. HAMRE: Well, Brent, the only place where the wind blows 100 percent of the time is Washington. So I mean, this is the only place you could substitute – (laughter) – nuclear for wind power.

But let me take you – also, you're wearing your national security hat – you know, but –

Going back to Eisenhower, he was trying to find a framework where we would manage the danger of nuclear power but we would still allow its promise for the world. And what – but now we're in this period where, look, America is going to shrink. I mean – just by very conservative forecast, 20 years from now we'll probably be down to 50 or 60 plants in America, and the rest of the world is going to build probably 200. So there'll be about 600 plants in the

world, 10 percent of them anyways. And if you go out another 20 years, it's probably going to be 2 percent in the U.S. How does America shape the security environment if this trend continues? How do you think about that, as a former national security advisor?

GEN. SCOWCROFT: Well, I think about that a lot. And I didn't even go to the national security aspects of it, which I think are dominant in a way. We're going to have a nuclear world. We're not doing anything. But Saudi Arabia, the homeland of petroleum, is building nuclear plants.

MR. HAMRE: Nineteen.

GEN. SCOWCROFT: Most of the world is building nuclear plants now – rapidly. We're not. The national security aspect of nuclear weapons – of nuclear energy is also extremely important.

And is there a way that we can spread nuclear power for its benefits and control the resulting capability to go to nuclear weapons, which is a world we're trying to avoid right now. And that's a difficult question, especially if we are not in the nuclear power business; then we lose all of our ability to control the development of nuclear energy around the world in a way which provides the benefits of nuclear energy without the detriment of weaponization.

MR. HAMRE: You know, if by 2050 we're down to two nuclear power plants, it's going to be hard to tell China with 150 how they ought to behave with nuclear power.

GEN. SCOWCROFT: Exactly.

MR. HAMRE: But we have now – it seems to me we've sketched out, with both Mayo's comments and Brent's comments – it seems to me the policy dilemma that we're facing, we firmly believe that energy should be grounded in the private sector in America. But the private sector is not going to give price signals that let us build nuclear on an economic basis.

Instead, it's the national security dimension we have to think about. But we don't know how to price national security and put it on top of customers. The only place we do it, basically, is in regulated utilities. And even then, it's not for national security reasons.

So it seems to me that's the dilemma that we're currently wrestling with. Mayo, let me ask you: How did Fukushima change your world. I mean, both as wearing your INPO hat, and wearing your Constellation and now Exelon hat.

MR. SHATTUCK: Well, it changed a lot, as you can imagine. Now, INPO is the organization that came out of Three Mile Island, and it was really designed to collectively have a single self-regulatory body that I think is best described as the body that makes sure that our weakest link is not so weak that its safety standards are compromised. And as a consequence, a methodology was put together where we self-evaluate – and in two-year cycles, all the plants in the United States are actually examined by INPO. And there are very, you know, serious and detailed reports, and they are reported out to a group of people that are all the chief executive

officers in the industry. And it is – it has had an incredible bearing on – it would last 30 years on the overall safety of the nuclear plants in the United States. The best demonstrated practices are, you know, continuously put in place to better each plant. When there's an event, the impacts of those events are turned into lessons learned and then disseminated throughout the industry. And this has had the added benefit, incidentally, of improving the efficiency or the capacity factor of these plants, from what was back in the 60 percent – they were basically operating 60 percent of the time back in the Three Mile Island days, and are now at 93 percent.

So in addition to improving the overall safety of these plants, their productivity has improved dramatically also, which – actually on these bubble charts, you know, shows that they – if they were put in terms of the actual production, nuclear has improved its production not only from that effect but also from uprates of the existing 104 plants. So they have become more important.

And so when Fukushima happened, the day-one instinct of INPO, obviously, was of great alarm, for two reasons. One is the desire to have an immediate understanding of what went wrong and what were the gaps associated between how the Japanese built their plants or what the designs were and us – and, you know, what have their practices been over the past 30 years to improve the safety margin relative to what we did.

So there were a lot of, you know, really detailed technical questions that needed to be understood. And I think surprisingly, this – there wasn't a blueprint for that that you could just look up on day one and say, oh, that was such and such a containment, this is exactly what happened, and therefore we have two plants like that and we need to go address those issues in those two plants. It was not that transparent at all. And in fact, it wasn't transparent until quite a detailed, you know, examination – a commission was put in place, a study of a large group of suppliers and vendors and operators in the United States could put together to try to help understand exactly what happened over there. And I'll come back to that in just one second.

But the second, of course, immediate instinct was, how do we make sure that Washington and others don't – you know, don't go ballistic on day one with respect to an assessment of this gap analysis. And so INPO is not the advocacy arm of the industry. That is NEI. INPO is all about safety and security ad making sure these plants operate well. But in conjunction with NEI, a very important sort of questions – I guess I could put it in the public relations dilemma of getting out into our communities, working with the NRC, working with the administration to convey why 300 million Americans didn't need to panic on that day.

And you'll all remember that in California, they're buying their pills and, you know, local communities were getting stirred up. But I think that the industry did a very effective job getting on the airway. This was all pretty new to us. I mean, it's not like we have a PR arm that is ready to, you know, drive out with, you know, a campaign on day one.

But I think it was pretty well orchestrated that we needed to be present to counteract the hype that was going on with the media, where the focus was all negative, you know, and this was what was happening in Japan. A lot of the information was very bad in those first few weeks and the way in which it was being communicated. I mean, you just couldn't turn on CNN without

seeing the image of the cooling tower. And it was – it was frightening for many people. So we worked very hard at sort of mitigating the effects of that and making sure that our natural allies like the NRC and the administration were, in fact, supporting the industry. And we – you know, during the same period of time, you could see that this was not happening very effectively in other countries, as the politics in Germany quickly swung in the other direction and decided to shut down the whole thing.

But the important thing, you know, after day one was to make sure that we weren't – that there was some instinct, I think, that could have been bad, which was to throw the Japanese under the bus. And that is to say, they do things a lot differently or their designs are a lot different and so forth. And I think that the industry immediately concluded that that was a very bad idea, because the principles of, you know, how you run these plants and most of these designs are relatively common. And so we just – we need to understand the specifics.

And what we learned over time was that it really wasn't the seismic event that caused the problem. It was the tsunami. But the effects of the tsunami on the plant itself were very profound and they led to certain conclusions around things like onsite power – you know, which is a key, key consideration for all of our plants throughout the world, about 440 of them. And the fact that that had been compromised was a severe problem, and we've been immediately ever since doing the reverse engineering to understand what we can do in the States to make sure that we don't have a similar-like problem. The same is true with the venting and the containments, or the evaluation plans and things of that sort that all came to light through these studies. We provided a lot of technical assistance, but we were as eager to bring back all those lessons learned so that both the NRC and INPO could put in place a plan of action of investment in all of the U.S. plants to react to the things that we know were a result of the tsunami. You may think that the seismic issue was relevant there only with respect to what it created. But of course it immediately led to a seismic study, and it will be years of study – of reevaluation here of the seismic credentials of our plants. So even though it actually didn't have an effect on what happened there, it certainly is having repercussions in the years ahead in terms of the evaluation of our plants.

But I would say, generally, that the industry reacted very well from a humanitarian standpoint, a technical assistance standpoint and a lessons-learned standpoint. And now we're in that phase of reinstatement. And it's going to cost us a lot, despite deteriorating economics, to react to Fukushima. And – but I think that the industry is going to be fine, and that is not true of other more mature developed countries that, you know, have taken the political reaction and carried it through to, you know, tearing the plants down. And for all of you who do not know, you know, there's only one reactor still working in Japan, and because they are on a 13-month refueling cycle, that plant presumably would now go down this month.

They do not have an effective process to assess the restart capability. And as a consequence, they are a little stymied. And we are going to see the repercussions this summer, because they will definitely be short power and they're going to have to figure out ways to cycle and go through blackouts and so forth. I think the country at large there is very responsive to trying to help in this respect in terms of usage. But at the end of the day it's going to be very hard to manage.

And one last clarification is that, you know, no one has died there from radiological exposure. There have been people who have died out of stress, heart attacks, you know, displacement in what was obviously a very tragic event. And some could be linked to, you know, the stress of the situation within our own industry.

But the radiological release is still being evaluated. You read last week about the water release into the ocean. There are still a number of things that have to be much better understood. But you know, so far, you know, we didn't have the kind of accident like Chernobyl that had, you know, actual mortalities.

MR. HAMRE: Let me just, so our colleagues here might –

GEN. SCOWCROFT: Could I make just one –

MR. HAMRE: Yes, please, Brent?

GEN. SCOWCROFT: – just one comment on Fukushima, on the national security aspects of it. I was visiting Japan just a month before the earthquake, visiting their nuclear facilities. I didn't go to Fukushima – not their power plants but their processing plants and their proposals for disposing of nuclear waste.

The Japanese that I spoke with were enthusiastic about nuclear power because it gave them back a measure of energy independence. They have run out – the Japanese have run out of coal. So they're wholly dependent on imports of gas and oil for their energy. And nuclear was seen as a way to mitigate that dependency. And so this was a profound shock to them.

Now, as Mayo says, they have one plant operating. They can't start up the plants without the approval of the local regional governors, none of whom are prepared to give approval. This is not a courageous political situation. They can overrule them.

But now, Japan is faced with a fundamental national security problem. The prime minister announced shortly after Fukushima, we're getting out of the nuclear business. But now, they're changing their mind, because if they get out of the nuclear business, where do they get their energy? And they're facing the problem that I outlined, which is down in the future for us.

Germany's done the same thing – we're closing down our nuclear – well, but Germany is being duplicitous about it all. They're just going to use French nuclear energy to power their system. So the problem remains – and as Mayo says, it's very acute in Japan now; they're going to run out of energy this summer if they don't do something about it. And what can they do?

MR. HAMRE: I think what – two very important things I've heard come out of these interventions. One is, as Brent just aid, I mean, there is a profound economic impact of why Japan needs to get back in business, just because they can't afford to slow up their economy. Their GDP is going to take a real hit if all of a sudden energy prices go up 20 percent because they have to import anything.

Also, I would argue we need them to be back in the game as leaders in Asia – I'm thinking about mixed nuclear – because they have been responsible states. This was a very tragic development. But they have been among the most responsible thinking about managing the security side of nuclear. Mayo made a very important point – and I don't know how many of you heard it – and that is that at the time of Three Mile Island, the efficiency of American nuclear power plants was only 60 percent. And in – because of the reforms – largely because of INPO – the efficiency today is 93 percent. We have effectively built 20 nuclear reactors in this country simply by improving the efficiency of nuclear power. Now, that was done by INPO. It wasn't done by the NRC.

That was done by INPO. And just – because I'm going to come to ask a question here – so do you understand why INPO is so important? Go back on that little moving chronology – you remember the Price-Anderson Act; 1957? Now, Price-Anderson Act established the legal liability that the industry had to take on. They had to insure themselves for the first $3 billion worth of losses. Beyond that, the government would step in. But the first 3 billion (dollars), each of the power companies had to pay for that. So they formed an insurance company – a mutual insurance company – so that they could then cover this, and then they have to pay premiums every year. Well, who decides the risk of individual plants and what their premium ought to be? It's INPO. So there's this dynamic. This is an exceptionally important organization. It's in the private sector, but it's an exceptionally important organization.

And I guess – so I come to this – Mayo, share with us how the industry evaluates itself because, I mean, this is – you know, you have to decide – you know, if you run a shoddy – if somebody else runs a shoddy plant, you're going to be paying for it with higher premiums unless you can find a way to bring the industry up. How does that work inside INPO?

MR. SHATTUCK: Well, you know, John, it is uniquely the most interesting culture that I've ever seen because you have at that table – there are about 600 employees of INPO. But you have at the table the guys and women that run the nuclear plants in the United States. So you've got the CEOs of every company. And they've all endorsed the notion that we're going to evaluate each other. And so there is a very, very rigid process of every two years, the plant – an INPO team goes to a plant and ends up rating these plants. And there's a rating system that goes from excellent to needs-to-be-shut-down. It's confidential. But it's very important, as you suggested, to the insurance coverage of each plant. You get a low number, your premiums skyrocket. So there's a natural incentive to do well. The industry is naturally very self-critical.

And so if there is a hint of defensiveness or arrogance or whatever in the response to an INPO evaluation, you know, the board of directors is going to hear about it. So there is fortunately a very high level and consistent respect for the INPO input at each plant.

And one anecdote that I'll give you that gives you a flavor of this – it was a personal anecdote because I was brand new to the industry and I went to my first CEO conference – the annual event. And at that conference – we spend two or three days together. There's a private session where if you have one of these low-rated plants, you have to stand up in front of all your

colleagues and, in effect, conduct a mea culpa and describe exactly everything that you're doing. These sometimes take an hour.

And in the first one that I went to, the CEO was brought to tears in this session, which gives you a sense of the emotional pressure that we apply to each other to make sure that everything that can be done to improve the operating safety of all 104 plants is being done and that we're going to help each other. This was an unusual concept for a guy who had been an investment banker for 20 years and basically wanted a win-win-win, to get into a culture where this wasn't about winning. This was about cooperating and helping each other and making sure that the weakest link didn't destroy us. And that's exactly what happens when you've probably – if there's an incident at Davis-Besse, as there was with a reactor head a number of years ago – you know, the earthquake that hit the East Coast that affect – is it the Santa Anna, the Dominion plant. And fortunately, in an evaluation, that was found to not have affected the plant.

But whenever something like this happens, we need to rally to understand what the lesson is from that, so that we can react. And it's not – you know, these plants are constantly being rebuilt, incidentally. These plants don't go up for 60 years and then get shut down. They are massive ongoing investment. You know, the redo of a steam generator or a reactor head or – you know, the reason that these plants can be relicensed is that the guts of them are constantly being rejuvenated. And so a lot of money goes into maintaining them.

But it a – it has become a very valuable and unique organization for our industry. And it's got a very low profile, naturally, because, you know, we're not in the business of, you know, frightening people about what is an incredibly important technology. We go about conducting out business.

But I would say that INPO was sought out after the Gulf crisis to see whether our model might actually apply to offshore drilling. And there were some very interesting testimony in front of Congress that went back over the history of INPO to try to in a way create a little bit of a catalyst to see whether that industry could get together to talk about best industry practices and hold themselves accountable to making sure that we didn't have a Gulf disaster. That hasn't taken on a great deal of legs, incidentally. And I don't know whether that's the right answer or not. But it's certainly, conceptually, for something that had as devastating a consequence when something goes wrong as an offshore drilling – it's a pretty interesting thing and model to evaluate.

MR. HAMRE: My personal guess is that it will take off, but that right now we're in this litigious environment where people are worried about, you know, getting too out in front of their lawyers and all that. It's going to take a little while probably for it to settle down. But INPO, it's a remarkable success story, where the private sector shares the burden of governance for an important national asset. It's an important thing for people to know.

Brent, my last question and then I'm going to turn to all of you. And that's, you – I don't know how many commissions you've headed up, Brent, national commissions. I mean, hundreds probably. But the most recent one, you and Lee Hamilton headed up the commission looking at what are we going to do the fuel cycle post-closure Yucca Mountain?

And this of course hangs over this industry. It hangs over our popular understanding of nuclear. So just give us a thumbnail sketch. How serious is this problem? How do we solve this problem? You know, what kind of priority do we give to this problem?

GEN. SCOWCROFT: Well, it's a serious problem with respect that nuclear power plants, nuclear energy produces waste. And after you have burned the nuclear pellets – incidentally, we use about 3 percent of the energy, and so there's about 97 percent of the energy left. But we take them out of the pants and then you have to dispose of them, and that's a problem. It's a problem we've spent 30 years on, because everybody understands that it has to be put somewhere – but it's not in my backyard; really, that phrase started on nuclear waste facilities. And that's what this commission was designed to do. For a long time, the government narrowed the focus, narrowed the focus and then decided that Yucca Mountain was the solution. Well, the Nevada government didn't like it. The counties in which Yucca Mountain existed wanted it. But the state didn't. So anyway, the president said, Yucca Mountain is dead.

And he set up this commission to look at alternatives. We do have nuclear waste that is waiting at decommissioned nuclear plants for storage. The nuclear utilities are the utilities, are paying the government for storage of nuclear waste. And it isn't being stored. So this commission was set up to deal with that problem. And that is what we're trying to do.

To give you an idea of the scope of it – and incidentally, even if we revolutionize nuclear power plants, even if we reprocess and so on, there still is going to be some nuclear waste that is highly radioactive material that has to be put away somewhere because we can't figure out how to get the energy out of it.

But the nature of the problem, at least – and Mayo, maybe you can refine this – the nuclear waste that's been produced so far is about the size of a football field, 20 feet deep. Now, you know, that's not an awful lot. But it has to be shielded, it has to be protected, and at least some people say it has to be protected for millions of years.

Well, we're actually looking. And in New Mexico, there are salt deposits that have remained unchanged for 300 million years. So there are ways to do it. But the problem is, how do you make it acceptable to the people. And that's what this commission is trying to do.

MR. HAMRE: I was on the floor of – I was a staffer in the Senate when then-Senator Chic Hecht said we're never going to let Nevada become the nuclear suppository for America. (Laughter.) I'm not sure that was a Freudian slip, actually. I think it was – but anyway –

GEN. SCOWCROFT: But there's one place in New Mexico near the Carlsbad Caverns call the way – WIPP – Waste –

MR. HAMRE: Isolation Pilot –

GEN. SCOWCROFT: Isolation Pilot Project. It has been enthusiastically embraced by the locals in New Mexico, and generally by the state itself. So it can work.

MR. HAMRE: But Brent, I think to your point, though. I mean, this is not the mountainous problem that's made out in the popular press.

GEN. SCOWCROFT: No.

MR. HAMRE: I mean, there's a nuclear facility, I think you own it, about 20 miles from here. It's been operating for 25 years. The entire waste stream is stored on the equivalent of two tennis courts. I mean, this is not the giant problem –

GEN. SCOWCROFT: No, it's not a huge problem.

MR. HAMRE: – that people make it out to be.

GEN. SCOWCROFT: It's a huge psychological problem.

MR. HAMRE: It's a psychological problem.

GEN. SCOWCROFT: Because, you know, in my commission we've had public hearings around the country. And one woman got up and she said radiation is the worst thing that's ever happened. It's responsible for obesity, for diabetes, for – you know – (evil ?). But it's that kind of fear which is what you have to deal with. And I think the way to deal with it is to show that it can actually be attractive, because near a nuclear waste facility you can have a nuclear research laboratory hiring a lot of very intelligent people – what can we do with nuclear waste, how can we make it productive and so on. So there are ways to do it.

MR. SHATTUCK: You know, if you just – if you just visit Yucca Mountain and – you know, which is a remarkable thing; you feel like you're on the moon. There's no other place like it in the United States I don't think and it's, of course, where we practiced our bombing in, you know, earlier years. So it has some experience with the industry.

But Yucca Mountain, you know, is a geological repository. And there's a big, you know, five-mile hole with a train that goes down through it. And it's designed so that you can take these titanium canisters that have the spent fuel in them and slot them into a spot where, in theory, they could be recovered a hundred or 200 years later and used again. As Brent said, you know, there's still a lot of energy left in spent fuel, and the technologies might be available a hundred years from now to reuse what is put in there. But if you actually physically see the simplicity, not just in terms of how small the physical volumes actually are that we're talking about but that, you know, there are ways to care for this that are a lot smarter than having it sit onsite at our plants – now, these are also safe but sort of temporary holding facilities. And it really has been a shame that we haven't been able to move this off the dyne. You know, it's very much about local politics. But from the standpoint of the science and the safety of it, it's – you know, it really was quite a sound idea.

MR. HAMRE: OK. I've taken too long and I apologize to all of you. We've got about 15, 20 minutes. We can open up for conversation here. We do have microphones, I think, right?

And we do want you to use the microphone because we've got friends in cyberspace. So we'll start right over here, please. Yes, ma'am?

Q: Hi. My name is Peggy Evans. I'm with the Senate Intelligence Committee. And I've been reacting to the psychology issue that you all mention. One place in the United States where we haven't had that problem is with the U.S. Navy. And in fact, the Navy has in humanitarian instances provided power from its vessels to areas that have suffered some sort of meteorological problem.

Given that, how would you react to a proposal that echoes a decision made by President Kennedy to put a large – or to make – for government policy to make possible the implementation of large transmission lines around both coasts, and then to use the technology that exists in naval vessels to start – on an offshore basis – to start offering the opportunity to U.S. industry to invest in large transmission lines and then begin to implement other sorts of power beyond the carbon fuels – wind, wave, nuclear – using that technology that doesn't have the same emotional reaction that the large land-based power plants do.

GEN. SCOWCROFT: Well, let me start while you're collecting your thoughts. Because – you know, you talk about Navy nuclear power as if it's pristine. It has the same problems that other power – what do you think happens after, when they decommission a ship?

It goes out to Idaho. And Idaho has passed a law that by 2035, it all has to be gone. Where's it going to go? So it doesn't – it doesn't solve the problems by taking it offshore and building the power plants offshore, if that's what you have in mind.

Q: It wasn't the storage I was referring to.

GEN. SCOWCROFT: Well, I know. But you have to do something with it. And the storage is the same problem, whether the plant's in Illinois or whether it's in a ship sailing around the world.

MR. SHATTUCK: Me, I'm not the expert on this but, you know, there are oddly enough the same number of rectors in the Navy – 104 reactors – as there are in the commercial side. And of course, they are a lot smaller and they require and use much higher levels of enrichment, and which is – and it would be against international standards, you know –

Because I've asked this question: Why don't we just go to, you know, sort of higher power levels, and – you know –

But because of the international standards, it would not be regarded as, you know, acceptable. They are, of course, unbelievably expensive, right, when they're, you know, designed as such, to be in a naval vessel. And so I think as a consequence, there's always something that's, you know, more efficient.

And I – you know, it gets back to this issue of, you know, should there be nuclear capacity in the United States that, you know, survives this generation of plants. And you know,

of course I'm a big advocate for nuclear and feel like the footprint, the generation footprint of 50 to 60 years from now has to have some nuclear. And for us – in a business where it takes so long to build things, to just presume that natural gas is going to be the fuel choice forever is, you know, to me a little naïve. And all it would take between now and 10 years from now is for there to be carbon policy implemented or, you know, a terrorist attack on a gas pipeline, you know, or something that happens to the cost deck in fracturing, you know, that would, you know, rapidly raised the cost of extraction from an environmental standpoint.

I mean, so there are all these things that to me are – could easily occur and just in the next few years that would change the game again. So the big paradigm shift that we're all just assuming is, like, this endless windfall – I wouldn't trust that, as someone responsible for the reliability of the grid.

And so the thing that makes me most nervous – and you know, I probably won't be alive, you know, on the day where, you know, people wake up to the issue, which is that we can't be dependent on a single fuel type. And so if we are going to ignore the dialogue we're having today and just say, now, what the heck, let's just – you know, we will keep putting up gas plants, there's no – in the near term because that's what price signals are telling us. But we have to deal with the policy issues because what I just described is a national security problem. You know, if we got to the point in 20 years where we're dependent on one fuel type and something radically changed, and all of a sudden we've got an unstable grid and God knows what could happen to us.

So the idea of having a mix is that we have to have policy considerations that keep in mind that we don't want the end game to be a hundred percent of anything. And you know, the intermittent energy sources like wind and solar, you know, we're very supportive of it, and we're in the game and so forth. But you know, they can't be more than a certain percentage of our total output. So I consider it not just a national security problem as it relates to supporting our military establishment. You know, there's one big issue which is that our supply chain and vendors and so forth, we have gone from an era where 90 percent of all the stuff that went into our reactors came from the United States to it being just the opposite now. And so we've lost the supply chain game which has an effect on the military establishment, which I think is – you know, we don't have the people interested in nuclear, you know, coming through the schools and we don't have, you know, people building, you know, important components to nuclear standards.

So I think that that's – I think that's a national security issue, and I think bad decisions on the diversification of the generational footprint is a national security issue. And when you put those two things together, I conclude, you know what, we've got to figure out a way to keep nuclear in the game. And that's – you know, which is why I think why this kind of dialogue is so important.

MR. HAMRE: Jim Hoagland?

Q: Thank you, John. Jim Hoagland from the Washington Post. It was Fukushima that brought INPO to my attention, and what I've learned has impressed me. And that extends to your remarks this morning.

I wanted to ask you, in that spirit, about a reference you made to the fact that INPO can issue a notice saying this plant should be shut down immediately. Has that ever happened? If yes, can you describe how it was resolved? If no, what's the most dramatic notice of that kind that you're aware of and how was it resolved?

MR. SHATTUCK: Well, you know, that is a complicated question because when a plant is in trouble, usually there's a decision that's made that's quite simple to keep it offline. And that is usually a collection of decision makers that might involve – certainly would involve the NRC, would involve INPO and would involve the company itself, just thinking about, you know, in the natural course what's safe.

And so we certainly have a lot of plants that over – I shouldn't say a lot – we have had some plants that over the course of time you would consider being of the lowest rating. But they do – they're not on. And so right now, as an example, the Ft. Calhoun plant in Nebraska is offline because of those floods and the impact and assessment of the floods in Nebraska. And the NRC and INPO, you know, we're trying to figure out how to get it back online. When it comes back online, it will soon thereafter get a rating, and one would hope it would have a rating of – you know, that's satisfactory. The San Onofre plant in Southern California is offline. There are a lot of concerns about understanding – once again, as always in the California plants, including Diablo Canyon, the seismic impacts on those plants.

But we've never had an instance that I'm aware of where we've had to force against the wishes of the company that a plant had to shut down because we felt that it was unsafe. I think they were hopefully way in front of the game on that front since Three Mile Island where, you know, we knew long beforehand that this plant needs a long outage, needs to do X, Y and Z, and they react accordingly so.

MR. HAMRE: I think, just for the mechanism, because I think it's – yeah. The mechanism, I think, Jim, is that INPO rates for purposes of insurance – what a rating would be – and if they give it the lowest rating, the mutual insurance company – NEIL I think it is –

MR. SHATTUCK: Yes.

MR. HAMRE: – will not write the policy. And by law, you can't operate a plant if you don't write the policy. So I think it really is a powerfully positive dynamic on how this works in this industry. We've got a question over here –

MR. SHATTUCK: Dave, did you want to – I think maybe Dave wanted to add a piece.

MR. HAMRE: Can we just over to Dave first and then – he's also a member of our commission.

MR. SHATTUCK: And he's a real nuclear expert.

Q: David Heacock of Dominion. And I just thought it's worth commenting and asking you to comment on this waste problem issue in comparison – in two regards. One is the nuclear industry tracks its waste, which is very small and compact and solid in form, to the nearest gram. And we know where all of it is. And the cost of that is internalized already through the collection of fees from customer, to the tune of, you know, somewhere around $15 billion thus far.

So the question is, if you use this scenario above, would the rough carbon equivalent result of this as an additional 400 million tons per year of carbon going into the atmosphere?

So would you rather have a small compact waste form, where you know where it all is and easily isolated and separated from the environment, where the costs are already internalized, or would you rather have this other problem of 400 million tons of carbon going out where the costs are not internalized? And I'd like for you to maybe comment on that internalization of the waste form and the tradeoffs between those two.

GEN. SCOWCROFT: Well, I think it's remarkable that we have ignored the costs to society of our coal and oil-fired plants. And – but we look at the statistics that result, but we don't internalize them as making any difference.

And that's where I say there's a psychology about nuclear which doesn't flow out to the other energy producers. And it's probably because they've been around forever and they're just part of the environment. We did pass the Clean Air Act, and it helped a lot. But just because you can't see it doesn't mean it's not there. But that's one of the psychological problems that we need to deal with, both making the nuclear – put it in its perspective as to how important it is and how it does or does not affect people, and what it is we're replacing – not just because it's running out but because it's a hazard to human health.

MR. SHATTUCK: You know, a lot of the – when the carbon debate was in full force, it appeared that most people thought that the electricity industry should reduce its contribution to carbon, which is significant, by 80 percent over a certain period of time.

And so we began to put together forecasts of, well, how much you reach – you know, an 80 percent reduction in our carbon imprint; you know, obviously the coal being the main contributor to that, being 50 percent of all generation in the states.

And you know, so you needed a lot of renewables and you definitely needed a lot of nuclear. And, but you know, the one thing that always was the sticking point, as attractive as gas was, is that gas still has 50 percent of the carbon imprint as coal. So you can't – you can't put into that model anything that has lots and lots of gas and ends up with the 80-percent reduction.

So there was just – there's a limit. And getting back to the generation mix issue, that yes, we should – we have not been good in America at pricing the externalities – the environmental externalities into the price of power. And as a consequence, you have federal and state issues that are complicated, that I think the EPA is trying to resolve through policy. But if you're a Maryland generator, as we are, and you're working towards the Healthy Air Act standards in Maryland, which are the tightest in the nation – but West Virginia is not, and they're burning

coal and they're shipping their power into Maryland – which we're a 30 percent importer of power – and we're getting all their air emissions coming in our direction.

So all of our own efforts – that's an economic unfairness issue that hasn't – this is why there's a sort of an interstate commerce-related issue. But it's a small anecdote of why this business is – gets pretty complicated, from a policy standpoint. And we have to keep in mind that, you know, as Dave rightly points out, the externalities of nuclear are actually – you know, have already been built into the pricing. We've raised $15 billion to, you know, build Yucca Mountain and try to get to the solution, and potentially that will all go by the wayside.

MR. HAMRE: Sir, I'm going to give you the benediction, because we're going to wrap up with a last question.

Q: Dave Garman, with Decker, Garman, Sullivan; with a question for Mayo, really. We've outlined a scenario that I venture to guess that very few of us in the room like, and it's dictated by a failure to enact any kind of carbon pricing and low natural gas prices.

I guess the question arises: Is there an opportunity for something, you know, to change that outcome, to change that scenario – with innovation, say, in small modular reactors, you know, factory-fabricated, rail deployable, mass produced SMRs that might change the business case, you know.

MR. SHATTUCK: Yeah, I think that that's – that really is the great hope here, that – particularly with SMRs – that, you know, technology advances and that we – you know, we're able to figure out another way to use the science that's efficient and effective. It's not there yet, and one of the key considerations in all of that is not just the production of the power, but there's a lot of infrastructure that goes around the plants. Getting back to the – you know, this is another kind of security issue – (chuckles) – which is that, you know, the protection of our plants is second to none in the world.

MR. HAMRE (?): That's right.

MR. SHATTUCK: You know, you go to France and visit a French reactor, and they have five security guards and rely on the local gendarmes for security. I don't know how long that will last. I will say that I can't describe what it is on our front, but it is a lot different from that. And if you visit a nuclear plant, you observe that. But the natural security infrastructure required around anything nuclear is vast in this – you know, and important in this country.

So this is where I get a little bit tricked up on the issue of the SMRs; is that, you know, even if they are – you know, like Bill Gates wants to bury them, you know, underground and they never need to be refueled for 20 years and then they just sort of die out – I mean, a lot of different notions in this respect.

But at the end of the day, there are some infrastructure costs that don't go away. And – but having said that, you know, I think that, you know, it's not an industry that's known for, you know, technology innovations; you know, rapidly changing things. I would say that, obviously,

gas is the biggest paradigm shift in, you know, 50 years, just in terms of the efficiency of the extraction. And that is changing the game. So hopefully there will be either another technology or a combination of technology and policy that lead us back to, again, the generation mix of the future that is well-balanced and well-thought out.

MR. HAMRE: Look – double thank-you's here. First, I want to say thank you to Brent and Mayo for chairing this commission. We will have – our commission report will be out in July. And the second thanks is of course for leading a fascinating discussion today. You know, our goal was to try to have Americans think about nuclear power. We don't think much about it.

And the goal here was to try to put the dimension – the richness of this issue in front of all of you with the expectation that you're going to carry this conversation further. So would you please thank these two men with your applause? (Applause.) OK, we've got 15 minutes. There should be sandwiches or boxed lunches outside.

(END)