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Citizen Scientist: Frank von Hippel's Adventures in Nuclear Arms Control PART 7. The Obama Administration, Iran, Foundations, and the Next Generation

Frank von Hippel and Tomoko Kurokawa

Program on Science and Global Security, Princeton University, Princeton, NJ, USA

ABSTRACT

The achievements in nuclear reductions during the Obama Administration were modest, in part because of waning public pressure. But the nuclear deal with Iran was important. Thanks in part to a former senior Iranian diplomat, Hossein Mousavian, joining Princeton's Program on Science and Global Security in 2010, the Program was able to make two significant technical contributions to that deal. The discussion then turns to the importance of foundation support for policy research in the United States, the necessary ingredients for successful policy activism, including working with citizens' groups, the role of the Program in training the next generation of activist technical-policy analysts, and a new initiative to engage more US physicists to help educate the public and Congress about the continuing dangers from nuclear weapons and about policy options for reducing those dangers.

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The Obama Administration

Tomoko Kurakawa **(*TK*)**: So tell us your views on the Obama Administration's accomplishments with regard to nuclear arm control and disarmament.

Frank von Hippel **(*FvH*)**: Obama was an undergraduate at Columbia University when the great million-person rally for freezing the nuclear arms race was held in Central Park on 12 June 1982. I have heard that he was in that rally, as was I. Three months after coming into office, Obama gave his speech in Prague setting out a vision of a world free of nuclear weapons, but, in the face of declining public interest in the subject and a military establishment and Republican Party still wedded to an extreme form of nuclear deterrence, what he was able to accomplish was disappointing.

He did manage to get a treaty for modest verified strategic nuclear-arms reductions. In exchange, however, he had to commit to a several-hundred billion dollar program to "modernize" virtually all US nuclear weapon systems, enabling the continuation of a US nuclear arsenal at the current level through the end of the century.

CONTACT Frank von Hippel fvhippel@princeton.edu Program on Science and Global Security, Princeton University, Princeton, NJ, USA

Obama wanted to take US ballistic missiles off launch-on-warning alert and adopt a no-first-nuclear-use policy but was talked out of both initiatives.

I was pleased that he chose John Holdren as his science advisor because John understands both the nuclear-weapons policy and climate-warming issues. Holdren had been chair of the Pugwash organization for a decade, including when it received the Nobel Peace Prize jointly with its founder, Joseph Rotblat.

TK: You were invited to be Holdren's assistant for national security?

FvH: He raised it with me once but then dropped it. He probably was told that the Senate would not confirm me.

Instead, he chose Philip Coyle, who had been Director of Operational Test and Evaluation of new weapons in the Pentagon during the Clinton Administration and before that an associate director of Livermore National Laboratory, one of the two US nuclear-weapon-design laboratories. Coyle might have appeared a safe choice, but he was not confirmed. A group of Senators blocked a vote on Coyle's confirmation because of his criticism of the G. W. Bush Administration's decision to deploy a ballistic missile defense (BMD) system designed to intercept long-range missiles in space even though it would be ineffective against obvious countermeasures. (An effective system was not in reach, but it was a Republican political imperative to deploy a BMD system with national coverage as quickly as possible.)

In July 2010, a year and four months after nominating Coyle, with a confirmation vote still not in sight, President Obama finally appointed him temporarily during a Senate recess as a so-called "recess appointment." By law, however, that appointment expired at the end of 2010.

After that, Holdren chose Patricia Falcone from Sandia National Laboratory who had been working as Coyle's assistant. Luckily for her, she had no public record of policy views on international security. She was confirmed in 2012 and served in the position until 2015, when she was recruited to Livermore National Laboratory.

So, during his eight years as Obama's science advisor, Holdren had a recess-appointed Associate Director for half a year and a confirmed Associate Director for National Security and International Affairs for 2.5 years.

For the remainder of the Administration, Steve Fetter, who had been appointed as an Assistant Director, which does not have to be confirmed by the Senate, was the acting director of OSTP's National Security and International Affairs Division.

Fetter has been a long-time friend and collaborator, so I occasionally met him for discussions at "Teaism," a little tea shop on the other side of Lafayette Park from the White House.

With regard to nuclear-weapon policy, the biggest effort the Obama Administration made was to fill the hole that was about to be created by the expiration of the START treaty at the end of 2009. The G.W. Bush Administration had negotiated the Strategic Offensive Reductions Treaty (SORT) but, reflecting the Bush Administration's disdain for nuclear arms control, SORT had no verification arrangements and was to expire at the end of 2012, on the same day its limits took effect.

The problem with getting treaties ratified in the United States is that they have to be approved by two thirds of the Senate and, to get that vote, support from the other party is almost always required. To get Republican support for Obama's New START treaty, it

was necessary to promise to replace all US intercontinental ballistic missiles, ballistic missile submarines, long-range bombers, and air-launched nuclear cruise missiles with new versions.

The total number of deployed strategic warheads would be down by about 30 percent from the SORT Treaty levels but the commitment of the US to a new generation of nuclear weapons was in jarring contrast with Obama's Prague vision of nuclear disarmament.

One has to have sympathy for Obama, however. The people in the Pentagon and in the Congress – including many Democrats – are true believers in an extreme form of nuclear deterrence focused on winning a nuclear war to the extent achievable and don't adequately understand the dangers. The strong anti-nuclear-arms race movement of the 1980s had demobilized with the end of the Cold War but the military-industrial-Congressional complex had not.

I saw this first hand when I was recruited into a group that was asked to put together position papers on national security for the Hillary Clinton campaign. The priorities in this group ran from nuclear arms control to assuring nuclear deterrence. I was, of course, at the arms control end. I was not worried about nuclear deterrence. As long as nuclear weapons exist, any sane leader should be terrified that they might be used. I wanted to make sure that they would not be used as a result of accident, confusion or insanity.

At the other end of the group, worried about assuring deterrence, was Brad Roberts, who, as Deputy Assistant Secretary of Defense for Nuclear and Missile Defense Policy, had been responsible for the Obama Administration's 2010 Nuclear Posture Review and thought it was perfect. In the end, the position papers presented both our positions.

It was the same with ballistic missile defense. I argued that US ballistic missile defense could easily be overcome even by North Korea and that it was stimulating offensive buildups by China and Russia. Roberts et al. pushed back that we could not abandon the effort. So one could see that, with such people staffing the Obama Administration, beyond John Holdren and Steve Fetter, there were very few who supported the priority Obama wanted to give to nuclear disarmament.

TK: So Hillary Clinton was not interested in nuclear arms control?

FvH: Although I never spoke with her, I don't think she felt the same urgency as Obama about the nuclear danger. She was definitely skeptical, as many people were and are, about his vision of total nuclear disarmament.

As the end of his time in office approached, Obama was frustrated that he had not accomplished more, and tried to establish a US policy of no-first-use of nuclear weapons. I have heard that, in the cabinet-level debate, Holdren argued passionately for no first use but did not prevail. According to the *New York Times*, Secretary of Defense Ashton Carter, Secretary of State John Kerry, and Secretary of Energy Ernest Moniz all argued that, given US allies' fears of Russian and Chinese aggression, it was not a good time to declare a no-first-use policy.

If Obama had declared a no-first-use policy, however, Trump could have reversed it. That might have been a greater shock to the international system than just maintaining the status quo.

TK: Obama's first national security advisor was General James Jones, and then Thomas Donilon, and finally Susan Rice.

FvH: I imagine that, someone as new to national security policy as Obama – only four years in the Senate with no service on the Senate Armed Services Committee – would depend mostly on other people for suggestions for filling important national security positions. It is scary to think about that challenge. But one would imagine that his later choices were better informed than his earlier ones and, in the case of his national security advisors, he didn't have to worry about Senate confirmation.

I once was in a meeting in Washington with Marine Corps General James Cartwright, who was Commander of Strategic Command during the second half of the G.W. Bush Administration and Vice Chairman of the Joint Chiefs of Staff during the first two and a half years of the Obama Administration. Cartwright was reportedly "Obama's favorite general" and I could see why. He was low-key and thoughtful.

After the meeting, I walked with Cartwright for about half a mile to the Metro and, in response to one of my questions, he talked about people being captured by "the building," the Pentagon. Between the Pentagon and its backers in Congress, a President who wants to change security policy is confronting a pretty formidable challenge.

The president who dealt with national security policy most skillfully during my involvement with these issues was George H.W. Bush. He had been a navy pilot during World War II, had served for four years in the House of Representatives, been ambassador to the UN, de facto ambassador to China before the US established diplomatic relations with Communist China in 1979, director of the CIA and vice president to Ronald Reagan. He had General Brent Scowcroft as his national security advisor for his entire term and managed the very difficult situations created by the disintegration of the Soviet Union and Iraq's invasion of Kuwait. Perhaps Obama thought Jones could be his Scowcroft. But it didn't work for him.

TK: Also President Obama put a higher priority on domestic issues, especially the economy after the financial crash that he inherited, and health care. Then, in his first mid-term election, in 2010, the Democrats lost control of the House of Representatives to Republicans and progress on Obama's agenda became very difficult.

Iran

FvH: The most important issue I was involved with during the Obama presidency was the negotiation with Iran over its nuclear program.

In 2003, Iran's nuclear program became public and it became a high priority for the international community to prevent Iran from producing nuclear weapons. From 2003 into 2005, Iran under President Mohammad Khatami negotiated with France, Germany, and the United Kingdom about potential limits on its enrichment program. The G.W. Bush Administration refused to join in those negotiations but, through the U.K., vetoed any solution that did not shut down Iran's enrichment program completely. In the words of Condoleezza Rice, President Bush's national security advisor during that period, the Bush Administration's position was that "not a centrifuge shall spin in Iran."

During that same period, I was a member of a group organized by the last US Ambassador to Iran prior to Iran's 1979 revolution, Bill Miller.[1] Other core members were Richard Garwin, Marvin Miller,[2] and W.K.H. Panofsky.

Bill Miller pulled us together to meet with Iran's then Ambassador to the UN, Javad Zarif, to brainstorm about possible compromise limits on Iran's nuclear program. During our brainstorming, we came up with a proposal that Iran would limit itself to an enrichment R&D program with only one hundred operating test centrifuges. Iran proposed 3,000 operating centrifuges. The Bush Administration was unwilling to accept that. By 2015, when the Joint Comprehensive Plan of Action (JCPOA) was agreed between Iran and the five permanent members of the UN Security Council (China, France, Russia, the UK and US) plus Germany, Iran had installed the equivalent of more than 20,000 first-generation centrifuges. The deal brought the number back down to about 5,000 operating centrifuges.

In 2005, the hardline candidate, Mahmoud Ahmadinejad, was elected President of Iran, replacing the more liberal Mohammad Khatami, who, in response to the prediction of a "clash of civilizations" by Harvard academic Sam Huntington, had proposed a "dialogue among civilizations". Bill Miller then organized meetings in the Hague and Vienna with Mojtaba Hashemi Samareh, who had served with Ahmadinejad in Iran's Revolutionary Guard during the Iran-Iraq war and was a close advisor. I don't think either Ahmadinejad or Samareh had ever been outside of Iran before Ahmadinejad became president. Samareh and we struggled to understand each other's thinking.

Then, in 2013, Hassan Rouhani was elected President of Iran, and brought in Zarif as his foreign minister. Our Princeton colleague, Hossein Mousavian, knew them both well because the three had worked together on the nuclear negotiations with France, Germany and the U.K. during 2003–2005 (Figure 1). So, suddenly, with Obama having replaced G.

Figure 1. Left. Hossein Mousavian; Right. Iran's Foreign Ambassador, Javad Zarif, talking to President Hassan Rouhani, who is on the right (IRNA).

[1]William Green Miller studied in Oxford with C.S. Lewis and J.R.R. Tolkien and wrote his own poetry. He started his career as a foreign service officer in 1959–64 in Isfahan, Iran. During 1975–76, he was staff director of Senator Frank Church's Select Committee on Foreign and Military Intelligence that, after Watergate, investigated illegal CIA activities. President Carter appointed Miller ambassador to Iran just before the hostage crisis happened and Miller spent the rest of the Carter Administration trying to negotiate the freedom of the hostages. During the Gorbachev period, Miller headed the American Committee on United States-Soviet Relations and lived in Moscow during 1988–93 where I first met him. During the Clinton Administration, he was the first US ambassador to Ukraine.

[2]Marvin Miller was a retired senior research scientist from MIT's Department of Nuclear Science and Engineering who had become an expert on nuclear proliferation, especially Israel's nuclear-weapon program, starting during a 1984–86 stint with the US Arms Control and Disarmament Agency.

W. Bush in 2009, Rouhani replacing Ahmadinejad in 2013 and bringing in Zarif as his Foreign Minister, and John Kerry replacing Hilary Clinton as Secretary of State that same year, both sides wanted to make a deal.

It was not easy, however; the negotiations lasted 20 months.

During the negotiations, our group at Princeton was able to contribute to the resolution of two key problems.

The first was the Arak reactor, a heavy water reactor with the same rating as the Indian reactor that produced the first plutonium for India's nuclear-weapon program. The Iranians did not want to give it up.

I talked to Jim Matos at Argonne National Lab, who I knew because of his role in the Reduced Enrichment for Research and Test Reactors (RERTR) program (see Part 5). Matos told me about a similar crisis in 1991 over China's sale of a heavy-water-moderated research reactor to Algeria. As in the Iran case, the US was concerned that the reactor might be used to produce plutonium for bombs.

In the Algerian case, the problem was resolved by China agreeing to change the reactor design so that it could be fueled only with low-enriched uranium (LEU) instead of natural uranium. It is neutron absorption in U-238 that produces plutonium and LEU contains much less U-238.

So we suggested that the Arak reactor be converted to operate on uranium fuel containing 3 percent U-235 instead of natural uranium, which contains about 0.7 percent. Our post-doc, Ali Ahmad, a nuclear physicist from Beirut, calculated that, with this change, the annual production of plutonium in Iran's Arak reactor would be reduced from 8 kilograms (enough to make a bomb) to 1 kilogram (Ahmad et al. 2014). Our write-up was shared with both the Iranian and U.S. negotiating teams. The same idea may well have come from China and from Argonne as well. In any case, along with design changes in the internal structure of the reactor that would make the fuel enrichment change difficult to reverse, that became part of the final Joint Comprehensive Plan of Action (JCPOA).

Our second suggestion related to an impasse over the number of centrifuges that Iran would be able to continue to operate under the deal. The Iranians were unwilling to go below 5,000 first-generation centrifuges. That would be down from the equivalent of over 20,000 (Figure 2). But the U.S. calculated that, if Iran fed the 5,000 centrifuges with low-enriched uranium, they could produce in a year enough weapon-grade uranium for a few bombs. Given the US goal to have at least a year to stop Iran if it decided to break out of the deal and race for a bomb, that was unacceptable.

This time we suggested limiting the amount of available low-enriched uranium in the form of UF_6 that could be fed into Iran's centrifuges. If there was not enough LEU feed to make a significant fraction of the amount of weapon-grade uranium required to make a single bomb, then Iran would be limited to feeding the centrifuges with natural uranium and it would take a year for 5,000 centrifuges to produce a bomb's worth of HEU (Von Hippel and Glaser 2014).

That became the compromise: the Iranians could keep 5,000 centrifuges but they could have only 200 kg of low-enriched uranium in the form of uranium hexafluoride (300 kg including the weight of the fluorine, Figure 3).

My only other involvement with the Iran negotiations was in February 2015 when Secretary of Energy Ernie Moniz, who had become involved in the Iran negotiations, called me up and asked if I could come down to a meeting. He had invited others as well,

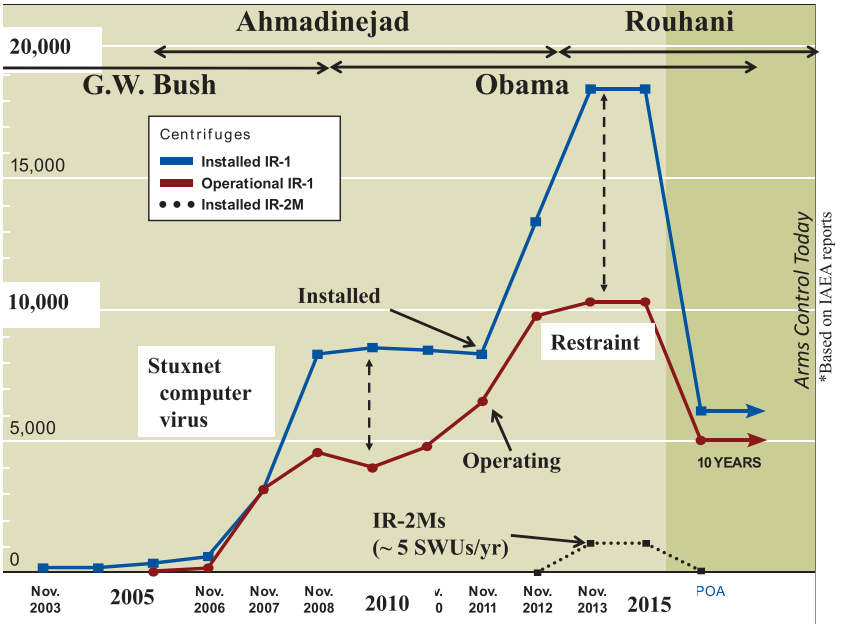

Figure 2. History of the number of centrifuges installed and operating in Iran up until the implementation of the agreed Joint Comprehensive Plan of Action (JCPOA) at the beginning of 2016. The low numbers before 2005 were in the Natanz pilot plant. The initial increase came from the installation of IR-1 centrifuges in the large underground centrifuge halls at Natanz after the election of President Ahmadinejad in 2005. The US-Israeli Stuxnet computer virus unleashed around 2008 caused speed changes that damaged thousands centrifuges but installation resumed in 2011. In 2012–13 installation began of the higher-capacity IR-2 M centrifuge. Centrifuge installation only stopped after President Rouhani was elected in 2013 resulting both Iran and the US having leaders who wanted to make a deal. In the deal, Iran agreed, for a period of ten years, to reduce to about 5,000 operating IR-1 centrifuges at Natanz with an additional 1,000 remaining installed but not operating at the second enrichment site near Fordow (adapted from Davenport, Kimball, and Thielman 2015).

including: Matthew Bunn from Harvard, Steve Fetter from the University of Maryland, and William Happer, another physicist from Princeton. We met in Moniz's conference room in the Department of Energy's headquarters.

The centrifuge experts from Oak Ridge had developed a computer model of Iran's IR-1 centrifuges and had a proposal for reconfiguring the way in which they were interconnected to make cascades so that reconnecting them to produce highly-enriched uranium would take much more time. Moniz wanted us to assess the proposal. But it did not become part of the agreement.

As I have noted earlier, a remarkable number of the graduate students in my classes during my three years at Stanford went on to key positions in the government. In addition to Moniz and Holdren, there were: Richard Meserve, who went on to become one of the most competent chairmen of the Nuclear Regulatory Commission (1999–2003) and then became President of the Carnegie Institution of Science in Washington; Tom Neff, who proposed the HEU Deal with Russia; Joel Primack who launched the Congressional Science Fellowship program (and my career) and then went on to an illustrious career as a cosmologist at the University of California Santa Cruz; and Jim Timbie who was the

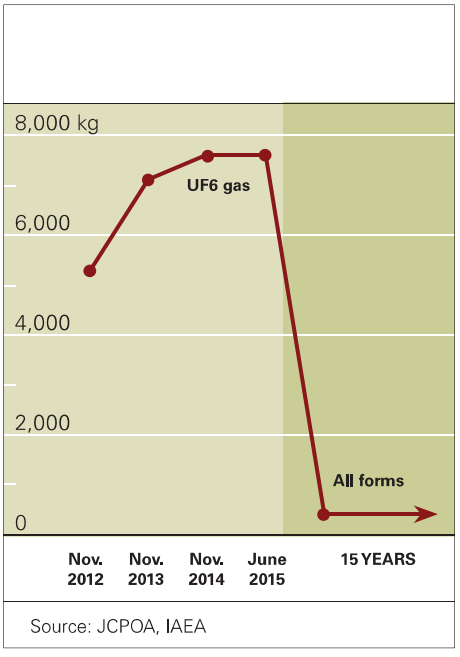

Figure 3. History of Iran's stockpile of low-enriched UF_6. Assuming that the low-enriched uranium (LEU) is 3.5 percent enriched, it would take 1,200 kilograms to produce 90% enriched uranium containing 25 kilograms of U-235, the amount assumed by the IAEA to be sufficient for a nuclear weapon. Under the JCPOA, Iran agreed to limit its stock to 300 kg for 15 years (adapted from Davenport, Kimball, and Thielman 2015).

technical arms control advisor to the State Department, including on the Iran deal, from 1983–2016.

I don't claim that I influenced these career choices. I just taught them classical electrodynamics and/or field theory. Holdren was influenced by Paul Ehrlich, the author of the famous (or infamous) book, *The Population Bomb*; Meserve already had a law degree; Neff and Timbie were probably influenced in their career choices by Panofsky, and Primack was Drell's student. Most important, however, was probably the Vietnam War and various environmental disasters that convinced many of us that we couldn't do a worse job than those running the government in Washington.

TK: You and your colleagues wrote many memos to the negotiators of the Iran Deal.

FvH: Just the two I have described. Also, there is a saying, "Success has many fathers; failure is an orphan." I don't know how much impact our input had. Indeed, some people on the inside, when I talked with them later, were very surprised to hear that we were involved at all. They didn't say that it was not true, but they had thought somehow that all these technical ideas were coming from Argonne National Lab and the Chinese in the case of the Arak reactor and from Oak Ridge in the case of the LEU stockpile. And perhaps they also were – or perhaps not. I learned from the Moniz meeting, that the Oak Ridge people were dreaming up much more complex schemes.

One of Mousavian's ideas is to deal with the problems between Iran and its Arab neighbors across the Persian Gulf directly with negotiations on a new regional security regime rather than through Washington.

One of the elements of the new regional security regime would be a Weapons of Mass Destruction-Free Zone. A Middle East WMD-Free Zone has been a long-term goal of both Egypt and Iran, and we have written about that (Von Hippel et al. 2013). But the focus there has inevitably been on Israel's nuclear-weapon program. Mousavian's idea was to put that aside for the moment and focus on reducing the dangers of either war between Iran and the United States over Iran's nuclear program or a nuclear arms race between Iran and Saudi Arabia.

We therefore contributed the idea that, instead of having competing national enrichment programs on either side of the Persian Gulf, Iran's enrichment program should be placed under multinational control (Glaser, Mian, and von Hippel 2015). Geoffrey Forden and Sir John Thomson had made a similar suggestion several years earlier (Forden and Thomson 2009).

More generally, I have been arguing for a ban on new *national* enrichment programs and a transition of existing national programs to multinational control (Figure 4). The "existence proof" for the feasibility of multinational enrichment is URENCO, the world's second largest provider of enrichment services after Russia. URENCO is controlled by Germany, the Netherlands and the United Kingdom.

Currently the only commercial enrichment plant in the United States is owned by URENCO. This is because the Clinton Administration transferred the operation of the huge but technologically-obsolete US-government-owned enrichment complex to the

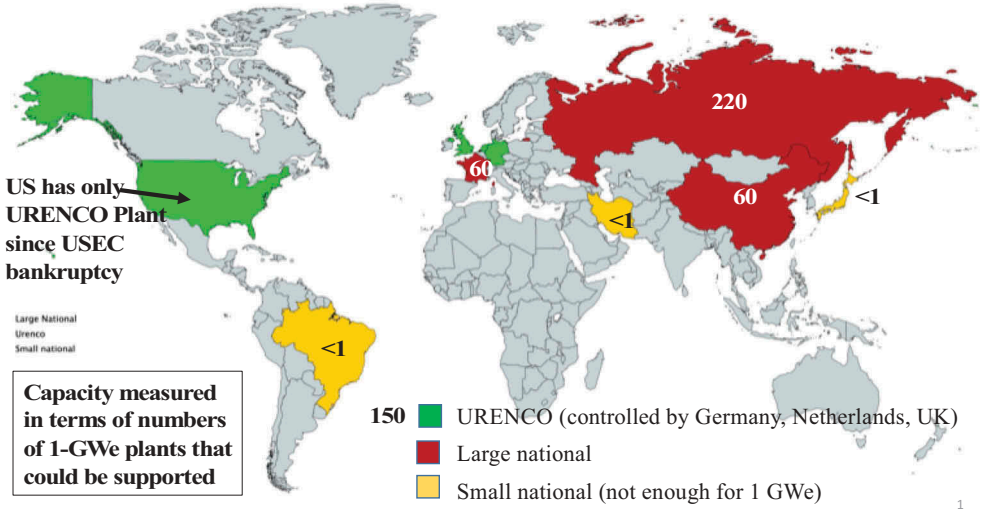

Figure 4. The world currently has four large suppliers of uranium enrichment services (Russia, URENCO, China and France) with a combined enrichment capacity sufficient to fuel 25 percent more nuclear-generating capacity than the approximately 400 GWe global total in 2020. URENCO is a multinational controlled by Germany, the Netherlands and UK. Three additional countries have enrichment capacities too small to provide fuel for a single large 1-GWe (million kilowatt) nuclear power reactor: Brazil, Iran and Japan (F. von Hippel).

United States Enrichment Corporation (USEC) in 1992 but USEC went bankrupt in 2013.

I've been lucky in collaborators. Bob Williams understands the energy problem; Hal Feiveson understood the plutonium problem before I did; Charles Gray deeply understands automotive technology; and Mousavian is a diplomatic genius.

TK: You didn't expect that Mousavian would work out that way.

FvH: No, I had no idea how good he was.

The Next Generations

TK: My impression is that you encourage foreign experts to come to Princeton and work collaboratively, like Li Bin from China, or Mousavian, or Jungmin Kang from South Korea.

FvH: The story of how I met Jungmin is a funny one. Tatsujiro Suzuki introduced us when Jungmin, still a graduate student studying at Tokyo University, was in the U.S. for a visit. The first thing Jungmin said to me was, "I hate plutonium!" After a discussion, I invited him to come to Princeton as a post-doc.

TK: How many years with Kang in Princeton?

FvH: Two years. That is our standard arrangement with post-docs. Thereafter, Jungmin had a series of fellowships and visiting appointments in the US and South Korea. Because of his opposition to their proposed reprocessing program, the nuclear engineers at the Korea Atomic Energy Research Institute (KAERI) blocked academic appointments for him in nuclear engineering departments in South Korea. In 2018, however, South Korea's newly-elected President Moon Jae-in appointed him chair of South Korea's Nuclear Safety and Security Commission (NSSC).

Kang is as honest as they come. Ironically, however, because of corruption scandals in South Korea's nuclear establishment, there is a rule that the chair of the NSSC cannot have received any money from the nuclear industry or from a government nuclear institute in the previous three years.

After Kang had been appointed Chair of the NSSC, KAERI searched and discovered that, while he was a visiting professor at the Korea Advanced Institute of Science and Technology in 2015, KAERI grant money had been used to pay Kang's way to a nonproliferation conference in the US. KAERI gave this information to the political opposition and succeeded in getting Kang forced out ten months into his three-year term.

Kang was in a state of shock for some months after he was forced out but then decided to continue the fight. I helped him write a proposal to the MacArthur Foundation that has given him two years' funding to fight against KAERI's campaign for reprocessing in South Korea. In early June 2019, he and I gave a press conference together in Seoul that was very successful. The press reported that the recent chairman of NSSC had explained why reprocessing was a bad idea and that dry-cask storage and direct disposal of spent nuclear fuel would be less costly and safer. Therefore, although his appointment as chairman of the Nuclear Safety and Security Commission was short-lived, it has given him status in South Korea's nuclear debate.

TK: How did he come to receive the appointment of chairman of the NSSC?

FvH: I don't know but I have a theory. President Moon is a critic of nuclear power and probably wanted an aggressive regulator as chairman. Other than Kang, there are essentially no outspoken nuclear critics in South Korea who are also PhD nuclear engineers. In February 2017, Kang and I gave talks in Busan, Daejeon and Seoul, South Korea on the danger of a spent fuel fire if there were a loss of water in a densely-packed spent fuel pool. Such a fire almost occurred in Japan during the Fukushima accident (see Part 8). There was a lot of coverage of our talks in the newspapers. Perhaps it was that publicity that drew the Moon administration's attention to Kang as a potentially honest, aggressive nuclear regulator.

When Kang speaks in English, he gives an impression of being somewhat shy and hesitant, but, as Masafumi Takubo pointed out to me, when you see him talk in Korean or Japanese, he is much more forceful and authoritative. *[laughter]*

TK: How about Masafumi Takubo? How did you end up working together?

FvH: I first met Masa in 1978. He was working for Gensuikin, the Japan Congress Against A and H-Bombs. A friend, Norrie Huddle, who had lived in Japan and had co-authored a book, *Island of Dreams*, about the environmental crisis there, invited me to join a group of Americans who were going to attend the annual commemorations of the nuclear bombings in Hiroshima and Nagasaki. Gensuikin was one of the sponsoring organizations and Masa was our escort.

Masa is largely self-educated. He did not finish college. But he insists in understanding things deeply and has become Japan's leading expert on a wide array of nuclear issues.

In 2004, Takubo quit Gensuikin to set up his own website on Japan's nuclear policy. He made ends meet by working as a free-lance translator of books and a simultaneous translator for people like me coming to give talks in Japan.

Takubo's primary interests are nuclear disarmament and nonproliferation. Japan's government has a schizophrenic approach to nuclear disarmament. It advocates nuclear disarmament but it also demands that the US be willing to use nuclear weapons first if Japan is attacked by China, North Korea or Russia. Japan also insists on maintaining a nuclear-weapon option and is the only non-nuclear-weapon state that both enriches uranium and separates plutonium.

In 2009, the Democratic Party of Japan (DPJ) came to power, interrupting for three years the long-term post-World War II dominance of the Liberal Democratic Party (LDP). Takubo was an advisor to the DPJ's Foreign Minister Katsuya Okada, and helped persuade him to overrule the career officials in Japan's Foreign Ministry who were lobbying the Obama Administration not to scrap the nuclear-armed cruise missiles that had been carried by US attack submarines during the Cold War. As a result, the Obama Administration did scrap those missiles. Unfortunately, the Trump Administration is proposing to bring them back.

TK: When you started the IPFM in 2006, was Masa an original member?

FvH: I believe he joined in 2011 after we began working together more intensively. In 2013, he also become a fulltime consultant to our Program.

Foundation Support

TK: Princeton's Program on Science and Global Security, which has helped create all these careers in public policy, is supported by foundation funding. How did you come to develop such good and enduring relationships with the foundation world?

FvH: When I first came to Princeton, Rob Socolow had a 25,000 USD grant from a small foundation, the Max and Anna Levinson Foundation, to work on a nuclear issue. I think the original idea may have been to work on fusion-energy policy because Princeton University manages the largest US fusion laboratory, the Plasma Physics Laboratory. Rob used the grant to fund my first year in Princeton while I was completing my work and outreach associated with the American Physical Society reactor safety study.

After a while, the Levinson Foundation's executive director, Sidney Shapiro, came to visit. He liked what we were doing. So, as our group working on nuclear issues grew, Sid began to recruit other small foundations to also support us.

Then we decided to try for a bigger grant from the Ford Foundation. The Foundation's president at the time was McGeorge Bundy, who had been President Kennedy's national security advisor. Bundy was interested in the plutonium issue but the director of the Ford Foundation's International Affairs Programs at the time, was concerned that we might be "too ideological." She was accustomed to supporting less crusading programs like that at the Kennedy School at Harvard. When she raised this issue with me I responded, "Yes, we are ideological. We are against nuclear war!" That seems to have resolved her concerns and the Foundation funded our work, which, at the time, was focused on critiquing the US government's plutonium breeder reactor development program.

Some nuclear industry representatives were infuriated by this work. David Rossin, an official from Commonwealth Edison, a big nuclear utility based in Chicago, wrote letters to McGeorge Bundy and to the president of Princeton University to inform them that our work was not up to even the standards Princeton expected of its undergraduates. So Bundy invited Rossin and us to his office for a debate. It turned out that Rossin didn't have much to say that was not *ad hominem*.[3] He continued to rise in the US nuclear-energy establishment, however: to Assistant Secretary of Energy for Nuclear Energy in the Reagan Administration and to President of the American Nuclear Society in the early 1990s. I met him again in Tokyo in 1993 when the advocates of Japan's plutonium breeder reactor program brought him in to denounce me as discredited in the United States. But he was no more successful in Tokyo than he had been with Bundy.

After Bundy left the Ford Foundation in 1979, the foundation's interest in international security waned and it moved into other areas, especially poverty.

In the meantime, I had been publishing a lot in the *Bulletin of the Atomic Scientists*. The first editor I knew there was Ruth Adams, who was deeply into nuclear arms control. She had been in 1957 the only woman participant at the very first Pugwash meeting in Pugwash, Nova Scotia.

In 1983, the recently-established MacArthur Foundation hired Ruth to be their first program director on peace and security. MacArthur has been our most important funder ever since. The program has had a series of dedicated women directors. Ruth's deputy

[3]Latin: An argument or reaction directed against a person rather than the position they are maintaining.

and successor, Kennette Benedict, later became the publisher of the *Bulletin of the Atomic Scientists*. The current director is Emma Belcher from Australia.

The second foundation that has supported our program for years is the Carnegie Corporation. In the late 1980s, the director of Princeton's Center for International Studies, Henry Bienen, introduced us to them. Later, he moved on to become the president of Northwestern University.

TK: When you get funding from two different funders, do you send them the same project proposal?

FvH: We have been lucky with our funders in that they have trusted us to set our own priorities. We developed this kind of relationship when we were funded by the small foundations. Every year, we would write a progress report for them all. Then, every two or three years, we would write a proposal in which we would say, in effect, "As described in our annual reports, we have been doing great things. If you like what we have been doing, please give us some more money and we hope to continue doing great things along the same lines."

I think that part of our success has been that our progress reports tell a story. Most researchers see progress reports as a chore and a distraction from their research. Reports written with that attitude are dull and not read. I decided to use our progress reports to tell why we thought our goals were important and where we were making progress; and why the policies we opposed were bad and why the alternative approaches we were proposing would be better. That forced me to review our goals and strategy annually. When I was unable to convince myself that we were making significant progress, I decided that perhaps we should try another approach.

I write well, so some of our funders actually started to read the reports! *[laughter]* I think that has helped keep them on board.

TK: So foundation support for your activities is very important.

FvH: Private foundations are more important in the United States than in other countries. It probably has to do with the tax laws. In the United States, if you put your financial gains into a foundation, they are not taxed.

The Rockefeller Foundation, which was established in 1913 with the profits from an oil refining and distribution monopoly, was very important to my family in the 1920s and 1940s. During the 1920s, with Germany in its post-World War I economic slump, Rockefeller supported my grandfather's experimental physics institute at the University of Göttingen. In 1927, my father received a Rockefeller Foundation fellowship to spend a year at the University of California, Berkeley. And, in 1936, when my father, as a refugee from Nazi Germany, needed a job in America, the Rockefeller Foundation paid half his salary for his first three years on the MIT faculty.

As far as I can tell, the Rockefeller Foundation's support of physics in those days was motivated by a pure interest in advancing the field. Today, in addition to foundations such as MacArthur, we have billionaires who set up think tanks in Washington to make propaganda. As a result, the impact of the "pure" foundations on policy is somewhat less.

TK: So that means persons like you have been successful because, in addition to your talents, you have support from American society, the foundations and civil society and liberal university colleagues. To what do attribute your policy impact?

Policy Impact

FvH: I was not that successful in pure physics but I was more successful than I would ordinarily have been because I could write well, so I made the most out of whatever I did by explaining it very clearly. Being able to write clearly is critical in the policy arena as well.

Another part is that, once you have become established in the minds of key journalists as an expert, they keep coming back to you. This happened to me in the area of reactor safety. I first became visible in the media – then still mostly the newspapers – as a result of the American Physical Society's Reactor Safety Study. Thereafter, each time there was a major accident: Three Mile Island in the US in 1979, Chernobyl in 1986 and Fukushima in 2011, the *New York Times* would contact me and quote me for its first story. Then journalists from other newspapers and from radio and television, observing that the *New York Times* thought I was an expert, would contact me too.

Currently, almost every weeknight, my wife and I watch the Rachel Maddow Show on the liberal cable channel, MSNBC. Maddow's approach is to build her program around interviews with experts. During Fukushima, she invited me a couple times and then Ed Lyman took over. Later, I was flattered when she said about her program, "We interview real experts, like Frank von Hippel!" *[laughter]* So, making important issues intelligible to people through writing, interviews and Congressional testimony is an important part of a policy activist's job.

Then there is the physics dimension. The physics calculations I do to deepen my understanding of the technical aspects of policy are not the calculations I taught graduate students how to do when I was at Stanford. They are much simpler – what physicists call "back-of-the envelope" calculations. You try to understand the essentials by asking, "Is there a simple approach that explains the order of magnitude of, for example, the energy required for an automobile trip so that I can figure out where the big opportunities for reduction might be?"

Back-of-the-envelope calculations were part of the culture when I was growing up as a physicist.

I tried to get my son interested in physics but his mother said, "Three generations of physicists is enough!" He studied music psychology but there were only few places in the world that had jobs in that area. So he got a master's degree in statistics and he now uses statistics to understand what works and what (mostly) doesn't in education policy. That's somewhat similar to what I do. He is a good writer too.

TK: What are other ingredients for success in policy?

FvH: Activism. Most of the people who come to work with us have been activists. They want to change the world, not just study it. Jeremy Stone, with whom I partnered during the Gorbachev years, once told me, "Ideology is worth ten points of IQ." If you know

what you want to do, that makes life much more simple. Otherwise, you have to spend a lot of your time trying to figure out, "What am I going to do?" I spent a lot of time on that question while I was doing physics. If you are not obsessed, you are at a disadvantage.

Jungmin, for example, has as a guiding principle, "I hate plutonium!" *[Laughter]*.

TK: It's tough to continue to stay as a minority because majority is easier. Being liberal means in many cases being in the minority.

FvH: But there are people like Sakharov who get tougher under pressure.

There are two other approaches I have found can increase one's impact on policy debates. One is discovering a third way. When I joined in the nuclear energy debate in the '70s, for example, the anti-nuclear-power people were emphasizing the dangers of nuclear accidents and radioactive waste while the pro-nuclear people were saying there was no choice: either we go forward with nuclear power or we freeze in the dark. Bob Williams and others discovered a third way: energy efficiency. If you don't like nuclear power, using electricity more efficiently will reduce the demand and give us more flexibility among supply options. And, in fact, in part because of energy efficiency improvements, global energy use has been growing half as fast as the global economy and, despite the ongoing shift toward electrification, global electric power use has been growing only as fast as the global economy.

The other strategy that I have found can increase one's policy impact is working with citizens' groups. I've written an article with the title "Activists and Analysts" (Von Hippel 1986). During the nuclear-weapons-freeze movement era in the early 1980s, activists would take me along as their expert to talk to congresspeople. Without them, I wouldn't have known how to get such a meeting. But, if ten constituents say, "We are coming to Washington and want an appointment with our Representative or Senator to talk about nuclear arms control and we will to bring along an expert," that's a powerful combination. Today, however, we mostly talk to staffers.

We have a local peace group, the Coalition For Peace Action (CFPA) in Princeton, which dates back the 1980s nuclear-weapons-freeze movement. During the approximately 40 years I have worked with the CFPA, it has grown from being a Princeton group to a regional group with chapters throughout the middle and south of New Jersey and also the Philadelphia region of Pennsylvania. We have educated one generation after another of our senators, representatives and their staffs. Other members of our group – especially Zia Mian and Robert Goldston[4] – are also involved.

During such briefings, the members of the citizen groups also listen to you and down the road start making your points in addition to their own. So you are helping them educate themselves as well.

We are now trying to spread this synergy nationwide. In April 2018, Steve Fetter, Richard Garwin and I wrote an article, "Nuclear Weapons: Dangers and Policy Options," in *Physics Today*, the journal of the American Physical Society, which has 55,000 members (Fetter, Garwin, and von Hippel 2018). The article grew out of a physics

[4]Robert Goldston is a Professor of Astrophysics at Princeton. From 1997 till 2009, he was director of Princeton's Plasma Physics Laboratory. Since, he stepped down, he has been working part-time with the Program on Science and Global Security.

colloquium I had given at the University of Michigan at Ann Arbor to try to reengage physicists with the nuclear-weapon issue.

I got only one response to the article but that response made the article worthwhile. It was from Stewart Prager, a plasma physicist in Princeton.[5] He came to my office and said, "I read your article. Shouldn't we be doing something about the dangers you describe?" He, Zia and I brainstormed and came up with a proposal for about ten pairs of physicists, one senior and one junior – because some of us are on the older side – to give perhaps a total of a hundred physics colloquia at US universities and national laboratories. In August 2019, the proposal received funding and backing from the American Physical Society. The APS imprimatur will be even more important than the funding in giving us credibility when we volunteer to give colloquia in physics departments.

In the spring of 2019, I was invited out to Salt Lake City to give a guest lecture at the University of Utah. As an experiment, I googled "peace groups, Salt Lake City," and found the Utah Campaign to Abolish Nuclear Weapons (UCANW). I emailed, telling them when I would be in Salt Lake City and asked whether I could help them educate any of the state's Representatives or Senators about what could be done to reduce the dangers from nuclear weapons.

I got an immediate response from the leader of UCANW, and she set up meetings with the office directors of the two Utah senators, both Republicans. She also brought a few other members of her group to those meetings, including a couple of physicists from the university. They were from my generation – probably also activated by the Vietnam War.

She and I followed up with meetings in the Senator's offices in Washington but I don't think we had a lasting impact there. With only one of us from Utah, we were not taken as a significant political voice.

Since there has not been a nuclear war in 75 years, most people have stopped worrying about the possibility of one happening. That is not necessarily the correct decision. Tokyo Electric Power Company and its regulators decided similarly that, since there had not been a large tsunami in Fukushima for one thousand years, there was no need to hurry to prepare for another one.

TK: Recently, New Jersey's State Assembly adopted a resolution supporting nuclear arms control and disarmament. Can you tell us how that happened?

FvH: Our area in New Jersey is now represented in the New Jersey Assembly by Andrew Zwicker (Figure 5), a physicist from the Princeton's fusion laboratory. He is very smart and energetic and has developed into a real political leader. He also has had a long-term interest in nuclear arms control.

So Zia Mian went to Zwicker and told him that California had passed a resolution supporting the Treaty on the Prohibition of Nuclear Weapons that has been joined by many countries in the southern hemisphere. Perhaps New Jersey could support the Treaty as well? Our precedent was the early-1980s Nuclear Weapons Freeze Movement whose first successes were resolutions of support passed by local and state governments.

As a result of subsequent discussions, the resolution was broadened to read:

[5]Stewart Prager is a professor of astrophysical sciences at Princeton University. He directed Princeton's Plasma Physics Laboratory from 2009 to 2016. He is now affiliated with Princeton's Program on Science and Global Security.

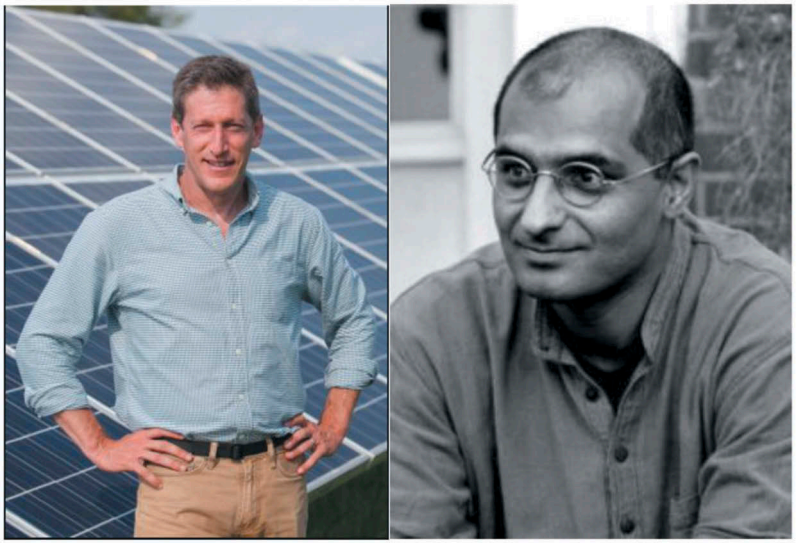

Figure 5. Left. New Jersey State Representative Andrew Zwicker; Right. Zia Mian, activist physicist and co-director of Princeton University's Program on Science and Global Security.

> "The General Assembly of the State of New Jersey urges the federal government to spearhead a global effort to prevent nuclear war by renouncing the option of using nuclear weapons first, ending the President's sole authority to launch a nuclear attack, taking U.S. nuclear weapons off hair-trigger alert, and canceling the plan to replace its entire nuclear arsenal with enhanced weapons, and actively pursue a verifiable agreement among nuclear-armed states to eliminate their nuclear arsenals [and] urges the President and the Senate of the United States to ratify the Treaty on the Prohibition of Nuclear Weapons."

Zwicker, as the chairman of the Science, Innovation and Technology Committee in the New Jersey State Assembly, organized a hearing on the resolution at which a few of us testified.

At the end of the hearing, the Democrats, who were in the majority, voted in support of the resolution and the Republicans abstained. They didn't oppose the resolution but they didn't support it either.

On 23 May 2019, the full Assembly voted to support the resolution by a vote of 56 in favor and 3 opposed with 15 abstentions. The composition of the Assembly is 54 Democrats and 26 Republicans, so at least two Republicans voted in favor.

TK: You still have a lot to do.

FvH: Yes, activists in the US are definitely engaged with the issue of climate change, which is an existential threat to the future of civilization. Many Democratic politicians have woken up to the threat to democracy from our growing economic inequality and now the disinformation being spread through social media. There is also widespread activism to defend from Republican attacks the progress in expanding healthcare coverage made during the Obama Administration. There is activism against the strategies Republicans are using to disqualify minority voters likely to vote for Democrats. So there are a lot of important issues that people in the United States are engaged with. Right now,

the danger of nuclear war is not one of them. As a result, very few representatives and senators know anything about the danger of nuclear war.

TK: Many of those who were in Congress during the 1980s have retired.

FvH: Yes, for example, the authors of the Hatfield-Exon-Mitchell 1991 amendment that ended US nuclear testing (see Part 4) are all gone. Senator Ted Kennedy, who, in the early 1980s led the fight for a Nuclear Weapons Freeze in the Senate (see Part 2), is gone.

TK: Former Senator Sam Nunn is alive and speaking out but retired from the Senate, as is former Senator John Kerry.

FvH: So we have to start again, educating the people and the Congress about the dangers from nuclear weapons and policies that could reduce those dangers.

And we can. With our colleagues in the Coalition for Peace Action, we've been working with key foreign-policy staffers of the three Democratic senators in New Jersey and Pennsylvania.

Our most important recent achievement was in September 2015, when we helped persuade two of these three senators not to vote against the JCPOA, the nuclear deal with Iran. The Republicans wanted to vote the JCPOA down in the Senate but they needed the votes of 60 out of 100 Senators to end the debate.

TK: Sixty?

FvH: Sixty, even though an ordinary majority would be 51of the 100 senators. The Senate has something called a "filibuster," whereby a group of senators can stop progress by speaking indefinitely. In order to stop a filibuster, you must have 60 votes. In the past, there were actual filibusters but these days, a vote is called to end debate and, if there are not 60 votes, the issue is dropped.

On the JCPOA, the most focused lobbying group was the American-Israel Public Affairs Committee. AIPAC was very much in the camp of Israel's Prime Minister Benjamin Netanyahu who wanted the US to go to war with Iran. I don't know if AIPAC wanted to go that far but they wanted to kill the JCPOA. They went to all the congressional offices and told stories about how the Iranians were cheating despite the fact that the International Atomic Energy Agency was telling the world that the Iranians were in compliance with the JCPOA.

Of the three Democrat senators from New Jersey and Pennsylvania, one, New Jersey Senator Robert Menendez, ended up voting against the deal. The two others, Senator Booker of New Jersey and Senator Casey of Pennsylvania, did not declare their positions until just before the vote. They both had influential supporters who were associated with AIPAC. But, in the end, we were able to convince them not to vote against the JCPOA. As a result, only fifty eight senators voted to end the filibuster, two short of the 60 needed, and the JCPOA survived. So we did have an important impact in this case. Of course, our victory was only temporary since President Trump took the United States out of the JCPOA in May 2018.

It is important for the nuclear arms control movement to have such impact in more states.

This is why I am so pleased that the American Physical Society has agreed to support our effort to get more physicists involved in promoting nuclear-weapons-risk-reduction efforts nationwide.

TK: Perhaps you can help revive activism on nuclear disarmament not only in the United States?

FvH: Yes. Stewart Prager, our leader in this project, has suggested that perhaps we could reach out to physics societies in other countries. We will do that with at least Germany. But, we have to start by seeing whether we can have an impact in the United States.

TK: There is one young physicist from Hiroshima University, Tadahiro Katsuta, who spent some time with your group in Princeton and is now teaching at the Meiji University School of Law. He might be interested.

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No potential conflict of interest was reported by the authors.

Notes on Contributors

Frank von Hippel is a Senior Research Physicist and Professor of Public and International Affairs emeritus at Princeton University's Program on Science and Global Security. He was a founding co-chair of the Program and of the International Panel on Fissile Materials. During 1993–94, he served as Assistant Director for National Security in the White House Office of Science and Technology Policy.

Tomoko Kurokawa works with Tokyo Broadcasting System (TBS), one of the major nationwide TV stations in Japan, since 1996. She is an experienced journalist in covering nuclear disarmament, non-proliferation and nuclear energy issues. She was a Visiting Scholar at Carnegie Endowment for International Peace (CEIP) from 2012 through 2013.

ORCID

Frank von Hippel http://orcid.org/0000-0002-7934-9584

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