

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE

**NUCLEAR ENERGY, NONPROLIFERATION
AND ARMS CONTROL IN THE NEXT
ADMINISTRATION:
IS NUCLEAR ENERGY THE
ANSWER?**

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GEORGE PERKOVICH: I've got to make sure my cell phone is off. Actually, if you have a cell phone that works here, you're lucky. Mine doesn't work here and I live here. (Laughter.) My name is George Perkovich. I'm vice president for studies here at the Carnegie Endowment. And I welcome all of you this morning.

We're really pleased to have this panel and these panelists to address the question, is nuclear energy the answer? Now, I'll just say a couple of words briefly that institutionally and also you'll see in the fine policy brief that Sharon Squassoni has done. We don't have an answer to that question or a stake in the answer to that question, but we do – and Sharon's work clearly shows and manifests – have a strong sense that whatever the magnitude and pace of the expansion of nuclear industry worldwide, it's very, very important to do it right.

And so that's what the effort here is primarily, to understand more about what it would mean to do it right, what are the implications of or definitions of doing it not right, and to bring in people from industry, from finance, from the technology side, from the regulatory side, from the business side, to over the next couple of years really interact around these questions of the so-called renaissance, but also what it would mean to do it right. And you have an example of that approach in Sharon's policy brief and also on this outstanding panel that we have with us here.

Charles Ferguson is going to moderate the day and say some further introductory words. I just wanted to introduce Charles and Sharon and Alan and then I'm going to get out of the way. Sharon Squassoni, who's the author of the brief that I hope you will all pick up, and not only pick up, but read, is the – (laughter) – which is a much rarer thing in Washington and we don't really have pictures in it or, you know – Sharon's a senior associate in the nonproliferation program and her general work is on nuclear nonproliferation and international security, but as you'll see with this paper and a much larger study that will be coming out shortly, she's really been focusing a lot of work on nuclear industry and energy questions going forward.

Before joining Carnegie, she served 14 years most lately at the Congressional Research Service, prior to that the State Department, prior to that at the late and mourned Arms Control and Disarmament Agency, and did a lot of distinguished work in all of those jobs, but the CRS, many people will remember who were fortunate enough to be on the mailing list there, fine reports that she did on a number of these questions.

Alan Hanson is executive vice president for technologies and used fuel management with AREVA. He's also the CEO of Transnuclear Incorporated, which is also an AREVA company. Transnuclear designs, licenses, and supplies dry storage casks and as I understand it, more than half of the casks used in the U.S. are produced by his company. Alan has experience with the International Atomic Energy Agency. We've worked a little bit together on another project that the American Academy of Arts and Sciences is doing and it's been a real pleasure for me in that project to get to know Alan a little bit. He's had some really impressive contributions on all these issues, so we're delighted to have him.

And then lastly, but who will be firstly, is Charles Ferguson, who's the Philip D. Reed Senior Fellow for Science and Technology at the Council on Foreign Relations and adjunct professor of Security Studies at Georgetown University. Charles is an old friend. I should add Charles has the extremely difficult job of managing and chairing the Council on Foreign Relations' taskforce on the future of U.S. nuclear policy, which is a collection – the taskforce is a collection, kind of across the

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spectrum of the U.S. establishment on these issues, and so if you can imagine – I mean, it gives bipolarity a different name. (Laughter.) And if Charles requires pharmaceutical help to manage this, I would be totally sympathetic; if I could write a prescription, I would. But he's done an outstanding job in working so far on this commission, which I know has taken a lot of time. But he's done a lot of work on nuclear energy questions and nuclear industry. He wrote an award-winning report, commercial radioactive sources. And he's going to moderate and we're excited to have him here.

And I'll get out of the way now. Thank you.

CHARLES FERGUSON: Well, thank you very much, George, for that kind introduction. And George is too modest to mention that he is one of the members of the CFR taskforce on U.S. nuclear weapons policy and he's been a tremendous help in keeping my sanity during this process, trying process, but I think we're going to come out with a high-quality report. So good morning, everyone.

I think most of you know Sharon through her excellent work. And George mentioned her extensive career in government and also in the NGO world, so I won't tell you about that again. I was privileged to have met her about eight years ago when I was working on nuclear safety issues at the State Department. And I've been admiring her work since then. With this newly published policy brief, Sharon has once again demonstrated her exceptional ability to give us a much needed reality check as to what nuclear power can and cannot do to provide for energy security, to wean U.S. and other countries' dependencies on foreign sources of oil, and to combat climate change.

Her policy brief also tackles and gives clearly reasoned answers to the pressing questions of, can nuclear safety be maintained at the high standards if the number of reactors and associated facilities greatly expands? Is an acceptable solution for nuclear waste at hand? And can nuclear power be expanded in such a way as to adequately control the added risk of proliferation.

In a few moments, I'll turn the stage over to Sharon and let her describe the policy brief, but I'd like to underscore just three major points she'll expand upon. Number one, nuclear energy does not exist in a vacuum. We need to examine this energy choice in a comprehensive assessment of a country's energy needs. As Sharon's report points out, building nuclear plants requires a long time and we need to weigh all the costs, including safety, security, and environmental costs when considering our energy choices.

Two, be careful of substituting one dependency for another. While the world appears to be many decades away from peak uranium production, that day will eventually come. And if nuclear energy experiences a major expansion, peak uranium production will come much faster. We need to keep in mind that nuclear reactors can last a long time, perhaps 60 years or longer. Will nuclear fuel that is relatively cheap now always be so cheap? A potential future shortage of uranium fuel under a nuclear power expansion is one of the main reasons that the Global Nuclear Energy Partnership, GNEP, has been trumped. The advocates of GNEP anticipate a world shifting to a massive use of plutonium-based fuels. Are we prepared to live in that world? Can we ensure that this plutonium will not be diverted into nuclear weapons programs, either state or non-state based?

And finally, nuclear energy is special. It's not just another way to boil water. As Sharon's report points out, no other energy source requires safeguards against proliferation into weapons programs. No other energy source can produce accidents that could have catastrophic

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consequences, although safety has dramatically improved over the last few decades. If you remember only one point from these opening remarks, it should be this: read Sharon's report. Tell your friends and colleagues, read her report. Tell politicians and policymakers, read her report. This is the best current definitive study on the issue of nuclear energy policy. I give you Sharon Squassoni.

SHARON SQUASSONI: Thank you, Charles. (Applause.) I'm actually going to sit here because I have a few slides and – just a few, and no maps today. A lot of you have seen my – I'm sorry – briefing slides that have a lot of maps of nuclear energy. But thank you, George, for the introduction and Charles, for the nice introduction.

I'd like to just start with telling you a little bit about the genesis of this policy brief. And it's been based on about a year's worth of research into the nuclear energy renaissance, which I like to term, energy enthusiasm, which I think is a little more accurate. It's a huge topic and hopefully we'll give you a few tantalizing snippets here this morning that might whet your appetite for this longer report that should be published soon. I have benefited from several larger research efforts in collaboration with folks from the American Academy of Arts and Sciences, Charles' own project, Council on Foreign Relations, NYU, et cetera.

I wanted to ask or wanted to answer a fundamental question about the nuclear renaissance and perhaps I'm going to date myself here. Some of you may remember an ad campaign by the company, Memorex, maybe it was 20 years ago, is it live or is it Memorex, is it live or recorded? And if I were to update that I would say, is it Sarah Palin or Tina Fey? (Laughter.) You know, is this renaissance happening now or how much of it is hype? And I think the answer is really, it depends. But a few things are clear.

First, I think it's clear that without substantial policy support and aggressive financial support that nuclear energy's global market share of electricity generation is expected to decline. It is right now about 15 percent globally. And projections that don't take into account major changes because of climate change concerns say that it's going to go down to about nine percent by 2030. There are a lot of reasons for this.

One of the fundamental reasons is that electricity demand is expected to go way up. I think it's about 85 percent. And sustaining nuclear energy's market share is going to require building a lot of nuclear power plants. What we also have to consider is that many – we have many aging nuclear power plants and those will need to be replaced. And I think in the U.S. one estimate from Booz Allen was that this would mean building 45 reactors by 2030. A second thing I think that's clear is that if we're talking about a nuclear renaissance, we're not just talking about numbers, numbers of power plants worldwide, we're talking about also a specific distribution.

You know, some scenarios posit that climate change requirements could mean doubling or tripling current reactor capacity. This could also mean twice as many countries with nuclear power plants. It could mean new types of reactors. And, in fact, a lot of the developing nations that are now looking at nuclear power will be, I would say, better off with smaller types of reactors and I would also say proliferation-resistant types of reactors. A nuclear renaissance could also mean new suppliers: China, South Korea, perhaps India. It could also mean closed fuel cycles that include reprocessing of spent fuel and potentially new countries with sensitive nuclear fuel cycle technologies, like uranium enrichment.

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And so if this is the case, there's the potential for additional proliferation risks. And that's where I've focused my recommendations in the policy brief on.

Well, let's take a look at if we need substantial policy and financial support, what could drive that? And there's the notion that we've seen in the press and in more substantive analyses that nuclear energy enhances energy security and it will significantly help climate change. And you might have noticed two weeks ago the OECD nuclear energy agency turned 50 years old and it released a report and a lot of that report focused on these two drivers.

On energy security, I'd like to make two points. And the first is that if you're looking to reduce dependence on foreign oil, nuclear energy is not your solution. This may seem like a very, you know, simple, obvious fact, but I think it gets distorted in the media. And I want to show one chart here. Let's see, okay, so this is an incredibly complicated chart. But basically it's all the energy inputs and where they wind up. And you can see that oil, the green on the bottom, has a lot of different uses, right, mostly in industrial and transportation uses.

Nuclear energy – wait, I'm trying to see, where is it, it's the red – it only produces electricity for now. And so this inherently limits its ability to substitute for oil. In the U.S., what this means is that it translates, when you look at oil, that oil is only used for about 1.6 percent of electricity generation. This is not the case for all countries, clearly. When you look at oil-producing nations in the Middle East, they're much more – they use a lot more of their oil for – or a lot more of their electricity generation comes from oil. It's about in the 30-percent range. And so, you know, they're not looking to reduce their foreign dependence on oil, but they are looking to reduce the opportunity cost of using that oil in their electricity. In other words, they need to make money from that oil for exports. And so for them, it makes sense to move away from oil to generate electricity as the prices have risen.

I would say one of the myths that gets perpetuated is that, you know, look at France and Japan, these are two nations that have used a lot of nuclear energy to reduce their foreign – their dependence on foreign oil. This actually isn't the case. And if you look at a study by Michael Schneider, he'll show that, you know, France's oil – dependence on foreign oil has actually gone up over time. And the fundamental reason is the transportation sector.

Now, if eventually we do deploy widespread use of plug-in hybrid electric vehicles, that could change that trade-off and that could be a very positive thing. Natural gas is another case. You can – nuclear energy can help reduce on foreign natural gas. But as this chart shows, you know, you use natural gas for other things as well, including residential and commercial heating.

The second point I want to make about energy security and nuclear energy is that countries pursuing nuclear energy are going to have to live with foreign dependence. And perhaps it's better to think about this as, you know, embracing interdependence. You know, a lot of factors play into this. The location of uranium, the structure of nuclear fuel supply, it's not just uranium mining and milling, but conversion, fuel fabrication, enrichment. The structure of the nuclear supply industry right now is very much concentrated in a handful of suppliers, including AREVA.

On climate change, there is no question that nuclear energy is a virtually carbon-free electricity source. I can't say zero carbon, because there is some carbon that when you do a life-

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cycle analysis comes from the uranium mining and milling. But I'd like to make just a couple of points here. We need big reductions of carbon dioxide emissions now. Not in 2020, not in 2030, but 2012 to 2015. And you need them now not just in power generation sector, but across all sectors, transportation, building efficiency. And most of the analyses show that efficiency is the number-one option.

So you have to really view the contribution of nuclear energy in that broader context. If you do – I mean, most analyses often also say that – and it's true – nuclear energy will continue to be part of the mix. I don't think that there is a major, you know, country with major nuclear power plants that is looking to totally get rid of them. But the question is, you know, how much does it contribute to the needed carbon reductions? Let's see.

This is a lot of information, but the one point I want you to take away from it is these are mostly International Energy Agency climate change scenarios. When you look at the column that says nuclear percent of carbon dioxide reduction, you're getting, for the most part, six to 10 percent, maybe a little bit higher. The bottom line is the MIT 2003 study with a higher – but you're looking to build many, many, many reactors for a percentage of the carbon reduction that is, you know, somewhere between six and 15 percent.

What this leads you to ask is, all right, if we're going to go down that route, how many reactors do we have to build and how quickly can we do that? The nuclear industry, there was a high rate of growth in the '70s and '80s, but the historical data show for the last 20 years that there have been between six and 10 new reactor construction starts in the last 20 years. And so a significant question is how long will it take the nuclear industry to retool? How quickly can they ramp up to building on the order of 25, 30, 45 reactors a year?

So stepping back from energy security and climate change, what are the other possible hurdles for new nuclear build? I haven't included many – any cost data here in my slides, Alan and I were discussing before this, you can use almost any cost estimates. There is such fluidity at this point. Historical figures are not a good guide to what new nuclear power plants are going to cost. Moody's, the credit rating agency, said last October, you know, there's no good baseline from which to judge this. And now we have on top of this the financial crisis and the credit crunch. And so a large percentage of the costs of nuclear reactor construction is in financing. And so it's a significant question how the nuclear industry, both in this country and abroad, will be affected by that. And I'd like to just put in a plug for a session we're going to have here on November 13th looking at that very question, just for the U.S.

On the other three areas in which there are hurdles – safety, waste, and proliferation – I'll just briefly touch on them. On safety, there have been some definite improvements over the years, but the question, when you're looking at a nuclear renaissance, is how will the safety cultures that are required and that take time, how will they develop in some of these new countries? If you have between 30 and the most recent estimate I've seen is 50 countries that are now looking at nuclear power, how will they approach this? How can we put in place the kinds of, you know, good practices that we want to see happen?

On nuclear waste, we're still looking for solutions. Fifty years after that first reactor lit a light bulb, we don't have a geologic repository. The U.S. and Finland are closest. Well, maybe I'll delete the U.S. Finland is closest to coming up with a geologic repository. Even if you reprocess, if

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you recycle spent fuel, that doesn't obviate the need for doing something permanently with the waste.

And then on proliferation, you know, there's a big divide in the nonproliferation community, what is the risk of nuclear power reactors versus other types of nuclear facilities, research reactors or sensitive fuel cycle facilities? Regardless of where you come down in that debate, you have to look at the countries that are pursuing nuclear power now and ask several questions. What is the extent of political instability, regional instability, terrorist activity? We need to take into account all of these considerations.

And so let me just go to the recommendations. First and foremost, and Charles mentioned this, I think we need to compare all energy options when we're looking at climate change, particularly efficiency. We can't just look at nuclear energy just in, you know, as one technology or just as one solution to generating electricity. We need to look across the board at all the options. I think we need to take the glamour out of nuclear cooperation. You know, the U.S.-India deal is a perfect example of this. Some of the press around it suggested that, you know, the entire U.S.-India relationship hinged on this nuclear cooperation deal. (Chuckles.) We need to de-link those.

And, you know, one potential solution is to – right now, the U.S. and other countries have separate diplomatic initiatives because nuclear energy is special. They have separate diplomatic initiatives to talk to countries about nuclear cooperation. Just fold it all under, you know, the broader energy cooperation and discuss the whole range of issues. We need to use the additional protocol, which is the system that the International Atomic Energy Agency has devised from 1997 to enhance inspection capabilities and information and access. We need to use that as the standard for nuclear supply. The nuclear suppliers' group has not been able to agree on this yet and we really need to move forward on that.

Two related recommendations are, you know, we need to supply nuclear reactors and components responsibly and increase transparency on what the range of nuclear suppliers are doing, both at the government level and at the corporate level, and tighten restrictions on sensitive technologies. You know, in the nonproliferation community, a question that has been debated for four years is how do we restrict the trade in uranium enrichment and, to a lesser extent, reprocessing technology? These two processes, you know, they can produce nuclear fuel or fissile material for nuclear weapons. And so we need to support that process for tightening the restrictions.

We need to give priority to small proliferation-resistant reactors. Currently, the industry standard is a large, you know, 1000-megawatt reactor. A lot of countries, smaller countries, their electricity transmission grids won't be able to deal with those large-size reactors, and so even though, for example, Westinghouse has a 600-megawatt reactor, they're not marketing it. And there is a real possibility that, for example, the Chinese and Indians who make smaller reactors will move into that market.

And the last and perhaps radical recommendation I have is to phase out or work towards phasing out national enrichment capabilities. And here this goes to my fundamental conclusion that part of the problem that we face with Iran and with other countries on this issue of enrichment is the prestige that's associated with having a national enrichment capability. Even a country like Brazil, which, you know, started out with a nuclear weapons program and, you know, joined the

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NPT, renounced nuclear weapons, there's still a lot of prestige associated with their national enrichment facility. And so how do you get at this problem?

And the conclusion that I've come to is that you need to make it so that nobody has a national enrichment capability. And how you do that is through a legally binding treaty. Bring it under a fissile-material production cutoff treaty. And the logic is that, well, if no one's making fissile material for weapons, there's no particular need for a national enrichment capability. So I throw that out on the table. Obviously, more work needs to be done there, but we can discuss it in the Qs and As. Thank you.

ALAN HANSON: Okay, good morning. Is this on?

MR. FERGUSON: It should be.

MR. HANSON: Okay, good. Let me start by addressing some of the questions which have been posed. George posed the question, is nuclear energy the answer, and I guess the best way to respond to that is it depends upon what the question is. But if we're talking about energy security and climate change, then I will say in no uncertain terms nuclear energy is not the answer. And I don't know anybody in the nuclear industry who's running around saying it is the answer. But it is part of the answer. It's part of the solution to both of those problems. That's the first thing that we need to recognize.

The other questions were posed by Sharon in the title to her brief and I now understand why she didn't try to answer them. (Laughter.) Nuclear renaissance: is it coming? Should it? And I'll also answer that by saying, yes, and yes. Now, when I was invited by Sharon to come and comment on her policy paper, she said I could tear it apart or even ignore it if I wanted to. And I'm not going to do either one of those because I happen to agree with George. It's a nice piece of work and there is much in here to agree with. In fact, I had a rather difficult time finding things in here that I would violently disagree with.

But let me walk through the question she poses and try to provide some comments from an industry perspective. Sharon's absolutely right with regard to oil dependence. We shouldn't cloud the nuclear issue with oil, at least not in the short term, because we have already pretty much phased out the production of electricity in the United States and in much of the Western world from oil and we have moved to nuclear, natural gas, and to some extent renewables, and, of course, coal, which is still in the United States the biggest source of fuel for electricity production.

But energy independence is something – I hate this phrase because people look at this as some sort of a wonderful world where we put up a fence around the United States and we don't need to go to anybody for fuel. Not only can't this happen, it shouldn't happen. I like Sharon's use of the word interdependence. I think an interdependent world is a far better and safer world in the long term.

What we do need, however, is to pursue energy security, security of supply. And the best way to do that is to have a widely diverse source of fuels from a wide variety of countries around the world. Nuclear energy does have the advantage of being run with uranium fuel. Uranium is pretty widely distributed and it happens to be distributed in some of the more democratic and friendly nations of the world than is the case for oil.

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So we do need to have a diversity of supply. In the long run, if we're looking at climate change – I didn't look at all the details of Sharon's slides, I couldn't see them, but it depicts where we are today. And the – we have two problems with regard to climate change and one of them is the electricity sector. The second one is the transportation sector. And in the long term, I don't know anyone who doesn't believe that we need to move away from a petroleum-based transportation sector to an electricity-based transportation sector. This would include an increase in mass transit and particularly in trains and also eventually to automobiles.

And so nuclear does contribute to the transportation sector, at least in a small way in this country. Charles came back from New York on Amtrak yesterday and –

MR. FERGUSON: Two hours late.

MR. HANSON: Two hours late.

(Laughter.)

MR. FERGUSON: (Inaudible.)

MR. HANSON: And not because of the nuclear electricity that was used to run the train.

MR. FERGUSON: (Inaudible.)

MR. HANSON: So I think there are some real improvements that can be made in this area in the long term. But it is the long term because just like it takes a long time to build nuclear power plants, it takes a long time to turn over our transportation fleet. That's somewhere between 13 and 17 years to turn over the whole fleet of automobiles, so if everybody bought a hybrid tomorrow, you'd still be looking at a 20-year solution. And, of course, that's not something that we can do.

The second question had to do with climate change. I've already addressed that in part. And I don't want to diminish the contribution that nuclear can make to climate change, partly because it already is. I don't think that we would be living in a very easily remedied world if we replaced the 20 percent of nuclear electricity in this country with fossil fuels. And, in fact, if we turned back the clock and never moved into nuclear energy, we would be burning 20 percent more fossil fuels than we are today. And most of that would be coal and our U.S. contribution to global warming would be even more than it is today.

So I would recommend first that we try not to do any harm by turning off nuclear power plants. They are making a significant contribution and they will continue to for the foreseeable future. I am not one of those wild-eyed optimists who believes that we're going to double or triple the number of reactors in the world over the next few decades, maybe even not in this century. But I am a strong believer that every one of those operating reactors needs to be replaced and, in addition to that, I think we need to have an additional contribution if we're going to get serious about climate change.

Today, if we don't build new nuclear power plants, the alternative is going to be coal in China, which is not the best way to go, and natural gas in the United States. We will be moving

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toward more use of alternative energy, but they are not scalable. They are intermittent and while they contribute to the solution, just as nuclear does, they too are not the answer. The answer to the question is really all of the above. That's really where we need to go with regard to our energy technologies.

Now, will the nuclear plants be cost-competitive? You know, I don't know. Sharon's absolutely right with regard to costs. There are numbers all over the map. I can tell you from my experience building dry storage casks, which are a relatively simple part of the nuclear supply chain, one of the things I learned a long time ago is you don't know what it costs until you're finished building it. And that's going to be true with nuclear power as well. It's going to depend upon on what the early leaders are in building nuclear power plants.

And I can assure you from our own experience at AREVA that the first of a kind of a new generation is quite expensive. It's always expensive and the real lesson comes later, can you move down the cost curve with economies of scale and lessons learned to being more competitive with unit two, three, 10, or 100? I think the answer to that is yes, but the jury is out on that one and I'm not going to debate the various costs.

The second factor is not necessarily just the cost of nuclear. The real important question to which no one has an answer is what is going to be the cost for carbon emissions. And nobody has any idea what that's going to be either. But I can assure you that after the election, regardless of who wins that election, we will start to get serious about putting a cost on carbon in this country. And that will be very important with regard to the future of nuclear and renewables and our entire energy sector.

Can safety be assured? Well, I guess that depends upon what assurance means. I think that we would not even be talking about a nuclear renaissance if we had not a demonstrably improved safety record in the nuclear industry over the last 20 years. That has to come first. It's a cliché to say that nuclear accident anywhere is an accident everywhere, but I fear that that is certainly true. So we need first to be eternally vigilant about safety and make sure that it's maintained in the existing fleet of reactors.

Now, Sharon's raised an interesting question with regard to the spread of nuclear technology to a lot of other countries. This is not a renaissance; this is a naissance, I guess. (Laughter.) And in this particular case, we are confronting a whole set of new problems. Because we do need to assure that the safety culture and the quality culture that has been built up over 50 years in the Western world is properly translated to those new countries. That's not going to be an easy thing to do. The lack of infrastructure, of regulatory oversight, and attention to quality and safety is something that just doesn't exist everywhere in the world. We need to export that along with the reactors. And I think that many of the companies involved in this industry are trying to do that.

And there's one way that I'm going to pose here, not as a proposal, this is not something that AREVA is doing now, but there is an interesting concept which I think could help us in this area. And that is a BOO: build, own and operate. In the past, we have exported reactors from various countries and the country that receives it, after they're taught how to turn it on and they're given the keys and then they run it. You don't have to do things that way.

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And particularly in some of the small countries without infrastructure, a better model might be to supply the reactor, supply the operators, and actually operate the reactor for some extended period of time until you can train the people and build the culture necessary. I think that we are going to see this model. It's going to have to be driven by nuclear utilities and operators, not necessarily by vendors such as AREVA. But I think we can start seeing this develop and we'll probably see it perhaps in the U.K. and certainly in parts of the Middle East.

Is an acceptable waste solution at hand? I don't know what at hand means. But I think I would start by saying that there is no technical or safety reason that demands that we start putting things underground tomorrow. There is a worldwide consensus that deep geological disposal is the ultimate answer, but the need to put things underground now is driven more by politics and policy than it is by a technical need.

I do need to make one correction here with regard to what Sharon said because we tend to overlook the fact that we are operating repositories in the world. We have one of them here, in New Mexico, the WIPP Repository, which stores low- and intermediate-level waste from the defense programs. And in Sweden, they have an underground repository for essentially the same thing for up to intermediate-level waste. These are operating geological repositories. They are accepted by the local community. And it is true that they do not store used fuel or the high-level waste from reprocessing activities, but it's a relatively small step to move from what's being stored now to storing those types of wastes. It will come. It's going to take time. And when it does come, I think it will open the door for a broader expansion of nuclear power.

Finally, the issue of proliferation and this is a real concern. The concern, to my mind, does not come in the area of the reactors, particularly if we're using models like build, own, operate. What the problem comes with the proliferation of two things. One is knowledge, which can't be stopped. And the second one is fuel cycle facilities, which to my mind also can't be stopped, but it can be impeded and slowed down and probably done better with international and multinational arrangements.

We are out in front in the world on technology; we're lagging in international politics and cooperation. And this is an area that really needs a lot more work. The fact that you can go to the Internet and find a design for a nuclear explosive and that you can buy an \$80 textbook and find everything you need to know about enrichment and reprocessing is what I mean by the expansion of knowledge. That just can't be avoided.

Sharon and I were both at a workshop at MIT last week and with regard to fuel cycle facilities, there was a very interesting, somewhat elegant comment made by the ambassador from South Africa who said that the days or the years in which the Western world could have the high technology and just export the low technology to the developing world are over, that the developing country has every right to the high technology and that they are going to participate as well. And by that he was meaning fuel cycle facilities. We do need to have an international regime to get a grip on how this is done and here's where I think the Carnegie Endowment has a great role to play.

Maybe I'm speaking a little bit too long here, but you can see I have a very extensive agreement with the policy paper that Sharon has produced. I also agree pretty much with a lot of the solutions, with perhaps one exception. I'm not enamored of the idea of proliferation-resistant small reactors, partly because I don't know what that means. It tends to imply that big reactors are

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proliferation-resistant and small ones aren't, which is certainly not the case. But more importantly, the economies of scale in nuclear sort of require that you build large machines in order to have some hope of making them economical. And so that area, while it's an interesting area for research, I think the fact that many countries do not seem to be asking for this and the supply community is not providing it, indicates that the marketplace right now does not seem to want to go in that direction.

Finally, with regard to the multi-nationalization of enrichment facilities, as we all know, that already exists in Urenco. It exists potentially in AREVA, with regard to the new facilities we're building in France and maybe in the United States. Russia has moved out in front on trying to do some multi-nationalization of their next enrichment facility. And that basically leaves the question of USEC and whether it remains a privately held U.S. venture or not. I think we will move in this direction not by being forced in that direction, but because it makes good sense from the point of view of politics, and particularly in the area of financing.

So that's, I think, enough to say for now. I appreciate the opportunity to comment on this and I particularly appreciate the ability to comment on something that I can enjoy because I agree with so much of it. Thank you.

(Applause.)

MR. FERGUSON: Hello again. And in perhaps less than 10 minutes, so make sure we have a good half an hour for Q&A, I know you're anxious for that, I'm going to talk about nuclear energy and how it's playing out in the presidential campaign because I don't think we've forgotten, we have an election in this country coming up in only six days. And I was reminded yesterday when I was in New York speaking at a roundtable event that I was hosting, I had Joe Cirencione and Andy Simmel (ph) talk about nonproliferation and it was – (inaudible) – event, so I won't mention the CFR person who said all that Barack Obama wants is solar energy. I said, well, wait a minute, that's not right. So if an educated person like that can say something along those lines, so maybe there might be, you know, a need to dispel some of these myths.

Well, both candidates, both Senator McCain and Senator Obama, agree on three imperatives. I'll just touch on these very briefly. The national security imperative – we're all aware of what the recent high price of oil has done for certain countries. Now, the price of oil has gone down, so these countries aren't earning nearly as much money as they have before, but once we get past this economic malaise, the price of oil will probably come back up again.

They also agree on the climate change imperative, which Sharon and Alan were talking about. So I won't really say really much about that, except to say that both Senator McCain and Senator Obama support a cap-and-trade system to regulate greenhouse gas emissions. Now, they differ somewhat in the details. If you look at their proposals, Senator McCain is proposing on the order of 60-percent reduction by 2050 of greenhouse gas emissions, based on 1990 levels. And Senator Obama is more in the 80-percent reduction range.

And they both agree that the U.S. is lagging behind economic competitiveness in what we're now calling the green economy. Both want the U.S. to take more of a leadership role in developing green technologies. And we're certainly falling behind. I have a couple pictures here showing the –

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(inaudible) – promise of General Motors. And as a GM stockholder, I'm like, uh – (inaudible, chuckles).

So what are Senator McCain's views on nuclear energy? Well, you are probably all aware that he proposed in the summer 45 new reactors by 2030. And I think Sharon mentioned in passing that you're probably going to need about that number if there are around 1,000-megawatts of electric power capacity to pretty much meet increase in electricity demand. And even that might not be enough because if electricity goes up, the 80 percent – so level by 2030 as she mentioned, then nuclear may decline in terms of its share of electricity production. Now, it's producing about 20 percent of U.S. electricity.

And I just mention, this is a somewhat more ambitious proposal than those made by NEI, although NEI may have corrected it last time I looked at their website, and also proposals made by Nuclear Regulatory Commission Chairman, Dale Klein. Dale Klein is talking more along the order of 32 new reactors, based on the interest stimulated by the 2005 Energy Policy Act. We've seen a lot of licenses being submitted. Probably most of those plants won't get built, but I think some of them will get built. You know, I applaud that. I think we'll probably see a wave, two waves. Chairman Klein has talked about a wave of maybe six to eight or so reactors by, say, 2020. And you may have another wave of maybe 20 or more by 2030, but that's going to be very challenging to meet.

You may ask, well, how did Senator McCain come up with the number of 45? Well, it's interesting, do a little research on this, and one of his main advisors, Douglas Holtz-Eakin who used to work at the Council on Foreign Relations, is a friend of mine, and he said the goal was arrived at because it is consistent with the desire to expand nuclear power, quote, but not so large as to be infeasible given permitting and construction times, end quote. Well, you know, we could debate that, but that's apparently how they came up with that figure.

Senator McCain also said he ultimately wants to have 100 new reactors in the U.S. And he didn't say when they would be built, but that's what you're going to need to do to replace the current fleet. We have 104 reactors now, average power rating of around 1,000-megawatts electric power capacity. Now, I need to point out a lot of the new reactors have a much higher power capacity. So if you get 100 new reactors, say at 16000-megawatts power capacity, like AREVA's doing with the EPR, then you would have a greater electric capacity than you currently have. Once again, we don't know how long it's going to take to play out.

We'll mention that the U.S. nuclear fleet is aging because we haven't ordered a new reactor in some 30 years. The last reactor that was really built was 1996, the Watts Bar Unit 1. And so we've had this huge lag of really no construction in country. And even with 20-year license renewals for all the existing reactors, this graph posits that all the 104 reactors basically get 20-year license renewals, so I'm basically starting a graph around 2030 and just when Senator McCain would like his 45 reactors all to be online, but you see there's a retirement cliff starting around 2030.

By the time you get down to 2035, roughly 40 or so reactors will have been retired unless – and here's where Chairman Klein is talking about another life extension out to 80 years. But Sharon's report points out that then we're in unknown territory at that point. Even going out to 60 years, we're in unknown territory. The nuclear age is pretty young. It's only middle-aged right now;

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it's 50-some years old. So we don't know what we're going to experience when we go out to 70, 80 years in terms of reactor life.

And what else does Senator McCain believe on nuclear energy? Well, he wants to have most of these parts of the reactors built in the good old USA. What true American wouldn't want that to happen? But in his campaign literature, he doesn't seem to recognize this is an increasingly globalized industry. And just to illustrate that point we have Alan Hanson from AREVA here with some other examples I have here in a bullet point, the mergers with General Electric and Hitachi, Westinghouse Nuclear with Toshiba, EDF, Electricite de France, North American Operations, AREVA USA, I can go on and on. You know, AREVA is investing in Newport News, Virginia, a major plant to build parts in the United States. This is something that is not going to be located in any particular country.

Senator McCain also favors Yucca Mountain as a permanent nuclear waste repository. Here's where he'll differ from Senator Obama, who I'll get to in a moment. And related to that, he supports reprocessing of spent nuclear fuel. Well, what's fascinating is, I'm watching the first presidential debate and Senator McCain was trying to a gotcha on Senator Obama and I should mention at the beginning I haven't advised either campaign, no one's, you know, none of the campaigns have asked me for any particular advice on this issue, but Senator McCain, I guess, was trying to get the best of Senator Obama and said, you know, he doesn't favor reprocessing.

And I imagine 99.9 percent of the viewing public said, reprocessing, what? And it wasn't explained. But it's a red herring. It is, you know, I think – well, AREVA's engaged in reprocessing, but in the U.S. there's really no imperative right now to engage in reprocessing. It's still a very costly enterprise. And it's something that we should be doing R&D on; I support that. But I don't think we need to go whole hog into a major reprocessing campaign.

And, okay, what are Senator Obama's views? Well, he hasn't offered a particular goal number of reactors. But he hasn't ruled out nuclear either. He says that we still need nuclear to help meet his aggressive climate change goals. But he says before that expansion takes place, we need to address three major issues: security of fuel supply, and waste, where to store the waste, and proliferation concerns. And, you know, Senator McCain has said, oh, that's kind of blah blah type of talk, but to give Senator McCain credit, when he's giving speeches on nuclear weapons issues and securing nuclear materials, he has said very important things on securing those types of materials. So I think they're both basically in agreement on dealing with proliferation. I think it's on the issue of waste storage that there's some – well, some significant disagreement.

On Senator Obama's legislative record, his website points out that he's introduced legislation to try to track, control, account for spent fuel at the plants, and he's also worked with Senator Lugar in a bipartisan fashion to improve international efforts to quote, identify and stop the smuggling of weapons of mass destruction, as long as dealing with other proliferation concerns. He and Joe Biden specifically do not support Yucca Mountain and this is a hot-button Democratic issue, now that Senator Reed is in control of the Senate. (Laughter.) Just a coincidence, all right.

What they say they want is, quote, "a safe long-term solution based on objective scientific analysis." They haven't specifically said that Yucca isn't based on scientific analysis, but I think really that is code for it's been politically unfair as to how Yucca Mountain has been selected. The

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onus has all been put on Nevada and I think what we need to do long term is open up more than one repository in this country and it shouldn't be any one particular state.

They do support, in the meantime, interim storage using the most advanced dry cask storage technology available. And then finally, the \$640 billion question, I don't know if it's going to cost \$640 billion, I think we all agree we don't know what the cost is, the reason I put \$640 billion is an allusion to the \$64,000 question a lot of you remember about. And so Senator McCain says that he supports a market-based solution. The market should determine winners and losers. It shouldn't be politically driven subsidies from Washington determining how to pay for these plants.

And then finally, Senator Obama said this is really his biggest concern, is what do you do with this money? Maybe the money will be better spent developing renewable energy sources, investing in energy conservation and efficiency efforts and improving the transmission grid. And with that, so I went over a couple minutes, but we have roughly 25, 26 minutes for Q&A. (Applause.)

MS. SQUASSONI: Let me just make two administrative remarks before we start the questions. If you have a Blackberry, please turn it off because it gives some kind of feedback with the microphones. And if you are staying for the next session, lunch will be served downstairs in the Choate room, so –

MR. FERGUSON: Great. So since I'm moderating, try to get my eye here. So Miles Pomper, and please introduce yourself. Wait for the microphone.

Q: Miles Pomper from Arms Control Today. Question for – two questions I have, I guess. The first one is for both of you and the second one is more for Alan, I guess. Alan brought up the point about this notion of what does proliferation resistance mean and I guess that would be my question to you, Sharon, on your suggestions. I mean, it seems to be tossed around a lot and there doesn't seem to be a very good definition. Alan, I'd be interested in your take on what's going to happen with GNEP after the election, particularly if Obama is elected.

MS. SQUASSONI: Thanks, Miles. Tough question. (Chuckles.) I don't think there is any established, you know, set of parameters of what is a proliferation-resistant reactor. There's a notion of, well, if you design nuclear safeguards into the sort of, you know, into the reactor from the ground up, that that would enhance the safeguardability of the reactor. There are other ideas out there, like floating reactors that you sort of station offshore and, you know, when they're done, you just cart them back and so the operator doesn't have to – you know, part of the, I guess, the issue is for these power reactors, will fuel rods be diverted? And that happens when you're exchanging fuel. So I don't have a very good answer, but there are some of these things that are being explored under GNEP. I think there's a working group now on this. But that's kind of – it's pretty much in the future.

I would like to just make one comment because, Alan, you were right. I didn't mean to conflate – there are two issues with regard to these developing nations. One is they need smaller reactors and they need proliferation-resistant reactors. And there's a connection there because if you have a country like India, which builds a 300-megawatt reactor, but it's a pressurized heavy water reactor, which you can make very nice weapons-grade plutonium from, then you've – I guess,

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is that hitting the jackpot? I'm not sure. That would be a bad scenario to be in. And I'll stop there. Did you want to say anything on proliferation resistance?

MR. FERGUSON: Oh, no, I think you covered it well. Alan.

MR. HANSON: I'm not going to try to define proliferation resistance because, again, it's a term that's used quite broadly, but everyone has their own meaning for it. I really have a hard time getting concerned about the concept of having a country divert spent fuel rods from their – (inaudible) – and doing something with it. I think anybody who's been on the refueling floor of a reactor and seen what it takes to move a fuel assembly and to ship it realizes that this is not something that somebody's going to do in the middle of the night. So I have less concern about that.

With regard to GNEP, Miles, I don't have the slightest idea. GNEP, as it was originally rolled out, was quite an expansive vision, a vision more than a program. And it has developed and changed quite a bit since – over the last two years. I suspect that some pieces of it will continue under either one of the next administrations, but I suspect that the grandiose approach will probably be abandoned. But reading through Sharon's paper, you can see a number of things in there where basically she is picking out and pointing out pieces of the GNEP program, including the small reactors piece, which was a part of the GNEP vision. A lot of effort hasn't been put into that, but that was.

What needs to be applauded about GNEP is for an administration who has basically driven their poll numbers into almost single digits because of some of its unilateral actions, the GNEP was a true multinational effort. And that, I think, is to be applauded. And I hope that that will continue with the next administration, that whoever's president, is going to try to cooperate with the nations of the world to make sure that as nuclear power expands, it's done in a safe and manner and with as little proliferation as we can possibly avoid.

MR. FERGUSON: Before I take – I'll take Norm next, but I want to pose a question to the two of them because this came up in one of Alan's comments about the build, own, operate philosophy or approach. And I think I tend to agree with him that you could operate, you could have an outside group operate reactors for some period of time and then that's a ramping up period, train the nationals in that country how to do it.

What I'm concerned about, though, is there are certain countries, and you know, I'll name the UAE as one, that's expressed interest in just buying everything, even buying a whole regulatory agency. And I'm actually going to the UAE next month, so actually this is a self-interested question on my part in terms of both of you, what your opinion is in terms of what should be our policy in terms of regulatory agencies. Should they just be staffed by nationals from that country? Can you bring in outsiders? Maybe you could bring in outsiders as advisors. How would you approach that?

MS. SQUASSONI: It's an interesting question because when I think about, you know, build, own, operate, when I think about, well, how do you reduce the national prestige element of nuclear power, maybe having, you know, these sort of reactors drop down out of the sky – (chuckles) – and have them being operated by someone else would reduce the sort of national pride in this technology. But I have questions about liability that I don't know that I can answer because

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mostly under the international conventions, the operator of the reactors is liable for any damages. And so I wonder if the UAE and others have sort of sorted out that difficulty in it.

I would say that one of the critical – I agree with you, Charles, one of the critical issues is having an independent regulatory effort. And, you know, there are those critics of the NRC in this country that say – (chuckles) – and the NRC isn't even here as independent as it ought to be and that's going to be a very big challenge. And I would say there is – I forget what it's called, the independent – there's an association that Dale Klein heads up of – international regulators' association and they have –

MR. HANSON: (Inaudible) – Regulators Association.

MS. SQUASSONI: Association. And they have put forth some guidelines that they hope will be adopted by countries that are newly pursuing nuclear power. But there's no – you know, these are just voluntary. These are just suggestions. And so the critical question is, how do you get those to be followed and how do you ensure that independence?

MR. HANSON: I would just add that the UAE would be a perfect example of a place where you could do build, own, operate. And maybe they're even thinking that way. I don't think they're planning to quite buy a complete regulatory system, but they have hired Bill Travers, a very senior person from the Nuclear Regulatory Commission, to help build their regulatory infrastructure. And I think this is a very positive development.

While the world no longer looks to the United States for leadership in the nuclear arena, they really look at France, Russia, and Japan, even more to South Korea, there is still one area where the U.S. serves as a model. And that is the USNRC. Many countries in the world consider this the gold standard with regard to a regulatory system. And I would applaud every opportunity we have to export the safety and regulatory culture which the USNRC has.

MR. FERGUSON: Great. Thank you. Norm Wulf, please.

Q: Two questions, if I could. You just talked a little bit about the problem with foreign countries having the expertise. I'm wondering, am I correct that there is a shortage in the United States if we had a nuclear renaissance, nuclear power, of trained and experienced personnel to operate these facilities safely? I know, for example, at staffing, getting experts from the United States to work at the IAEA has become increasingly a challenge. And so is there a problem there?

And number two question is the old standby that we already heard alluded to some extent and that is has public acceptance, the siting of nuclear facilities gotten any better? I can recall maybe 20 years ago being in Canada and we were complaining about the NIMBY problem, not in my backyard. And the Canadians said, we've moved beyond that, we're into BANANA, build absolutely nothing anywhere near anything. (Laughter.)

MR. FERGUSON: Great.

Q: Are there solutions to those, you know, first the manpower issue and secondly the siting problem? Thank you.

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MR. HANSON: Go for it.

MS. SQUASSONI: I think I'll leave it to Alan to discuss the industry efforts that are under way to build up labor force. You know, I think the nuclear industry in the U.S. faces labor issues across the board, from skilled construction and craft labor, to nuclear operators. And what we're facing is, I think – and France is as well, within the next few years, I don't know, somewhere between 35 and 40 percent of nuclear workers or workers at nuclear power plants are going to retire. There are lots of other data out there on, you know, the number of Ph.D.s in nuclear engineering, et cetera, but they are very low at this point. But there are programs to build up that workforce, but it's going to be an issue, I think, for a while.

Just on public acceptance, it's very hard to tell. I mean, we see public opinion polls; they vary greatly. But I think, you know, part of my message in looking at energy security and climate change is that there has been this push to say, hey, you know, nuclear energy is now clean, green, and domestic, and we're hoping that this will, you know, improve the public acceptance of nuclear power.

MR. HANSON: I would not say that the staffing issue is a problem. It is certainly a challenge. But it's also an opportunity. And I think that's where I might differ a little bit in tone with Sharon's paper. A lot of this is a question of whether the glass is half full or half empty. And we can fill the glass. Everybody seems to have forgotten that when we started to build a nuclear industry in the United States a long time ago, we didn't have the people that were experienced to do that at all. And in the space of less than 25 years, we went from zero commercial reactors to nearly 120. France, in a shorter period of time, went from zero to 58. Having done it before, there's no doubt in my mind it can be done again. It's a matter of will and planning. And I think a lot of that is under way.

Charles referred to one of the initiatives that we're taking. I brought a few copies of a release here, not enough for this audience, but we announced that AREVA, in cooperation with Northrop Grumman, is building a \$400-million fabrication facility at Newport News, we're going to break ground next year, to make sure we can build the components in the United States. And we are going to be in the process of doing that, training a workforce to do some of the things that we used to do and have not done for a while.

I don't want to be too facetious on this subject because I happen to own one of the Ph.D.s in nuclear engineering, but that's not what we need. The Ph.D.s in nuclear engineering usually go to the national labs or to the colleges and teach. But what you really need are health physics technicians. You need electricians. You need mechanical engineers. We need more civil engineers than we are producing. The problem is not in nuclear engineering. That need is pretty small. The people chasing the neutrons is a small subset. It's really the engineering talent and here we are lagging compared to some of the countries we compete with, like India and China.

Public acceptance, always a big issue. I haven't got a complete answer on that. What I will point out is that almost all of the proposed new reactors are at existing sites. And that's for a variety of reasons, including having the infrastructure there and having the trained workforce. But it's also because in those sites, there is already public acceptance and people are enthusiastically competing to get some of those reactors. The real interesting factor will be when we try to break ground in new

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locations and there are a couple places where that's happening. And that will test the public acceptance.

MR. FERGUSON: Great. Thank you both. The lady in the front row, please. And while she's waiting for the microphone, I'll just briefly add that we're facing critical shortages not just in the nuclear industry, but a lot of industries, power industries. So it's not just the nuclear power industry itself. And also reminded as someone who went to the nuclear Navy, Admiral Rickover (ph) said the only two majors that are worth a damn are mechanical and electrical engineering. I was a physics major. He didn't trust physics majors; they were too theoretical. But, yes, ma'am, please identify yourself.

Q: Yeah, hi, I'm Susan Cornwell with Reuters. And I wanted to ask you, Sharon Squassoni, about your last point when you said we need to – you suggested phasing out national enrichment capabilities. I'm just wondering how that – I'd like to hear a little bit more about that, how you think that could work? I think you said you need to make it so that no one has it. And then I looked in your paper here and it says that existing plants would need to be converted to multinational ownership and perhaps operation. I'm just wondering, you know, what groups of countries you're thinking of, you know, in terms of multinational. I'd just like to hear a little bit more about that.

And then a question for Mr. Hanson. I think you mentioned that uranium is pretty widely distributed. I'm wondering if that's the case and, correct me if I'm wrong, but I think the United States imports a lot of uranium from Russia. I'm just wondering why we do that and if you think that's a good thing.

MS. SQUASSONI: Well, I think Alan made the point that there's also – there's already – and actually, Charles' slides also made the point – there's already a lot of multinational or whatever you would call it, multinational nature in these big companies, and especially in enrichment, you have Urenco, you have EURODIF, you have AREVA building plants here in this country. I think a little more work needs to be done in looking at the views of, you can call them the non-aligned states or the, you know, the states we are seeking to influence within the Nuclear Nonproliferation Treaty about, you know, what concerns they might have in looking at multinational nature of an enrichment facility, you know, how much government involvement, how much government ownership might be included to sort of scope out what that might look like.

My key point is, though, that under the NPT, there is no prohibition on having these sensitive fuel cycles. And you can debate what Iran has done in terms of violating its safeguards agreements and everything else, but it is not prohibited under the NPT for it to have a national enrichment facility. And that is why they have dug their heels in on this issue. I think, you know, if it were only a case of Iran, I might actually be less concerned. But the feedback from President Bush's 2004 proposal to restrict enrichment and reprocessing technology just to the current technology holders has suddenly made a bunch of other countries interested in enrichment: Canada, Ukraine, South Africa and Brazil is proceeding with its national enrichment facility, it's not quite online yet.

But my only point was that, you know, if you don't have a legally binding commitment, you're going to be forever chasing and trying to come up with some set of incentives for countries to forswear these kinds of national capabilities, but, you know, I think it's a difficult path to take.

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And if you could get it, if you're going to pursue a fissile material production cutoff treaty anyway, why not explore this option of, you know, all future enrichment facilities will be multi-nationally owned and, you know, then you'll gradually convert the existing ones.

MR. HANSON: I won't say too much on the multinational aspect, as Sharon's covered it fairly well. I think the world is going to move in that direction for good commercial reasons where it can. I don't know any way to really impose this from the top. I think it would be extraordinarily difficult to expand the NPT or to create a new treaty that places restrictions on fuel cycle facilities. I'm afraid that the barn door closed a long time ago on that opportunity, even though it would have been good if we did that at the time that the NPT was originally constructed.

With regard to uranium, it's widely distributed, but in getting it out of the ground is the issue. The reason that we are importing so much uranium today from Russia is for a very important nonproliferation program, which is taking weapons material in Russia, down-blending it, and then using that down-blended uranium to fuel U.S. reactors. This is a good thing. It is also a relatively inexpensive way to fuel our reactors and so it makes commercial sense as well. Is it a good thing? Yes, I believe it is good. I think cooperation with Russia is absolutely essential in the future of the nonproliferation regime.

With regard to the, why don't we dig it out of the ground in the United States, I would suggest that it's probably harder to site and license a mine to dig anything out of the ground than it is to do a nuclear reactor. We are not very friendly towards these type of industrial activities in the United States. Fortunately, most of the uranium is coming from Canada and Australia, good friendly democracies. Increasingly it's coming from Kazakhstan as well. But we have uranium in the United States and if there's a will and it makes economic sense, we can dig it out of the ground here or recover it with – (inaudible).

MR. FERGUSON: And then the lady next to Miles Popper. Please identify yourself.

Q: Yeah, hi, I'm Eringina (ph) from the American University. I just wish to take up the statements that Sharon had given related to nonproliferation treaty and nonaligned states like India, also because in the example of India had been taken up so many times. I would just like to say that the model of India and what India is doing, I mean, it's a nonaligned state in spite of the nuclear deal and in spite of the statement that the Indian Prime Minister Manmohan Singh had recently given that India is committed to disarmament. You had rightly commented that India still has reactors which are heavy pressurized water reactors, which are capable of producing nuclear grade material. But don't you think the model of India is kind of different because India has Pakistan, a country like Pakistan as its neighbor, though India has sort of a no-first-use policy with Pakistan, Pakistan has repeatedly refused to sign a similar one with India, so don't you think countries like India need to have nuclear grade material? I mean, it's not just a country like India, there might be several other pockets of such belligerent activity going on, so don't you think a country like India requires to have some nuclear grade material?

MR. FERGUSON: Sharon, what do you think? (Laughter.)

MS. SQUASSONI: Are you – maybe your question is, should India continue producing fissile material for nuclear weapons?

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Q: Yes.

MS. SQUASSONI: Okay. I think the – one of the nonproliferation benefits that was touted by the Bush administration of the U.S.-India nuclear deal was that it would move India into the nonproliferation mainstream. The mainstream is not producing fissile material for nuclear weapons. None of the five declared nuclear weapons states is producing fissile material for nuclear weapons. China has not said that publicly, but it's been that way for more than 10 years. And so to that – in that context, I would suggest that India should no longer produce fissile material for nuclear weapons.

I totally understand the security context. I understand what Indian leaders are saying. But I think that a fissile material production cutoff treaty, which has been on the table for, I don't know, something like 50 years, is the next and critical step if we all want to move toward disarmament.

MR. FERGUSON: We are running short on time, two or three minutes left. So let's group – oh yeah, please briefly, Alan.

MR. HANSON: I'd like to add something here. And I here this is a personal view because I don't think AREVA has a position on this. But I would argue that because of the belligerent atmosphere in that part of the world, that's exactly the reason that we shouldn't have nuclear weapons there because they might actually get used. Nuclear weapons are probably the most useless thing that's ever been produced on the face of the earth and fortunately they've been used very little. But the idea that they could be used in some sort of a tactical fashion or that they could actually be part of a useful armory, I just don't believe that.

And in that regard, I'm going to go even further because Sharon hasn't touched on this, but I know she feels strongly about it. We've got too many nuclear weapons in the world already, in this country and in Russia. And we can't hope to have countries like India and Pakistan abjure nuclear weapons and fissile production until we set a better example by reducing or eliminating the weapons that we have in the Western world.

MR. FERGUSON: And before taking – I'll take two final questions the last minute or two, but I want to put in a plug for the excellent work that George Perkovich and James Acton have recently done, the Adelphi paper that came out for IISS on looking at how we should think about abolishing nuclear weapons, the hard road that's going to take, the verification and compliance and enforcement challenges. So let me take the gentleman there and Laura Holgate. And we'll combine those two and have Sharon and Alan answer. Oh, and Steve Dolley, too. We'll get those three combined, next couple minutes.

Q: Ian Talley, Dow Jones. Given Obama's more stringent carbon constraint goals, the current technology for sequestration, or lack thereof, economically, the transmission that's needed for large renewable buildup and the constraints on natural gas becoming the major electricity producer, would it be wrong to extrapolate that Obama's nuclear expansion requirement would be as large or larger than McCain's?

MR. FERGUSON: I'll take that in a moment, but let me get Laura Holgate and Steve Dolley and we'll all – we'll do a wrap-up.

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Q: Just a reminder that there is an agreement on a definition of proliferation resistance between Inpro and the Generation for a Nuclear Reactor research goals, so that's not as much of a chimera. I can't describe it – (laughter) – that's not fair. (Laughter.) But it exists. But it is a technical decision rather than a political decision – I mean, definition. So that is an important point.

For you, Sharon, what would it look like if government really did take seriously the small reactor and encouraged it, given that there is a lack of interest in not only on the supply side, but also on the demand side? How would you change that? And how much of that is possible within U.S. policy space and how much of it requires a more global approach?

Alan, for you my question is what do we need to do differently about above-ground storage than what we're doing now to make it viable for 100 years while we figure out a good solution to the really long, long term?

MR. FERGUSON: Good questions. And finally, Steve Dolley in the back.

Q: Steve Dali with Platt. This is for everybody. Under GNEP, aside from the other diplomatic efforts to multi-nationalize fuel cycle facilities and the fuel cycle as a whole, the main nonproliferation approach has been technical and you see proposals for reprocessing cycles such as Urex and Urex-plus and et cetera, et cetera, where the technical approach is to keep uranium and plutonium mixed throughout the reprocessing and fuel fabrication cycle, in some cases continue to keep it mixed with radioactive actinides to increase the proliferation resistance of the product during the process. And I guess this is for all of you, is this technical approach to nonproliferation sufficient? Would you be happy to see or at least comfortable to see a world where reprocessing facilities and fast reactors were in a number of countries around the world, provided that there were never a pure plutonium or uranium stream coming out of any of those facilities? Is that technical approach sufficient?

MR. FERGUSON: All right. Now, we're trying to wrap up in the next couple minutes. Sorry we're running a little bit late. We have another event, double-header. So to address the gentleman's question about would Obama really be in the same ballpark in terms of nuclear reactors that we would need. Well, if it's a climate change problem we're trying to deal with, that's a global problem. So we don't necessarily have to have all the reactors built in the United States. But on the other hand, as Sharon points out in her report, location matters. This isn't real estate, but for different reasons here. It matters in terms of the proliferation problem and a safety challenge problem and a security problem. So you could argue that from safety, security, and proliferation, probably some of the best places to build those reactors would be in the United States.

If you look at the wedge model, we don't have really time to go into here, but the excellent work that Socolow and Pacala did at Princeton University a few years ago looking at 15 different technologies that you could deploy to try to flatten out carbon dioxide emissions by mid-century, if you deploy seven of those wedges, you could flatten out emissions. And for nuclear, that wedge would be on the order of 1,000 or so large nuclear reactors worldwide. Right now we're at the level of 439, 440. In terms of power capacity, we're probably at the level of roughly 400. So those would have to be replaced. Then you'd have to build another, you know, 600 or 700 on top of that. So it's a huge challenge. I'm not saying it's impossible, but it's very daunting. All these energy wedges that they outline are all very challenging. This is going to take a massive global effort to try to get our hands around combating climate change.

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MS. SQUASSONI: I would just add, okay, so if you're talking about 1,000 reactors and you distribute them according to the distribution that you have now, you know, the U.S. has 25 percent of reactor capacity, so you're talking 250 reactors here in the U.S. which is more than double what we have.

I just wanted to make a point on your transmission for renewables. You know, no matter what electricity generation countries are going to choose, they're going to have to expand and update and renew, spend a lot of money on transmission and distribution. I think not – what people don't realize is that transmission and distribution costs equal the costs of, you know, the new generation. So it's a lot of money there.

On Laura's question, I think Alan pointed out, you know, the market, when you look at economies of scale, these big vendors are not, you know, are not selling right now small reactors. And the problem for countries is that you can't – you know, if you put a large reactor, you could overwhelm the electricity grid, so you're not actually supposed to – if you want reliable supply, you don't want one source to be more than 10 percent. And so you know, the short answer is it's going to take money. Maybe that means government loans, subsidies, you know, R & D spending for those small reactors. There are a few that countries – I'm sorry, that companies are considering, I think Westinghouse is one of them, but that's, you know, that's 10, 20 years down the road. So if you want to speed up that process, it's probably going to take a capital infusion.

MR. HANSON: And I'll try to wrap up a couple questions that were directed at me. Laura, with regard to above-ground storage, honestly, I don't think that we need to do anything to make it better. Once you move the used fuel out of the pool and into dry storage, you've pretty much removed all the driving forces for a serious accident and dispersion of open material. One could argue that it might be better to collect it in a number of places, rather than having it at each one of the 60-some sites in the United States, but I don't want to get into that particular debate. I also know from having designed these things, you know, reactors probably aren't going to last beyond 80 years, maybe if you replace a pressure vessel, but I can assure you that the dry storage containers out there are going to last as long as the pyramids have. They can go on virtually forever. This is not going to be a problem.

Steve Dolley, with regard to the reprocessing advanced technologies, I'll just make the statement that proliferation is not a technical problem; it's a political problem. We need political institutions in order to prevent the proliferation of weapons and weapons usable material. If you can build and operate an enrichment plant or a reprocessing plant, I don't care what the technology is, you already have the knowledge to abuse that facility and that's why we have safeguards and that's why we need multi-nationalization. We can't solve it with some great technical fix. That's just not going to happen.

MR. FERGUSON: So I will leave you once again with one final comment and admonition: read Sharon's report. Please join me in thanking Sharon and also Alan for his comments. (Applause.)

MS. SQUASSONI: Thank you all for coming. And for those of you staying for the next session with George Perkovich and Rose Gottemoeller, lunch is being served downstairs. Thank you.

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(END)