

ADDRESSING GLOBAL THREATS—CLIMATE CHANGE AND NUCLEAR SECURITY

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Narrator: This episode of the Slice of MIT Podcast was produced alongside the MIT Alumni Association's Cardinal and Gray Society, a program that invites MIT alumni who have reached the 50th anniversary of their MIT graduation to gather for social and intellectual events between their five-year reunion festivities. For more information on the Cardinal and Gray Society and its upcoming events, visit the communities section of the MIT Alumni Association website at [alum —dot —m —i —t —dot —e —d —u —slash —communities](http://alum.mit.edu/communities).

This talk by former United States Secretary of Energy and MIT Professor Emeritus Ernie Moniz, titled “Addressing Global Threats: Climate Change and Nuclear Security,” was recorded during the society's Spring Lecture and Luncheon at the Cosmos Club in Washington, DC, in April 2018. The talk also include introductory remarks by Cyril Draffin, Jr. '72, SM '73, who is a member of MIT's Corporation Development Committee, the MIT Club of Washington, and is a project advisor with the MIT Energy Initiative.

The lecture and luncheon was jointly organized by the Cardinal and Grey Society; the Emma Rogers Society, which helps surviving spouses of MIT alumni stay connected to MIT; and the Katherine Dexter McCormick (1904) Society, which honors donors who have left planned gifts and bequests to MIT.

Cyril Draffin, Jr. '72, SM '73: I'm honored to have the privilege of introducing our speaker, Dr. Moniz. Dr. Moniz served as the 13th Secretary of Energy from 2013 to 2017. As Secretary, he advanced energy-technology innovation, nuclear security, and cutting age capabilities for the American scientific research community. He also placed science and innovation at the center of the global response to climate change.

He joined Massachusetts Institute of Technology faculty in 1973 and was the founding member of the MIT Energy Initiative. He is the Cecil and Ida Green Professor of Physics and Engineering Systems, emeritus, and special assistant to the MIT president.

He received a bachelor's of science degree in physics from Boston College, a doctorate in theoretical physics from Stanford University, and eight honorary doctorates, received the distinguished Public Service medal of the Department of Defense, in addition to numerous awards for his worldwide efforts. Please join in welcoming the dynamic Dr. Ernie Moniz.

Cecil and Ida Green Professor Emeritus of Physics and Engineering Systems Ernie Moniz HM '11: Well, at least you didn't say the "static Ernie Moniz." Well, thanks, Cyril, for that introduction. And thanks for the invitation to come here. Your work on cyber and grids—it's not something I was going to mention today. But I actually spent about a half an hour this morning talking about that to others, a very, very serious issue, in particular, as we see the risks to our infrastructure growing. And I won't get into why the risks might be even higher these days or over the next weeks than they have been. But that's great.

And I really appreciate the work that you do with MITEI, the Energy Initiative, which I will mention a bit later on, as continuing to look for solutions to some of our problems. But let me not let me not go there now. I'll come back to that.

It's good to be back with MIT folks. I spent, frankly, most of my time during the week here in Washington, carrying on now guerrilla warfare for the issues that I was dealing with as Secretary. I do want to clarify my term going to 2017. That was noon on January 20, just to make it completely clear.

So the Department of Energy, even for those of you in Washington, is often not understood for its complexity. And my good friend here, Mike Telson, with whom I served in the Clinton administration at the Department of Energy knows very well that at least my whimsical description of the Department of Energy is the Department of weapons and windmills, quarks, and quagmires—so nuclear weapons, clean energy, basic science, and cleaning up the Cold War mess. I mean, those are four big missions.

But I think what's important—I think we made some progress in raising the profile. But it's still not sufficient, I think. What holds all of those missions together is science and technology? The Department of Energy really is a science-and-technology powerhouse. In all of those mission areas, it's about applying science and technology to get solutions.

And there is a very special asset—the 17 national laboratories—which again, people often confuse. They think OK, does bombs. And an Oak Ridge does clean energy. No, they all do all of the above. And it's that intertwining of those missions from basic science to technology development to national security that really gives the vitality to those as

research institutions, not to mention, of course their extensive collaboration with universities.

So that's kind of a very small snapshot of the department. But what I want to emphasize, and what will be the thrust of my remarks today, is that certainly, my tenure at the department at secretary—frankly, I was extremely fortunate, because the president's priorities—this is, can assure you, not always the case. The president's priorities actually aligned with DOE's responsibilities.

When he was in office, President Obama, in just less than two months, he gave a very important speech in Prague on nuclear security, on nuclear weapons, nuclear-materials control. He started a series of four international summits literally summits with like 50 leaders of countries coming on nuclear security issues—unheard of, so obviously, we had a chance to really help advance that—but then of course, clean energy, innovation, and climate change—another major priority of the president, especially in the second term, when I was at the department. And I'll come back. These will form, again, the core of my remarks—but just to say that you all know, it makes a hell of a difference when the president actually wants to see you get something done in these areas.

And the Department of Energy is not always in that position. That's for sure. So anyway, I will talk about those. Now of course, it's also a threat of what I would call global risks—climate change, nuclear weapons. I would add to that, bio issues, pandemics. I won't speak about that today although I'm happy to do so in questions. But again, this is a case, where again, the technology advances—gene editing, and CRISPR, and the like hold of course, tremendous upside for the economy for people's health, et cetera. But we also know, with it, comes some risks.

And we can go into that.

But the bottom line is just to say what I'm doing now here in DC—one organization, the Nuclear Threat Initiative, would have been named the Global Threat Initiative if that wasn't already trademarked. So we do bio anyway—and then doing some work with former colleagues in the Energy Futures Initiative, which is on the energy and climate side.

So now the nature of those risks is very different. I would call—climate change is kind of a slow-motion train wreck, whereas the nuclear risks are for potentially kind of cataclysmic events, with the potential of being set off, frankly more through miscalculation than intent—so very different in their natures. The bio, the pandemic threat is again, very different in its nature. But what's in common is that these are really global threats. And what we need to do, especially with the scientific and technical background, is really try to generate the solutions, or at least the risk- mitigation

strategies in these areas.

Now actually, we heard earlier at the table, 1993 was raised. I was going to raise 1992 as a reference point that boy, did things look different than in both these arenas. On the climate side, we forget that addressing climate change, roughly speaking, is the law of the land.

In 1992, under President Bush the senior, in an amazingly short time, the Senate ratified the Rio de Janeiro treaty to address climate change. What was left was the details, like, what are the numbers et cetera? But the idea of addressing this was ratified by the Senate.

In, 1992 we were at the end of the Cold War. And it looked like this horrible nuclear business was behind us. Well unfortunately, now we go forward a quarter century, certainly the latter is not the case. As I'll describe, I think we are at a more risky situation than we have been since the Cuban Missile Crisis.

And on climate, at a minimum, we see uncertainty, and we see frankly, that we are way beyond the curve, in terms of reaching the kinds of objectives that were put forward in Paris. In 2015, going back to that issue of being aligned with the president at the Department of Energy, we did have two major steps forward in these areas. One was the Paris agreement on climate. And the other was the Iran deal for preventing nuclear weapons in Iran. And as we'll discuss, we know obviously, the challenges we have with both of those. But we'll also talk about what may be part of the solution.

So let me start with the climate issue. In Paris, as I'm sure you all know, the last day, by definition, of the Paris meeting in December 2015—essentially, every country in the world came together and took on some form of significant target it was a significant step, but only a first step. And we'll focus on that.

But it was important. What was important was that every country was involved. So I remind you, we had the '92 treaty signed, as I said. But then in '97 was the Kyoto Conference. You should think about, the Kyoto was the follow-on to Rio to try to put some of those numbers in. That's what it was. But frankly, it was horrible to be perfectly honest—and mainly because it drew this bright line that said that only the developed countries had responsibilities.

And in the United States, we had the Byrd-Hagel Resolution. Many, I think, people in this room are—I hate to say it—but old enough to remember it. And that was the statement. It was a unanimous vote in the Senate to say, if the large

developing economies aren't part of this, forget it.

Paris finally answered that question. And so if you go from '92 to the Paris agreement, it's got its imperfections, its political commitments, not-binding commitments, et cetera. But fundamentally, it was the track that was demanded by the Senate. And we have it. Then I'll come back to President Trump's threatening, at least, to pull out of that.

But what I want to say first before we get onto that is that there was a second announcement at the Paris meeting, which I think will prove to be as significant—maybe because I'm MIT—as the agreement. And that is on the first day of the Paris meeting, the national leaders, including President Obama, announced something called Mission Innovation. And that was a commitment by 20 countries—it's now 22 plus the UE—but 20 countries to double their innovation investments in clean energy over a five-year ramp-up period.

Now we knew that was going to be hard to get there. But what we've seen now in the United States—but that was a big deal. It's following the introduction. It was an international declaration that innovation is at the heart of climate solutions. I mean, that's really what it was. And that's an important step, in and of itself, even if you don't quite make that doubling over five years.

Now many countries are actually working at this. They're really working at it. There was a wonderful report put out from a meeting in Mexico looking at the opportunities of accelerating transformational acceleration from new materials, using high-throughput robotic technologies and artificial intelligence, with the goal of reducing the time for introducing these materials from 20 years to two years. Now whether they get it, I don't know. But this is the innovation thinking that's going on in the international sphere.

Now I've got some bad news and some good news. The bad news is that frankly, the administration, in submitting its budget to the Congress, forgot that the factor of 2 belongs in the numerator and denominator. The good news, however, is—and this is really good news—Congress completely ignored it and, in fact, gave an increase of roughly 10 percent, so kind of half of the 20 percent metric for the doubling, doubling in five years. Programs that the administration wanted to zero out, like ARPA-E, apparently because it was successful, were instead given a 15 percent increase.

I'll give an example. The loan program, they wanted to eliminate. And frankly, my colleagues and I did a paper two months ago pointing out that why would you zero out a program that's got \$40 billion of loan authority—not giving

money, loan and loan guarantee authority—which could be leveraged, perhaps, to as much as \$100 billion of energy infrastructure when you are calling for an infrastructure program that you don't know how to pay for? Congress said, yeah, not a good idea. We'll keep the loan program and go forward. So the good news is despite all the rhetoric, on the innovation side, the solution side, there's a lot of support there to keep this going. And we need to keep that innovation train running so that when the policy catches up, we'll have a lot of solutions that can be deployed in a timely way.

Now, the other thing, however, is that, as I said, the targets that the countries adopted in Paris are important. But if that's all there is, we will not be addressing the global warming challenge at anything even close to what is the international consensus of trying to limit global warming to 2 degrees centigrade as, frankly, a reasonable compromise between mitigation efforts and the very expensive need that we will have and are already experiencing in adapting to the results of global warming. We see it, I would say, particularly clearly from the point of view of rising and warmer seas. But it's in many, many other ways and in terms of disease vectors, and fires, and all kinds of consequences.

So that was taken as a reasonable place to go. But bluntly, we are not anywhere near a track to reach that goal. That's not a statement of pessimism. It's a statement about going back to that innovation agenda because the real target is not 25 percent or 30 percent reductions by 2030, which is a typical kind of target in Paris. It's really an 80 percent reduction, at least in the industrialized economies, by a mid-century kind of time frame. That is tough, and we're not going to get there without a hell of a lot of innovation across the board.

Now, let me talk about different sectors. Clearly, efficiency or demand management, reducing demand across the board, is absolutely essential to any possible solution that we can imagine to this challenge of greatly reducing greenhouse gas emissions. The second absolutely essential part, by which I mean I cannot envision a solution without also having the electricity sector go to essentially zero carbon—now, that can be, obviously, renewables. It can be nuclear. It can also be something like even coal power plants if you capture the carbon and can securely store it for a very long time underground. So it's not necessarily limiting the fuels, but it's got to go to zero carbon.

And the reason I say that is electricity is ubiquitous. Its role in the energy system is growing. And frankly, there are a lot of options to get there. Once you do that, the next statement is, well, if you've got a nice, clean electricity system, electrify everything that you can. And obviously, electric vehicles, light-duty vehicles—there's a lot of progress being made. I think the battery, the work of MITI and others, have brought costs down dramatically for batteries. I think there will be another factor of two within a decade, and that factor of two is a big deal, then, for the competitiveness of

light- duty vehicles, straight-up competitiveness in the economy.

That's great, but let's get real. We are not going to electrify the entire transportation sector. And the obvious example is aircraft. It's hard to see a jumbo, battery-powered aircraft. So that's going to be tough. Let's go to industry—even harder. Are you really going to electrify industry to replace—there's probably some chemical engineers here in the room—high-temperature process heat for these very carbon-intensive industries? Not very likely.

So with my physicist, back-of-the-envelope calculation—and I can assure you, that's all I can do anymore—I have a hard time seeing how, even with innovation on the technologies we see in front of us, we can actually reach that deep decarbonization. We'll need something really innovative. Maybe it's—don't laugh. Maybe it's a revival of the hydrogen economy idea, and electrons and hydrogen are the carriers for energy. I think what it needs, in any case, is yet another, let me call it, sector. And that is large-scale carbon management.

That could be capturing carbon dioxide from sources like power plants or industrial facilities. However, to make a difference, you would have to capture so much that the—and it shouldn't be surprising—that the management issue you have with carbon dioxide—carbon dioxide fluid is an industry as large as the oil industry because after all, oil produces a third of CO₂. So it shouldn't surprise you, to have a big impact, you have to have an industry at that scale.

So it just gives you an idea that it's not rocket science to have an industry of that scale. But imagine the challenges you have to get there and to do it in accelerated fashion. So really, this innovation is important. Second point I would make is we need innovation at all-time scales. So for example, in the near-term, we need innovation. A lot of it is business model innovation. We need innovation that just stretches the technology a little bit and gets it deployed. Then we need what I would call—let's call it the—I'm just being crude here—the venture capital world, let's say, of new technologies, some of which, in the intermediate time frame, may be able to penetrate into the energy system. And then we need, frankly, a lot of basic science yet to manage some really hard problems that can be the long-term, really deep decarbonization solution.

I'll give you as an example—this would be a very extreme example, but it doesn't violate the laws of physics. It's utilizing carbon dioxide with water and sunlight to make a hydrocarbon fuel. It's done today in minuscule quantities. But as you know, there's a little issue about scaling these things up and making them cost-competitive.

But that's the innovation agenda. It's a big agenda that we have got to go on. And going to the MIT Energy Initiative

and what Cyril was working with, it's very encouraging. First of all, the agenda is that broad. And secondly, the fact that nearly 30 percent of all of MIT's faculty, not just the engineering school, all of the faculty, in one way or another, had been involved with MITI—research, education, campus energy management, and the like—is itself an incredible statement.

So our faculty, and therefore, our students and staff, recognize this as one of the grand challenges—that innovation is central to addressing it, and that MIT is going to be part of that solution. So I think that's the hope and where we'll go. Now, going back to the current realities, especially here, as we indicated, the president, President Trump, on June 1 of last year made his announcement about withdrawing from Paris. I do want to say that without going through all the arithmetic, technically, withdrawal of the United States cannot happen until the day after the next presidential election, which is a nice irony. But nevertheless, the real issue would be not executing programs that would be needed moving forward.

However, I'm going to posit—and this is another optimistic statement—that the president's announcement, in the end, will be of little consequence. We're not going back. We may have more bumps in the road for the next few years. A few things could be a little bit slower. But what happened within days of his announcement was absolutely critical. Governors and mayors across the country said, we're not changing what we're doing. In fact, maybe we'll double down.

And if you remember, all the things that—well, many of the things that were put forward to address climate were actually not even in effect yet. The real decrease in American emissions has come from state action and from market forces in which natural gas replaced a lot of coal, bluntly. So I don't want to be Pollyannaish, but that is very encouraging. Maybe even more encouraging—within days, 1,700 business leaders said, we're not doing anything different, because they read the tea leaves. We're not going back. The world is not going back. And I'm not going to sit here and do my capital allocation planning for the next 20 years based upon that statement on June 1.

So companies are largely—there are the obvious exceptions, frankly, the exceptions trying to get exceptions in the policy and regulatory world. The first attempt at that with the Federal Energy Regulatory Commission completely bombed. The proposal to support especially coal plants was defeated five to zero by the Commission, four of whom had been appointed by President Trump. So there's a lot of things saying, we're going there, and we got to hold to this innovation agenda to make sure we have the solutions, when the time comes, to be able to really move them out. And I think, by the way, that time is not going to be so far away.

And by the way, another MIT person has been part of a group that has put forward the kind of solution that I think we will eventually see. That individual is George Shultz, who, you may remember, was at MIT 70 years ago, come to think of it, this class of '48 kind of thing. He was on the faculty, I think, at least, '48.

But George Shultz, Jim Baker, Hank Paulson, really Republican conservative people, they, for example, put out a plan that says, first of all, we've got to price carbon at a price that really reflects the social costs—\$45 a ton, shocking compared to what people normally say. But that's what it is. That is the actual social cost of carbon.

Then they say, and whatever you do, don't let the government get their hands on the money. So collect the money. We're talking a lot of money. We're talking \$45 a ton times maybe 6 billion tons. It kind of adds up. But their approach is, look, don't use it for deficit reduction. Deficit reduction, you've got to tackle the honest way. Don't use it for more R&D. Support R&D the honest way. Take these funds, divide it up equally, and send it back to the people. And that is a progressive—let's use the horrible word—tax. The lower 70 percent of the income distribution would come out ahead. That's great for part of the political spectrum. What about the other part of the political spectrum?

Well, the third leg of the stool is now that you have a carbon price, you have to remove a lot of regulation and other tax incentives. It makes sense as a package. So that's the kind of thing that's bubbling. I think it's getting a little traction. And at some point, we're going to have that happen. And that, with the fruits of the innovation, can see tremendous deployment in a short time with businesses coming up with new business models maybe as exotic as block chain, which maybe somebody here can explain, but new business models that will provide new services, clean energy, and I think in a very competitive economy. So that's the way that I think we can see our path forward.

Let me change to what is, frankly, a less cheerful subject, the nuclear security issues. And there are three that—I'll be relatively brief, but three that I will bring up—the Iran nuclear agreement, where I'm sure many of you know, there's a May 12 due date for presidential decision; North Korea, where there's a possible summit discussion coming up; and finally, Russia. And I'll come back to Russia.

On Iran, let me just make a few points. First of all, what the agreement is badly misunderstood despite all attempts to clarify. Let me try again. You probably hear a lot of statements that, oh, this is a terrible deal because it's sunsets in 15 years. And all you've done is you bought us 15 years and essentially guaranteed Iran as a nuclear power in 15 years—completely wrong.

What happens is the restrictions on Iran's peaceful nuclear activities go away in 15 years, but we are not back to where we started by a long shot because what persists is the world's, by far, most stringent verification regime. That's the heart of the agreement.

Think about it. Do you think Iran or any other country is going to make a nuclear weapon using their declared nuclear facilities where the IAEA, the international inspectors, have access? Well, that would be a nice invitation to get bombed. It's going to be at a covert location.

That's what the agreement does. It provides forever access to any location for which there is reason to be suspect, and uniquely requires Iran to provide access within 24 days forever. Unbelievable to give that up, to cancel the deal for no obvious security benefit, to give that up. So this is a momentous decision coming up. It doesn't look good, to be honest. But that's really what it's about. Secondly—and as you all know, I think, I mean, I was at the table for the negotiations. And as anybody would, Iran, of course, tried every which way to drive a wedge between the United States and the others, most especially the Europeans. They could not succeed. So why don't we just hand it to them? Here's your wedge, because the Europeans are on a completely different page from us. And this is something to take very, very seriously because, in my view, the sources of American power, internationally, are alliances, international institutions, financial institutions, trade relationships, and value-based systems.

Every one of them is, shall I say, euphemistically suffering from some uncertainty in the current discussion. So this is fundamental to how the United States has built the order over the last 70 years and how we continue with our strength. And frankly, if that is to be replaced by a mercantile focus on bilateral trade deficits, fantastic. Let's play China's game. We don't have a chance of winning a mercantilist game. So I think the gravity of these kinds of decisions, I think, is sometimes overlooked. And we've got to keep working to do this, to change this. And the other thing I would say is on the Iran deal—OK, let's say in what I would consider to be the ideal case, that the president does take the action required to sustain the deal, the other thing—and this has a lot of technical components. We are not spending our time thinking about how we want and how we shape the development of the Iranian nuclear program over 10 to 15 years so that it comes out on the other side in a way that is acceptable in terms of the regions and the world's security needs.

So I want to be clear. We have a lot of problems with Iran, obviously. And we've got to work hard on those other problems—Syria, Yemen, human rights. I mean, missiles, Hezbollah—these are serious problems. But you don't help solve those problems by getting rid of the one progress you've made in terms of making sure nuclear

weapons are not part of the equation. So that's a few things on Iran.

On Korea, let me say, first of all, unequivocally, that, acknowledging the risks, I think it's a good idea for the president to have a discussion with the North Korean leader. I know the risks, but the alternative doesn't look very good either.

The question is, what is the president trying to accomplish? And this is where—and I wrote a fantastic op-ed in the *Boston Globe* two weeks ago. Please send it out to the members—which noted that in effect, if you come back and say, Kim Jong-un is committed to eventual denuclearization, you've accomplished nothing. It's like the fourth time we've come back with that statement. Whereas, for example, something like coming back with a clear understanding that if there are going to be negotiations, real negotiations, right from the beginning, verification is on the table. That is going to be tough for them to swallow because they are such a closed society, much more closed than Iran.

And now comes a linkage. How could you make that argument if you've just killed the world's best verification regime? So there is this linkage. And I think the president has an opportunity to make really historic progress, but he's got to do it on the two tracks and not just, frankly, throw bombs, roughly speaking.

There's more to say on that, but I think I'll just make my last comments on Russia. When all is said and done, it focuses the mind to remember that only Russia is actually an existential threat to the United States. And they've got thousands of nuclear weapons, as do we. And the trouble is our relationship has probably never been worse, arguably has never been worse. Certainly, military-to-military dialogue is minimal. And yet, we are, in many situations, the potential for direct conflict, from the Baltics to Syria.

Let me make it—I don't think anybody wants a nuclear war. And that includes all the states with nuclear weapons. With Russia and the United States, I am particularly concerned about stumbling into it through miscalculation and events that spiral out of control.

So one of the things that we see—and I had an earlier discussion that we think—at the Nuclear Threat Initiative, we will continue to work to see what we can do to increase dialogue and cooperation in areas of clear mutual interest. I'll give you one example. And this is all about—it's a little bit of confidence-building. It's a little bit of how scientists and engineers during the Cold War did so much to prepare the ground that, when the opportunity came, there were

relationships, et cetera, that could be drawn upon to control risk—that, in the same way, we need to get more stuff happening. Frankly, we've cut off even basic science collaboration, which is, I think, a mistake.

But so I'll give you one example in my organization that we've done. And we need 50 of these, is that—so we had a meeting. We organized a meeting, which included the US government, the EU. It included Russia. It included the international inspectors—a meeting in Kazakhstan and, as a follow-up, meeting coming up in Kyrgyzstan, in which we work together to start a program to identify the radioactive sources left over from the Soviet Union days in the Central Asia republics that could be used in the dirty bomb.

It's a mutual interest to all of us to pursue this. So what we're doing is—and we actually do have a list of 50 projects that we'd like to keep moving and just try to help prepare the ground so that when there is a chance for more dialogue on the big issues, that we have the kinds of relationships, including scientist-to-scientist relationships, that can hopefully help solve these problems. So I'll end and say, in all of these areas, including going back to the climate area, diplomacy is something that we need to become reacquainted with. And frankly, I think—and I'm not totally objective, particularly in Iran kind of situation. And I think there's a lot more room for science in diplomacy as we address these range of major threats to our and other societies. So thank you for your attention.

Narrator: Thank you for listening to this episode of the Slice of MIT Podcast. Share your thoughts on this talk by Ernie Moniz on Twitter at [m-i-t-underscore-alumni](https://twitter.com/m-i-t-underscore-alumni). And if you want to hear more surprising, quirky, and insightful stories about MIT, subscribe to the Slice of MIT Podcast on iTunes. Please rate the podcast and leave a review. Tell us what you liked and didn't like about this episode. Thank you to the MIT Cardinal and Gray society for the audio of this podcast. And for more information the MIT Cardinal and Grey Society, and the many other communities available to MIT alumni and friends, visit [alum .mit.edu /communities](http://alum.mit.edu/communities). Thank you for listening to the Slice of MIT Podcast.