CARNEGIE INTERNATIONAL NONPROLIFERATION CONFERENCE

CHALLENGES TO GLOBAL NUCLEAR POWER: TECHNOLOGICAL, POLITICAL AND ECONOMIC

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TUESDAY, APRIL 7, 2009

Transcript by
Federal News Service
Washington, D.C.
ARIEL LEVITE: Good morning to you all. In the interest of time, let us get started. Let me briefly introduce our speakers this morning and then get right down to the topic at hand.

My name is Ariel Levite, and I am a non-resident senior fellow for the Carnegie Endowment. With me on the podium here we have Jacques Bouchard, the chairman of Generation IV Forum and previously with a distinguished career at the French Atomic Energy Commission. Next to him is Professor Ernie Moniz who heads the MIT Energy Lab and also had a distinguished career with the Department of Energy, the last position being undersecretary of Energy. And to my immediate left is Charles McCombie who is both an independent consultant and also the executive director of an NGO called Arius which deals with multinational solutions to the nuclear fuel cycle.

What will set apart, I hope, this panel from the previous ones that have dealt with the prospects of nuclear renaissance are two issues. One is we are trying to present a global perspective as distinguished from the U.S.-oriented one. And the second thing is we’re not trying to try and capture what is currently happening, but we are trying to figure out what needs to happen for nuclear energy to evolve in a successful, sustainable way, both from an economic, technical and policy perspective.

The order whereby which we’ll go is Jacques Bouchard will go first and talk about technological and technical challenges that need to be met. Then Ernie Moniz will talk about political and policy challenges that lie in front of us. And then Charles McCombie will look at the things from an economic and industrial perspective and the kind of issues that need to be happening for nuclear energy to have a sustainable future.

So without further adieu, Jacques, please.

JACQUES BOUCHARD: Thank you, Eli, and good morning, ladies and gentlemen. As Eli said, I am here this morning to give the technical part of the show. So I will try, in a few minutes, to summarize what are the challenges to succeed in the development of nuclear energy in the next decades, assuming, of course, that all the other problems, political and economical, are solved. But it’s a matter for my colleagues.

We have limited time, so I would only touch upon three topics. The first one safety, then sustainability and adaptability. Why the choice of those three topics? Because I think that they are the most important ones to succeed in the development of nuclear energy, whatever the choice which are made by various countries and the way that they develop their own system and the way they will use nuclear energy in the future.

So let me start just by recalling that we have a need for developing energy. We have a need to develop it. It was stated in presentations yesterday that to succeed in satisfying and fulfilling the needs, we will have to use nuclear energy, and we will have to use nuclear energy for many reasons because there is no greenhouse gas emission, because there is a security of supply, because there are possibility of developing new systems and also because it’s already a competitive, safe and reliable energy source. It has been demonstrated by the operation of the existing reactors during the last few decades.

So what can be the future? If we want to discuss the challenges, of course, we have to place this discussion in some prospects on the future. My prospects are quite optimistic. And I would say
voluntarily optimistic in such a way that we can really see where the problems are. So we are relying on the growing energy demand, the part of nuclear energy, which we assume it will increase maybe after 2030 because it takes time to restart and to build all the new systems, but the part will increase.

And light-water reactors will remain dominant during these few decades, it’s clear. And most of the new builds will be in countries which already have large fleets. And this is a quite important problem. If we look to the prospects, let’s say, on this figure, on this slide, you see that we have made the assumption that there will be 1400 gigawatt of nuclear energy by 2050. Most of it, once more, will be LWR but most of it will be in countries which have already a large experience with nuclear energy, other developed countries, industrialized countries or developing countries with large populations, such as China or India. So in fact, more than 80 percent – or more, probably 90 percent – of this capacity will be in such countries.

Safety – safety, first point, safety has been considerably improved during the past decades. And in particular, a new move has been made with the development and with the design of generation-III systems. We have several generation-III systems on the market today. All of them are satisfying a new criterion for safety.

In particular, there are not only degrees of reduction of the probability of severe accident but in any case a mitigation of the consequences. And this is clearly a new move, and we cannot and we will not go back. That means that any new nuclear system will have to satisfy the same criteria, if not do better, and this is clearly a challenge. It’s a challenge for the next generation. It’s a challenge for the next development of systems because it’s not what we have considered in the past, and it’s clearly a necessity today.

So either by passive/active systems, whatever, we have no particular difficulty with that. There are a lot of possibilities to develop technical systems, but that means that in particularly if we develop new types of reactor, fast reactors, high-temperature reactors, others, we will have to satisfy at least the same criteria as the generation III light-water reactors today. And this is the first point I would like to mention because it’s a clear objective today, and it’s an objective which is not so easy to reach in any case.

Now, what are the other issues for the future? Once more, the safety. We can consider that the level which is obtained with the generation-III systems is a reasonable one for the future, so this is clear. No major improvements on nonproliferation has been made during the last few – the new developments of the system operated during the last few decades were not considering innovations for nonproliferation. And the need for system development means the need to account for new criteria, and this has been at the origin of the development of the so-called generation-IV systems.

In fact, we have considered that if there was such a development of nuclear energy following for instance, the example I have given, we need to consider not only the economy and the safety, as in the past, but we have also to consider more seriously the use of natural resources, the waste minimization and the security problems. All the problems are quite important for the sustainability of the nuclear energy system. And those are technically very important problems.

You know that it has been – these considerations have been at the origin of the Generation IV International Forum. Now we are 13 members, 12 countries and EURATOM working together, at least 10 of them working efficiently in this cooperation for developing such systems. And I think
that you know that we have selected, let’s say, a few basic concepts to help to make the good R&D in such a way that we can develop really new systems according to those criteria. So most of these basic concepts are fast-reactor systems, and this is clearly related to the fact that the uranium resource is not forever without any problem.

In fact, when we look to the data which are to be published annually by the IAEA and the NEA, the OECD NEA, you know that we consider today that we have approximately 15 million tons of resources of uranium. And still yesterday, we heard that with that we can feed the reactor for 200 years – 200 years there if we keep the level of today. But if we increase the number of reactors by four, by three or by four or by five by the middle of the century, it will no more be 200 years, it will be 50 years, 60 years, just the lifetime of the reactors and no more. So in fact, we are facing a real problem if there is an extension of the pack of worldwide nuclear reactors such as the one I mentioned before. You see for 1,400 gigawatt of nuclear energy by 2050, which means that we will have consumed or earmarked 16 million tons, more than the assumed resource today. Earmarked means that it will be consumed during the lifetime of the reactor.

So there we have a real problem, and we know that we will have to move to fast reactors to solve this question because even if we consider the possibility of using the uranium in the phosphate which is approximately 20 million tons, even if we look to other sources of more expensive uranium, it will be anyway limited to a few decades more maybe, but it’s not the solution for long term. So for the long term, we have to move to fast reactors in such a way that we can breed. It’s not new, but it’s clear that if there is a development of nuclear energy, such as the one we are considering today, this move to fast reactors will have to be done during this century, not after. And this is clearly an option which is on the table today.

The other problem is the accumulation of spent fuel and the content of the spent fuel. Always we see the same scenario that means around 1,400 gigawatt of nuclear capacity by 2050, we will have in storage approximately 1 million tons of spent fuel around the world, 1 million tons in storage if we do nothing before. And 1 million tons of spent fuel will include 8,500 tons of plutonium. So there will be everywhere around the world 8,500 tons of plutonium for any good use or any wrong use, depending on who is in charge of keeping them. I mean, this is the other real issue.

And for that, we said, okay, we cannot consider that anyway if we need to use fast reactor and to breed we will have to recycle. And if we recycle, we should solve this problem of risk of increasing the proliferation risk because of the recycling. And there’s a reason why in the gen-IV systems we are working on full actinide recycling. That means we are working no more on reprocessing. When we separate elements at the output of the process, we work only on reprocessing leaving all the actinide together in such a way that in the waste we have only fission products. But the actinide remains together in all the process, which means that the materials which is used is the reprocessing plant in fact is always a very active one. There is no risk of easy diversion of materials, so just the scenario which are often used in proliferations studies related to this part of the fuel cycle.

By the way, at the same time, we solve also, at least we hope to solve, the problem of waste management because in fact burning all of the actinides means that there is a decrease of the gradual activity of the waste with the time very much more efficient in such a way that we reach level comparable to the uranium after only a few hundred years, which is, of course, a good measure
of improvement for waste management.

If we can say, okay, we have to keep the waste, including the high-level waste, but only for some few hundred or even few thousand years, there is no more problem of 1 million years, as we heard yesterday. There is no more problem of making demonstration that we can overcome the 10,000 years with any kind of storage. I mean, we can easily solve the problem in such a way. So for that we have to develop fast reactors.

So for that we have to develop fast reactors, and as I said, there are new requirements: the economy, of course; safety; the full recycling of the all of the actinides. Some new solutions for the breeding to avoid proliferation risk, I mean, this is clearly on the table, and we are working on it in Generation IV International Forum. And I think we will succeed in developing such a system.

Now, there are other challenges. I have no time to develop them. I will just mention the fact that we are working on high temperature for other uses of nuclear energy. It’s clear. But I will just make a mention on the adaptation for countries, you heard about this grid-appropriate type of reactors which is more or less in discussion around the world. In fact, today, we consider the problem of countries which start in the nuclear business. The main problem for them is infrastructure. And the IAEA has made a lot of development on what they are to do and so on.

Small- and medium-sized reactors is sadly not the solution in the short term. Why is that? For two reasons. The first one, because a country which starts now, wants to have a proven system, and no one around the world is operating small or medium-sized reactor today. And the second reason, because we need, as I said before, to have the level of safety of generation III. And there is not yet any small- or medium-sized reactor developed with this level of safety.

So I think that the main issue on the technical side for those countries is not so much the size of the reactor if we can find a way to accommodate, to have agreement with other countries and so on. The real problem is robustness because new countries working in the field means new people without experience. And even if they are helped by countries or by organizations which have a lot of experience, it’s better to start with more robust systems.

Thank you very much.

(Applause.)

LEVITE: Ernie, please, enlighten us on policy and political events.

ERNEST MONIZ: Perhaps. Well, thank you, Eli.

LEVITE: You’re allowed to disagree with Jacques. I noticed that there are a couple of areas – (chuckles).

MONIZ: It’s always good to follow my friend Jacques.

LEVITE: They always play this odd-couple dynamic.

MONIZ: Okay. I’ll just make a few remarks largely around a framework really discussed
over the last five years with colleagues at MIT and with the Scowcroft Group.

Clearly, this discussion is a focus on nuclear fuel cycle issues and proliferation and threshold-state issues. So from this point of view, I want to just distinguish that, for example, Iran would be more relevant than, say, North Korea to the kinds of discussion at least I intend to have. And obviously, it’s all about weapons-usable material, HEU and plutonium and so, of course, enrichment and recycling are the questions of issue.

The framework in which we always – we always try to talk about a framework that does not involve things like reopening the fundamentals of the NPT but rather focus on a balance of economic choices, believable security of fuel supply guarantees, like the fuel bank that President Obama just mentioned, for example, and resolution of internal let’s call them political challenges in individual countries, such as is often the case with the nuclear waste back end that in fact Jacques just made some comments on.

A third framing point I would say is that clearly, well, at least I certainly believe that climate-change risk mitigation will remain a major concern and indeed will increase in prominence. Again, recent news, the Arctic ice sheet disappearance acceleration, for example, and combined with energy supply and security concerns and, I think, also, importantly and not often enough emphasized, uncertainties in fossil fuel price volatility, I think, will all be strong forces for driving expansion of nuclear power worldwide.

There are countervailing issues, of course, around the large capital expenditures, for example, for certainly today’s plants and financing structures. There are issues of waste management, proliferation and the need for, in some sense, a dependence on safe operation everywhere are factors which come in with different weightings in different countries.

And finally, in a sense of kind of framing remarks, I’ll just note that in 2002 as part of an MIT nuclear power report, we did a scenario for global deployment of a 1 to 1.5 terawatt nuclear power future in 2050, again certainly consistent with the kinds of numbers that Jacques was using. I want to make clear, it was not a prediction or a wish necessarily. It was a scenario of, what would a distribution of a terawatt or a terawatt-plus most likely look like if it were achieved? And the reason for the terawatt is that that is kind of the material unit for contributing to serious climate risk mitigation. So it was really a question of, if nuclear power is to be a material contributor to climate risk mitigation, what would it look like?

Now, one could argue with it, but what we did is go through kind of a country-by-country scenario in terms of what looked likely. And the relevant points are two, at least as we saw it. Number one is when you include the nuclear weapon states, and I’m including in there not only the P-5 but also India and Pakistan, and you look at the scenario, number one, it’s very hard to see, in our view, how the world reaches 1 to 1.5 terawatts unless the United States is a major player.

So in some sense, the U.S. role is critical 300, maybe even 400 gigawatts. Secondly, those nuclear weapon states, as I’ve defined it, in total would account for over 60 percent of that deployed 1 to 1.5 terawatt. By my definition, I am not considering those to be fuel-cycle-deployment risks. They have dedicated programs. I’m not saying one shouldn’t worry about the nuclear weapons issue. I’m just saying that the nuclear fuel cycle is not the primary concern. Others, Indonesia, Brazil, Iran, for example, just those three countries would be, say, 50 gigawatts in this scenario.
The important issue in our scenario is that if you look at the expansion of nuclear power in the terawatt-plus scenario into countries that you would consider to be part of this proliferation discussion, some of direct concern with regard to nuclear weapons development and/or threshold state status, others not really of concern in that sense, at least with our current politics, but nevertheless ones that we should include in this bucket, we could not see how that group of states would account for more than about 20 percent of that terawatt scenario. And today, it’s about 15 percent.

This is relevant in the sense of the degrees of freedom that I think it permits one in talking about institutional arrangements for the growth of nuclear power. And I’ll come back to that. I mean, the basic argument is very simple. Our view was that a key issue is: what is one going to do with the spent nuclear fuel?

We would view it as a considerable incentive in a fuel-leasing arrangement to take back the spent nuclear fuel and not with the idea of just processing it, as is the current practice, and then, in principle, returning the high-level waste to the country but actually returning the fuel and disposing of it according to one’s national program. Then, I think, it’s a very important issue to realize that the increment from let’s call it countries of concern would be a relatively small one on top of the challenge for waste management in the United States, Europe and Japan. No matter what you think of how difficult or how easy that challenge is, it’s a relatively small increment.

So as I’ve already said, all of this leads to and our view remains that some sort of fuel-leasing arrangement with incentives in which there is secure supply of fresh fuel and then a return of spent fuel remains at the key. This is not inconsistent with international fuel-cycle centers as well, although we’ll come back to that point briefly.

So basically, again, at least our view is that some form of this fuel leasing would be an ideal approach. We would supplement that by adding relatively strong incentives along the lines I said earlier – economic, political, et cetera. For example, fresh fuel could be subsidized in a way which has an international condominium, not necessarily by direct payments. But for example, at least in the current world in which nuclear power generally is not considered admissible for things like international carbon credits and trading, one could imagine a system in which the relatively small number of countries who opt into this are given carbon credits. That may be just one simple example of how one might incentivize it.

But just to note that the kinds of carbon pricing discussed in any international carbon-trading system would translate for a subsidy of nuclear fuel into something that would essentially cover the entire cost of fuel and some operations of the reactor.

Taking back spent fuel, as I mentioned earlier, globally it’s a less than 20 percent issue, at least for this half century. And here, I must say that, obviously from the United States perspective, one would say, well, given our situation and, shall we say, the considerable uncertainties surrounding Yucca Mountain – the administration has said Yucca Mountain is not an issue – one might find this to be kind of deadly for the kind of thing I’m talking about. I would argue not, indeed. Frankly, I think that taking a re-look at the waste management situation may turn out to be a very good thing. We do not have a technical rush. And I personally have always felt that long-term, managed storage in fact makes good sense.
And third, we would argue that there is no need – this goes back now to the issue of the NPT – there is no need to advocate such a system to be forever. There’s nothing wrong with taking it, say, in 10-year increments where there are commitments, one sees how the international nuclear fuel cycle evolves, and countries can make let’s say 10-years or 15-year commitments in terms of the fuel leasing arrangement, game the benefits in that time period and then return to it later on. There are other issues, of course, like adherence to additional protocols. I won’t go into those.

Now, there are several issues raised with any of these schemes. Security of supply – we’ve already discussed the fuel bank idea. In our view, the fuel bank should be only one part of a hierarchy of security-of-supply arrangements that start with commercial contracts and rely upon them to the extent possible but then eventually go up to a fuel bank with Security Council guarantees.

There’s the issue of technological leadership. Would countries feel that they were falling behind? Well, we would advocate that we have, with all due respect, not a gen-IV forum but a real R&D program with collaboration on reactors, although not on all fuel-cycle technologies, so countries opting in would not somehow, quote, “be left behind” in terms of a possible future advanced reactor program.

Then there’s the issues of asymmetry and incentives, but we would argue, again, that with the economic and political benefits, this could be framed frankly as a victory.

In concluding, I’ll just point to a few other issues that I think are needed in this framework to have anything like this kind of framework going forward. One is that we certainly need to reestablish our nuclear cooperative relationships with Russia. It’s hard to see how things go forward otherwise. I will note that in 2000 we were very, very close, frankly, and close is not good enough, to a significant agreement with Russia that would have advanced these kinds of issues. I believe we have a good chance to return to that in the contest of a 1-2-3 agreement.

Another kind of issue is let’s say the UAE and Abu Dhabi. Again, another 1-2-3 issue in front of us. There are clearly questions in terms of some history of transshipment, et cetera. But I believe if we’re serious on the nonproliferation side, we simply have to make that work and work with them as an excellent model.

On uranium, I have to say that – well, and finally, my last comment will be on kind of fuel cycles, et cetera, just to excite some discussion with Jacques. First of all, there is no pressure, in our view, whatsoever from the uranium side to move towards reprocessing. And I think Jacques’ own numbers would suggest that there is plenty of time, particularly in light of the history about resources.

I’m sorry, just one minute as an aside, I think it’s worth – let’s talk about natural gas, something that’s quite present. But running out of natural gas, we’ve had fuel acts to control its use, all kinds of issues. Now, we have so-called unconventional natural gas, a 9-percent increase in domestic production last year. But an interesting point is this issue of finding new resources, especially, quote, “unconventional ones,” the implication that these have enormous costs just is not in accord with our history with natural resources.
Indeed, in the current economic downturn, the number of gas drilling rigs has fallen by about a factor of half. The first ones to go were the so-called conventional drilling rigs because a lot of the unconventional supply is now, at the margin, economically more attractive. It’s very hard to believe that we don’t have uranium coming out of our ears for a long, long time. It will take other issues to drive us towards different fuel cycles.

And on that, I strongly believe that we must continue to very strongly oppose a spread of the PUREX/MOX fuel cycle which, in my view, has essentially no redeeming positive features – we’ll have an argument with Jacques in terms of economics or waste management – while we do support the issue of looking at more advanced fuel cycles that could, in the long term, have some serious benefits for waste management.

So I think those are all very important framing issues for the bigger thing around fuel leasing, et cetera. Thank you.

LEVITE: Thank you. Thank you, Ernie.

Charles, please.

CHARLES MCCOMBIE: Ladies and gentlemen, I’ve been asked to address the economic and the industrial challenges that we’re facing if nuclear is going to expand the way some people think it will. The issues I’ve picked out are listed here – these are cost-effective generation (of course), the issue of availability of large components, training and education, providing in the operation of the facilities the safety and security that we want and, lastly, (and with most weight, I hope), the provision of disposal solutions for all the countries that are going to use nuclear power. So these are the issues I’m going to talk to. I’m going to move through them, because of the time, fairly quickly and also because there are experts here who know far more about some of these issues than I do. I’ll address them one at a time and try to give you a simple “finish message” for each.

On the cost-effective side, of course, we know that licensing and construction times are not good and need to be improved. Some of the latest results are not very encouraging. The capital costs could be coming down, but the financial crisis is affecting things already. South Africa has backed off from its overambitious plans already. Regarding generation costs – this is the good news – the life-cycle costs are low, and I’ll come to that in a minute. But the back end costs are still high, and they tend to be ignored. You know, a deep geological repository (i.e. the back end of the back end) costs the same order of magnitude as buying your first reactor, and people should remember that.

Here we look at the costs – and, because we’re international, I’ll use figures from my own second-home country, from Switzerland. You don’t have to read all of this slide. The important point is that right down in the corner here, there’s nuclear. The two bars for each technology are for 2000, 2030. So in this Swiss situation – this is a government study – the nuclear life-cycle costs are the cheapest, and they’re going to stay the cheapest for a long time.

Now, I get confused as well because if you look around in the States, of course, the message you get here is very different, very often, including in Ernie’s MIT study, for example. The difference is largely to do with the financing mechanisms around here. Even Greenpeace has latched onto this. However, the Nuclear Energy Forum of the European Union has just produced a
study on the competitiveness of nuclear power, which ends with a quote, “In all cases, financing can be assured without nuclear subsidies.” And they look at all the risks, and that doesn't sync with what happens here. And I think, as I say, it's partly to do with how the financing is done and so on. Life-cycle costs over the long time have been criticized as not being the most relevant thing. However, I think maybe we should be looking more at life-cycle costs. Maybe we need to think long term. Maybe we should have Warren Buffett and not Bernie Madoff as an example of how we should be doing our finances into the future. So it's a costing issue.

The second issue was the components. Availability of components has been discussed quite a lot in the industry—and the biggest problem is the large forgings. Currently, in the Western world, Japan Steel Works makes these, and nobody else does. But without going into details, this is the kind of challenge which the industry, in general, is geared up to try to match. And you can see on this overhead some of the efforts that are now being put in place to start that. So to make it very clear, I think this is the kind of technological challenge that the industry can manage; this is, in some ways, one of the easier challenges.

The next one was the availability of trained staff. This is not a new problem. Already in 2000 there was a big NEA study and report, chaired by Tom Isaacs (at the back of the room there). This was when we were worried about having enough people for the death of the nuclear industry; we thought it was dying out. Now it's going the other way, so the needs are even higher. Luckily, as you see at the bottom of the overhead, people are taking this much more seriously now. It was neglected for far too long, but the efforts have been increased hugely. But it has to be sustained—we need actions, not words, not talking about education but doing education, doing training. I work in some training courses, and when we put out appeals to send your people to be trained, there are still some bosses who come out and they say, “I can't afford to lose him for the two weeks, six weeks or whatever is necessary.” That doesn't work. You have to have action to back up the lip service being paid many places to the training and education part.

Next, safety, security and nonproliferation – I don't have to say much at a conference like this. There are many, many more experts out there. But a reactor accident anywhere is a reactor accident everywhere. We know that. In the reactor operational safety side there's been large efforts made, and they've been very successful. Nuclear security has also been improved. The new World Institute for Nuclear Security, just recently started up, will help now. We need to strengthen the methods that we use. We need to attack also the “latent proliferation,” and maybe this will be done more rationally in the new administration than it was done in the previous administration. We have to have more controls of fissile materials than we've had very recently and these things are moving ahead. So this is good. These are national and global issues. Technological approaches are necessary. They have to be fully developed, but they are not enough. We have to have improved governance at a national scale and at an international scale.

Lastly, the disposal issue which is close to my heart. Geological disposal, as we heard in the first part of this panel yesterday, is not yet done, geological disposal, anywhere in the world. There are some programs which are well along the way. You see them mentioned here – Finland, France, Sweden. Many, many countries don't have any program at all.

The point is that even if they all try to have programs, we have to have a multinational approach. We need this because the small nations, as I said, can't afford it. We had plans for take-back of spent fuel. I made in the previous panel this morning already a comment about that. It was
that the take-back plans that were built into GNEP disappeared even before GNEP started to disappear. The Russians, with their global nuclear power infrastructure by Putin, had the same kind of problems.

The other option to take-back is partnering, and I’m very closely involved with partnering concepts. I thought I would illustrate that with an overhead which some of you may have seen, but is well-worth re-showing. This is the U.S.A. with (very generously marked) two geological repository projects—I think one of them should be in a dotted signature perhaps! But if I put Europe on the same scale (and it fits pretty well as you see) things in Europe look different. Some countries have a national program, some don’t know yet, and some are willing to look at sharing. Some do not have nuclear power yet; but, even if they don’t, they still need deep geological repositories. And this is the point. If we do not have any partnering, if we do not have any sharing, if everybody has to build their own deep geological repository which will cost several billion dollars, then the slide shows the large number that we need in Europe. And this is just a role model. It applies also to other places in the world. It applies in Southeast Asia. It applies in Central and South America. It applies in the Arab countries. We have to do it. There’s no way we can have every country with its own deep geological repository.

So that was the international part. I’ll finish off with an outsider’s view, if I may, of some of the U.S. back-end program points. Firstly, the U.S. lost its leadership role in the fuel cycle way back in the ’70s. It chose to lose it, if you like. It’s now rediscovering recycling, but some of the issues from GNEP, which built this back in are pretty flawed. Importing French technology and copying a French plant does not seem to be the way forward. The National Academy has taken a position on that, which I very much agree with. We want to be looking at advanced ways to do this. There’s no hurry—I agree with Ernie Moniz—to do reprocessing.

The U.S. also lost its lead in repository development, to some extent, because of all of the problems that were had with Yucca Mountain. The price tag rose and rose and rose; it became 1 (billion dollars), 2 (billion dollars), 3 (billion dollars), 4 (billion dollars), $9 billion. It strikes terror into hearts of people in other countries in the world—the prospect of having to pay $9 billion without having built anything. The siting program is also too top-down; it’s old-fashioned now. But the USA has, by nature, got to be a leader and has got to get back to being a leader in the nuclear community.

So what should it do? Well, the first thing it might do is let the USNRC decide on Yucca Mountain. The Obama administration made a strong point of using “sound science” in its policy, but it seems to have left this little corner of policy out. The NRC should be trusted to be able to judge whether Yucca Mountain is sound science or not. So let the regulatory review go ahead.

However, even if it is sound science, this doesn’t solve the problem. Sound science today is not enough to site a geological repository. It’s got to be complemented by some kind of societal acceptance — enough, not the whole of society, but enough — so that even if the sound science is there, it’s not enough. And that’s been recognized in many places.

The other thing one could do while waiting on the USNRC and on this new Commission that should be formed, is initiate the second repository program, with consensual siting as its target there. There is something people do not know. Because I was involved in this for a long time, I get slightly irritated when I see these 70,000 tons in Yucca Mountain being described all the time as a
“statutory limit.” It’s not a statutory limit, it’s a number that was chosen for ethical reasons. The latest USDOE report on the necessity for a second repository ends with a big bold conclusion – unless we increase the capacity of Yucca Mountain beyond 70,000, we will need a second repository. But, that’s why the 70,000 was there, to make sure that you did need a second repository.

For ethical reasons, it was decided, way back then, that the U.S. should have more than one repository. So this circular conclusion was really kind of a waste of paper in the whole of the report there. You could revive the second repository program. And then who knows what then happens to Yucca Mountain? So that’s, in principle, how I would do it for now.

A credible U.S. national program should be the first priority. If the U.S. is going to lead again, it needs a long-term storage solution that’s good. It needs advanced recycling and research. It needs to look at other siting options, and it has to work on an adaptive or a staged siting process that goes beyond science and technology and into societal issues.

And then, lastly, and not least in my agenda certainly, the U.S. could help a lot by supporting multinational initiatives with fuel take-back, with third-party, third-country hosting or with partnering—in the ways that I said. Thank you.

(Applause.)

LEVITE: Charles, when I look at the kind of challenges you put forward, I don’t think there’s going to be a nuclear renaissance in the United States any time soon.

All right, you know the deal – the drill. Let’s go for questions. Make sure it’s a question. Keep it brief. Go ahead. Please identify yourselves.

Q: Thank you. Steven Dolley with Platts.

And I think this debate is already well underway, but I just wanted to throw it back to the panel for a little more elaboration, because it’s not – it’s not just hypothetical or power-points. An AREVA official said last week that AREVA has been talking to a number of U.S. utilities about possibly building a privately-financed – not conventional PUREX, but not advanced-type reprocessing plant in the United States, with thermal MOX recycling as the option.

So what I’m interested in, in the perspective from the panel, is – and there have been some incidents already, obviously – will this help the nuclear renaissance; hurt the nuclear renaissance; help or hurt the development of the advanced fuel cycles down the line; or will it just sort of be a side-track on the interim?

MONIZ: Jacques, do you want to get this?

LEVITE: You’re going to get disagreement in the panel, go ahead.

BOUCHARD: No, no, no. We are not – we are not in disagreement.

No, I will not comment on the announcement. I would just comment on the situation, once more, of the spent fuel accumulation and necessity to, by some way, to start recycling not too late.
I heard my friend Ernie saying that we have time – we have time so we can take time to develop a new system, and we will see, and so on. I agree that we have to develop new systems. It’s my job. I’m chairing this forum, and we try to gather all the knowledge around. There has to, to work in the best way, to prepare a new system. But, at the same time, I think that we should move. We cannot wait forever. We cannot wait to start to clean, by some way.

And I can say that the experience we have in France is most interesting in this way, it’s interesting because we have cleaned 90 percent of the past fuel – spent fuel; we have separated the uranium-plutonium; and from the rest, and the rest is already vitrified. So even if we take 10 years more to open the disposal – and we will open the disposal repository by 2025, even if it takes some years more it’s not a problem because everything is vitrified, everything is installed, no problem, no more to process anything on it.

So, I mean, once more, I would like to avoid opposing development of future system, more efficient, more perfect, and so on, to the fact that we have also to move. We have to – we cannot wait forever. We accumulate spent nuclear fuel. And I would not like to be in the situation of having the responsibility to have accumulated so much fuel somewhere, and the next generation – my son, or my grandson, will say, okay, what have they done in the time, they have left us all this matter to clean now. I mean, it’s a real problem there. It’s not only a technical problem.

MONIZ: There are other, which I – and I consider to be more pressing intergenerational issues. For example, proliferation. I would argue we are less prepared to handle some of that than we are this spent fuel issue.

Let me say, by the way, first of all, I mean, as far as France goes, I mean, you know, France, in the 1970s that was: A, it was a different time and France obviously is a country – or Japan, for that matter, with a far different natural resource, energy resources situation, and so a choice was made. What I’m talking about is the issue of the spread of the specific – particularly, the PUREX MOX fuel cycle, to other countries, because, again, we are, in fact, at a different, at a different time.

The issue of the accumulation of the spent fuel – talking about a million tons, or whatever, just does not particularly move me. And, indeed, going back to the question, as it was framed, my personal view is that in the United States, putting everything else aside, my view is that if we were to move – if there were a strong move right now to go to, essentially, conventional reprocessing, I do believe it would be a complication for what I consider to be a more important issue right now, which is moving forward on “first mover” nuclear plant construction so we can understand, in the United States, what a new generation of nuclear power plants would actually cost to build and operate, to go through the new licensing procedures, and to see if nuclear power is or is not going to be a material contributor to climate risk mitigation.

I think that is the open question. It’s the most – to me, it’s the most important question, and we are just getting into side shows with these other discussions.

LEVITE: Thank you. Please.

Q: Miles Pomper, from the Center for Nonproliferation Studies.
Two questions: One, you mentioned – several of the panelists mentioned GNEP. I was wondering, both your thoughts on whether it will continue in some form or another in the Obama administration, and whether it should. And the second question is for Mr. Bouchard on, the United States has concluded a 1-2-3 agreement with the UAE, as Dr. Moniz said, which calls for a take-back of our technology if the UAE engages in enrichment and reprocessing. I was wondering if France would be willing to conclude similar agreements.

MCCOMBIE: Well, it’s difficult – I think, for people inside the States, to decide whether GNEP will continue. I think it would be good if it did continue, in particular, with its international component. It’s been a good forum getting people together. The GNEP people are very keen in ensuring that a long list of countries are in there. Actually it is interesting to make a list of countries that are not in there, and do a comparison which actually shows some of the aspects of GNEP which caused some disquiet for some countries. They thought – understandably, in my opinion—that GNEP was threatening to take more from them than it was offering to give them.

But, if you work on these things, and, as I said, the international part certainly seems to have given a good forum for collaboration, which is always good.

LEVITE: Jacques, you want to respond on France – that question with respect to France?

BOUCHARD: What agreement was –

LEVITE: And the UAE?

BOUCHARD: – what agreement was –

MONIZ: (Off mike.) It was the Abu Dhabi.

BOUCHARD: Abu Dhabi, okay.

Okay, let’s say two things: First, I will – I just had a comment on GNEP. Of course, the U.S. will manage the program as they intend to do. But, I mean, I think that there’s been a clear wish from many countries participating in this discussion to continue to have this kind of forum for political discussions – it’s clearly political discussions, about the way we can progress in the future for the fuel cycle around the world.

So I think that whatever the program itself, it’s important to keep such a possibility of discussion. And it’s – of course, it’s in parallel with the IAEA, and you can say why not to have this discussion within the IAEA? In fact, I think that the advantage of the forum offered by GNEP was – is to be limited to the countries which are interested. That mean there are 20, 30 countries discussing together, all of them are really interested by the topic, and all of them are wishing – willing to progress.

Concerning the agreement with the new countries, such as the Emirates, it’s clear that if there was – all the agreements France will sign will always be including all the rules we are discussing together, within the IAEA.

Q: I’m asking the question about, if there’s a condition on renouncing enrichment and
reprocessing, and if there’s going to be equipment take-back as the U.S.-UAE agreement calls for?

BOUCHARD: I think that it’s clear that if we are supporting a program, for instance, in the Emirates, it will be a program of reactors, and with a fuel supply – complete fuel supply, but certainly not with fuel-cycle facilities.

LEVITE: Yeah, probably we’re going to take it; you know, reprocessing it; the send back to them vitrified waste. And so they can’t do it legally, more than interim storage.

BOUCHARD: No, but no fuel, no facilities.

LEVITE: Please.

Q: Paul Gunter, with Beyond Nuclear.

I would like the panelists to comment on – given the fact that governments are now going to be the, both the financer and the builder of this next generation, could you comment on the challenges and conflicts of being both the promoter and the regulator?

LEVITE: (Off mike.) Do you want to say something –

MONIZ: Well, the United States – I mean, it’s by no means clear, I think, the statement that the United States would be both financer and regulator.

First of all, I do want to reinforce what Charles said, that the financing arrangements are absolutely critical to the economics of high-capital cost projects, be they nuclear or renewables – just that the chunks are a lot different in renewables than they are in nuclear. (Chuckles.) So the financing is critical.

Within the United States you have very, very different arrangements, according to different regulatory structures, in different parts of the country. But, I think, in terms of the United States – at least, well, our position is that we did support the idea of public subsidies for a few “first mover” plants, given the fact that the marketplace is not conditioned – carbon prices, regulatory structures. But, we are equally opposed to having any continuing subsidy for any technology, specifically, including nuclear.

So my assumption is that it will go – maybe they’ll been some gigawatts of support, and then the whole system, hopefully – well, in my view, hopefully, with the carbon pricing coming into place – it’ll be a market decision, recognizing the markets are conditioned differently, in different countries, and even in different parts of the United States.

MCCOMBIE: I would just add, again, and emphasize that it’s different outside the United States. In my home country, Switzerland, we have three general permit applications in for new reactors. None of them are financed by the government in any way.

And in other countries? The Finnish reactors are also not directly financed by the government, yeah. So that there is not this regulatory conflict that you mentioned there. In some countries, it’s always been there, even before, where the government regulates, and all it can do is
separate the powers as high in the system as it possibly can, as has happened in the States.

LEVITE: Mr. Garwin.

Q: I'm Dick Garwin, IBM fellow emeritus.

On generation IV I would have liked to have heard of substantive progress in some of these plants.

And I have a question, though. Yesterday, Bob Rosner said the only way to make progress really is through a science-based simulation approach. And that would mean having a laboratory in which one perfected the tools of simulation at all scales, and could design a reactor, as we designed the 777 Boeing aircraft without having a prototype. So eventually, one would have a prototype.

And I just wondered whether we are making progress sufficiently rapidly in the old fashioned Generation IV Forum, rather than in this simulation, science-based approach?

BOUCHARD: Okay, thank you. Thank you for the question.

I think it’s quite important to point to two things. The first one, Bob yesterday was speaking mainly of the tool used by the nuclear industry. And I can say that most of the laboratories around the world – including the U.S. laboratories, of course, but also the French ones, the Japanese ones, and so on, are using more advanced tools for looking to the future.

The major reason for that is well-known by most of you in the – it’s due to the fact that it’s very difficult to have agreement for new tools from the safety authorities. It takes time. And so the industry takes new tools only when it’s really completely needed, and after a lot of procedure to have them accepted, let’s say, by the safety authorities.

So it’s – I mean, it mean that, in practical, we have development programs which are, by some ways, science-based, with new tools. And, I can say, for instance, in the field of thermal-hydraulics the work which is done, both for a supercritical water system or even for liquid metal cooling, they are made with very, very advanced tools, and with the best – and we have also development for the fuels, in particular, and with the ab initio tools which are completely new developments.

I mean, so we are developing with the most advanced – of course, we can do better, we can always make progress, but, I mean, we have very advanced tools for development. And, on the other hand – let’s say, the business-as-usual work of the industry is done with tools which have the advantage of being well-known by everybody, including the safety authority.

MONIZ: I would just add to Dick's comment. I must say, I share the idea that when all is said and done, progress is really painfully slow, and possibly absent. (Chuckles.)

LEVITE: Please.

Q: Sharon Squassoni, the Carnegie Endowment. Thanks for a very interesting panel. A nice compliment to the one we did yesterday.
I had a question for Jacques and one for Charles.

Jacques, you said that small to medium reactors were not a long-term solution. And I’m assuming you’re talking about the new nuclear states, that nobody’s operating smaller reactors.

It may be that the big vendors are not prepared to sell. For example, Westinghouse has a 600-megawatt reactor licensed, but it’s not marketing it. What about other countries, like India, which does operate 200- to 300-megawatt reactors, they’re CANDU-based, what kind of risks might that pose?

And then my question for Charles was on costs. In noticed that – and maybe I couldn’t quite see, it looked like the cost figures you had for Swiss reactors were Gen-II and Gen-III, which leads me to believe that those are existing reactors.

I think nobody gains – you know, nobody would dispute the fact that existing reactors, the lifecycle costs are quite low. It’s true in the U.S., somewhere between 3 and 8 cents per kilowatt hour. However, the new reactors estimates – and nobody knows for sure, but they’re much higher in the U.S., 11 to 14 cents per kilowatt hour, which really calls into question their cost-effectiveness.

Overall, when you look across the world – I know the U.S. has certain characteristics – like deregulated electricity markets, and other things, weak dollar, et cetera, but can you make some kind of judgment, across other countries, will they be experiencing smaller costs for new reactors? Thanks.

BOUCHARD: I start? Thank you, Sharon, for the question.

I think that this matter of small and medium reactors – medium-sized reactor is not an easy one. You mentioned – you were right that the makers today are not selling such reactors. I think they are not selling because there are no market. In fact, when they have made the – it’s clear that when Westinghouse or General Electric have made the economic calculation for their model of 600 megawatts, they have decided to move to 1,000, and to even more, because it was not marketable due to the cost.

So it’s one of the reasons why it’s difficult to imagine today that we will develop small reactors, such smaller or medium-sized reactor for new countries. We’ll have the same economical problem, but this is one reason, once more, that we need to have proven system for those countries.

And, as long – the only chance will be, if for any reason, there was a kind of niche which appears in developed countries, and which need to use small reactors to satisfy the needs. I heard from some sometimes it was a question of developing new system, like that for Alaska, for other countries.

Okay. If some part of the country needs to have small reactors like that, you can develop the small reactors. Okay, there will be experience by countries with all the experience on the systems, and after that – after that that means 10 years after, it will be marketable in other countries if, economically speaking, it’s acceptable.
So today I am not completely pessimistic on the long term. And, in fact, we are working on small reactors in the long-term, in particular, with high-temperature reactors or fast reactors. But, I think that the prospect of developing small light-water reactors for new countries today, in my view, is completely dead.

LEVITE: Jacques, the one comment – the one part of the question you didn’t answer was –

BOUCHARD: Yeah.

LEVITE: – she was implying that the AECL was out there pushing type of CANDUs –

BOUCHARD: I am not uncertain on India. And there my answer is clear, we are not – today we consider that we should not develop more heavy-water reactors for new countries. It’s not reasonable from the proliferation point of view.

LEVITE: Charles, you want to comment on the second question – very quickly –

MCCOMBIE: Yes.

LEVITE: – because we have a long list of people.

MCCOMBIE: Very, very quickly, of course. There’s also the PBMR. The South Africans were looking at 165-megawatt reactors for distributed use in other kinds of countries.

On the cost issue, I believe Sharon knows much more about it that I do, but this study was for future – it was not for the existing reactors, it was for future build. It was done in a study by Stefan Hirschberg, for the government, and they were looking, in fact, at the generation III reactors when they did it. I can give you the full study so you can look at all the numbers afterwards.

MONIZ: Could I just note, Eli, on that one point, that you may know, in our MIT study in 2003 – well, 2002, really, the work was done, we had a careful look at the economics based upon data at that point. We talked about overnight costs, not owner’s costs, but overnight costs, at $2,000 a kilowatt. That was roundly criticized by various vendors. It proved to be low.

I would just note that we have a new study. It should be posted on the Web site very, very soon. The lead author is John Parsons, and it will talk about an update based upon recent experience of the data on power plants; and, transparent again, and you can put in whatever financing costs you want to get the levelized costs.

LEVITE: Thank you.

Please.

Q: Hello, my name is Jill Parillo from Physicians for Social Responsibility.

Monsieur Bouchard, we’re making you work really hard today – (chuckles) – but I have one final question for you.
I was wondering if you could outline for us France's plans with COEX and GANEX, and how France thinks this will enhance nonproliferation policy; and, in particular, a time line when you foresee using these technologies in the future. Thank you.

BOUCHARD: Once more, as I said – thank you for the question, as I said before, I think that we cannot solve everything in the following day or in the following months. We should proceed step by step. Today we have existing reprocessing plants which are based on the PUREX system.

And we know that, of course it cannot be applied everywhere. We can certainly not recommend building such new plants in other countries, except in countries which have – which offers all the guarantees. And, in particular, I don’t think the problem is really in the U.S.

But, anyway, we have to progress. And today we are able to build new plants if we – we are deciding to build a new plant tomorrow, we will use the so-called COEX process, which is a way to limit the separation and to extract both plutonium and uranium together in order to, let's say, make more difficult – even if not impossible, more difficult the separation for wrong use of the plutonium.

So this is a step. It’s clearly not an objective for the long-term. It’s a step. If we, once more, if we need to, and in our view it’s necessary to develop a recycling; if we need to build new plants now, we have this process. In 10 years from now, probably we’ll have another process, and then we will see after that what the best one is.

But, once more, it’s still an intermediate step. And because it’s an intermediate step, and because there are still some inconvenience, some drawbacks, from the proliferation point of view, in particular, we are still thinking that it should be limited to a few countries. But, okay, it’s a step in the development.

LEVITE: Thank you.

Please.

Q: Joseph DeThomas, from Civilian Research and Development Foundation.

In the last presentation there was a discussion about the need for human capacity building, which I took to be largely focused at the existing nuclear industry. If you look at this from the point of view of new entrants, the problem might even be more daunting. So when you say “action, not words,” thinking about how to fill the capacity needs of new entrants, what would an action plan be, in your view?

LEVITE: Let me try and pick up that question and just say the following.

I mean, a lot of it depends on whether the new entrants would rely on operators who are transnational in nature, who would be going and operating the reactors for them. And I think, for some of the new entrants, this is what they are looking for, which would still require developmental skills for independent regulatory authority, and things of that nature, but that would lower the initial barriers for entry for example in terms of demands for, in terms of human resources.
If they actually want to do the whole thing, I think we're talking about a complete shortage of skills available, in terms of both – even in terms of enough trainers to get them to do it. But, more importantly, this is not just an issue of training, this is an issue of development of security culture, and a safety culture, and more broadly a nuclear culture, if you wish. That's a 20-year prospect.

So I think it's going to be daunting, and wherever you're going to see rapid progress is only in those places where transnational operators would deploy. They would need people even because of the biological attrition of the current operators.

The schools are coming around, but I think one issue where there hasn't been given enough attention to date, and I'll quickly mention it, is, what the curriculum look like? Is it purely engineering, or are they actually have to incorporate it into – and, currently, the industry is pushing into a very narrow interpretation of their curriculum because of the acute human resources demands that they have. Not particularly encouraging. And so the real challenge is not that there will be – or not only enough nuclear engineering, but that they would get the proper training.

Please.

Q: Dan Horner from Arms Control Today.

I wanted to ask about the back-end fuel assurance, because I think most people would agree that's an important part, and many people would say even more important than the front-end fuel assurance that have been talked about.

But, what countries are we talking about, that would actually be accepting it? Russia was, at one point, seen as the likely recipient, but that seems much more uncertain. I think, in the U.S., it's fair to say there would be a lot of political difficulties in taking foreign power reactors' spent fuel.

Mr. McCombie talked about regional repositories, but it seems there is at least arguably a difference between one EU country taking spent fuel from a neighboring country, in probably relatively small quantity; as opposed to the much larger quantities from a non-EU country that we'd be talking about if the renaissance came to fruition in the way some people are envisioning.

So what countries really are serious potential candidates for this mission? Thanks.

LEVITE: Charles, why don't you try and take this.

MCCOMBIE: I get asked this question all the time—you know, who's offering to do it? And my answer is, nobody's offering to do it now, and we're not expecting anybody to be offering to do it right now.

No siting program, no national siting program starts on day-one by saying the repository is going to be here. If it does, it's headed for disaster. The closest that maybe some country came was Germany, which nominate the site at Gorleben, back in the '70s, and that's not been an unqualified success.

So there are certain things you have to do before you can start talking about where the site is
going to be, whether it’s national or multi-national. The first thing you have to do is you have to get all the actors (which, in our case, would be countries), together to agree that we need a common site, or more than one site. If you don’t pass that hurdle, then you shouldn’t start looking. And then you have to build up trust in the organization doing it, and so on.

And this could happen. In fact, right now there’s a European Repository Development Organization working group being set up in Europe, which will include representatives from 10 to 12 countries. This is actually being financed partly by foundations, thanks to the Sloan Foundation, and, I hope, the Hewlett Foundation.

These countries will get together and they will not decide on day-one. They will not put their hand up on day-one and say, I’ll have it, or I won’t have it. They’ll go through the same process that you go through in a modern, consensual national siting process.

And if you go through that process, so you first of all establish the trust that’s needed in the implementing organization – and that’s what’s lacking, very often, in national programs, since the implementers are often governments—who are famously not trusted, and so you have to establish the trust!

Then you have to build up the arguments on both sides. There are up sides and down sides to hosting repositories. And that’s worked at a national scale – in Finland and Sweden, where you have communities competing to host the repository. So we think that the same steps can be applied.

Of course, the barriers are higher, the hurdles are greater, but it will go in the same way. And if you do that, then it’s perfectly feasible, to my mind, that in Europe, or any of the other areas of the world that I mentioned, that—some time from now—some country will say, “Yes, okay, I’m convinced. We can do it. It’s a good deal for us all around.” So that’s the approach.

LEVITE: Given we’re beginning to run to of time, let’s take all the remaining questions quickly, and then have the panel answer. So just say who you’re addressing it to, and try to keep it brief. Go ahead.

Q: Christina Hensell, Monterey Institute. And, I’m not sure – maybe to Ernie Moniz. I just came back from the IEA nuclear security conference last week and learned that, for example, DOE labs are looking at a new way to design fuel assemblies so they’re harder to cut into, and then various measures to improve security. And, therefore, I’m very curious about these advanced recycling concepts, because it seems to me that if you have your UREX-plus, COEX, other such measures, the product of that will be fairly simple to then use the well-known PUREX technology in derived plutonium.

So, I’m wondering, are there more advanced, or other ideas for the future that we should be looking at, that may be truly proliferation resistant. Or how valuable are these processes? And what’s the point of a new fuel assembly if we’re just going to have COEX, and so on, happening?

LEVITE: Jessica.

JESSICA MATHEWS: Jessica Mathews, the Carnegie Endowment. I wanted to ask Ernie two questions about a possible transition to long-term managed storage in the United States. I ask it
because I think that the lack of a back-end solution, a waste management solution, keeps Americans thinking about nuclear – whether or not we’ve run short of interim storage space, keeps the country thinking about nuclear as uncertain, unproven, risky, unfinished, et cetera. We have a record of failure on geologic that stretches back now a half a century, right to the salt caverns in Kansas.

So my first question is, what would it take, or how could you imagine, politically, divorcing ourselves from geologic storage, and making this – the mental transition to long-term managed storage? How can you imagine that happening, or can you?

And the second question is whether anybody has looked at whether there’s any way to use Yucca Mountain in a long-term managed storage capacity and get back some of that $9 billion? Thanks.

LEVITE: Please.

Q: Tom Cochran, with NRDC. I would like to get the panel’s assessment of the Thorium Power, Inc.’s proposal to develop a seed-blanket once-through thorium fuel. And whether, particularly in France, whether they would have any interest in that use of that in French – (inaudible).

LEVITE: Let’s get the last two questions, because we’re beginning to run out of time. Go ahead.

Q: My question is to Dr. Moniz, or any of the panelists.

LEVITE: Would you just identify yourself?

Q: Sorry, Peter Hayes, Nautilus Institute. Much of the purity of growth would come from East Asia and Southeast Asia. Yet, in Indonesia the ulamma have declared a fatwa against the nuclear power plant at Muria, which is a bit of a problem for proceeding with nuclear power plants. A very rational evaluation of nuclear power reactor technology at that site, in that country, with their culture, and the economics – not a general opposition, but specific to that site.

You go through each of the Southeast Asian countries and you come up with a country-specific set of barriers that seem pretty basic and fundamental. In Vietnam, in Thailand, for different reasons, it’s going to be very difficult to move forward. Taiwan is highly constrained. Korea is highly constrained. It really boils down to China, coal and climate.

So my question for Ernie is, can he actually envision China implementing the higher levels of nuclear power targets that have been announced recently, given the political and economic transition, and institutional demands that would be imposed on that country over the next 20 to 30 years? Is that really believable, that we could see those high levels of nuclear power growth?

LEVITE: Please. Last question.

Q: Jim Conklin (sp) of New Mexico State University. It was nice to see Charles refer to the only successful nuclear waste repository program in the world in southeastern New Mexico in the Solano salt. No one ever talks about that. But, we’ve even recently disposed of recycled spent fuel
So it's kind of – it's a really excellent program but there was a bureaucratic decision made 30 years ago that kind of leaves it off of everyone's discussion. But, that was merely a bureaucratic decision. Thanks.

LEVITE: Thank you. Let's go in reverse order in which we started. Two minutes each. Charles, please.

MCCOMBIE: Okay, well, I'll just pick up two of the questions. One is, of course, the salt. The WIPP is a fantastic facility. It's been very successful, after a long period getting it up and running. And, you know, if you do have a consensual siting program in the USA, then obviously some of the areas that might be suspect, if you like – looking at international experience—are areas where there has been positive experience already. New Mexico would be one of these.

The allied question to that, as part of Jessica's point, is of course, that in a rational world it would be beautiful just to use Yucca Mountain for an interim storage facility. It's probably the best interim storage facility site in the world – it's dry, and it's easy accessible, and it's horizontally accessible, and so on, and so on.

If there were no other constraints, that's what I would do. I would shift this stuff into Yucca Mountain where it can stay happily for the decades that you need to develop advanced reprocessing. And, meanwhile, you'll be looking for a second repository site that could be used instead of, or along with, Yucca Mountain. But, that's in a rational world—which we don't have!

LEVITE: Ernie, talk about the rational world, will you?

MONIZ: (Chuckles.) Well – talk about which world?

LEVITE: A rational world.

MONIZ: A rational world, but how about the questions that were asked?

(Laughter.)

MONIZ: On the last question, on China, you know, I don't see any reason why China cannot, and, frankly, would not reach its stated goals of many tens of gigawatts over the next couple decades. But, as you said in the question with China, that's a drop in the bucket compared to coal – 300 gigawatts in the last five years, and that's the real issue, the real climate issue.

In our scenario we had China at about 100 gigawatts in mid-century. It's probably the only country in our scenario that is actually on the terawatt path, at least as defined in our scenario.

Going back to the first question, very briefly, with advanced technologies, et cetera, for nonproliferation, I would reinforce what somebody said – I forget, that I think, as far as proliferation goes, the advanced fuel cycle technologies are more about “do no harm” as opposed to providing a solution. I do hold out some hope that there could be, however, material waste management contributions from advanced fuel cycles, even though I'm skeptical as to how they
might become economic.

With regard to Jessica’s questions – the second question first, and on the uses of Yucca Mountain, one of the things that I always advocated – and, I guess, kind of, off the record when I was at DOE, on February the 1st, 1998, when the Waste Act called for DOE to begin picking up spent fuel, my proposal was a combination of going towards consolidated managed storage, which I’ll return to, but with regard to Yucca Mountain, to move the military waste into Yucca Mountain as it was planned, and when it would be available.

The argument being that the planned military waste – you know, from Hanford, in Idaho, et cetera, would be about 10 percent of the 70,000 tons, and is a fixed amount. It’s not a growing amount. It’s attached to the test site, in a certain sense. And so, for all those reasons, I thought having the military waste there would be useful and would probably have far less political issues. And yet it might exercise Yucca Mountain, over several decades, and allow more chance for study.

With regard to the issue of moving from geological disposal to managed storage, first of all, I wouldn’t say it’s moving in the sense that, ultimately, I think geological storage will be called for, but, in my view, one of the benefits of moving to managed storage – well, there are several benefits of moving to managed storage, let’s call it century timescale.

One is the geological disposal is, if anything, helped, as heat goes down, and, you know, especially heat – (inaudible) – for Yucca Mountain, especially heat. Secondly, it preserves optionality if the magic advanced fuel cycle comes about, in 30 or 40 years, one has it there.

I think the political issue is difficult. I think it wouldn’t have been difficult if we had started with this perspective in the first place. But, I agree, we’re kind of – kind of bought into this public perception that now it’s a failure if Yucca Mountain, specifically, is not licensed.

I think, as you know – I mean, you were on our advisory committee, our view is quite the contrary, that this managed storage approach, with eventual geological disposal of something, is actually the preferred approach. And I think the trick is to sell that – and I don’t know how to do it, the details I can’t – you have to give the magic answer. But, I think it’s important to keep emphasizing, in doing that, that the science – generically, not for any specific site, but the science does support the idea of long-term geological confinement of spent fuel or high-level waste.

And so we have options. We have the option – people don’t like it, Jacques doesn’t like it, but we have the option of continuing managed storage for a long, long time if that is attractive, and we have many technology options that will come in at different time frames, potentially, like geological isolation, and maybe advanced fuel forms.

Another example – going back to Dick’s point, by the way, another example where we’re doing no research to speak of, by the way, advanced fuel forms, advanced waste management packages that can come in over a long time.

LEVITE: A final word to Jacques – thorium power.

BOUCHARD: Fine work, I know, thank you. (Chuckles.) But, just to try to complete the answer to the question, one question about what kind of a back-end process we should develop for
the future in order to avoid continuing with PUREX and with COEX, and so on.

Okay, as I said, there are several ways to see the possibilities in the future for the back-end – for the recycling in the back-end of the fuel cycle. The first possibility is one I have mentioned, which is a main path in the gen-IV today, which is to recycle all the actinides together.

And once more it will solve both the problem of waste management and the problem of proliferation risk. So, if we can succeed, and maybe there is an economical problem, we will see at the end, but if we can succeed in this way I think that it should certainly be the simplest way to solve all of our problem.

There are other paths which can be explored in particular. Bob Rosner yesterday mentioned the fact that we can also try to work on the a very high-burn up systems in such a way that we come back to once-through, with limited waste. It will not be so elegant for the waste management. It will accumulate a lot of things in the waste. But, on the other hand, it could simplify the decision.

So we are also working on that, and we should – it will take time. Now for –

LEVITE: 30 seconds – just 30 seconds because we’ve run out of time.

BOUCHARD: Now for the thorium – for the question concerning the thorium one-through. We have made several attempts, during the last few years, to reopen the question of the thorium cycle. Each time we reached the conclusion that there is no real interest. There is no real interest from the waste point of view, and there is no real interest from the proliferation point of view.

The only reason for which some countries are still working on thorium – on thorium cycle is the fact that the thorium is abundant in some part of the world, rather more than uranium, but it’s only a matter of resources.

LEVITE: Please join me in thanking the panelists for this unvarnished view of nuclear power.

(Applause.)

(END)