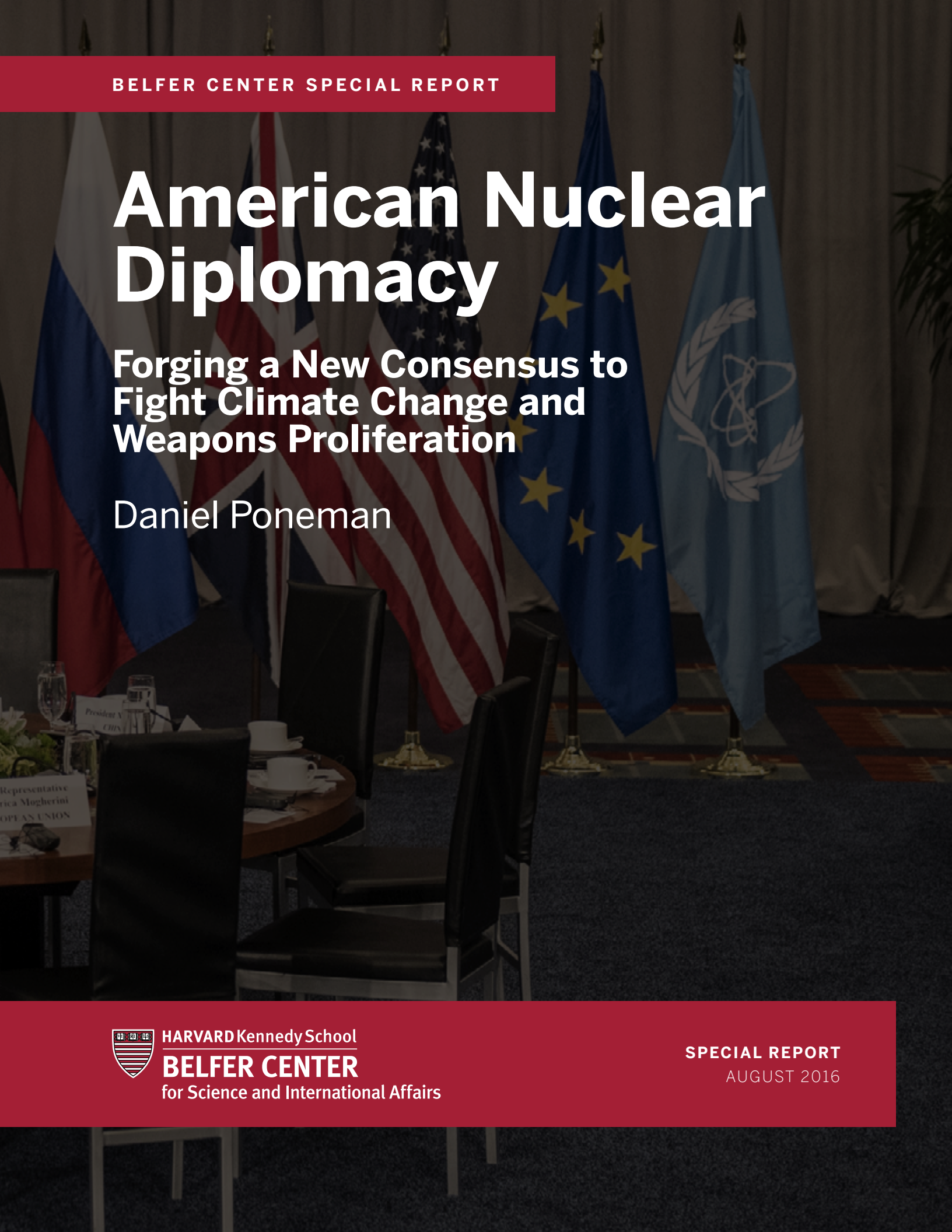

BELFER CENTER SPECIAL REPORT

American Nuclear Diplomacy

Forging a New Consensus to Fight Climate Change and Weapons Proliferation

Daniel Poneman

HARVARD Kennedy School
BELFER CENTER
for Science and International Affairs

SPECIAL REPORT
AUGUST 2016

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Daniel Poneman is the President and Chief Executive Officer of Centrus Energy Corp. (Centrus). Centrus provides enrichment, fuel, and fuel services to utilities that operate nuclear reactors throughout the world and has investments and business interests in some of the sectors discussed in the report. Mr. Poneman wrote this report in his private capacity, and all opinions expressed are his alone. Funding for the report was provided by the Harvard Kennedy School's Belfer Center for Science and International Affairs.

Cover image: A table is set for the members of the P5+1 to meet on the margins of the 2016 Nuclear Security Summit in Washington, D.C. on April 1, 2016.
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About the Author

Daniel Poneman is a Senior Fellow with the Belfer Center. From 2009-2014, Poneman was Deputy Secretary and Chief Operating Officer of the Department of Energy. Between April-May 2013, he was Acting Secretary of Energy.

Poneman's responsibilities at the Department spanned the full range of energy issues, including fossil and nuclear energy, renewables and energy efficiency, and international cooperation around the world. He led the 2009 negotiations to address Iran's nuclear program and played an instrumental role in the Department's response to crises from Fukushima to the Libyan civil war to Hurricane Sandy. He also led the Department's efforts to strengthen emergency response and cybersecurity across the energy sector.

From 1993 through 1996, Poneman served as Special Assistant to the President and Senior Director for Nonproliferation and Export Controls at the National Security Council.

Poneman has published widely on energy and national security matters and is the author of *Nuclear Power in the Developing World and Argentina: Democracy on Trial*. His book *Going Critical: The First North Korean Nuclear Crisis* (coauthored by Joel Wit and Robert Gallucci), received the 2005 Douglas Dillon Award for Distinguished Writing on American Diplomacy.

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This project would have never happened but for Graham Allison's invitation to return to the Belfer Center for Science and International Affairs as a nonresident fellow, after a brief thirty-year hiatus. I am sincerely grateful to him for offering me that opportunity. In all important respects the Belfer Center had not changed; it remains a place electric with ideas and imbued with the excitement of people of all ages and points of view working hard to solve the world's toughest and most important problems. And the colleagues and wonderful staff there—including Sarah Donahue, Patty Walsh, Isabel Carey, and Andrea Duarte—have been generous and supportive in every way.

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The shortcomings that remain in the report despite all of the help I received from these and other colleagues are of course entirely my own responsibility.

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U.S. President Barack Obama addresses world leaders at the opening plenary session of the Nuclear Security Summit in Washington April 1, 2016.

REUTERS/Jim Bourg

Introduction: Two existential threats

Today, as a species, we face two existential threats: nuclear annihilation and catastrophic climate change. Both stem from human origins.

We need to fight both threats aggressively. There are many things we can and should do to tackle the climate threat, beginning with putting a price on carbon emissions, promoting market mechanisms that reward efficiency, leveling the playing field for all lower-carbon energy sources, and leveraging the Paris Climate Agreement into more effective international action.

But even adding up all existing national commitments to curtail greenhouse gas emissions, and assuming perfect execution, the world falls far short of the cuts needed to avoid catastrophic climate change.

The expanded use of nuclear energy can make a major contribution to closing that gap and meeting our climate goals. But inherent in the use of atomic fission is the risk that the technology and materials can be diverted to terrorists or hostile nations.

The key question becomes whether we can preserve or even expand the environmental benefits from nuclear energy without increasing the risks of nuclear terror. Better yet, can we enjoy those benefits while *reducing* nuclear threats through smarter policies and practices? If not, then governments and societies would face a cruel choice, indeed.

This report will argue that well-crafted laws and policies, implemented with an ethos of constant vigilance, and embedded in a culture that weaves safety and security goals into the fabric of our nuclear programs, can manage nuclear risks to the point where, on balance, the benefits from the use of the atom outweigh the costs. Some nuclear risks—such as those presented by armed adversaries—can best be dealt with head-on, through traditional tools such as diplomacy and counterterrorism, arms and export controls, deterrence and compellence, law enforcement and intelligence, and, in the last resort, the use of force.

Other nuclear risks—such as those related to the stewardship of nuclear arsenals—must be dealt with through inculcating the custodians of nuclear weapons with the appropriate skills, backed by the appropriate force and resources, steeped in a deeply ingrained sense of responsibility for the inviolable mission to protect nuclear weapons and radiological materials from theft, sabotage, or accidental loss or detonation. These elements of response to the nuclear threat, though difficult to implement effectively over time, are well documented and understood, and will be addressed only briefly in these pages.

Less consensus, however, exists regarding the relationship between the nuclear threat and the use of nuclear energy itself. Can policies be derived and implemented that will *reduce* the risk of nuclear terror even as the use of nuclear power *increases?*

Answering this question is complicated by lack of clarity over the motives of the governments in countries pursuing the development of nuclear energy. Since India's detonation of a so-called "peaceful nuclear device" in 1974, the question has always loomed whether those governments are simply seeking energy solutions for their citizens or a nuclear weapons option.[1] As will become clear in the pages that follow, in some cases the answer turned out to be both. But in many cases, the principal vector toward nuclear weapons development has been a program dedicated to that aim, while in other cases a nuclear energy program did not cloak any military intent.

How should U.S. policy respond to this messy reality? One thing that history shows is that a one-size-fits-all policy does not work well. Before 1974, a generally open-door approach to promoting nuclear energy led to nonproliferation controls that were too lax, as evidenced by the Indian test and a series of proposed nuclear fuel cycle deals—with countries such as Brazil, Pakistan, South Korea, and Taiwan—that would have led to a world with far too much capacity to produce nuclear weapons-grade materials.

But today, a too-restrictive *unilateral* U.S. policy toward peaceful nuclear cooperation with other nations could chill demand for U.S. supplies of nuclear goods and services. Ironically, this putatively "tougher" nonproliferation policy would drive nuclear business into the arms of other suppliers and therefore actually *weaken* nonproliferation and safety efforts, given that U.S. nonproliferation standards are second to none globally. Not to mention the

1 The author's first book addressed this issue; *Nuclear Power in the Developing World* (London: Allen & Unwin, 1982).

fact that such a policy would continue to weaken the U.S. nuclear industry at a time when it needs to regain strength, not only to contribute to solving America's energy and environmental challenges, but also to sustain America's global leadership in nuclear safety and nonproliferation.

So this report will advocate a set of U.S. policies that acknowledges that messy reality, and makes robust use of the expanded and strengthened set of nonproliferation tools developed over the last several decades to target those governments, programs, and terrorists that are likely or known to be developing a nuclear weapons option. At the same time, it will advocate policies designed to promote the ability of nuclear energy to contribute significantly to the effort to prevent catastrophic climate change, to promote the ability of the United States to participate fully in that effort and, indeed, to start rebuilding the strength that it has lost in recent years.

What will these policies look like? They will include three features. First, they will require continued focus and effort by governments to make full use of the toolkit of *diplomatic, political, economic, law enforcement, intelligence and military assets* needed to address those governments and terrorist organizations that represent proliferation threats. Second, they will require continued focus and effort by governments and industry to tackle the ongoing challenges—*safety, security, cost, regulatory,* and otherwise—that have constrained the ability of nuclear energy to live up to its potential in creating a low-carbon future. Third, they *will require the establishment of a new consensus* on how to reduce risks of diverting peaceful nuclear cooperation to military or other violent uses, specifically by focusing on that aspect of commercial nuclear power that is most vulnerable to possible misuse*: the nuclear fuel cycle.*

The nuclear fuel cycle includes one process that can enrich uranium to a very high concentration of the uranium-235 isotope (known as "highly enriched uranium", or HEU), and another process that can separate plutonium-239 from used nuclear fuel. Both HEU and plutonium-239 can be fashioned into nuclear weapons.

There are two ways to minimize the risk of diversion of HEU and plutonium to military uses. One is to make sure that wherever those materials exist, they are subjected to strict nonproliferation and physical protection standards. The other is to minimize, reduce, or eliminate stocks of those materials and the facilities that produce them.

The United States can play an essential role in both of these approaches. But we must start by recognizing that, with or without the United States, nuclear power is now deployed globally. It is here to stay. Indeed, now that many lessons from Fukushima have been applied, and the 2015 Paris Climate Agreement has set out a course to lower global carbon, demand for nuclear energy is projected to grow.

By how much? Today, there are 440 reactors operating worldwide, plus 66 under construction, and 170 planned or under contract. According to the International Energy Agency (IEA), in order to limit climate change to 2°C in this century, global installed nuclear capacity "would need to more than double from current levels of 396 GW to reach 930 GW in 2050, with nuclear power representing 17% of global electricity production."[2] Of the 66 reactors currently under construction, 61 are being built outside the United States in 14 different nations. And a number of additional countries are planning to deploy nuclear power.

So the question is not whether nuclear power will form an important element of the world's future (it does and it will), but only how much of a role the United States will play in building that nuclear future. Will the United States lead or watch? Will the United States remain the leading producer of nuclear energy in the world, with the largest nuclear fleet generating the most carbon-free power? Or will we continue to see safe, well-run, efficient, clean energy production sources cut down in their prime by the confluence of cheap natural gas, failure to impose a price on carbon emissions, discriminatory tax regimes, and deregulated markets that fail to compensate either for the security provided by a diversified energy portfolio or the reliability of always-on nuclear power, which keeps the lights on even when storms or freezing weather clobber other generators? And will we continue to shut down massive producers of carbon-free electricity that vastly exceed the amount of wind and solar power being added to the grid, even under the most ambitious growth scenarios for renewables?[3]

2 International Energy Agency, "Technology Roadmap: Nuclear Energy" (2015). https://www.iea.org/publications/freepublications/publication/technology-roadmap-nuclear-energy.html

3 For example, Exelon's decision to shut down the Quad Cities and Clinton reactors would eliminate about 25,000 gigawatt-hours of carbon-free electricity per year, overwhelming the increased renewable electricity generation from wind and solar by 659 gigawatt-hours of increased wind and solar the state of Illinois added to the grid in 2015 by a factor of nearly forty to one. U.S. Department of Energy, Monthly Generation by State, Producer Sector and Energy Source.; Illinois EPA Report, January 2015.

Clearly, the United States has a lot to contribute, given its leadership role since the dawn of the atomic age in maintaining the highest standards for safety, security, and nonproliferation. But if the United States cannot figure out a way to keep building nuclear power plants and fuel facilities, or even to keep those that are operating well in business, then its contributions to lowering carbon will shrink. If the United States cannot continue to attract young Americans to the nuclear field or to build new generations of safer, cheaper, more secure nuclear reactors, then its leadership will fade. If the United States cannot figure out a way to compete effectively in an increasingly competitive global market for nuclear reactors and fuel services, then its international influence will decline. Given all these uncertainties, one has to wonder if the United States will be able to continue to exercise the degree of global nuclear leadership—and command the same degree of nuclear respect—as it has traditionally enjoyed.

If the United States is able to address these challenges, then it will be well-positioned to address both avenues to reduce the risk of diverting HEU or plutonium to violent uses. *First*, it will be able to continue to promote the strongest standards of physical security and nonproliferation, drawing from a set of nonproliferation laws and regulations as rigorous as any in the world. *Second,* it will be able to lead the creation of a multilateral Assured Nuclear Fuel Services Initiative (described below), which could offer reliable nuclear fuel services and minimize the need to build more multi-billion-dollar enrichment and reprocessing facilities in a market that is already glutted with overcapacity. *Third,* it will be able to continue to innovate and deploy new nuclear technologies that are safer, more secure, more environmentally friendly, and more cost effective than today's technologies.

In short, if climate and nuclear threats are to be effectively addressed, then we will need tough-minded policies to enable nuclear energy to succeed, at once both *increasing* the effectiveness of the controls to be applied to all nuclear activities in general and to exports in particular, while *minimizing* the number of facilities that handle weapon-usable materials.

One last point: if these policies are to be successfully implemented, they must be embraced by a *bipartisan consensus*. The reason is simple: nuclear policies are implemented over years and decades, and involve billions of dollars of investment. If the United States wants to be accepted as a nuclear partner for countries developing nuclear energy around the world, we need to embrace

a policy, stick to it, and be seen to do so. No one is going to jeopardize a multibillion dollar program by partnering with governments or contracting with companies that may change the rules of the game or the terms of the deal based on changing parties in power in Congress or the White House, or prevailing political sentiments, or any grounds other than those that are clearly agreed to by the parties from the outset.

Decades ago, four-time U.S. Cabinet member George Shultz observed the same problem and aptly described the risks inherent in jeopardizing the fact and appearance of reliability in international trade, a phenomenon he called "lightswitch diplomacy":

> "An extra element has been added to international trade in the past few years: a political dimension overlaid on commercial transactions. The political factor is a vigorous and flamboyantly administered initiative that uses trade as a tactical instrument of foreign policy, a situation sometimes referred to as "lightswitch diplomacy." The government seems to believe that individual trades can be turned on and off like a light switch to induce changes in the domestic and foreign policies of a host government. As a result, the U.S. trading position is being eroded, as other countries view the U.S. as unreliable trading partners. The U.S. must realize that its dependence on world trade has increased greatly. It is important for the government to provide a stable and predictable set of rules governing trade policies. Trust, confidence, and continuity must be incorporated into trade agreements."[4]

While the rancor of modern politics in Washington may suggest that such a bipartisan consensus is beyond reach, it is worth noting that both Republican and Democratic presidents have traditionally treated nonproliferation as a major U.S. foreign policy objective, and that among both career employees and political appointees, there have been deep currents of consistency over many decades in U.S. nuclear diplomacy. Things have often been rockier, in fact, between the executive and legislative branches than between the parties.

The biggest "rule change" in U.S. nuclear diplomacy since the passage of the 1954 Atomic Energy Act occurred in the negotiations leading to the passage of the Nuclear Non-Proliferation Act of 1978, which did stress relations between Congress and the Administration, but ultimately passed both houses and was signed

4 George P. Shultz, "Lightswitch Diplomacy," *Business Week*, May 28, 1979.

by the President, and did significantly strengthen U.S. nonproliferation efforts in important ways that ultimately strengthened international efforts as well.

And now, once again, the stakes for U.S. nuclear diplomacy are high enough, in terms of advancing American national security, environmental, and economic interests, that we should be able to summon the spirit of Arthur Vandenberg and agree that, when it comes to vital nuclear issues, "politics stops at the water's edge." That is why this report calls for a new consensus in American nuclear diplomacy.

That's not math, it's arithmetic...

In a forthcoming companion to this Belfer Center report, the author will argue for a set of policies that clearly identifies the fight to reduce carbon as the central organizing principle for all energy policies worldwide. These policies will be driven by an ever-widening consensus—forged from science over several decades —on the accelerating pace of climate change and the need to take concerted action to change course.

Science and diplomacy converged in Paris in December 2015, as 190 nations gathered at the 21st Conference of Parties of the United Nations Framework on Climate Change. Their goal: to bind the international community into universal agreement on climate, with the aim of keeping global warming below 2°C.

And at the end of the day, they did. The parties set 2°C as their goal for temperature change before 2100, and agreed to pursue efforts to limit change even more sharply, to 1.5°C. The agreement moved beyond the old debates over which countries had more or less responsibility to take action, instead embracing 187 national goals that had been submitted in support of the global effort to cut greenhouse gases. The Paris Agreement provided for enhanced transparency measures, and called for five-year reporting cycles on progress made.

To be sure, the deal was far from perfect. Its commitments were not legally binding and it included no enforcement mechanism. But the biggest problem was this: *Even if every signatory meets 100 percent of its own commitment to limit carbon emissions, the world will not even come close to meeting the Paris*

temperature targets. On the contrary, a number of studies have concluded in this case that the world would substantially overshoot the 1.5°C.[5] Of course, there are different assumptions, uncertainties, and ranges among these studies, which have been carried out by a number of entities, including the International Energy Agency, the European Commission Joint Research Centre, the London School of Economics, the Massachusetts Institute of Technology, the UN Environment Program, and others. But many of the studies project that full INDC implementation would still lead to temperature increases well in excess of 2°C , while the most pessimistic (the MIT high case) shows a 5.2°C outcome.

So we need to recognize that Paris just isn't enough.

Doubling down on nuclear energy

Let us take the IEA projections that the world needs to more than double its installed nuclear capacity by 2050 if we are to reach the Paris targets. First, just to give a sense of the scale of that effort, it would require the deployment of around 390 reactors by 2050. (That assumes an average of 1.2 GWe-sized reactors; if the world moves to small modular reactors, that number increases.) That in turn translates into more than a dozen nuclear reactors per year, every year between now and 2050, even more if you take into account the five-year gap between making a decision to build (assuming it could be decided today) and designing, building, and commissioning a reactor. To put that into perspective, China currently is adding on average six to eight new nuclear reactor orders per year until 2020, and 10 new units per year after that.[6] Twenty-one units are under construction and their 13th five-year plan projects that 135 new reactors will be deployed between 2016 and 2030.[7] In the United States,

5 Kelly Levin and Taryn Fransen, "With Latest Climate Commitments, How Much Will the World Warm? It's Complicated.", *World Resources Institute*, November 18, 2015; http://www.wri.org/blog/2015/11/latest-climate-commitments-how-much-will-world-warm-its-complicated

6 World Nuclear Association, "Nuclear Power in China" Last updated June 2016. http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx

7 135 new reactors are reached by adding seven per year from 2016 to 2020 and 10 per year from 2021 to 2030.

during its peak era of nuclear power plant construction in the mid-1970s, almost nine plants were being added to the grid each year.[8]

The target is ambitious. How shall we proceed? The author will address that topic more extensively in a subsequent volume, but for now suffice it to say that a number of challenges would have to be overcome to add sufficient nuclear power to meet the IEA forecast. Specifically, in all nations nuclear energy must measure up in terms of safety, security, environment (including waste management), economics, and security.

The rest of this report will focus on the last criterion: security. Specifically, nuclear power cannot flourish globally unless we contain the threat of diversion to military uses of nuclear equipment, technology, or materials. And given the strong interests in minimizing that threat globally, and in promoting the transition to a low-carbon future, ideally the United States would continue to play an important role in the global deployment of nuclear energy, for three reasons.

First, when it comes to nuclear power, an accident or security incident anywhere is an accident or security incident everywhere. So simply to protect the hundreds of billions of dollars invested in our own U.S. nuclear fleet, the United States has every incentive to continue to promote the world's most effective safety, security, and nonproliferation standards, to minimize the risk of a future Fukushima or act of nuclear terrorism anywhere in the world.

Second, if the United States is going to develop the capability to build reactors at the pace implied by the IEA target for new build, it will need a much larger supply chain of nuclear-specific contractors and subcontractors, along with thousands of skilled workers to support that effort. Given the modest pace of new build in the United States today, leveraging the much larger demand of the global market for nuclear power could provide U.S. industry with a much larger base of demand over which to spread its costs and find new revenue streams that will help support the U.S. industry at a critical time. So international opportunities could help revive the U.S. nuclear supply base, and accelerate its expansion. Obviously, this would not only support the expansion of carbon-free power in the United States but also represents a major

8 Data from the IAEA's Power Reactor Information System, "United States of America" Last updated June 28, 2016. The peak era was 1972-1976; for the decade as a whole the United States was adding 5.9 reactors per year to the grid on average. https://www.iaea.org/pris/CountryStatistics/CountryDetails.aspx?current=US

opportunity to increase American exports of goods and services and support well-compensated jobs in communities nationwide.

Third, the world is still a dangerous place, and the U.S. has traditionally led global efforts to combat the proliferation of weapons of mass destruction, most recently in the case of Iran, but also ranging across a host of multilateral and bilateral diplomatic initiatives and institutions, from the NPT to North Korea to the Nuclear Suppliers Group and many more besides.

So the United States needs an effective diplomatic strategy to support the safe and secure deployment of nuclear power in a manner that minimizes the risk that dangerous equipment, technology, and materials could fall into the wrong hands. It is to that strategy that we now turn.

The correlation of forces...

Earlier, this report argued that it is necessary to forge a new consensus on how to reduce the risk that uranium enrichment or plutonium reprocessing labeled as "peaceful" elements of an energy program might be diverted to support a weapons program.

As noted, strict nonproliferation and physical protection standards will be necessary, but there is nothing conceptually new about that. The harder question is how to minimize stocks of those materials in the first place, because that task requires governments to *abstain voluntarily* from actions they clearly have the technical and institutional power to perform. And in the aftermath of the 2016 Iran nuclear deal, governments could also cite that deal as precedent supporting their own so-called "right to enrich."[9] Therefore, we will need to

9 Few, if any, concepts in nonproliferation have been more widely misinterpreted than the so-called "right to enrich." The source of that right can be found in Article IV of the Nuclear Non-Proliferation Treaty, which established "the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy *for peaceful purposes* without discrimination *and in conformity with Articles I and II of this Treaty*." (Emphasis added.) By its own words, then, the Treaty confers no rights to enrich uranium for non-peaceful purposes, while Article II of the Treaty commits non-nuclear weapon states "not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices." Where a nation has engaged in a major clandestine effort to develop centrifuges, has failed to cooperate fully with the International Atomic Energy Agency, and has failed to resolve international concerns about the possible military dimensions of its program, it is not clear that that nation is not seeking to acquire a nuclear weapon, or that its enrichment activities are entirely intended "for peaceful purposes." A fair reading of both Articles II and IV of the NPT would therefore not confer an inalienable right for Iran to enrich uranium.

rely on *persuasion*, rather than *physical restraint,* to reduce the deployment of enriched uranium and separated plutonium.

In considering how best to design this aspect of nuclear cooperation, one must start with a recognition of what the Soviets used to call "the correlation of forces." In this sense, one reality that the United States must address is that our role in international nuclear commerce has diminished. When it comes to the sale of nuclear reactors, Russia, France, South Korea, and Japan have all proved to be formidable competitors, collectively controlling over 90 percent of the world market in new reactor construction.

The same is true regarding the sale of the most strategic component of the front end of the fuel cycle: enriched uranium. In that industry, Russia, France, and URENCO (a European enrichment consortium with the British, Dutch, and Germans each holding equal ownership shares) now control nearly 90 percent of the world market. And China has begun moving into the nuclear export business, both with reactors and uranium enrichment. Moreover, since 2013—when the last operating commercial U.S. enrichment facility shut its doors—the U.S. share of the market has not been based on any indigenous enrichment capability.[10] Rather, it relies on marketing existing inventories and sourcing new production from the other enrichers in the industry. Bottom line: the United States is far from dominant and, at least in enrichment, stands at serious risk of falling out of the market completely.

The modest U.S. share of the world market for nuclear reactors and uranium enrichment does not help American efforts to minimize the spread of enrichment capabilities and the proliferation threat that goes with it. First, to the extent that the U.S. seeks as a matter of policy to provide assurances of reliable fuel supply to the world market so that other countries do not need to reassure themselves with their own supplies, a five percent market share based on zero home-grown production is not a very robust source of reassurance.

10 While one of URENCO's four enrichment facilities was built and operates in New Mexico, that is a *transplanted* rather than an *indigenous* capability. What difference does that make? Since URENCO USA is foreign-owned and uses foreign technology, except for the purposes of regulatory oversight, that technology is "black-boxed," i.e. not sharable, with Americans. The enriched uranium that it produces therefore cannot be used as targets for the production of the tritium supplies needed to support the U.S. nuclear arsenal or as naval reactor fuel for U.S. Naval submarines and aircraft carriers. That said, one consolation is that every SWU sold from the URENCO USA plant carries an American flag for purposes of nonproliferation conditions that apply—requiring peaceful use assurances and application of IAEA safeguards to all facilities where that enriched uranium is irradiated.

Second, the export of every U.S.-based reactor or fuel element takes with it an American flag, and with it all of the nonproliferation conditions enacted by Congress and signed into law by the President—including the strengthened requirements enacted in 1978 in response to the Indian nuclear test of 1974—and provides the most powerful, legally binding set of nonproliferation conditions that can be found anywhere in the world of nuclear reactor exports.[11] Fewer U.S. exports translate directly into fewer U.S. controls.

A stronger role in the global marketplace would also strengthen the hand of the United States diplomatically. Once any government that is a member in good standing of the NPT decides to build a nuclear power plant, it should therefore be U.S. policy to *promote U.S. nuclear exports* as much as possible. The United States is not creating global demand for nuclear power and associated fuel services, but it is in the national security interest of the U.S. to satisfy as much of that demand as possible.

Going the extra yard or moving the goalposts?

If that is the case, then it is necessary to address a question that has divided the legislative and executive branches for years: how should we manage the international agreements the United States negotiates with partners in order to engage in peaceful nuclear cooperation? These agreements are called "123 Agreements," after the section of the Atomic Energy Act of 1954 that authorizes and regulates such cooperation, and the complex negotiation process continues to illustrate the connection between peaceful and potentially dangerous uses of nuclear power. A Section 123 Agreement is required for significant nuclear cooperation with the United States, such as building a nuclear reactor or a fuel cycle facility.[12]

11 While, as noted above, URENCO exports from the United States do carry U.S. nonproliferation conditions, some 85 percent of URENCO sales go to its U.S. and European customers, where compliance with existing nonproliferation norms is already well established.

12 The U.S. government has restrictions either separate from or complementary to 123 agreements, including what are commonly known as "Section 810" agreements managed by the Department of Energy, as well as Nuclear Regulatory Commission export and import licenses for nuclear material, and Department of Commerce dual-use technology licenses.

Originally, under the 1954 Atomic Energy Act, other parties to 123 agreements needed to agree that security safeguards and standards would be maintained, that any material to be transferred would not be used for atomic weapons, research on or development of atomic weapons, or for any other military purpose, and that any material to be transferred would not be transferred to unauthorized persons or beyond the jurisdiction of the cooperating party (except as specified in the agreement).[13] The legislative purpose of the Section 123 agreements was to prevent the export of technology for peaceful purposes to be diverted to military purposes.

The intense Congressional reaction to the 1974 Indian nuclear test led to a major strengthening of the nonproliferation conditions attached to 123 Agreements, through passage of the Nuclear Nonproliferation Act of 1978. That law amended the Atomic Energy Act to manage U.S. nuclear exports more closely.[14] Specifically, the amendments required nonnuclear-weapon states to accept full-scope International Atomic Energy Agency safeguards as a condition for entering into nuclear cooperation agreements with the United States, authorized Congressional review of export licenses, and provided for halting exports to a country that tested a nuclear device, violated safeguards agreements, or continued nuclear weapons-related activities.[15]

While many governments resisted, most ultimately relented, and the 1978 standards have become "global best practice" in terms of setting strong nonproliferation requirements. These standards are now reflected in Section 123 agreements with 22 other countries, in addition to other agreements with the European Atomic Energy Community (Euratom), Taiwan, and the IAEA.

Notwithstanding George Shultz's wise counsel about light-switch diplomacy rule, in this case it did make sense for the United States to change the rules in the middle of the game. (Remember: Alexander Pope said "a foolish consistency is the hobgoblin of little minds.") Why? Because those rules were shown to be inherently flawed by the 1974 Indian test. The United States was therefore right to ratchet up nonproliferation constraints through the 1978 law, and to promote those strengthened controls globally.

13 U.S. Atomic Energy Commission, "Legislative History of Atomic Energy Act of 1954." Public Law 703, 83rd Congress, W. Losee comp. 1, 1955.

14 Paul K. Kerr and Mary Beth D. Nikitin, "Nuclear Cooperation with Other Countries: A Primer," Congressional Research Service, December 3, 2015. https://www.fas.org/sgp/crs/nuke/RS22937.pdf

15 Nuclear Non-Proliferation Act of 1978. Section 201. Policy.

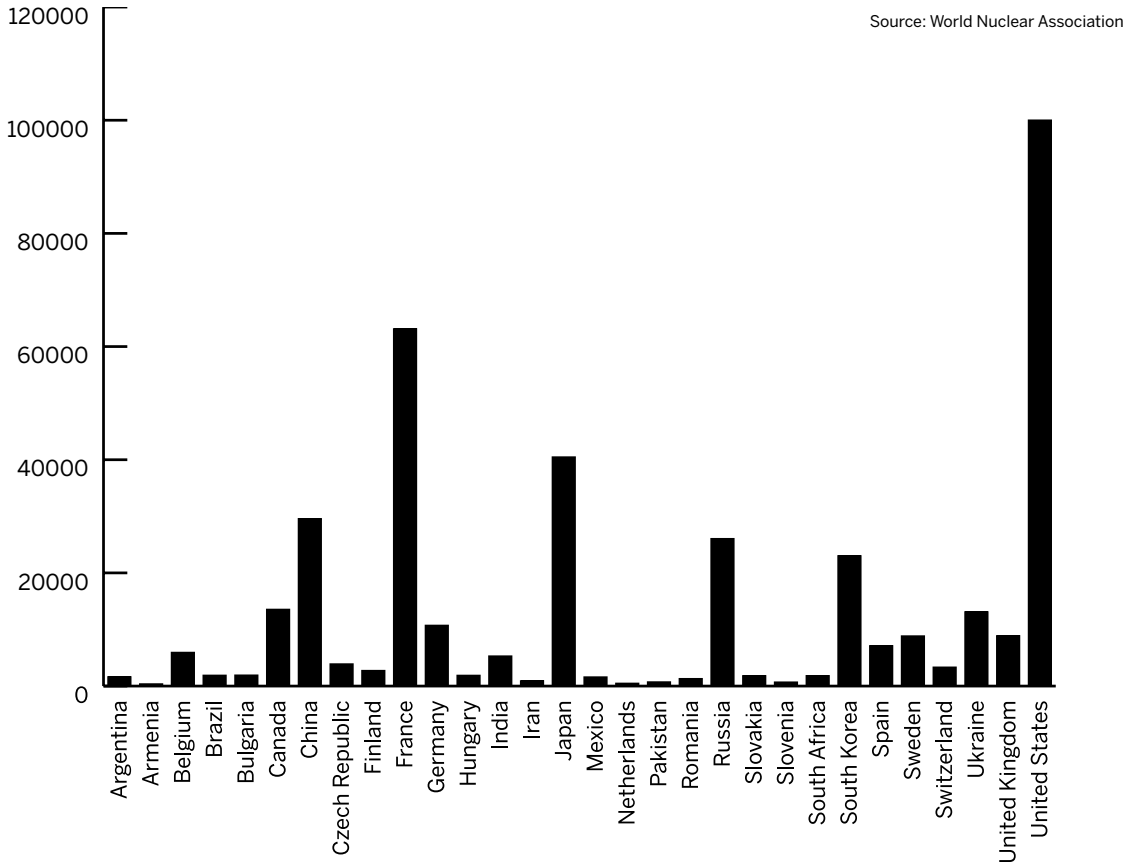
The question presented here, however, goes further: Should we ratchet up US unilateral controls *yet again?* Were the 1978 increases in nonproliferation constraints inadequate? Should we risk appearing to be unreliable partners by insisting that other countries accept *even greater* restrictions than the already uniquely restrictive U.S. statutes require—which themselves are more restrictive than the global nonproliferation regime requires—as a condition for the privilege of entering into a 123 Agreement with the United States? Or should we strongly encourage as many governments as possible to accept the existing 123 agreements, without extra requirements, on the theory that the best way to spread U.S. nonproliferation standards is to spread U.S. commercial nuclear contracts subject to the strengthened nonproliferation constraints of the 1978 Nuclear Non-Proliferation Act?

The answer to this question depends on how you view 123 Agreements and their role in American nuclear diplomacy. Some view 123 Agreements as conferring credibility and status on U.S. counterparties, and therefore believe that we should only "reward" other governments with a 123 Agreement if they *first* accede to unilateral U.S. standards *beyond those required by existing U.S. law,* which is as rigorous a statutory regime as exists anywhere in the world. Those U.S. standards at least include nonproliferation commitments and, in the view of some, should also include human rights or other American values.

Others believe that it is *always* in the U.S. interest to assure that nuclear cooperation is conducted pursuant to the strongest global nonproliferation standards and, since U.S. nonproliferation standards are as strong as any in the world, that we should negotiate 123 Agreements with any government willing to sign up and accept the statutory requirements for standards of conduct as reflected in the Atomic Energy Act of 1954, as amended (including by the Nuclear Non-Proliferation Act of 1978).

People holding this view often view minimizing the spread of nuclear weapons as the highest order objective of U.S. national security policy, and therefore would not withhold a 123 Agreement from other governments even if we have concerns about their attachment to other U.S. values and objectives, however worthy those might be. They also worry about the erosion of influence resulting from the light-switch diplomacy driven by shifting U.S. policies.

Installed Nuclear Capacity, 2015, net MWe



The problem with the former approach—requiring governments to concede to evolving unilateral U.S. nonproliferation demands before they can "earn" their 123 agreement with the United States—is that it fundamentally misunderstands the reality of today's global nuclear marketplace. In the 1960s or even the 1970s, when the United States was a powerful, if not dominant, player in global nuclear commerce, and served as an undisputed security guarantor to certain governments, we had more ability to impose our will on others. Even in those days, U.S. influence was limited. For example, in April 1977, President Carter announced a wide-ranging nuclear policy shift, moving away from plutonium reprocessing for conventional light-water reactors and early deployment of breeder reactors, and tending toward "a restrictive and coercive approach" to granting permission to other nations to reprocess U.S.-origin fuel. Not surprisingly, longstanding allies and nuclear partners such as France and Japan bridled at U.S. efforts to muscle them into abandoning nuclear fuel policies that the United States had itself supported for many years. Ultimately the U.S. had to retreat from its "unduly rigid position" in order to avoid

alienating many governments—including close allies—whose support would be critical to the success of U.S. nonproliferation diplomacy.[16]

Professor Joseph Nye, as deputy under secretary of state during the Carter Administration, was deeply involved in the implementation of the president's nonproliferation policies. In managing the diplomacy surrounding these changes, he realized that the "confrontational approach that was driven by events threatened to isolate the United States and further disrupt the regime." Maintaining and refurbishing the regime "would require a general approach around which a broad group of nations could rally."[17] Thus was born the two-year International Nuclear Fuel Cycle Evaluation (INFCE), which included 134 working group meetings, produced 25,000 pages of reports, and—while not producing agreements on specific actions to thwart proliferation—at least provided the basis for establishing common ground concerning the need for more concerted multilateral efforts in reducing the proliferation risks arising from the nuclear fuel cycle.[18]

Since that time, it has been clear that if the United States is to succeed in shaping nuclear fuel cycle choices of the world to suit American interests, it needs to be on a consensual basis. Governments—even our closest partners—are not simply going to accept American preferences (especially when those preferences have sometimes changed dramatically, without consultation with the partners affected) unless they can be persuaded of the benefits.

If that conclusion was true nearly 40 years ago, when the U.S. global leadership in nuclear energy was preeminent, it must be that much more so today, since the U.S. role in global nuclear commerce has shrunken dramatically in the intervening years. The only two U.S.-based reactor vendors—Westinghouse and GE-Hitachi (owned by Toshiba)—depend on Japanese support. [19] Westinghouse did score a signal success in selling four AP-1000 reactors to China; workers broke ground at the Sanmen and Haiyang sites in 2008 and the units are expected to begin operations in 2017. Westinghouse is also pursuing construction of the AP-1000 in the United Kingdom and is negotiating for the construction of six reactors in India.

16 Joseph Nye, "Maintaining a nonproliferation regime," *International Organization,* 35, 1, Winter 1981, p. 23.

17 Ibid, p. 24.

18 Ibid., pp. 24-29.
See also: R. Skjoldebrand, "The International Nuclear Fuel Cycle Evaluation - INFCE," *IAEA Bulletin* 22:2, pp. 30-33.

19 These companies are still considered American and are indeed treated as U.S. companies from a nuclear export control perspective, even though Westinghouse is majority-owned by Toshiba and GE is joint venturing with Hitachi.

Construction of Sanmen unit 1, an AP-1000 reactor in Zhejiang, China, April 24, 2014.

For GE, the only existing nuclear export is the ill-starred Lungmen project in Taiwan, which, after $9 billion invested, is effectively stalled by Taiwan's deep-seated post-Fukushima opposition to nuclear power. In 2015, GE filed for arbitration against Taipower to recover payments owed on the two-reactor project. On a more positive note, Hitachi-GE (not to be confused with GE-Hitachi!) intends to build two GE-designed Advanced Boiling Water Reactors on the Isle of Anglesey off the coast of Wales in the Horizon nuclear power project, with a view to launching operations in the first half of the 2020s.

But those American exports comprise less than 10 percent of the reactors now under construction worldwide. Though the U.S. vendors have pursued reactor projects in a number of other countries, including Bulgaria, the Czech Republic, India, Turkey, and Vietnam—many of which remain prospective purchasers—every other major reactor deal in recent years has been won by foreign competitors, all of whom are state-owned and state-supported. By far the most active exporter today is Russia's Rosatom, which "estimated the value of export orders reached $300 billion with 30 plants in 12 counties" by September 2015.[20] Russian bidders have won contracts in Bangladesh, Belarus, China, Egypt, Finland, Hungary, India, Iran, Turkey, and Vietnam. South Korea won the four-reactor sale to the United Arab Emirates.[21] France won the Olkiluoto deal in Finland and a second project (with Japan) in Turkey.

20 Stratfor, "Russia: Exporting Influence, One Nuclear Reactor at a Time," October 7, 2015.

21 Nuclear Energy Institute, "Contracts," Last updated June 9, 2016. http://www.nei.org/News-Media/News/Contracts

Not surprisingly, China—which now has 33 reactors in operation and 21 under construction—is the latest foreign competitor to enter the fray.[22] Having started as an importer of nuclear technology from Framatome (then succeeded by Areva) and Westinghouse, China has evolved into a nuclear exporter. During President Xi Jinping's October 2015 visit to London, the Chinese committed $9.3 billion to purchase a one-third share of the Hinkley Point C nuclear power station to be built by Electricité de France, paving the way to deeper Chinese involvement in building new reactors in the United Kingdom. China and the UK also agreed to jointly fund a nuclear R&D center, under the leadership of the UK National Nuclear Laboratory. In November, China signed a $15 billion agreement to build two new nuclear reactors in Argentina. The first would be based on Canada's heavy-water technology, which the Chinese have already deployed domestically. The second would be a new Chinese design: the Hualong One, which represents a Chinese decision to merge the reactor development efforts of China General Nuclear Corporation (CGN) and China National Nuclear Corporation (CNNC) for promotion in export markets.[23]

In short, the United States is hanging on to its role in the global nuclear marketplace by a thread. Far from being in a position to dictate terms, U.S. policy should be aggressively seeking to promote the completion of 123 Agreements with a view to try and claw back market share. The reason to do that is not just to create well-paying American jobs, promote domestic manufacturing, and improve our trade balance, though it will do all of those things. Nor is it just to begin to level a playing field that foreign competitors have tilted steeply against us, although it could help there, too.

No, the most compelling reason to press U.S. 123 Agreements wherever we can *is to promote U.S. national security and global nuclear safety.* No country has stronger nonproliferation or safety criteria than does the United States. So if we care about stopping weapons from spreading or minimizing the risk of future accidents, we should be promoting U.S. nuclear equipment, services, and technologies, not playing "hard to get.'

22 World Nuclear Association, Country Profiles, "Nuclear Power in China," Last updated June2016. http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx

23 The Hualong One reactor design draws from CGN and CNNC Generation III reactor efforts. "Hualong One joint venture officially launched" *World Nuclear News,* March 17, 2016; *see also* Jonathan Hinze and Yun Zhou, "China's Commercial Reactors," *Nuclear Engineering International*, China Supplement 2012.

Misreading history: The myth of the "gold standard"

Many of those who argue that the United States should insist on meeting certain strict criteria as a precondition to getting a U.S. 123 Agreement strongly believe that their approach is intrinsically moral in its rigid insistence on strict nonproliferation standards, and useful in securing stronger commitments to refrain from building dangerous facilities to enrich uranium or separate plutonium—the two principal pathways to nuclear weapon manufacture. They enthusiastically cite the 123 Agreement signed with the United Arab Emirates, for example, under which the UAE made a legally-binding commitment never to acquire either uranium enrichment or plutonium reprocessing capabilities, calling it "the gold standard".

Unfortunately, proponents of the "gold standard" misunderstand history, and misjudge human nature. As to history, they delude themselves into thinking that somehow the U.S. compelled Abu Dhabi to forswear enrichment and reprocessing. In fact, the Emiratis had *already* decided to do so, as they explicitly declared in an April 2008 white paper on the country's still nascent nuclear program, *before* the U.S. "insisted" on the UAE accepting the so-called "gold standard" and which in turn was reflected in a law that was signed by UAE President Sheikh Khalifa bin Zayed al-Nahyan in October 2009.[24] Given that American legislators and diplomats have claimed credit for "requiring" the UAE to accept this standard, it is worth taking a look at what the Emiratis had decided on their own before they concluded their 123 agreement with the United States. The relevant passage appears under the section of their 2008 white paper entitled "Renouncing an intention to develop a domestic enrichment and reprocessing capability and undertaking to source fuel from reliable and responsible foreign suppliers" and warrants quoting at length:

> Unlike many countries having civilian nuclear energy programs, the UAE will not be involved in nuclear fuel-cycle activities beyond those that would be required for the management and disposal of radioactive waste in the event that the UAE deployed nuclear power plants within its territory. A number of factors underlie this view, including the economic infeasibility of operating enrichment and reprocessing

24 United Arab Emirates, *Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy*, (April 2008). https://www.fanr.gov.ae/En/Documents/whitepaper.pdf

> facilities for comparatively small nuclear fleets, concerns from the international community regarding spent fuel reprocessing and enrichment plants in developing countries, and the dual-use nature of components employed in fuel fabrication and processing. In consideration of these factors, the UAE will not seek to develop domestic capabilities in those areas, either as part of its evaluation of nuclear energy or as a component of future UAE nuclear program.
>
> In lieu of domestic enrichment and reprocessing, the UAE would seek to conclude long-term arrangements with reliable and responsible governments and contractors for the secure supply of nuclear fuel, as well as the safe and secure transportation and, if available, the disposal of spent fuel via fuel leasing or other emerging fuel supply arrangements.[25]

The UAE, then, had made its policy crystal clear, in a formal, written statement *before* the U.S. "insisted" on the UAE accepting the so-called "gold standard." The U.S. government role, then, was simply to insist that the Emiratis reflect their existing national policy in the text of the 123 Agreement, and convert it into a legally-binding pledge to the United States. Forgetting President Harry Truman's dictum that "It is amazing what you can accomplish if you do not care who gets the credit," U.S. officials coined the unhelpful "gold standard" label while taking credit for "persuading" the UAE to do something it had already done.

And that is where the misjudgment of human nature occurred. For by taking a voluntary commitment of restraint and turning it into what appeared to be buckling to American coercion, the United States essentially made it impossible for any self-respecting government to make the same pledge that the Emiratis had. By vainly bragging about a "gold standard" to be imposed on others, the United States alienated the very governments it sought to influence. As the Canadian parliamentarian and former coal miner Ralph Smith argued in a debate over a century ago: "If [people], after making voluntary settlements, are to be penalized by being compelled to stand by them, they will not make them."[26]

25 ibid, p. 9.

26 Official Report of the Debates of the House of Commons of the Dominion of Canada, 3rd Session, 10th Parliament, 6-7 Edward VII., 1906-07, vol. LXXIX, p 3880. https://books.google.com/books?id=P2MZAAAAYAAJ&lpg=RA1-PA3879&dq=better%20to%20rely%20on%20voluntary%20than%20compelled%20action&pg=RA1-PA3879#v=onepage&q=better%20to%20rely%20on%20voluntary%20than%20compelled%20action&f=false

Sanctimonious policies seldom persuade, and the "gold standard" is no exception. Indeed, no nation has accepted that standard since the UAE deal, and it is likely that none ever will—especially after the United States itself did *not* insist on imposing the "gold standard" on Iran which, unlike the UAE, actually *did* pursue a covert uranium enrichment program apparently aimed at developing a nuclear weapons capability. Nor did the United States impose the "gold standard" in the 123 Agreement it negotiated with India in 2008, with strong bipartisan Congressional support, even though New Delhi actually *had* diverted U.S. and Canadian assistance to build its first nuclear explosive device, refused to limit its enrichment or reprocessing activities, and built a sizable nuclear arsenal.[27]

To be clear, this is *not* to argue for reopening the Indian and Iranian nuclear deals and seeking to retroactively impose the "gold standard;" those ships have sailed and in both cases we should remember George Shultz's admonition and continue our current course. But it does suggest that, if the United States continues to insist (except when it doesn't) that others adhere to the "gold standard" as a condition of peaceful nuclear cooperation, it will enjoy the hollow satisfaction of knowing that it has the strongest nonproliferation policy in the world—on paper. In practice the result will simply be to drive potential partners away from the United States into the waiting arms of our competitors, unilaterally sacrificing both markets and global influence.

What made the UAE improvisation particularly unfortunate was that the global standards already in place to guard against proliferation bear the heavy imprint of U.S. leadership—from the NPT, to the Nuclear Suppliers Group guidelines, to the Non-Proliferation Act of 1978, the last of which imposed the strictest set of nonproliferation criteria to govern nuclear commerce anywhere in the world. And the U.S. technology and safety, security, and nonproliferation standards away from which we were driving potential partners were second to none and widely admired. Governments could justly argue—as Japan had 30 years before—that they were fully adhering to strong and universally accepted nonproliferation norms, but that the United States could not stick to its own standards, however worthy and widely embraced.

27 *Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy* (April 2008). http://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat

A new paradigm for American nuclear diplomacy: The Assured Nuclear Fuel Services Initiative

If insisting on the "gold standard" is counterproductive, what policy would be more successful in advancing U.S. nonproliferation standards and objectives? And how can we achieve our goals of minimizing the spread of dangerous fuel cycle facilities while promoting American nuclear exports?

One approach would be to implement a strategy that has been proposed, promoted, and debated for decades—but never effectively implemented. The idea is simple: to launch an Assured Nuclear Fuel Services Initiative (ANFSI), involving leading nuclear supplier entities from around the world, and offering comprehensive nuclear fuel services to all nations that live up to global nonproliferation norms. This specific proposal dates back a decade, to the time following the 2003 Iraq war, when it seemed prudent to develop non-military approaches to combating the spread of dangerous fuel cycle capabilities.[28]

The ANFSI seeks to resolve the tension between, on the one hand, the strong energy security requirement for a reliable source of nuclear fuel and, on the other, the extensive technical challenges and enormous financial cost of developing, building, and operating an indigenous fuel cycle. It substitutes reassurance for coercion as a leitmotif, and can be structured in the framework of a commercial bargain rather than as the submission of a supplicant to a benefactor.

Under the ANFSI, countries that already possess fuel service capabilities, including uranium enrichment or plutonium reprocessing, would agree to offer guaranteed nuclear fuel delivery and used fuel removal at attractive prices to countries needing those services, in exchange for a commitment not to seek either enrichment or reprocessing technologies or capabilities for an extended period of time, say, ten to fifteen years. All transactions and facilities within the network of assurance would be subject to IAEA safeguards. While the actual fuel-cycle transactions would be arranged through commercial contracts among the providers and customers, guarantor governments could assure attractive commercial terms through credits or price discounts on fuel services provided to the customer. They could also use export credit

28 This section draws liberally from "Making the World Safe for Nuclear Energy," by John Deutch, Arnold Kanter, Ernest Moniz, and Daniel Poneman, *Survival* 46:4 (2004).

guarantees or other familiar financial incentives that would encourage participation in the ANFSI without introducing market distortions.

In order to persuade countries to join the ANFSI, guarantor states would need to provide confidence in the strength and durability of their commitment. This could be done through three levels of guarantee—at the level of the contractor, the offering state, and the International Atomic Energy Agency. The first guarantee would simply be contractual, and enforced through whatever mechanisms the parties to the contract agreed upon. The second guarantee would be government-to-government, allowing the guarantor state to step in so that a commercial dispute would not produce unacceptable consequences to national nonproliferation policies. The third guarantee—from the IAEA—would assure that a bilateral political dispute, unrelated to the recipient state's compliance with its international safeguards and nonproliferation commitments, would not disrupt fuel shipments under the guarantee.

This final backstop—the international guarantee—would only be voided if the beneficiary state violated nonproliferation commitments or international safeguards, as determined by the International Atomic Energy Agency. In other words, political or other issues unrelated to the nuclear transaction would not be permitted to enter into the consideration whether to honor a guarantee in the presence of a disruption of nuclear fuel service. In the event that a guarantor state declined to honor its guarantee because of an alleged safeguards violation, and the IAEA did *not* find that the allegation was valid, then the IAEA guarantee would be invoked, and the needed fuel services delivered to the requesting state.

A credible IAEA guarantee would deter a guarantor government from dishonoring its guarantee for grounds unrelated to nonproliferation violations, while also providing a safety net that would be used if necessary. The IAEA fuel bank, to be built in Kazakhstan, would be a linchpin of the IAEA guarantee. But the Agency could also contract separately with other supplier nations to step in to provide the needed fuel supplies or services if support beyond the IAEA fuel bank were required. Thus the IAEA would not need to engage in any enrichment or reprocessing activities itself; it would just need to be able to contract with the existing players in those market segments on a contingency basis.

Participating states would also be invited to participate in an international R&D program for advanced, proliferation-resistant fuel cycle technologies

and advanced reactors, so that they would also be assured that their nuclear-related personnel would continue to move up the learning curve in nuclear technology, and not suffer for their commitment to self-restraint in not pursuing enrichment and reprocessing capabilities.

Implicitly, the underlying concepts of ANFSI picked up support from both the George W. Bush and Obama Administrations. In 2006, President Bush launched a new initiative called the Global Nuclear Energy Partnership (GNEP) with the goals of improving energy security, promoting clean energy, and limiting nuclear proliferation.[29] Two key aspects of GNEP were the development of "proliferation-resistance recycling technologies" and a fuel services program that would provide nuclear fuel for countries that forego indigenous enrichment and reprocessing capabilities.

Three years later, at Hradcany Square in Prague, President Obama set forth his vision for our nuclear future and how to reduce nuclear threats. In that speech, he called for "a new framework of civil nuclear cooperation ... including an international fuel bank, so that countries can access peaceful power without increasing the risks of proliferation." The President continued:

> "That must be the right of every nation that renounces nuclear weapons, especially developing countries embarking on peaceful programs. And no approach will succeed if it's based on the denial of rights to nations that play by the rules. We must harness the power of nuclear energy on behalf of our efforts to combat climate change, and to advance peaceful opportunity for all people."[30]

29 U.S. Department of Energy, "The Global Nuclear Energy Partnership: Greater Energy Security in a Cleaner, Safer World," February 6, 2006. http://energy.gov/sites/prod/files/edg/media/GNEP/06-GA50035b.pdf

30 The White House, "Remarks by President Barack Obama in Prague As Delivered," https://www.whitehouse.gov/the-press-office/remarks-president-barack-obama-prague-delivered

Thousands of people gathered as President Barack Obama delivered his speech at Hradcany Square in Prague, Czech Republic, Sunday, April 5, 2009. (AP Photo/Petr David Josek)

Clearly, this kind of framework would need widespread international support to succeed. These efforts were channeled through the successor to the GNEP, the aptly but inelegantly named International Framework for Nuclear Energy Cooperation (IFNEC). IFNEC broadened the scope of GNEP to include 33 participant nations and 31 observer nations, in an effort to ensure the safe and secure expansion of nuclear power in the world.[31] IFNEC aims to promote reliable fuel assurances from nuclear supplier to client nations, so that the latter will have less reason to invest the enormous sums needed to develop and deploy enrichment and reprocessing technologies on their own.

The appeal of such an initiative is straightforward. Nuclear power plants are expensive, costing on the order of at least $5 billion for a 1,000 MWe unit, and often more. The capital and lifecycle costs dominate the overall investment in a nuclear plant. That said, without fuel, the reactor operator has no choice but to shut down the reactor, effectively stranding that multibillion dollar asset and, depending on the size and commercial arrangements of the unit, incurring millions of dollars per day in opportunity costs.[32]

31 World Nuclear Association, "International Framework for Nuclear Energy Cooperation (former Global Nuclear Energy Partnership)," Last updated August 2015. http://www.world-nuclear.org/info/inf117_international_framework_nuclear_energy_cooperation.html

32 "Harris shutdown could cost Duke Energy millions," *Nuclear News*, May 31, 2013. https://nuclear-news.net/2013/05/30/harris-shutdown-could-cost-duke-energy-1-5-million-a-day/

More importantly, the prospect of idling nuclear reactors that are strategically critical to a nation's electricity supply represents a major national security threat. History does supply examples of fuel uncertainty that raised reliability of supply concerns. In the 1970s, the U.S. Government shifted its nuclear fuel supply contracts with Brazil from firm to conditional status, contributing to Brazil's justification for developing its own domestic uranium enrichment capability.[33] And pursuant to the 1978 Nuclear Non-Proliferation Act, the United States stopped providing nuclear fuel to the Tarapur reactor in India.[34] The charge that the United States has not always been a reliable nuclear supplier is a convenient rhetorical device for governments who want to build their own enrichment or reprocessing facilities, for whatever reason.

What price energy security?

So owners of nuclear power plants are strongly motivated to avoid even the slightest risk of a fuel supply cut-off. How to minimize that risk? The most conservative way to assure that you will have the fuel that you need when and where you need it is to build your own nuclear fuel cycle facilities. But that is an extraordinarily expensive way to provide fuel cycle reliability. Enrichment plants alone typically cost on the order of $5 billion to $7 billion for a facility with a three to four million SWU capacity per year. A plant of that size may support the nuclear fuel needs of approximately twenty-eight 1,000MWe nuclear reactors per year (approximately 140,000 SWU are needed to enrich fuel for a typical 1,000 MWe light water reactor).[35] The overall cost of an enrichment plant is dominated by fixed costs such as the facility, equipment, and electricity. Given that SWU prices at their peak did not exceed $200, and have since fallen to $60 per SWU, that is an extremely unattractive investment or, put differently, a very expensive insurance policy to buy reliability in nuclear fuel supply. As a rule of thumb, "for countries with relatively small nuclear energy programs (less than 25,000 megawatts or so), economics will almost always make indigenous enrichment and

33 U.S. Senate, *Multinational Corporations and United States Foreign Policy. Hearings, Ninety-third Congress: Volume 3, Parts 15-17*, (January 1, 1973), p. 125.

34 The Tarapur reactor has regularly operated at reduced power levels or been in danger of shutting down. B Sivakumar, "Nuclear Fuel Shortage Slows Generation," *Times of India*, August 25, 2012. http://timesofindia.indiatimes.com/city/chennai/Nuclear-Fuel-Shortage-Slows-generation/articleshow/15646007.cms

35 World Nuclear Association, "Uranium Enrichment," Last updated May 2016. http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Conversion-Enrichment-and-Fabrication/Uranium-Enrichment/

reprocessing facilities a higher cost option compared to purchasing fuel services on the international market."[36]

One option for a country with a smaller nuclear program would be to build an optimally-sized enrichment plant of, say, three million SWU capacity, use 1.4 million SWU to satisfy its domestic requirements, and export the rest. But the global market for enrichment services is already glutted and figures to remain so for the foreseeable future. Indeed, the capacity of the existing fleet of enrichment plants so far exceeds the need for SWU that, for at least the next 8 to 10 years, there will likely be no need for additional plants. And unlike most industries, where falling prices lead manufacturers to shut down plants or curtail operations, operators of gas centrifuge plants keep spinning their machines, even in the face of an over-supplied market.

Why? At least two reasons may explain this anomaly. First, gas centrifuge machines spin at such high speeds that they are extremely sensitive to even microscopic imbalances; spinning them down from high speeds to a halt tends to be a risky business in which machines can easily crash, creating both safety and economic concerns. To avoid that risk, operators often keep the machines spinning even when a pure commercial calculation would suggest the better financial decision would be to shut them down.

Second, outside of the United States, all enrichment enterprises are state-owned, and governments may choose to continue to operate a gas centrifuge facility for strategic or political reasons even when it is a money-losing proposition.

So while governments could still cite the classic argument that considerations of energy security, or even energy independence (an objective many Americans have promoted for the United States), argue against relying upon an Assured Nuclear Fuel Services Initiative to keep their multi-billion dollar reactors running, such an initiative could effectively address those energy security concerns in countries that want nothing more than energy security. And it will invite appropriate additional scrutiny for those that still insist on building uranium enrichment or plutonium reprocessing facilities.

An Assured Nuclear Fuel Services Initiative could also prove to be useful on the back end of the nuclear fuel cycle. Used fuel storage, reprocessing of used

36 Deutch, Kanter, Moniz, and Poneman, ibid. p. 69.

fuel, and disposal in geologic repositories could all be included in the services offered under the Initiative. That aspect of the ANFSI could appeal to Japan, which continues to struggle with its project to complete construction of the Rokkasho reprocessing facility, now running two decades behind schedule and with costs reportedly soaring to $25 billion.[37] The facility was designed to process up to 800 tons of uranium per year, corresponding to the used fuel generated from about forty 1,000MWe reactors. Fukushima undermined the *raison d'ĕtre* of the facility; when all 54 Japanese reactors shut down, it robbed Rokkasho both of a source of used fuel to run through its processing lines, and customers to purchase the output (in the form of mixed-oxide fuel containing the plutonium separated at Rokkasho).

Given those circumstances, Japan could offer the services of Rokkasho as part of its contribution to the Assured Nuclear Fuel Services Initiative. Then, should another government decide to close its fuel cycle by separating plutonium from used fuel, it could enter into a contract to tap into the vast and unused potential of Rokkasho to provide that service. That government would not need, and could not easily justify (given the vast expense as well as the proliferation risks inherent in separating plutonium), pouring billions of dollars into building its own plutonium reprocessing facility with Rokkasho sitting idly by.

So market realities for *both* uranium enrichment *and* plutonium reprocessing favor the establishment of an ANFSI today. On the enrichment side, we have seen a massive glut of capacity that is likely to persist well into the next decade. The only plausible rationales today to invest in a new plant would be either (a) to create a nuclear weapons option, or (b) to achieve autarkic self-sufficiency in enriched uranium supplies, at pharaonic cost. The first motivation is unacceptable, and the second strains credulity, given that there is no evidence of any nation being unable to purchase enriched uranium supplies freely on the commercial market.

37 Citizen's Nuclear Information Center, "Rokkasho Reprocessing Plant: 14 Month Delay, Nuke Info Tokyo No. 132," September 10, 2009. http://www.cnic.jp/english/?p=2024; Stephen Stapczynski and Emi Urabe, "Japan's $25 Billion Nuclear Recycling Quest Enters 28th Year," *Bloomberg,* January 5, 2016. http://www.bloomberg.com/news/articles/2016-01-04/japan-s-25-billion-nuclear-recycling-quest-enters-28th-year.

Reprocessing alternatives...

The current market realities mirror those that drove the United States in the mid-1970s to abandon the idea of reprocessing plutonium from used fuel to be recycled for use in conventional light-water reactors. Then, as now, it was *much cheaper* to mine fresh uranium from the ground, mill it, convert it into gas, enrich it, and fabricate it into fuel than it was to reprocess used fuel and use the extracted plutonium to fabricate mixed-oxide fuel.[38]

This 40-year validation of the American view, however, has still not carried the argument in all places, and in Asia it is a live issue today.[39] While neither of the other major Asian nuclear power generators, China and South Korea, currently reprocesses used fuel, both have expressed interest in doing so. Decisions in both countries will be important to the global approach to reprocessing. For example, with 33 reactors operating, 21 under construction, and a total of 135 new plants planned by 2030, China will inevitably become a major player in decisions relating to the back end of the fuel cycle. While Chinese policy since 1983 has proposed to "close" the fuel cycle by reprocessing the used fuel arising from their reactors, the country has moved slowly and did not, in fact, approve construction of a 200-ton commercial reprocessing demonstration facility until 2015. Now China must decide whether to build that facility, notwithstanding the challenging economics of reprocessing. In 2016, a Harvard Belfer Center report reached the following conclusion on that subject:

> Fundamentally, we conclude that investing in large reprocessing facilities in the near term would be much more expensive for China than the alternatives. China has the luxury of time, as it has access to plenty of uranium to fuel its nuclear growth for decades to come, and dry casks can provide a safe, secure, and cost-effective way of managing spent fuel for many decades, leaving all options open for the future.[40]

38 For future generation reactors that use fast neutrons, which can burn up used fuel that would otherwise need to be disposed as waste, the case for reprocessing is stronger, but introduction of such fourth generation reactors is still many years away.

39 A few nations—Russia, the United Kingdom, France, and India—do reprocess used fuel for use in current generation reactors. Some advocate used fuel reprocessing for waste management purposes, but others have argued that the benefits in waste management terms of concentrating the most highly active wastes in a smaller volume are substantially offset by the additional intermediate- and low-level wastes that are generated as part of reprocessing.

40 Belfer Center for Science and International Affairs, Managing the Atom, Harvard University, *The Cost of Reprocessing in China*, by Matthew Bunn, Hui Zhang, and Li Kang (January 2016), pp. 3. http://belfercenter.ksg.harvard.edu/files/The%20Cost%20of%20Reprocessing-Digital-PDF.pdf

So far, despite its questionable economics, China has continued to maintain that it intends to close the commercial fuel cycle. This has sparked concerns of the possible proliferation of vulnerable stockpiles of plutonium around Asia. U.S. Energy Secretary Ernest Moniz reiterated long-standing U.S. policy in March 2016 when he said that "[w]e don't support large-scale reprocessing," adding that construction of China's first commercial-scale reprocessing facility "certainly isn't a positive in terms of nonproliferation."[41]

To be clear, the current controversy relates to the prospect of Chinese *commercial* reprocessing. China, of course, is formally a nuclear-weapon state as defined by the NPT, and has had a *military* program to separate plutonium since the 1960s.[42] The issue is the minimization of separated plutonium stocks that could be diverted to military purposes by either state or non-state actors. As the country with the fastest-growing nuclear power program in the world, China has already exported reactors to Pakistan, and has agreements, plans, or ambitions to sell units to Argentina, the United Kingdom, Iran, Turkey, South Africa, Kenya, Egypt, Sudan, Armenia, and Kazakhstan.[43] In that respect, should China decide in the end to build its own reprocessing facility, it could mitigate the possible adverse proliferation effects if it entered into used-fuel take-back contracts with its nuclear reactor customers. In other words, it would be better for an existing nuclear-weapon state to host a centralized reprocessing facility than for additional non-weapon states to launch their own reprocessing programs.

No doubt, the wiser, safer course would be the once-through fuel cycle, but if that goal proves elusive, it would be safer not to leave the reprocessed plutonium in its separated and hence more vulnerable state, when it is easier to handle safely and to fashion into a nuclear weapon. At that point, greater anti-proliferation protection would be achieved by creating a radiation barrier around the separated plutonium. That could be done by converting the separated plutonium into mixed-oxide fuel and irradiating it once again in a nuclear reactor, so that the plutonium would be so contaminated by radioactive byproducts and thus much harder to divert to military use for a number of

41 Brian Spegele, "China's Plans to Recycle Nuclear Fuel Raise Concerns," *Wall Street Journal* March 17, 2016.

42 Harvard Kennedy School, Managing the Atom Project, "China's Stockpile of Military Plutonium: a New Estimate" by Hui Zhang (July 2011). http://belfercenter.ksg.harvard.edu/files/INMM-PU2.pdf

43 World Nuclear Association, "Nuclear Power in China" Last updated June 2016. http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx

decades, until it cools off.[44] Indeed, under that scenario, a Chinese reprocessing facility could become part of the Assured Nuclear Fuel Services Initiative.

South Korea has a large-scale nuclear energy program, with 24 operating reactors and four more under construction. The government there has expressed strong interest in closing the nuclear fuel cycle, and sought long-term prior consent for reprocessing from the United States in the long and arduous negotiation of a renewal of the US-ROK 123 Agreement. Indeed, the difficulties in reaching agreement led Seoul and Washington to negotiate a two-year extension to their 1972 agreement to give the parties more time to resolve their differences. Another impediment to South Korea closing the fuel cycle is the 1992 North-South Denuclearization Declaration, which prohibits both uranium enrichment and plutonium reprocessing anywhere on the Korean peninsula, though many South Koreans view that pact as a dead letter in light of North Korea's clear breach of its own commitments to refrain from either uranium enrichment or plutonium reprocessing.

In 2015, Seoul and Washington did succeed in concluding a new 123 Agreement, which continued to require consent to any reprocessing of material subject to the agreement, but also committed the two countries to continue a long-term study of options regarding what to do with South Korea's used fuel, and established a new High-Level Bilateral Commission to facilitate bilateral consultation and cooperation on nuclear energy and security matters.

In short, the die has not been cast, and in the coming years one can expect a robust discussion regarding how Asian nations will manage the back end of the nuclear fuel cycle. Given the various challenges—legal, economic, security, and political—faced by Asian governments in addressing what to do with used fuel and nuclear waste, it may make sense to take advantage of the massive investment Japan has already made in the unused (to date) Rokkasho plutonium reprocessing facility by designating it as a regional nuclear fuel center and opening it for use by other Asian nations, perhaps (as suggested above) as the cornerstone of the Advanced Nuclear Fuel Service Initiative. Given the

44 Self-protection of used fuel varies by fuel type, as explained by Harold Feiveson, Zia Mian, M.V. Ramana and Frank von Hippel (eds.), in *Managing Spent Fuel from Nuclear Power Reactors* (International Panel on Fissile Materials (September 2011), p. 7: "For about the first 100 years, LWR spent fuel emits gamma radiation at a dose rate greater than 1 sievert per hour, which would be lethal to about 50% of adults (LD50) in three to four hours. At such exposure, the IAEA considers irradiated spent fuel sufficiently radioactive that it could only be moved and processed with specialized equipment and facilities, beyond the practical capabilities of sub-national groups, therefore "self-protecting".... It will be seen that CANDU spent fuel is self-protecting for only a few years." http://fissilematerials.org/library/rr10.pdf

slow and uneven pace of reactor restarts in Japan, at least for the next few years the facility could handle over three-quarters of the used fuel discharged each year from existing light-water reactors in China, Japan, and South Korea. That would buy valuable time for the governments to study alternative ways to address the used fuel problem, including through adoption of the once-through cycle should they conclude (as the U.S. government has concluded), that reprocessing and plutonium from used fuel to recycle in conventional nuclear reactors does not make sense either in economic, nonproliferation, or environmental terms.

Though progress has been made in easing the traditional tensions in Tokyo's bilateral relations with both Beijing and Seoul, it would probably still be hard to persuade either of the latter two to ship their used fuel to Rokkasho for reprocessing. But given the many other complications each capital is facing in fulfilling its existing goals when it comes to reprocessing, it might be possible to make the proposal more palatable by "internationalizing" Rokkasho or otherwise organizing this effort as a trilateral or multilateral initiative, with U.S. participation, again, in support of an Assured Nuclear Fuel Services Initiative.

What about Iran?

Could the ANFSI help address the Iranian nuclear challenge? Perhaps. Many of the critical constraints that the Joint Comprehensive Plan of Action (JCPOA) imposes on Iran's uranium and plutonium activities expire in 15 years. Moreover, the JCPOA allows Iran to continue research on some of its more powerful centrifuge designs and to replace older centrifuge technology with more advanced technology at various points during the course of this 15-year period.[45] These aspects of the JCPOA have generated concern that, by the 15-year mark, the breakout time for Iran to acquire enough highly enriched uranium for a nuclear weapon will be reduced to two to three months.

But if in the next few years an Assured Nuclear Fuel Services Initiative took root, and gained credibility in the international nuclear fuel market, it could offer reliable, attractively priced enrichment services to Iran. This would

45 Belfer Center for Science and International Affairs, Harvard University, *The Iran Nuclear Deal: A Definitive Guide* (August 2015). http://belfercenter.org/files/IranDealDefinitiveGuide.pdf

help provide a counterweight to Iranian arguments that it "needs" to build uranium enrichment or plutonium-reprocessing facilities once the JCPOA constraints expire. Indeed, in order to give Iran every reason to say "yes" to the ANFSI, Tehran could be offered not only long-term agreements with the ANFSI in order to secure long-term reliable nuclear fuel services or supplies for any Iranian reactors that need them, but also the opportunity both to make equity investments in the enterprise and to obtain the benefits of ownership. As a country with a significant ownership interest, Iran could also capitalize on shareholder profits of ANFSI and access to reactor fuel without having to expend potentially billions of dollars of its own resources to build, maintain, and operate a uranium enrichment facility.

Of course, the Iranians may decline the opportunity to participate in the ANFSI. Even if their real reason for doing so were to move back down the road toward nuclear weapons development, they would find a more politically acceptable reason to demur. For example, they might cite their bitter experience with the French gaseous diffusion enterprise, Eurodif. In 1974, at a time when western governments were courting favor with the government led by the Shah of Iran, France accepted $1 billion in loans from the Iranian government to build the Eurodif plant. In exchange, Iran would be entitled to 10 percent of the enriched uranium produced by Eurodif.[46] But after the 1979 Iranian revolution, Iran cancelled its payments for planned shipments of nuclear fuel (due to Ayatollah Ruhollah Khomeini's lack of interest in nuclear power) and won a long legal battle to recoup its original loan to France.

Despite this move, Iran continued to maintain an indirect ownership through an Iranian-French consortium that owned 25 percent of Eurodif. Iran later reversed its decision with respect to Eurodif and tried to acquire nuclear fuel through the original contract but, due to French refusal and international sanctions, that effort did not succeed. Iran interpreted this outcome as confirmation that international fuel sharing agreements were not reliable.

The Iranians specifically cited their longstanding frustrations with their Eurodif experience in October 2009, when France joined with the United States and Russia—in sessions chaired by outgoing IAEA Director General, Mohamed ElBaradei—to offer 20 percent enriched uranium to meet the needs of the Tehran research reactor to produce radioisotopes for medical

46 Oliver Meier, "Iran and Foreign Enrichment: A Troubled Model," Arms Control Association, Arms Control Today, January 1, 2006. https://www.armscontrol.org/act/2006_01-02/JANFEB-IranEnrich

treatments, in exchange for Iranian agreement to ship 1200 kilograms of low-enriched uranium from the Natanz enrichment facility to a location outside of Iran. In the end, while that deal was agreed at the negotiating table in Vienna, it failed to gain the support of the Tehran government, and ultimately fell apart.[47]

The point is, however, that an effective ANFSI, backstopped by guarantees at the commercial, national, and international level, would raise legitimate questions about the motives behind Tehran's insistence on making a multibillion-dollar investment in an uneconomic uranium enrichment facility. If Iran defies such an offer, that rejection would invite (as it would in other nations, as noted above) additional international scrutiny of any Iranian plans to expand its domestic uranium enrichment capability. And that would create the political space for the United States, its allies, the IAEA, and the UN Security Council to continue their vigilant monitoring of Iran's nuclear activities—including through IAEA safeguards. Should these efforts detect any safeguards violations, or uncover any clandestine nuclear efforts outside of safeguards (as happened with both the Natanz and Fordow enrichment facilities in the past), then Iran would once again be subject to UN Security Council actions for violating its nonproliferation obligations.

In short, while the end of the 15-year limitations in the JCPOA certainly increases the risk of Iranian breakout, the P5+1 governments can use the 15 years to strengthen the presumption against enrichment, in part by establishing precedent through the Assured Nuclear Fuel Supply Initiative. The more governments subscribe to the ANFSI, the more that model can become an accepted best practice, the less credible it would be that Iran "needs" to build its own commercial enrichment plant to ensure reliable supply of enriched uranium for commercial nuclear power reactors.

47 The Vienna negotiations, in which the author participated, are described in Mohamed ElBaradei, *The Age of Deception: Nuclear Diplomacy in Treacherous Times* (Picador 2012).

Vested interests in security

Logic and experience both suggest that a nuclear terrorist incident anywhere in the world could be as devastating to public confidence in nuclear energy as would another Fukushima.

If nuclear energy is to play a greater role in averting catastrophic climate change, and as more nations introduce nuclear power programs around the world, it will therefore be essential to minimize the threat of a nuclear security incident, of any provenance. *Any* nuclear incident—whether a full-blown nuclear crisis reminiscent of the Cold War, an accidental launch or detonation, a nation-state covertly diverting peaceful nuclear cooperation to military uses, or a jihadist nuclear terror attack—would have a devastating effect on public support for nuclear energy as a tool to fight climate change

The more nuclear reactors there are in the world, the greater the losses that would be suffered should any safety or security incident occur. Governments understand this. So do reactor owners and operators. So do regulators. But it is a lesson that requires constant reinforcement, continuous training, rigorous peer reviews, and vigilant oversight.

Think of it differently. Consider the hundreds of nuclear reactors now in operation, under construction, or still in the planning phase. Collectively, they represent hundreds of billions of dollars of investment, if not more. There will be enormous incentives to dedicate the effort and resources to protect that investment. In that sense, it will be easier to maintain a vibrant and questioning safety and security culture if the nuclear industry remains robust, practiced, and an attractive place for talented people to work. If, on the other hand, the nuclear industry declines, or loses those stakeholders who have the deepest roots in national security, nonproliferation standards, and safety culture, then the chances for further decline may sharply increase.

The mining industry offers a cautionary tale of what can happen when a complex industry is starved of sufficient investment. According to the *Wall Street Journal*, "large mining companies have experienced a rise in fatal accidents in 2015, when most are enacting heavy cost cuts as they battle to remain

profitable amid a downturn in world commodity prices."[48] While it is difficult to attribute a direct causal link, the timing of the increase in fatal accidents merits further attention for similar industries that are also facing difficult budget and investment choices.

As more countries launch new commercial nuclear power programs or expand existing ones, American leadership will remain important. To be sure, professionals and leaders in countries the world over are strongly committed to nuclear safety and security. It is fair to say that in its commitment to nuclear safety and nonproliferation, the United States stands proudly in the front ranks. And, given the global nature of the nuclear industry, it is therefore not only in the U.S. national interest, but indeed in the global interest of all those who support nuclear energy for its potential contribution to lowering world carbon emissions, for the United States to continue to demonstrate that degree of commitment.

This report has argued that we need effective policies to prevent the expansion of nuclear energy programs that can advance our climate goals from inadvertently accelerating the spread of nuclear dangers, be they state-based or terrorist-driven. But cutting off that one avenue to acquisition is necessary but not sufficient; we need to cut off all other avenues as well. At the end of the day, nuclear threats result from dedicated efforts to obtain, deploy, and potentially use nuclear weapons. The leaders of those programs will not be dissuaded from their purpose by an Assured Nuclear Fuel Services Initiative or incentives. They can argue that they do not want to rely upon an ANFSI to keep their multi-billion dollar reactors running, noting that the United States itself certainly has emphasized the importance of energy security, and that the world has shown that it is prepared to use energy resource-denial as a form of sanction.

In such cases, the only utility of a concept like the ANFSI is that it allows the international community to call the bluff of a country, like Iran for example, that claims its nuclear programs are purely peaceful in intent and needed to defend its energy security, when the evidence—such as clandestine enrichment facilities buried underground, a heavy water reactor ideally suited to provide an abundant source of plutonium, data on the possible military dimensions of a nuclear program—points to a weapons program.

48 Rhiannon Hoyle, "Brazil Dam Breach Casts Spotlight on Mine Safety," *Wall Street Journal*, November 8, 2015. http://www.wsj.com/articles/brazil-dam-breach-casts-spotlight-on-safety-at-major-miners-1446990333

Blocking and tackling...

When it comes to nuclear security, perfection is unattainable yet must remain our goal. A terrorist with a nuclear explosive need only succeed once out of unlimited opportunities, while societies must succeed 100 percent of the time at 100 percent of the locations, from schools and hospitals to shopping malls and theaters, to arenas and countless other potential targets. To mitigate that risk requires a comprehensive approach, including continued investment in U.S. nuclear forces and the supporting infrastructure needed to preserve our ability to deter potential adversaries, increased international cooperation to confront and defeat jihadi terrorists and their networks, and vigorous application of strong international safeguards to guard against the diversion of nuclear technology and materials from peaceful to violent purposes.

To promote these wider objectives, the cornerstone institutions of the Nuclear Non-Proliferation Treaty and the International Atomic Energy Agency have been complemented and reinforced by a number of additional measures, including UN Security Council Resolution 1540 and the Global Initiative to Combat Nuclear Terrorism.[49] Going back to 1991 legislation sponsored by Senator Sam Nunn (D-GA) and Richard Lugar (R-IN), the United States has engaged in extensive cooperative threat reduction with Russia and other nations, dismantling thousands of nuclear weapons from the former Soviet Union and protecting dangerous materials from falling into the wrong hands through the Material Protection, Control, and Accounting Program.[50] In addition, the Nuclear Security Summit that President Obama launched in 2010 and subsequent Summits in 2012, 2014 and 2016 also made substantial contributions to enhancing nuclear security through strengthened legislation, exercises, training, and establishment of Centers of Excellence. A substantial number of Summit participants strengthened their laws and regulations,

49 The Global Initiative to Combat Nuclear Terrorism (GICNT) is a partnership of 86 nations that have endorsed a core set of nuclear security principles. The mission "is to strengthen global capacity to prevent, detect, and respond to nuclear terrorism by conducting multilateral activities that strengthen the plans, policies, procedures, and interoperability of partner nations." Like other nuclear security organizations, GICNT provides a forum to bring together expertise, ideas, and resources, but with a focus on countering nuclear terrorism.

50 The Material Protection, Control, and Accounting (MPC&A) Program is a critical component of the U.S. National Nuclear Security Administration (NNSA) to combat vulnerabilities in nuclear security. MPC&A serves as "a first line of defense in preventing nuclear terrorism" and works with "international partners to secure and eliminate vulnerable nuclear weapons and weapons-usable material." MPC&A focuses on strengthening the domestic capabilities of international partners on physical security, guard training, and infrastructure. Some examples of MPC&A improvements include hardened doors and windows, locks and keys to control access to secure areas, perimeter fences, monitoring and detection systems, and central alarm systems. Amy E. Woolf, "Nonproliferation and Threat Reduction Assistance: U.S. Programs in the Former Soviet Union, *Congressional Research Service,* February 4, 2010, pp. 31-32.

A Security Forces team member handcuffs an intruder at "Hotel 2" during the Launch Facility Recapture portion of the Nuclear Security Inspection (NSI), Malmstrom AFB, Montana. (USAF photo)

enhanced security over radioactive sources, upgraded physical security measures, reduced or eliminated their stocks of highly-enriched uranium, or took legal, financial, or other practical steps to enhance nuclear security. The 2016 Nuclear Security Summit, held in Washington, DC, helped drive the final ratifications needed to bring into force the 2005 amendments to the Convention on the Physical Protection of Nuclear Materials and Nuclear Facilities, which provides for cooperation among states in locating and recovering stolen or smuggled nuclear material and in mitigating any radiological consequences of sabotage.[51] Recent years have also witnessed an increased focus on the security mandate of the IAEA.

Moreover, since nuclear power continues to expand globally, it will be essential to assure that the rules of the road for peaceful nuclear cooperation reinforce those fundamental nonproliferation norms.[52] As this expansion continues, international networks and institutions that promote nuclear security will become increasingly important. In this context, the World Institute for Nuclear Security (WINS) has become a crucial addition to the effort to improve nuclear security from a global

51 International Atomic Energy Agency, "Convention on the Physical Protection of Nuclear Material," Accessed June 10, 2016. https://www.iaea.org/publications/documents/conventions/convention-physical-protection-nuclear-material

52 World Nuclear Association, "Plans for New Reactors Worldwide," Last updated April 2016. http://www.world-nuclear.org/info/Current-and-Future-Generation/Plans-For-New-Reactors-Worldwide/

perspective.[53] WINS was established in 2008 through collaboration of the Nuclear Threat Initiative, U.S. Department of Energy, and the Institute of Nuclear Materials Management. WINS also works closely with the International Atomic Energy Agency and is conveniently collocated with the Agency in Vienna, Austria. WINS broke new ground as the first international organization whose primary focus is to facilitate sharing of nuclear security best practices and information, and it has created a certification program for nuclear security professionals. It has already made great progress in its short history, building a strong membership of over 2,500 members from more than 110 countries. Going forward, WINS will serve as an essential forum to share information and improve the quality of nuclear security around the world.

However, broad institutional efforts will never obviate the need for robust diplomatic efforts on the world's most acute nonproliferation challenges.

Russia and China: indispensable partners

Even the most energetic diplomacy can only succeed with the full cooperation of the world's major players. For North Korea, that includes the United States, South Korea, Japan, China, and Russia. For Iran, that includes the United States, the United Kingdom, France, Germany, China, and Russia. Apart from the United States, the common denominators in both cases are China and Russia.

The trend of U.S.-Chinese nuclear diplomacy has been one of slow, incremental progress over the years. Traditionally, in the days of Chairman Mao, China opposed U.S. nonproliferation efforts, expressing solidarity with the Non-Aligned Movement, and viewing U.S. nonproliferation policy as a hegemonic effort to assert its dominance through its nuclear monopoly vis-à-vis the less developed nations of the world. By the mid-1980s, China had begun to view itself less as a revolutionary and more as a status quo power, which opened the door to the possibility of working with the United States to oppose proliferation in other nations. The turning point came, subtly, in a toast by Premier Zhao Ziyang at a State Dinner at the White House on January 10, 1984:

53 Nuclear Threat Initiative, "World Institute for Nuclear Security (WINS): Improving Nuclear Security Worldwide," Accessed June 10, 2016. http://www.nti.org/about/projects/wins/

> We are critical of the discriminatory Treaty on the Non-Proliferation of Nuclear Weapons, but we do not advocate or encourage nuclear proliferation. We do not engage in nuclear proliferation ourselves, nor do we help other countries develop nuclear weapons. We actively support all proposals that are truly helpful to realizing nuclear disarmament, terminating the nuclear arms race and eliminating the threat of nuclear war.

Those guarded words opened the door to years of painstaking diplomacy, as the United States sought to address nonproliferation challenges around the world, with China playing an inevitably influential role. And, while China invariably advocated greater caution and less pressure vis-à-vis the targets of multilateral diplomacy, whether North Korea or Iran, ultimately China could be persuaded to join a consensus to bring pressure to bear on a nuclear miscreant. North Korea, in particular, appears to have tried China's patience by its reckless and aggressive behavior.

During President Obama's first term, China and the United States took another step toward each other in support of global efforts to fight nuclear weapons proliferation. President Hu Jintao attended the first Nuclear Security Summit, hosted by President Obama in Washington, DC, in April 2010, and agreed to build a Center of Excellence in China.

With North Korea's continuing provocative actions and China's expanding role in global nuclear commerce, the importance of building on that commitment in U.S.-China nonproliferation and security relationship has increased since that time. So it was good news when, in March of 2016, in the run-up to the fourth Nuclear Security Summit, high-level officials from both countries attended the opening of China's nuclear security Center of Excellence in Beijing.

The Center will serve as home base for bilateral and regional talks on nuclear security (e.g., Chinese nuclear exports, North Korea's nuclear program, and regional reprocessing programs), technical exchanges and training, and research and development at its state-of-the-art laboratories. The United States will contribute equipment and technical expertise to the Center, which will be the first of its kind to offer a full range of security capabilities, from materials management, to physical protection, to guard forces.

One source of continuing challenge—but perhaps opportunity—is Pakistan. China has traditionally been Pakistan's major strategic backer. (Among other things, they share an enmity with India.) And Chinese support, unfortunately, has extended to Pakistan's nuclear program, including nuclear power reactors at Chasma, assistance for Pakistan's uranium enrichment and plutonium reprocessing efforts, and the design and highly-enriched uranium for Pakistan's first nuclear weapon.[54] In May 1998, on the heels of India's first official nuclear weapons test (recall the fiction that the 1974 blast was a "peaceful nuclear explosion"), Pakistan detonated its first nuclear device, and is now believed to have an arsenal of 110 to 130 nuclear weapons.[55]

The dangers inherent in that arsenal are many. At least some of the weapons are believed to be deployed in the field, not garrisoned in secure locations. The Pakistanis have acknowledged that they are now fielding tactical nuclear weapons, which raises the risk at some point of provoking Indian action, possibly preemptively, and of being overrun in a conventional battle with India, further compounding the risk of detonation. Finally, Pakistan's internal divisions and infiltration by Islamic extremists, both in the intelligence organizations and in the Army, mean that the insider threat is constant and severe.

The Chinese leadership is intensely focused on preserving domestic stability, which, in turn, suggests that a nuclear incident in South Asia would be anathema to Beijing. We should therefore encourage China to exercise its unparalleled influence with Islamabad at least to ensure that the nuclear weapons that Pakistan does possess are kept under strict controls, robust physical security, and protected by security personnel who are carefully and continuously vetted to assure loyalty as well as competence in the vital mission of prevent the theft, diversion, loss, destruction, or detonation of a nuclear device there.

North Korea is the other proliferation challenge where China can play a major—or perhaps even decisive—role. We will address North Korea in detail later in this report. At this point, suffice it to say that North Korea basically survives at the sufferance of China. Chinese food and fuel shipments to North Korea are indispensable to the sustenance of the hermit kingdom and, not incidentally, to the current political leadership there. So even the threat of

54 Joseph Cirincione, Jon Wolfsthal, and Miriam Rajkumar, *Deadly Arsenals: Nuclear, Biological, and Chemical Threats* (Second Edition, Revised and Expanded), Carnegie Endowment for International Peace, 2005.

55 SIPRI, "Global Nuclear Weapons: Downsizing but Modernizing," June 13, 2016. https://www.sipri.org/media/press-release/2016/global-nuclear-weapons-downsizing-modernizing

curtailing, much less cutting off, those supplies would confer enormous leverage on Beijing.

For many years, the United States and other nations have urged China to take more advantage of that leverage to compel North Korea to curtail its nuclear weapons program. China has traditionally declined, arguing that to do otherwise could destabilize North Korea, which in their view represented the more imminent threat. It has been the task of the United States and others in the international diplomatic community to persuade the Chinese leadership that failure to act more forcefully to reverse North Korea's reckless nuclear weapons policies today will breed even more instability tomorrow than what currently preoccupies Beijing. As we shall see below, this view may now be gaining additional traction in Beijing.

Turning to Russia, we find a different situation entirely. Ironically, despite having tens of thousands of nuclear weapons pointing at each other throughout the Cold War, Russia and the United States have had a longstanding and generally cooperative approach to addressing nuclear security issues in third countries. For example, U.S. and Soviet diplomats worked together in the negotiations leading to the 1968 Nuclear Non-Proliferation Treaty. During the 1980s, the two sides engaged in regular nonproliferation consultations.

After the 1991 breakup of the Soviet Union, cooperation on reducing nuclear threats intensified. That year, Senators Sam Nunn (D-GA) and Richard Lugar (R-IN) cosponsored legislation that launched the Cooperative Threat Reduction program, which facilitated the dismantlement of thousands of nuclear weapons, missiles, and launchers, the removal of all nuclear weapons from Ukraine, Kazakhstan, and Belarus, the destruction of thousands of chemical weapons, and consolidation and security upgrades for 260 tons of fissile material. It was not all about hardware and materials but also about people; the International Science and Technology Center provided gainful employment on meaningful projects to engage the talents of over 58,000 scientists and other weapons-program staff from hundreds of organizations across the former Soviet Union. In the "lab to lab" program, scientists from the U.S. and Russian national laboratories—former adversaries who spent decades designing nuclear weapons intended to annihilate each other's homeland—forged strong personal and professional relationships that both sides found rewarding and that provided a positive environment for bilateral cooperation aimed at

reducing the risks of nuclear technology or materials winding up in the wrong hands.

Also, in a negotiation that began under President George H.W. Bush and continued uninterrupted under President Bill Clinton, the United States and Russia concluded a 1993 agreement whereby the United States would purchase 500 metric tons of HEU from the Soviet military program—enough for 20,000 nuclear warheads—to be blended down to LEU that could not be used for weapons but did, in fact, supply about half of U.S. commercial nuclear fuel needs for 20 years. The "Megatons to Megawatts" program, as it became known, showed the power of harnessing a national security imperative (reducing nuclear threats from highly-enriched uranium) to a commercial driver (utilities' demand for low-enriched uranium fuel). Even during fraught periods in US-Russian political relations, the HEU deal kept chugging along, eliminating the equivalent of three nuclear weapons per day, without fail, for 20 years.

Nunn-Lugar and Megatons to Megawatts made the world a safer place than many feared would emerge from the break-up of the Soviet Union and the danger that the loss of centralized control over the former Soviet arsenal would produce a hemorrhage of talent, technology, equipment, and fissile materials to adversaries and terrorists around the world. These programs continued even when trouble afflicted the wider political agenda, as occurred in the first decade of the new millennium. U.S.-Russian relations sustained a long-term downturn, first over the 2004 "Orange Revolution," which led Ukraine to distance itself from Russia, and then over the 2008 short, sharp conflict with Georgia, when Russian military actions facilitated the quasi-independence of the breakaway provinces of Abkhazia and South Ossetia.

President Obama had sought to move beyond the tensions arising from the Ukrainian and Georgian crises of the George W. Bush era, by hitting the "reset" button on the relationship with Russia, and seeking win-win outcomes across a wide range of issues, including nuclear energy and security cooperation. In July 2009, he and President Medvedev established the U.S.-Russia Bilateral Presidential Commission, comprised of a steering group and 19 working groups. (The author had the privilege to co-chair the Nuclear Energy and Nuclear Security Working Group with Mr. Sergei Kirienko, the Director General of the Russian national nuclear enterprise, Rosatom.)

The working group produced tangible results. It drove the completion of the longstanding project to shut down the third and final Soviet plutonium production reactor and to replace the power from that unit with a conventional power plant at Zheleznogorsk. It sponsored US-Russian joint work to collaborate with Armenia to enhance the safety of the Metsamore Nuclear Power Plant. It confirmed the feasibility of converting six Russian research reactors from high-enriched to low-enriched uranium fuel, no longer able to be used in nuclear weapons. It advanced the program to take back research reactor fuel from third country research reactors, under which 1,998 kilograms of fresh HEU and used nuclear fuel (enough to produce about 80 nuclear weapons) were returned to Russia and 1,554 kilograms of fresh HEU and used nuclear fuel to the United States. We also signed a new bilateral legal instrument on safe and secure transportation, storage and destruction of weapons and materials.

But even while relations were going strong at the level of the working group under the Bilateral Presidential Commission, there was an undercurrent of change. When the umbrella agreement with Russia supporting Nunn-Lugar cooperative threat reduction expired after 20 years of cooperation, the Russians were not willing to renew what they viewed as an anachronistic mechanism that smacked more of "assistance" from a benefactor to a beneficiary than of a partnership between equals. Fortunately, there was sufficient interest in retaining some degree of cooperation in these critical matters that had so benefited the safety and security of the region and the world that a mechanism to preserve some cooperation was found: the 2003 Framework Agreement of the Multilateral Nuclear Environmental Programme in the Russian Federation. In 2013, the United States and Russia concluded a protocol under the framework that continued threat reduction cooperation at a reduced scale (without, for instance, Russian Ministry of Defence participation), and with Russia responsible for more of the financial burden for the program.

In 2014, the sharp deterioration in U.S.-Russian relations following the Russian annexation of Crimea led the U.S. to suspend the activities of the Bilateral Presidential Commission, and inevitably the chill coursed through the nuclear security cooperation agenda, a worrisome casualty of the wider deterioration in U.S.-Russian relations.

At the same time, in critical areas where both Washington and Moscow perceived continued self-interest served by working together, cooperation continued—most significantly in the P5+1 diplomacy to confront the Iranian nuclear threat. But the broad downward trend in the relationship continued. In 2016, Russia declined to participate in the final Nuclear Security Summit Washington, D.C., complaining that limited groups of states should not interfere with inclusive international fora, such as the International Atomic Energy Agency.

The question remains: how much progress can the nuclear security community make without one of the largest stakeholders at the table? What risks are not being mitigated in the absence of that participation? While the Nunn-Lugar model of U.S.-funded projects in Russia may no longer be viable, the U.S. needs to work with Russia to devise a new, mutually-acceptable model that can carry these two nuclear powers into the future, jointly supporting nuclear security.

Considering the great strides made by the U.S. and Russia in advancing nuclear security, and the significant opportunities for future progress given their status as the owners of the world's largest nuclear arsenals and stockpiles of nuclear materials, the leaders of the United States and Russia should take a page from the history of the Cold War, when Moscow and Washington put aside their profound differences—even as they continued to target one another with thousands of nuclear warheads—to cooperate in reducing nuclear dangers. The stakes are too high to walk away.

North Korea redux

The conclusion of the Iran negotiations in July 2015 inevitably drew attention back to another rogue nuclear state: North Korea. This is not the place to rehearse in detail the diplomatic history of efforts to constrain the North Korean nuclear threat, but some understanding of it is necessary both to understand current attitudes toward negotiating with "the hermit kingdom" as well as to inform the path forward. The author participated in a couple chapters of that history, beginning with efforts under President George H.W. Bush that included the first direct U.S.-North Korean talks facilitated by Under Secretary of State Arnold Kanter. After President Bill Clinton was inaugurated on

March 12, 1993, the North Koreans reacted to pressure to disclose evidence regarding their efforts to cover up IAEA safeguards violations by announcing their intention to withdraw from the Nuclear Non-Proliferation Treaty.

Eighteen months of tortuous negotiations later, North Korea agreed to give up its plutonium program. The October 1994 Agreed Framework between the United States and North Korea committed Pyongyang to freeze and ultimately dismantle its plutonium-production program— including both reactors and reprocessing facilities—which intelligence services estimated had already produced 12 to 24 kilograms of plutonium, enough for one to six bombs.[56] In exchange, the United States agreed to work with its Japanese and South Korean allies to provide two light-water reactors, 150,000 tons of heavy fuel oil within a year, plus 500,000 metric tons annually thereafter. The Agreed Framework also required IAEA monitoring of North Korea's progress and a security guarantee that the U.S. would not use nuclear weapons against the North.[57]

For eight years, the Agreed Framework contained the North Korean plutonium program, but after evidence emerged that Pyongyang was covertly pursuing a uranium enrichment program, US Assistant Secretary of State James Kelly raised the issue with North Korean Vice Foreign Minister Kang Sok Ju in Pyongyang in October 2002.[58] The confrontation that ensued shattered the Agreed Framework and, with it, the safeguards on the 8,000 spent fuel rods at Yongbyon. The rods disappeared and presumably yielded up their harvest of four to six plutonium bombs for North Korea's growing arsenal.

In 2003, North Korea withdrew from the NPT, but diplomatic efforts—now embodied in six-party talks involving both Koreas, China, Japan, Russia, and the United States—continued in fits and starts, producing a joint statement of principles in September 2005 that reaffirmed the goal of the Six-Party Talks as "the verifiable denuclearization of the Korean Peninsula in a peaceful manner." The joint statement committed North Korea among other things to abandon "all nuclear weapons and existing weapon programs and [to return], at an early date, to the Treaty on the Non-Proliferation of Nuclear Weapons and to

56 For a thorough historical treatment of the events leading to the negotiation of the 1994 Agreed Framework, see Joel Wit, Daniel Poneman, Robert Gallucci, *Going Critical: The First North Korean Nuclear Crisis* (Washington: The Brookings Institution, 2005).
See also: Federation of American Scientists, "DPRK Nuclear Weapons Program," Last updated November 16, 2006. http://fas.org/nuke/guide/dprk/nuke/

57 Nuclear Threat Initiative, "US-DPRK Agreed Framework," Signed October 21, 1994. http://www.nti.org/learn/treaties-and-regimes/us-dprk-agreed-framework/

58 For a detailed treatment of the diplomacy of this period, see Yoichi Funabashi, *The Peninsula Question: A Chronicle of the Second Korean Nuclear Crisis* (Washington: Brookings Institution, 2007).

IAEA safeguards." For their part, the other five of the six parties stated their willingness to provide energy assistance and even to discuss the provision of light-water reactors to North Korea "at an appropriate time." The statement looked beyond the short term and contemplated long-term steps: by Japan and North Korea to normalize diplomatic relations; by all six parties to promote security and economic cooperation; and by all related parties to "negotiate a permanent peace regime" on the Peninsula "at an appropriate separate forum."[59] Ultimately, the promise of the joint statement went unfulfilled, as North Korea went on to test nuclear weapons in 2006, 2009, 2013, and 2016.

In parallel, North Korea also developed an arsenal of hundreds of ballistic missiles of increasing range and accuracy, evolving from Soviet-era SCUDS to the Nodong to the Taepo Dong II, which, with its 8,000 km range, could reach Alaska and parts of the Pacific Northwest. The combination of these active nuclear weapon and missile efforts constitutes a serious threat to the region and beyond.

The North Korean nuclear weapon and missile programs represent an increasingly dangerous regional and global threat, presented by a brutally tyrannical regime that has starved its people and engaged historically in bloody acts of terrorism. Its atrocities include assassinating four members of the South Korean cabinet and 17 others in a Rangoon bombing in 1983 and planting a bomb that killed all 115 aboard Korean Air Flight 858 in 1987. In March 2010, North Korea torpedoed the South Korean ship, *Cheonan*, killing 46 sailors, and in November of the same year it shelled Yeonpyeong Island, killing four South Koreans, including two civilians.

U.S. policy has included efforts to engage Pyongyang as well as efforts to isolate and apply pressure. President George W. Bush included Pyongyang in the "axis of evil," and in that spirit Vice President Cheney famously rejected a draft diplomatic statement aimed at resuming multiparty talks with North Korea by saying "We don't negotiate with evil; we defeat it." The Bush Administration also sanctioned Macao's Banco Delta Asia, which then froze $25 million of the North's money, even as it was negotiating the far-reaching 2005 joint statement of principles that reaffirmed North Korea's commitment to denuclearization.[60] The Bush Administration further succeeded in negotiating a 2007 agreement under which North Korea actually began to disable its nuclear weapons

59 U.S. Department of State, "Joint Statement of the Fourth Round of the Six-Party Talks Beijing," September 19, 2005. http://www.state.gov/p/eap/regional/c15455.htm

60 Joseph R. DeTrani, "Negotiations, Not Capitulation," *The Washington Times,* March 17, 2016, http://www.washingtontimes.com/news/2016/mar/17/joseph-detrani-north-korea-negotiations-not-capitu/

production capability, beginning with the demolition of the cooling tower of the 5-megawatt reactor that had produced the plutonium for Pyongyang's nuclear devices.

The North Korean issue worsened in the early months of the Obama Administration with further missile and nuclear weapon tests conducted by Pyongyang in the first half of 2009. In November 2010, former Los Alamos National Laboratory Director Sig Hecker visited North Korea and viewed what appeared to be a uranium enrichment program, lending further urgency to efforts to address the growing enrichment threat. On Leap Day 2012, Pyongyang agreed to suspend work at the uranium enrichment plant at Yongbyon, to halt nuclear and missile tests, and to allow inspectors from the International Atomic Energy Agency back into the country, in exchange for 240,000 tons of food aid from the United States. Within weeks, however, that agreement fell apart as North Korea announced a satellite launch that represented a *de facto* ballistic missile test.[61]

After the sudden death of Kim Jong Il in December 2011, his youngest son, Kim Jong-un, took over and asserted his primacy through a series of brutal purges of the leadership, including his own uncle and defense minister. Missile and nuclear weapon tests followed in 2013. For its part, following the collapse of the Leap Day agreement, the Obama Administration eschewed direct engagement with such an unpredictable and apparently unreliable interlocutor, adopting a posture of "strategic patience" until the miscreant regime showed "an early and demonstrable commitment … to denuclearize."[62]

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61 Mark Fitzpatrick, "Leap Day in North Korea," *Foreign Policy,* February 29, 2016, http://foreignpolicy.com/2012/02/29/leap-day-in-north-korea/

62 For useful commentary on diplomacy related to North Korea, see:
"U.S. Policy Towards North Korea," Testimony by Glyn Davies, Special Representative for North Korea Policy, Statement before the Subcommittee on Asia and the Pacific of the House Committee on Foreign Affairs, Washington, DC, July 30, 2014 http://www.state.gov/p/eap/rls/rm/2014/07/229936.htm
North Korea: U.S. Relations, Nuclear Diplomacy, and Internal Situation, Emma Chanlett-Avery, Ian E. Rinehart and Mary Beth D. Nikitin, Congressional Research Service, January 15, 2016
Joseph DeTrani, "Negotiation, Not Capitulation," *The Washington Times*, March 17, 2106 http://www.washingtontimes.com/news/2016/mar/17/joseph-detrani-north-korea-negotiations-not-capitu/
Joel Wit, "You Can Negotiate Anything—Even North Korea," *Foreign Policy*, April 27, 2016. http://foreignpolicy.com/2016/04/27/north_korea_negotiations_kim_jong_un_agreed_framework/
Joel S. Wit, "How 'Crazy' Are the North Koreans?", *The New York Times*, January 9, 2016. http://www.nytimes.com/2016/01/10/opinion/sunday/how-crazy-are-the-north-koreans.html
Victor Cha and Robert L. Gallucci, "Stopping North Korea's Nuclear Threat," *The New York Times*, January 9, 2016, http://www.nytimes.com/2016/01/08/opinion/stopping-north-koreas-nuclear-threat.html
Mitchel B. Wallerstein, "Ignoring North Korea's Nuclear Threat Could Turn Out to Be a Dangerous Mistake," *The Washington Post*, December 18, 2016, https://www.washingtonpost.com/opinions/the-price-of-inattention-to-north-korea/2015/12/18/a3eb5308-9d3b-11e5-8728-1af6af208198_story.html

Meanwhile, North Korean nuclear weapon and missile development continue. In October 2015, Admiral William Gortney, the Combatant Commander of the United States Northern Command, publicly assessed that North Korea has the ability to miniaturize nuclear weapons and deliver them to the U.S. homeland on the KN-08 missile. He continued: "…I think the American people expect me to take the threat seriously."[63]

On January 6, 2016, the North Koreans conducted their fourth nuclear test—this time claiming it was a hydrogen bomb, to a chorus of skeptical observers. Despite the ambiguity regarding its success, North Korea's fourth nuclear weapon test, along with a subsequent ballistic missile test, seems finally to have galvanized more effective international action. UN Security Council Resolution 2270 (the fifth sanctioning North Korean nuclear and missile activities) imposed the most forceful set of sanctions yet levied against North Korea for its proliferation-related activities.[64] The resolution added new financial sanctions as well as a travel ban and asset freeze, while striking at North Korean shipping, including through inspections on all cargo traveling to or from North Korea.

Now that the management of the Iranian nuclear challenge is embedded, however fitfully, in a framework that will constrain both the enriched uranium and separated plutonium paths to a nuclear weapon for the next 15 years, it is time for international leaders to turn their full attention to containing the North Korean nuclear threat. Meanwhile, the mercurial Kim Jong-un amped his rhetoric, boasting of developing the vastly more powerful hydrogen bomb, flaunting photographic images purporting to show a miniaturized implosion device, bragging of intercontinental missiles that can incinerate Manhattan, with fictionalized graphic images to illustrate the point. While his boasts may be vastly exaggerated, there is no doubt that his regime does possess nuclear weapons and ballistic missiles, that there are easier, low-tech ways to deliver a warhead (such as a truck or a tramp steamer) if he so chooses, and that the level of pain that he (as opposed to his beleaguered citizens) has been forced to endure via the concatenation of US Security Council sanctions imposed on North Korea to date has, evidently, been insufficient to temper his conduct.

Kim Jong-un's bluster, even if exceeding his capability, is itself provocative and potentially destabilizing to the region. As former U.S. Ambassador Robert

63 Department of Defense Press Briefing by Admiral Gortney in the Pentagon Briefing Room, April 7, 2015, http://www.defense.gov/News/News-Transcripts/Transcript-View/Article/607034

64 United Nations, "Security Council Imposes Fresh Sanctions on Democratic People's Republic of Korea, Unanimously Adopting Resolution 2270 (2016)," March 2, 2016. http://www.un.org/press/en/2016/sc12267.doc.htm

Gallucci has argued, relentlessly confronted by such an untrammeled North Korean nuclear threat, it would be no surprise should voices within South Korea and Japan—the countries most directly threatened by Pyongyang— decide to reconsider their own nuclear abstinence. And those voices may gain strength if at that very moment, some Americans cast doubt upon the continued U.S. willingness to honor its decades-old treaty commitments to defend South Korea and Japan with the U.S. nuclear deterrent, while expressing little concern about those two nations defending themselves with their own nuclear weapons.

There is yet another reason to confront North Korea: not content to build up its own arsenal and threaten others, Pyongyang has shown itself to be an active participant in the global black market in weapon-related nuclear technology. It would appear to have been the beneficiary of the same set of stolen uranium centrifuge designs that A.Q. Khan shared with Pakistan and Iran. Moreover, North Korea shared its own expertise, as well as equipment and personnel, to support the covert Syrian five-year effort to build a plutonium production reactor, until an Israeli F-15 attack destroyed the facility in September 2007. (The incident was shrouded in secrecy at the time, but the International Atomic Energy Agency investigated the site and, finally, in 2011 Director General Yukiya Amano confirmed that the target had been a nuclear reactor.)[65] North Korea has also assisted the ballistic missile programs of both Iran and Syria.

These developments come at a time when East Asia is already unsettled and growing increasingly volatile in response to China's actions to bolster territorial claims in the South China Seas through construction of military outposts there, in addition to longstanding disputes, especially with Japan, in the East China Sea. Further destabilizing acts by North Korea will only constrain options and increase the odds that some unexpected match will set off a conflagration that could spiral out of control.

Given the longstanding, deep defense ties between the United States and our treaty allies, Japan and South Korea, and in light of President Obama's 2011 strategic decision to reemphasize America's commitment to the Asia Pacific region—including through our strong military presence there—the inauguration of a new American president in January 2017 offers the opportunity to

65 Al Jazeera, "Syria target hit by Israel was 'nuclear site,'" April 29, 2011. http://www.aljazeera.com/news/middleeast/2011/04/201142962917518797.html

inject the management of the North Korean nuclear challenge with the attention it deserves.[66]

And given the intractability of this problem, it is clear that unless the nations of the world unite to take forceful action against North Korea, seriously driving up the price Pyongyang must pay for its continued nuclear outlawry, then North Korea will continue to increase its nuclear weapons capabilities along with the means to deliver them. Pyongyang's willingness to share nuclear and missile capabilities to others only adds to the urgency of acting.

But what should the United States and its negotiating partners do? When trying to address such an intractable problem, it is useful to go back to first principles. First, North Korea represents an unacceptable threat both to the region and the international regime to combat the proliferation of nuclear weapons. Second, the North Korean leadership appears to value nothing more highly than self-preservation, and by their explicit statements have indicated that they view their possession of nuclear weapons as a guarantor of their hold on power. Therefore, third, the United States and its partners must break that logic, and persuade North Korean leaders that failure to curtail their nuclear weapons program will threaten their ability to maintain political control.

As noted above, China is the country with the greatest ability to bring that kind of pressure to bear on North Korea, which still depends heavily on China for the food and fuel its economy needs to survive. Despite their traditional patronage, in recent years China has grown increasingly exasperated with North Korea's nuclear and missile provocations, which have continued in the face of repeated Chinese admonitions of restraint. That fact, perhaps combined with the years of painstaking diplomacy between Washington and Beijing, led China to respond to Pyongyang's January nuclear weapon and February ballistic missile tests by voting in favor of UN Security Council Resolution 2270—the most extensive sanctions China ever supported in the UN Security Council. While China has traditionally tempered its willingness to support strong sanctions with the even stronger desire to avoid steps that could destabilize North Korea, time will tell if this time China will be more willing to support implementation of sanctions sufficiently forceful to persuade Pyongyang to change course.

66 President Obama explained the so-called "pivot" toward Asia in a speech to the Australian Parliament on November 17, 2011: The White House, "Remarks By President Obama to the Australian Parliament," Parliament House, Canberra, Australia; https://www.whitehouse.gov/the-press-office/2011/11/17/remarks-president-obama-australian-parliament

The United States should seek Chinese support to do just that. If fully enforced, the actions embodied in the five UN Security Council Resolutions that impose sanctions on North Korea can bring substantial pressure to bear on Pyongyang. We saw how, in the case of Iran, effective implementation of the December 2011 sanctions—including the active cooperation of China, India, Italy, Japan, South Korea, Italy, and Turkey—imposed sufficiently onerous costs to force Tehran to the negotiating table, ultimately producing the nuclear deal of July 2015. While North Korea is far less exposed to international commerce than Iran, strong Chinese support for enforcement of the sanctions could bring enough pressure to bear to compel North Korea to return to the bargaining table and, possibly, to begin to constrain or even roll back Pyongyang's nuclear program.

To that end, Washington should seek to persuade Beijing that the stability of the Korean Peninsula is more threatened by Pyongyang's continued unfettered missile and nuclear weapon activities than it would be by a unified international community imposing strong sanctions against the North Korean regime until it returned to compliance with international nonproliferation norms. The United States should also make clear that North Korea's proliferation actions represent a national security threat to U.S. and allied interests and therefore, absent sufficiently robust Chinese application of pressure, the U.S. and its regional allies will have no choice but to take matters into their own hands.

What would that mean? It would require a strengthened U.S. security presence in Northeast Asia. The United States has consistently maintained that its security commitment to the South Korea is unshakable, and as the North Korean threat increases, we need to show that our actions and deployments support those assurances. We will do neither ourselves nor our Korean allies any favors by allowing a disconnect to open between our doctrine and our capabilities, nor should we leave North Korea—or China—in doubt regarding our intentions.

In that context, Washington and Seoul should engage in more explicit and continuing political-military discussions about mutual security and assistance in the event of a North Korean attack, and steps that we should take now that could both deter or, if necessary, enhance our response to North Korean aggression. These could include exercises on both the military and civil side focused on nuclear incident scenarios, whether overt nuclear use, terrorism, sabotage, or accident. It could also include strengthening our conventional defenses in the region and a more robust schedule of traditional field exercises.

These steps would enhance our collective capabilities against North Korean forces, while also hopefully persuading Beijing to act in restraining any imprudent actions from Pyongyang.

We should also consider more robust force deployments, such as strengthening the U.S. forward presence by redeploying some or all of the 9,000 U.S. Marines slated to leave Okinawa under the plan to relocate the Futenma military base to South Korea, instead of Guam or other destinations. This could effectively restore U.S. Forces in Korea from 28,500 today to the 37,000 level that had been present prior to Secretary of Defense Rumsfeld's broad-reaching redeployments of U.S. forces in Asia and Europe a decade ago.

To the extent that Beijing does not wish to see that bolstering of U.S. and allied military forces in the region, we should be amenable to tempering our actions insofar as Beijing agrees to undertake measures that would have an equal or greater effect in curbing North Korea's nuclear and missile activities.

This diplomatic outreach to China would be supported by a strengthened allied posture vis-à-vis North Korea, applying pressure through both sanctions and a strengthened military presence.

What should be our negotiating objective? The advantage of the 2005 Joint Statement is its clear and comprehensive objective: "the verifiable denuclearization of the Korean Peninsula in a peaceful manner." But so much water has passed over the dam since then—beginning with four nuclear weapon tests—that it may make sense to start with an interim agreement that would stabilize, but not roll back, the North Korean nuclear program. For example, if North Korea agreed not to build or test any more nuclear weapons, and not to export nuclear materials, equipment, or technology, the United States and its allies could confirm that they do not intend to replace the North Korean regime, could reopen Kaesong complex, and could provide food aid (subject to appropriate monitoring that the aid goes to hungry families, not the North Korean military).

Once this interim agreement is implemented and confidence begins to return to the relationship, then a more complete settlement, including full implementation of the 2005 Statement of Principles, could be addressed.

The next step would be to define, in simple terms, the nature of a deal that would meaningfully constrain the North Korean nuclear program in exchange

for relief from those concerns that concerted allied action is able to generate. In 2008, former Los Alamos National Laboratory Director Sig Hecker, who has visited North Korea seven times and understands the situation well, proposed "three yeses for three no's." If North Korea built no more bombs, performed no more bomb tests, and made no nuclear exports, then the United States and partners would respond by addressing North Korea's security concerns, energy shortages, and economic woes.[67]

Given how far North Korea has gone in developing its nuclear weapons and missiles, achieving Dr. Hecker's three "no's" would be a challenging negotiating objective, and one worth dedicating significant diplomatic effort to achieve. But the right number of nuclear weapons in North Korea is still zero, so the goal of U.S. diplomacy should be zero nuclear weapons on the Korean Peninsula.

After containing the nuclear threat, our ultimate goal should be to establish a lasting peace on the Peninsula. The police action that launched the Korean War in June 1950 was suspended through an armistice, not ended through a treaty. One day, the Peninsula may be united again under a peaceful, stable, democratically elected regime. But in the meantime, it is imperative to cauterize the unconstrained North Korean nuclear challenge before a dangerous situation becomes an irreversible tragedy.

One more point: As in the case of Iran, the nuclear threat is the most significant danger North Korea presents, but far from the only one. The disgraceful abuse of human rights, dangerous missile proliferation activities, counterfeiting, drug running, and other evils carried out by the North Korean regime all deserve to be vigorously opposed. But, again, as in the case of Iran, all of those problems are rendered more acute by the augmentation of an unconstrained nuclear threat. We should not hold resolution of that threat hostage to solving the other concerns at the same time. Linking these issues together will only make them harder, individually and collectively, to resolve and, in the case of the nuclear threat, we cannot afford to make it more difficult to manage than it already is.

67 Steve Fyffe, "Hecker assesses North Korean hydrogen bomb claims" *Bulletin of the Atomic Scientists*, January 7, 2016. http://thebulletin.org/hecker-assesses-north-korean-hydrogen-bomb-claims9046

Washington, D.C. is seen being attacked by a nuclear weapon in a North Korean propaganda video, published March 25, 2016.

Conclusion: Forging a new consensus

We end where we began. As citizens of the world, and custodians of this precious planet, we must do all we can to prevent catastrophic climate change, and to prevent nuclear terror. Simple arithmetic tells us that, even with ambitious efficiency and renewable energy programs, and 100 percent fulfillment of all Independent Nationally Determined Contributions to the Paris Agreement on Climate Change, the world will fall far short of meeting its targets to limit global warming to 2°C, much less the 1.5 °C goal cited in Paris.

Nuclear energy is needed to close the gap. Yet in order for nuclear energy to serve that noble end, we need to take extra steps to assure that the promotion of nuclear energy will not once again lead to the proliferation of nuclear weapons. We need to *forge a new consensus* supporting U.S. nonproliferation policies, recognizing that we are of the world, not above it. We will have no influence over slowing nonproliferation in countries that will have nothing to do with us because, even with the toughest nonproliferation laws of any nation on the books and an international regime that strongly bears the imprint of U.S. policy preferences, we cannot resist light-switch diplomacy, with the

erosion of American credibility that goes with it. This, despite the fact that we are moving the goalposts to a place other countries (even our closest allies) will not go, in a world where U.S. nuclear reactor and fuel sales have gone from dominant to modest. Failing to seek to impose the "gold standard" on countries that *have* sought nuclear weapons badly compromises U.S. efforts to insist on that standard with countries that have not, and that have lived up to the international nonproliferation requirements embodied in the Nuclear Non-Proliferation Treaty and the supporting IAEA safeguards system.

Instead of that doomed approach, the U.S. should embrace an Assured Nuclear Fuel Services Initiative. That approach puts the United States in lockstep with the interests of all the countries around the world that want to partner with the United States, want to buy from U.S. companies, and value our commitment to safety, security, and quality, *but do not know* if they can count on the United States over the long run to be a reliable supplier or to refrain from changing the rules in the middle of the game.

If we succeed, it can usher in a new era of U.S. nuclear leadership on a global scale, where the United States can retain and expand its ability to promote the responsible deployment of nuclear energy in a manner that helps advance our global climate objectives even as it reduces the threat that dangerous nuclear materials, equipment, and technology may fall into the hands of those who would do us harm.

Right now—with renewed focus on the climate commitments the world made in Paris in December to reduce carbon emissions, on the full and faithful implementation of the Iran nuclear deal, and on the continued reckless nuclear posturing of North Korea—is the best time to have this discussion, and to use the occasion of the inauguration of the next President of the United States to try to forge that consensus for the benefit of the health, safety, and security of this and all succeeding generations.

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