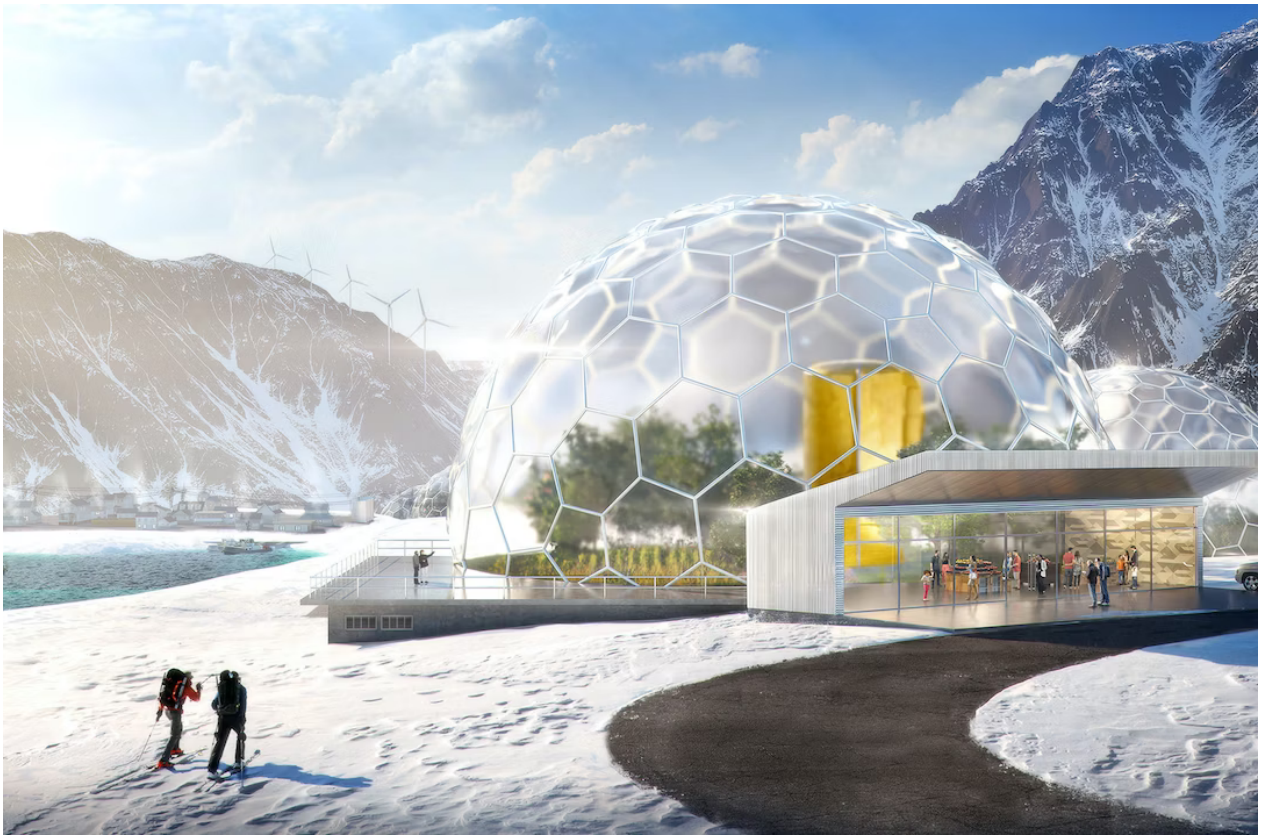
THIRD WAY

REPORT *Published July 24, 2018 • 13 minute read*

Redefining Nuclear Security in an Advanced Nuclear Age—Can the U.S. Regain Security Leadership?



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The United States is losing its leadership role in the global civilian nuclear marketplace. As a result, its influence on nuclear security is at risk even as US companies are developing a number of innovative reactors that could disrupt the entire nuclear market. Could these advanced reactors be America's ticket to reclaiming a portion of the lost market share? And if so, how can they also be used to strengthen global nuclear security?

Third Way reached out to over 25 experts across disciplines including academic researchers, reactor developers, security and technical experts from NGOs and national labs, and former policymakers to get their take on these issues. After a series of candid, off-the-record conversations, here's what we learned:

1. **More effective coordination between US industry and security leaders could accelerate advanced nuclear deployment;**
2. **Security considerations need to be "baked-in" to advanced reactors at the design phase;**
3. **US advanced reactors need to win on cost in order to impact security;**
4. **Internationally, the United States needs to engage the International Atomic Energy Agency (IAEA) to develop global security guidelines and best-practices for advanced reactors; and**
5. **Domestically, the United States must dedicate significant attention and resources to a long-term commercialization and deployment strategy for advanced nuclear technology.**

Before we get into each of these in detail, let's recap where the United States currently stands in the international nuclear pecking order and how this came to be.

Looking Back

Until about 25 years ago, the US was the world's dominant vendor for countries seeking to purchase a nuclear reactor and the only nuclear power plants available were variations on the large, light water reactors still in use today. [1] This benefitted American national security interests, because the United States could largely dictate which countries should have access to civilian nuclear technologies. If the US government deemed a country unready, untrustworthy, or too unstable, they would be crossed off the export target list. This dynamic led some US security experts and policymakers to adopt a tactic of blocking the sale of US commercial nuclear reactors to certain countries to prevent them from developing weapons capabilities. [2] This approach contributed to tension between the US security community and the US commercial nuclear sector, who wanted to sell more of their goods and services abroad.

Since 2000, the United States' share of the global civilian nuclear market has declined due to the combination of a shrinking domestic market that led American nuclear companies to shift to other technologies, the emergence of stiff competition from foreign civilian nuclear companies, and outdated federal policies. While America's nuclear sector stagnated, Russia, the Republic of Korea, France, and China were ramping-up indigenous nuclear technology and robust domestic supply chains to support new projects around the world. [3]

In this increasingly competitive environment, the US government is losing its ability to have a major say in whether or not a country gets to build a nuclear plant. Other countries have moved in and are filling the role of civilian nuclear vendors to the world—often with less concern about security and non-proliferation. Individual countries are responsible for establishing and enforcing their own security standards, but reactor vendors can have a significant influence on this process through both formal and informal channels. The United States still has influence on nuclear security norms and behavior through our participation in the International Atomic Energy Agency

(IAEA), the body tasked with safeguarding most nuclear facilities around the world. In the past, selling reactors abroad gave the United States a vital opportunity to provide security-focused regulatory guidance, workforce training, and operating experience to new nuclear countries, enhancing global security in the process. It's a common saying in the nuclear industry that the sale of a single reactor establishes a hundred-year partnership with the host country.

Advanced Reactors Can Revitalize U.S. Nuclear Security Influence

While the United States is struggling to compete in today's civil nuclear market, it could be on track to succeed in the future. There are dozens of American companies seeking to commercialize advanced reactors with unique features and potential cost savings that could disrupt the global nuclear market altogether. [4] But even in the advanced nuclear sphere, the United States is up against state-backed competition from China and Russia, both of which are hustling to enter this emerging market. [5] If the United States wants to reclaim global leadership in nuclear energy—and the economic and security benefits that come with it—swift and strong action is needed. Both the Obama and Trump Administrations, with bipartisan support in Congress, have acted to provide advanced nuclear innovators with more funding, technical resources, and leadership from the Department of Energy. The Nuclear Regulatory Commission is modernizing its processes in anticipation of licensing applications for new reactor designs.

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To maintain the United States' global leadership, however, advanced nuclear reactors should not only provide affordable, zero-carbon power; they should provide it in a way that builds upon the nuclear security architecture developed over the last five decades. That's why Third Way gathered some of the brightest minds in nuclear technology and global security to identify ways in which advanced reactor designs could raise the bar on nuclear security, and how these features could make US technology more competitive. The experts we engaged came up with a plethora of ideas that centered on five major themes:

1. Coalition Building

Both the security experts and the commercial nuclear sector leaders we spoke to acknowledged that in this new paradigm, it could be good for global nuclear security if the United States exports more nuclear reactors, including to countries that may not have deemed ready for a nuclear program by the standards used decades ago. This represents an evolution in thinking about how to manage nuclear security risks. It also signals an opportunity to foster better cooperation between industry and security experts—two communities that haven't always seen eye to eye. We were encouraged to find that many reactor developers have proactively thought about how to enhance the security characteristics of their reactor designs—and are reaching out to security experts at the US national labs and international organizations such as the World Institute for Nuclear Security (WINS) for guidance. Participants in our workshop agreed that formalizing such outreach and funding to reactor developers to engage security experts would be a strong step in the right direction. Several organizations represented at our workshop are already paving the way for cooperative technical and policy engagement across communities. In order to increase exports and influence around the world, the United States will need to effectively leverage the expertise of both groups and expand existing efforts to recapture the global market.

2. Advanced Reactor Security- and Safeguards-by-Design

Sensitive materials at nuclear facilities need to be protected, and countries developing nuclear power infrastructure must be prevented from nuclear weapons—these are the underlying motives behind nuclear security and safeguards. There is no silver bullet solution to these issues. Until advanced reactors are commercialized it will not necessarily be clear whether they are inherently more secure than conventional technologies. However, a variety of technology-specific solutions at the design phase could help US advanced reactors take the mantle as the most secure generation of nuclear plants on the market.

Developers have the opportunity to engineer-in much more elegant, and potentially less costly security solutions to reactors that are still in the design and development stages. Nuclear engineers refer to this as security-by-design (where developers incorporate protections against theft and sabotage into the architecture and engineering of the reactor) and safeguards-by-design (where developers incorporate design elements that enable easy monitoring and accounting of nuclear materials into their reactors). In the past, US vendors built reactors and then figured out how to address security concerns as they arose. This trend intensified in the wake of the September 11 attacks, as the US Nuclear Regulatory Commission and civilian nuclear industry upgraded facility security standards to protect against terrorist attacks. [6] Advanced reactors give civilian nuclear developers and security experts an opportunity to think holistically about how to integrate the most stringent and forward-thinking security features much earlier in the process.

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Many proliferation concerns can be addressed through deliberate collaboration between advanced nuclear developers and security experts at the design phase, rather than relying on the current practice of engagement only after construction. To illustrate, the United States typically doesn't want new nuclear countries to enrich their own uranium—security experts argue that building enrichment infrastructure is a first step to developing weapons-grade material. US companies can work with these security experts to create advanced reactors and fuel designs that eliminate the need for domestic enrichment and reprocessing in any target export country. Another design goal is to equip advanced nuclear facilities with novel fuel types and monitoring systems which can enhance the accounting of sensitive materials, deterring their theft or misplacement. Finally, the experts we spoke to emphasized the need to enhance the cybersecurity protocols used at advanced reactor facilities, which may rely extensively on remote operations and digital control systems.

Having a variety of advanced nuclear reactors with different security attributes could help the United States better connect the right buyer with the right technology for their specific needs, while still meeting high security standards.

3. Exceptional Security at a Competitive Cost

The large, light water reactors on the market today often require far too much up-front capital for emerging nuclear countries to afford, and they also generate more electricity from one power plant than the market needs. Small modular and advanced nuclear technologies' smaller scale and niche applications could make them more attractive and affordable to countries with little previous experience operating nuclear plants. This could also enable new US technologies to compete with Chinese or Russian designs that are less expensive due to state financing.

A number of the experts who participated in the workshop raised an important concern: even if US advanced reactors can reach the highest levels of security and safeguards-by-design, no country or utility is going to purchase them if they cost too much. This rings particularly true given that developing nations are one of the primary export targets for US advanced reactor companies.

The US government and nuclear industry should not repeat the mistake of assuming that American reactors are the only game in town when it comes to providing these new technologies to energy-

hungry nations. All indicators suggest there will be fierce international competition among exporters of small modular and advanced nuclear reactors. It's a tall order, but aligning costs and security to make US products competitive will be necessary to compete with other exporters like Russia and China.

Advanced reactor security and safeguards-by-design could have the potential to reduce the enormous costs that come with adding security and safeguard features in an ad-hoc manner—either during construction or after a reactor has begun commercial operation.

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One promising idea to emerge from group discussion in our workshop was that advanced reactor security and safeguards-by-design could have the potential to reduce the enormous costs that come with adding security and safeguard features in an ad-hoc manner—either during construction or after a reactor has begun commercial operation.

4. International Actions to Encourage Best Practices

One tricky aspect of incorporating security-by-design and safeguards-by-design is the uncertainty of how different nations' regulatory standards would apply to the various types of new reactors that are under development in the United States. This is critical information for developers if they are going to comply with best practices for integrating security features into their designs. The IAEA is in the early phases of adapting their safeguards protocols to new reactors and fuel cycles. [7] It may be possible for the Nuclear Energy Agency of the Organization for Economic Cooperation and Development to establish a parallel process to the current Multinational Design and Evaluation Program (MDEP) for advanced reactors. The MDEP brings nuclear regulators together to harmonize safety regulations, but it could also include discussion of security regulations and safeguards issues associated with advanced reactors. [8]

US companies face a disadvantage in the current IAEA process, as only government officials, and not private sector developers, can engage the international body in its formal safeguards and security processes. Technologists from countries with state-backed nuclear companies can work directly with IAEA in their capacity as government officials in this process, while US commercial developers from the private sector can only watch from the sidelines. [9] The US government needs to develop a smart engagement strategy to make sure that our technical experts in the federal government, national laboratory system, *and* commercial industry are involved in the process of

clarifying how safeguards methods and security guidelines will apply to US products in order to keep an equal footing with our competitors. Developers can work through an official IAEA partner organization, like the Nuclear Energy Institute, to gain access and participate in this forum to help shape IAEA technical guidance going forward. Additionally, the IAEA's International Project on Innovative Reactors and Fuel Cycles (INPRO) offers the opportunity for US advanced reactor designers to access the safeguards and security experts within the IAEA to review advanced designs and processes. [10]

5. Domestic Actions to Enable Advanced Reactor Developers

As expectations are clarified at the international level, there are steps the federal government can take through private-public partnerships to help developers incorporate these best practices in the most efficient and cost-effective way possible. To help facilitate this, our workshop participants suggested that the US Department of Energy's (DOE) Gateway for Accelerated Innovation in Nuclear could be expanded to include access to technical expertise on security- and safeguards-by-design through the national laboratories. DOE, as well as the other agencies involved with the export process of nuclear technologies, could continue work to prioritize approval processes and timelines for 123 Agreements, which provide the bilateral diplomatic framework for the US to engage in the sale of a commercial nuclear reactor and fuel materials. This might also require additional funding to meet expanded demand or shifts in priorities to accelerate the review process.

Federal support—through power purchasing agreements, siting on federal lands, or cost-sharing on NRC licensing reviews—could also help developers progress to constructing first-of-a-kind plants that will facilitate international sales. And federal support for US exports through the Export-Import Bank, the Overseas Private Investment Corporation, or the US Agency for International Development can help our reactors compete with state-backed designs from Russia and China. [11] If the mandate to export US small modular and advanced nuclear technologies were accepted by federal agencies as a global security and geopolitical imperative, not just another trade mission, their efforts could be improved substantially by allocating additional resources and adopting more ambitious timelines.

Conclusion

Advanced nuclear reactors could provide an opportunity for the United States to strengthen its leadership role in setting international nuclear security and nonproliferation norms and standards. Our initial workshop and investigation was encouraging—we found a diverse set of experts and organizations who agree that re-establishing this leadership is vital and are already doing their part to make this vision a reality. Third Way is committed to coordinating and redoubling these efforts by engaging a broader community about the security value of US advanced reactors, and advocating the approaches above to make US advanced nuclear technologies the most affordable and secure technologies available. This will require rethinking our national and international engagement strategies for getting these technologies to market. It will also require a new level of coordination

and cooperation across communities. If done correctly, the U.S. government and advanced nuclear developers could be in the position to enhance global nuclear security and safeguards as a new set of aspiring nuclear countries looks at deploying a new generation of nuclear reactors.

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ENDNOTES

1. Suzanne Baker, Ryan Fitzpatrick, and Matt Goldberg. "Getting Back in the Game: A Strategy to Boost American Nuclear Exports." *Third Way*, 10 Jan. 2017, https://www.thirdway.org/report/getting-back-in-the-game-a-strategy-to-boost-american-nuclear-exports. Accessed 20 July 2018.

2. Victor Gilinsky and Henry Sokolski. "Exporting power reactors: No way to fight proliferation." *Bulletin of the Atomic Scientists*, 16 Nov. 2017, https://thebulletin.org/2017/11/exporting-power-reactors-no-way-to-fight-proliferation/. Accessed 20 July 2018.

3. Alpern, Peter. "U.S. Cedes Capability for Largest Nuclear Forgings." *Forging Magazine*, 16 June 2009, http://www.forgingmagazine.com/feature/us-cedes-capability-largest-nuclear-forgings. Accessed 20 July 2018.

4. Todd Allen, Ryan Fitzpatrick, and John Milko. "Keeping up with the Advanced Nuclear Industry." *Third Way*, 8 Feb. 2018, https://www.thirdway.org/graphic/keeping-up-with-the-advanced-nuclear-industry. Accessed 20 July 2018.

5. Todd Allen and John Milko. "The Global Race for Advanced Nuclear." *Third Way*, 18 May 2017, https://www.thirdway.org/infographic/the-global-race-for-advanced-nuclear. Accessed 20 July 2018.

6. "Backgrounder on Nuclear Security." *United States Nuclear Regulatory Commission*, April 2014, https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/security-enhancements.html. Accessed 20 July 2018.

7. "International Safeguards in the Design of Nuclear Reactors." *International Atomic Energy Agency*, 2014, https://www-pub.iaea.org/books/iaeabooks/10710/International-Safeguards-in-the-Design-of-Nuclear-Reactors. Accessed 20 July 2018.

8. "Multinational Design Evaluation Program (MDEP)." *Nuclear Energy Agency*, 30 May 2018, https://www.oecd-nea.org/mdep/. Accessed 23 July 2018.

9. "Safeguards legal framework." *International Atomic Energy Agency*, 2018, https://www.iaea.org/topics/safeguards-legal-framework. Accessed 20 July 2018.

10. "About INPRO." *International Atomic Energy Agency*, 1 June 2016, https://www.iaea.org/INPRO/about.html. Accessed 23 July 2018.

11. "Federal Coordination." *Nuclear Energy Institute*, 2018, https://www.nei.org/advocacy/compete-globally/federal-coordination. Accessed 20 July 2018.