PGS Nuclear News and Views: Commentaries

2020 Edition

Index

Non-Proliferation and Next-Generation Nuclear Power (September 25, 2020)

The nuclear non-proliferation and security agendas seem intellectually immobile at a time when new challenges demand aggressive, non-traditional new thinking.

At the forefront of the new agenda is the increasing demonstration of climate change destructiveness at home and abroad and its intersection with the zero-carbon and steady electricity production attributes of next-generation nuclear power.

These issues need to be incorporated into a new, integrated policy envelope that balances traditional proliferation concerns with new climate realities resulting in enhanced global security.

The non-proliferation and security regimes were designed to manage the proliferation potential of traditional large nuclear plants and related facilities. These reactors are now at a 30-year low and their number is unlikely to rebound significantly.

The future increasingly looks to be smaller reactors and those with exotic fuel cycles. The next-gen advanced reactors are still largely at the beginning of their development process, but the proliferation and security agenda is becoming clear.

One of the most important non-proliferation red lines is uranium enrichment above 20% of the fissile isotope U-235. At the 20% level and above it is considered to be highly-enriched and at 90% enrichment and above it's considered nuclear weapon grade.

A number of advanced nuclear reactor designs require a fuel that is from 5-20% enrichment (likely much closer to 20%) called HALEU or high-assay low-enriched uranium. The higher enrichment allows for a smaller reactor design and lengthier fuel use, but it raises eyebrows in the non-proliferation bunker.

According to the U.S. Department of Energy (DoE), the next-gen nuclear industry may need "nearly 600 metric tonnes of HALEU by 2030." At the moment the U.S. does not produce HALEU, although it has a pilot project to demonstrate its production.

The non-proliferation and nuclear security concerns about HALEU are important and need to be assessed. But in the evolving global environment, these worries will need to be balanced against the necessity of achieving zero-carbon emissions in a few decades to stave off the worst impacts of climate change.

One example of the coming proliferation-climate tradeoff is embodied in the Natrium power production and storage system. This is a new partnership between Bill Gates' TerraPower and GE Hitachi Nuclear Energy (GEH). The system is designed to support the deployment of renewable energy by storing energy and then releasing it for electric power production when renewable energy flags and power demand picks up.

The reactor at the center of the concept would run on HALEU. The Natrium system would store energy in molten salt. This storage concept is similar to that employed by concentrated solar power, but in this design the power production from the reactor is continuous, not intermittent as with renewables.

The potential value of this concept recently was illustrated when California was whacked with the overlapping catastrophes of a record-breaking heat wave, massive fires, and extreme smoke cover. That reduced solar energy output and contributed to electricity blackouts in America's most populous and economically dynamic state.

It is not clear that California would welcome a proposal like Natrium, as it is on track to eliminate all existing nuclear power. But, in concept, it would reduce or eliminate the need for reliance on carbon producing natural gas as a backup to its renewable energy backbone. This hybrid renewable-nuclear solution also may have applicability for other countries, particularly those with developing economies, small electrical grids, and growing populations.

Of course, at the moment, advanced reactor systems are completely conceptual, and problems will arise. But DoE, supported by a rare bipartisan consensus in Congress, is pushing forward with an advanced reactor demonstration during the next decade.

Through that process, other brewing next-gen nuclear security controversies will emerge, including the potential reprocessing of spent fuel, deployment of small reactors in remote locations and dangerous regions, military use of microreactors, and the geopolitical value of nuclear exports. They will require new policy responses that will need to be generated by a multidisciplinary coalition, not a single issue silo.

It is now clear that continuing climate crises and nuclear proliferation concerns inevitably will cross over during the next decade.

The desperate demand for zero-carbon energy will drive the development and maturity of next-gen reactor technology. If proven operational, these reactors will require the intelligent modernization of existing nuclear security and non-proliferation guardrails. That is a process that can result in greater global security if the policy recognizes the demands of the climate-nuclear nexus.

The Perilous Convergence of Climate, China, and Continued Complacency (September 11, 2020)

The nexus of climate change, nuclear energy, and the global security challenge from China are rapidly converging issues that require a new policy playbook. Rather than confronting this reality, the world seems to be in a COVID-induced coma, relying on traditional issue stovepipes to develop responses that are blithely blind to the important intersection of these collective, critical concerns.

It is impossible to ignore the historic wildfires now ravaging America's West Coast, the unprecedented blanket of smoke they have produced, and the resulting negative impact on renewable energy generation. This smokey swathe has significantly reduced the generation capacity from California's solar farms which has fed rolling electricity blackouts and turned major cities dayglow orange. This dystopian sequence is occurring in a state that ranks as the equivalent of the world's fifth largest economy.

Denying that climate change is a contributor to this disaster or defending an over-reliance on renewable energy as the only clean energy answer are equally inexcusable responses to this tragic reality.

Still, resistance to the development of all zero-carbon power sources is persistent, particularly when it entails the potential contribution from nuclear power.

This bias endures despite the fact that a new Senate Democratic special committee report and a special subcommittee of the Commodity Futures Trading Commission (composed of financial, corporate, and non-governmental members) have reached extremely similar conclusions about the economic impact of climate change.

The Senate committee leads its report by starkly stating, "[t]he climate crisis threatens our lives and livelihoods." The CFTC group assesses that, "[c]limate change poses a major risk to the stability of the U.S. financial system and to its ability to sustain the American economy."

It is, therefore, difficult to fathom the financial concern that is the go-to argument from nuclear opponents when the stakes are so high and scale so skewed. At issue is sustaining and expanding over $20 trillion in U.S. GDP, currently the largest economy in the world, versus the hundreds of millions the U.S. is investing in next-generation nuclear technologies.

A nuclear subsidy may be considered a crime against the U.S. taxpayer by some, but the government underwrites a range of energy technologies. And the amount pales in comparison to the crime against humanity that would be the collapse of the U.S. and developing nation economies because of a continued climate battering. These new reactors can replace carbon producing fossil fuels and cleanly power developing nations, many of which have small, distributed electric grids and are facing unprecedented climate ravages.

In fact, the Senate special committee determined that, "[t]he clean energy transition in the electric sector will not proceed rapidly enough without the aid of substantial government investment" including for nuclear advancement.

This situation has geopolitical implications as well. America's main emerging rival, China, would like nothing more than to help hobble the U.S. economy, assume the global GDP crown, and dominate next generation technology. As a new book notes, China's leaders believe that for it "to win, America must lose."

The U.S.-China struggle also impacts global security and the future of nuclear proliferation.

A new analysis identifies that one of seven trends that will shape the future of proliferation is the declining "ability of the United States to use civil nuclear energy sales and assistance to advance nonproliferation objectives." That erosion impacts the "U.S. ability to write the rules of the game" and cedes important technological, energy, and geopolitical territory to China and Russia, "which provide nuclear assistance on more competitive terms – and with fewer nonproliferation strings attached."

Allowing Russia and China to write the 21st century's nuclear norms will be a monumental mistake because it could facilitate the creation of new nuclear weapons states. But it may be unavoidable if these nations are able to corner the next-gen nuclear market because the U.S. and its allies cannot produce and effectively market small nuclear power plants. The cost of this outcome will dwarf any government investment in the development and demonstration of the technology.

The convergence of climate change, China, and nuclear security presents a new force of nature. Responding to this nexus requires new thinking, expertise, and investment. But inertia is impeding the development of a new policy playbook, and if that continues much longer it will be extremely perilous.

Navigating the Zero-Carbon Crosswinds (August 21, 2020)

In another impressive and depressing feat for this plagued year, the most recent assessment of the state of the global climate notes that in 2019 the average carbon dioxide concentration at the earth's surface was the highest recorded by modern instruments. It exceeded levels found in ice cores dating back 800,000 years. This further intensifies the case for zero-carbon energy of all kinds, not only renewables.

The impacts of this carbon concentration are on display in California where just days ago the highest temperature ever recorded on earth was reached in Death Valley. At the same time, wildfires are once again raging across the state, and the world's 8th largest economy is experiencing rolling electricity blackouts as a result of a heat wave and inadequate power supplies.

Wind and solar farms now provide more than one-third of California's energy supply while battery storage for that power has lagged and the state has decreased its reliance on natural gas, large-scale nuclear power, and coal.

The reliance on renewable energy makes California a poster child for the energy transition that is necessary to achieve net zero-carbon emissions by 2050. But it also makes it the "the canary in the coalmine" according to the head of the Electric Power Supply Association.

The canary has stayed alive until now because California can still ramp-up its natural gas output and it imports power from other Western states. But in recent days the gas surge has fallen flat, and the heatwave drove up neighboring state electricity demand, leaving less for the Golden State.

However, a small part of the California electric grid is a participant in the Utah Municipal Power Systems (UAMPS) project to receive the electricity scheduled to be produced by the country's first small modular nuclear reactors. These units are being produced by NuScale Power and sited at Idaho National Laboratory.

If successful, this new power generation could open the pathway to the deployment of small reactors that can displace fossil fuels, particularly in smaller and distributed electric grids. But, the usual nuclear cost and schedule problems are already surfacing for the UAMPS project.

The question is whether the U.S. government will allow these difficulties to fester and fatally weigh down this initiative, and those lined up behind it, or whether it will prove it can meet the high-hurdle technical challenges of this century the way it did in the last one.

The stakes of failure are high, particularly for global security. Russia has already cornered the international large-reactor market. China is making inroads in that area. And both are eyeing the export market for their next generation of small nuclear power technologies.

Developing economy nations that face major population and electricity demand growth are a prime target for small nuclear reactor deployment. But most of them are newcomers to nuclear power and will require significant support to effectively integrate this technology into their energy systems. The U.S. and its allies are best positioned to provide this assistance because they prize strong safety, security, and nonproliferation standards.

But to uphold those norms, it is necessary to have a proven technology that can compete with Russian and Chinese reactors. Holding back American nuclear commerce can exacerbate proliferation and nuclear security concerns if the market is then dominated by its undemocratic geopolitical rivals.

The recent exposure of China's collaboration with Saudi Arabia on uranium mining is clear evidence of the current and likely future impacts of the continued weakness of America's nuclear export capacity. Saudi Arabia is actively pursuing both large scale and small modular reactors raising concerns from American lawmakers about the potential for weapons proliferation. But those same concerns are slowing U.S. nuclear cooperation with the kingdom. The congress will need to decide whether China or the U.S. is better positioned to restrain nascent Saudi nuclear weapon ambitions and over which nation's policy it can exert the most influence.

As the climate continues to warm and global electricity demand increases, it will become increasingly necessary to navigate the strong crosswinds emerging in the zero-carbon energy space. The global population will grow, energy demand in developing economies will increase, and the need for net zero-carbon by mid-century is well established. Cherry-picking preferred technologies is unsustainable. No zero-carbon contribution can be left off the table. This will inevitably become ground truth because this reality is already on graphic display in California.

Strategically Countering China's Global Nuclear Ambitions (August 7, 2020)

BY Ken Luongo and Paul Murphy

In an increasingly carbon-choked world, a global nuclear power groundswell seems to be surfacing. The civil nuclear future will be providing smaller and non-traditional nuclear power plants to developing economy nations, remote settlements, and industrial operations including desalination and hydrogen production. The question is how this next-gen nuclear wave will play out and whether China will dominate it.

A recent spate of speeches and articles have augured the beginnings of a new U.S.-China Cold War. This conflict is not a certainty, and if it develops, it will not mimic the classic Soviet-American competition. It will be much less about ideology and much more about global technological superiority, competitiveness, and influence.

How the nuclear energy landscape of the latter half of the 21st Century evolves is a significant concern. The future of clean energy is a central global economic, energy, environmental, diplomatic, and security issue.

At the moment, the U.S. arguably has the technical edge in next-generation nuclear, but that may not last if it is not carefully nurtured and accelerated through policy innovations that emphasize both technology promotion and effective project delivery. China's reactor development is state financed, its exports state supported, and the Belt and Road Initiative (BRI) its market conveyor. Made in China 2025 is a state-led blueprint for elevating China to the top of the world's high-tech pyramid. Under this framework, its High-Temperature Gas Reactor (HTGR) at Shidao Bay is advancing, and China has invested heavily in molten salt technology, which also has military applications.

China's global nuclear ambitions can be countered. Romania's recent elimination of the China General Nuclear Power Corporation (CGN) from its Cernavoda reactor competition is a prime example. But the strategy of the future must be global, holistic, and persistent.

An effective strategy to counter China's 21st Century nuclear ambitions would have 5 components: (1) integrate essential partners; (2) provide competitive financing and project delivery solutions; (3) target key markets and provide early stage support to newcomer nations; (4) ensure the highest project standards; and (5) maintain strong nuclear safety, security, and safeguards.

There is demonstrated, deep bipartisan support in the U.S. for next generation nuclear power. The Executive Branch and the Congress have provided a stream of legislation and funding. But, despite this commitment, the scale of the financial support from the government for meaningful project development is relatively small and the deployment strategy not well defined. There also are disconnects between government agencies and with (and within) the next-gen nuclear industry. Bridging these gaps is essential and would force the focus to be on results, not just research, and that is the only way to win the future nuclear competition.

Expanding partnership internationally also is essential. The U.S. can't go it alone. The atrophy within its nuclear industry supply chain necessitates collaboration with allies. And these allies have woken up to China's metastasizing challenges. Canada, Australia, the U.K., and the European Union have all taken tougher stances against China's missteps and aggressiveness, including its political crackdown on Hong Kong, military activities in the South China Sea, treatment of minority groups within China, deception on COVID-19, coercive diplomacy, trade threats, and intellectual property theft. America should take advantage of this reversal of fortune to recraft its alliances to ensure they effectively respond to China's nuclear strategies.

While the necessity of creating stronger international and private sector partnerships is clear, there are two potential showstoppers on the path to checking China's future nuclear power dominance – financing and future market cultivation.

Democratic nations and private sector companies are at an extreme disadvantage when facing state financing from China. Recently the U.S. has taken steps to enhance its nuclear export financing capability. The U.S. International Development Finance Corporation removed a nuclear power financing prohibition and the U.S. Export-Import Bank created the Program on China and Transformational Exports.

If deployed rapidly, creatively, and robustly, these tools will strengthen the U.S. ability to compete with Chinese financing offerings. But they may not be enough to overcome China's sovereign investment strength. America and its allies need a comprehensive private sector and government financing mechanism that covers multiple phases of a project's lifecycle, from early-stage programmatic support with hands-on training based on experiential knowledge through project delivery and operation.

This type of financial strategy also would support the cultivation of target markets for next-gen reactors. Foundations need to be laid far in advance of the technology selection with

countries considering small modular and advanced reactors. The deployment of the first of these new reactors will arrive inside of 10 years. America and its allies need to aggressively take advantage of this decade to cultivate clients because China will be unrelenting in leveraging its advantages to establish dependent relationships with these nations.

The core of this future nuclear market is developing economy nations that require smaller scale, distributed electricity. Because they mostly are nuclear newcomer nations, they will require enhanced support to ensure that the technology is operated responsibly. This includes "how to" training and direct advisory support. The ability to offer this comprehensive training and to support high levels of safety, safeguards, and security is a strategic advantage possessed by the U.S. and its allies.

In responding effectively to China's competitive nuclear advantages, the U.S. needs a comprehensive, calculated, and integrated strategy that promotes its interests, values, partnerships, and global stability. The consequences of the failure to act strategically, globally, and successfully to counter China's nuclear ambitions could be a century dominated by China-exported and controlled civil nuclear technology. This will create global security dangers and exacerbate geopolitical disadvantages.

The China challenge has been raised in high relief in recent months, but the integrated strategy for countering it is lagging. If that lasts for much longer, the opportunity to provide an effective counterweight may be lost.

Ken Luongo, President, Partnership for Global Security
Paul Murphy, Managing Director, Murphy Energy and Infrastructure Consulting, LLC

Politics of Next-Gen Nuclear Energy Respond to New Realities (July 24, 2020)

This year has been a cold slap in the face to business-as-usual. But, apparently, it has not been enough to jolt us from our pre-COVID cocoons of complacency. That may be changing, as the responses to important, but siloed, issues begin to intersect to form an effective solution set.

Reigning in global carbon emissions remains a critical, stubborn global challenge. Because of the economic impact of the novel corona virus, emissions are projected to be 7% less in 2020 than in 2019. But that trend is already being reversed as global industry gears up and high level calls for a "green" restart go unheeded. The result, as identified in an interesting new analysis , is that over the next 50 years, the earth's barely livable hot zone could expand from 1% to 19% of its surface. This zone would include some of the world's most populous, poverty stricken, and precarious nations.

An excellent new article on climate strategy notes that the fixation on a transformative climate revolution is undercutting the practical but impactful actions that can be taken within the current confines of national and international politics.

One element of the strategy is the "big role" that nuclear power could play in reducing global electric power emissions. But, the article underscores that this will require new technologies that can bring down the high costs of nuclear energy. And that will require significantly more investment and sustained political support.

Interestingly, in the sad circus that now passes for American policymaking, a strong bipartisan consensus has solidified on the need for the next generation of nuclear power.

This foundation has been built on bipartisan legislation that has sought to modernize the regulatory structure of advanced reactors, spur on accelerated demonstration of the technologies, and provide funding for eventual export.

The change in export support is fairly radical, as a new agency created by the Congress, the International Development Finance Corporation (IDFC), has removed a legacy prohibition on financially supporting nuclear projects.

But, even the IDFC's announcement of the potential policy change, which made specific reference to the role advanced reactors could play in emerging markets and its value for carbon reduction, nonproliferation standards, and U.S. global influence, generated a rattled response about the security dangers of changing the nuclear status quo.

The issue of maintaining strong nonproliferation standards is absolutely critical to global security and the future of nuclear power. Despite its current state of disorder, the U.S., and its allies, are better equipped to lead that fight than Russia or China, which very effectively use state financing to export their reactors and undermine U.S. nonproliferation values.

But you can't win a fight if you are not in the ring, and this is something that both sides of the political aisle in America now grasp.

While the country is being wracked by partisanship in a presidential election year, both the Democrats-only House Select Committee on the Climate Crisis and the presumptive Democratic party presidential nominee have expressed support for advanced nuclear technologies. In addition, a new organization , formed by a group of politically progressive women , promises fresh approaches to working with the climate advocacy community to foster better understanding of the role of next-gen nuclear.

These progressive positions are not in conflict with the current administration which recently released a new U.S. nuclear export strategy and is aggressively pursuing next-gen reactor technologies to support evolving defense objectives and other national goals.

Beyond the U.S., the Liberal Party government of Canada continues its aggressive work on Small Modular Reactors (SMRs) including developing an SMR Action Plan that follows its 2018 SMR Roadmap. Further, Canada's Natural Resources Minister recently stated , "I've said it before, and I'll say it again: there is no way of achieving our goal of net-zero emissions by 2050 without nuclear energy." This reference encompassed all nuclear technologies including the next generation.

This cross-party political support will make it difficult to drive a political wedge that excludes next-gen nuclear from being part of the global climate and clean energy solution set. And, surprisingly, the political mainstream seems to be ahead of the majority of the non-governmental community on the nexus of these issues.

Too often the environmental and nuclear nonproliferation communities close out important global concerns that do not fit neatly into their traditional issue scope. But the intensifying intersection of new global realities is making it clear that the business-as-usual issue silos

cannot thrive or ultimately survive in this new environment. Creative cross-sector thinking is beginning to seep to the surface. It's value certainly will become contagious.

Pulling the Pieces Together for the Next-Gen Nuclear Market (July 10, 2020)

If there is one thing that has become crystal clear in this calamitous year, it is that lack of preparation is a killer. That is true for the novel coronavirus and it will be true for marketing next-generation nuclear technologies unless a comprehensive global preparation plan is rapidly developed.

Next-gen nuclear has been one of the few issues benefitting from bipartisan support in the thoroughly shattered U.S. political landscape. The Congress has rhetorically and financially supported technology development and demonstration on an accelerated schedule. The Department of Energy (DoE) has responded with the Advanced Reactor Demonstration Program (ARDP) that aims to build two operational reactors in 5-7 years. DoE has identified three driving forces for this push – security, the environment, and market opportunities.

While the focus on technology development and demonstration is essential, it is insufficient. Even the best technology will face serious headwinds if the global market is not prepared to use it.

A case in point is the new report from the House of Representatives Select Committee on the Climate Crisis. The document expresses its support for the zero-carbon electricity generation by existing nuclear reactors, noting that it makes up "more than half of all zero-carbon electricity" in the country.

It also identifies next-generation nuclear technologies as a "promising" source of future carbon-free energy. It further highlighted the potential for a long-term power purchase agreement from next-gen reactors by federal agencies, particularly those with national security responsibilities.

But the committee raises two key concerns about the emerging technologies – safety (including cyber security) and the potential for nuclear weapons proliferation. Both of these issues will be high on the list of any country, community, or commercial industry investigating whether these small reactors are applicable for their needs. So, they need to be thoroughly addressed.

The Global Nexus Initiative (GNI) , is the leading entity examining the intersection of nuclear power, climate change, and global security – the very intersection on which the Congress

and executive branch are now both focused. Last Summer, GNI produced the first comprehensive public analysis of the nuclear proliferation, security, and geopolitical implications of advanced reactors. There clearly is more detailed follow-up work to be done from that publication's initial findings and that is being explored both inside and outside of government.

But there are a number of other activities that are required to prepare both the domestic and international markets for next-gen technologies. Many of these focus on the intellectual, industrial, financial, and legal readiness of newcomer nuclear nations to deploy advanced nuclear technologies.

The International Atomic Energy Agency has a comprehensive Milestones Approach designed to guide nations through the nuclear power development process. It identifies 19 important issues, but they currently are scaled for the deployment of large Light-Water Reactors (LWRs), not smaller next-gen technologies. These future reactors may mitigate some of those key issues and require more attention to others. But the adaptation of the Milestones is not well advanced and the process for achieving its evolution is currently undefined.

Any new nuclear nation will need a deep and expansive support system to ensure adequate project finance capability, risk assessment, educational and training capacity, industrial infrastructure, and legal, regulatory and governance competence.

These issues plus nuclear security and nonproliferation need to be woven into a comprehensive strategy in the near term so that the global community can become familiar and comfortable with the technology evolution that is coming over the next 10-15 years.

The next-gen nuclear wave is breaking onto a very different global landscape. The market is going to demand low carbon and high security. Preparing for these dual demands now by creating an integrated, effective market strategy is the smart way to proceed.

Clawing Back Nuclear Markets Requires More Than Rhetoric (June 26, 2020)

The U.S. is talking a good game about the global security importance of wresting the international nuclear market back from the clutches of authoritarian governments. But, despite the uptick in government prioritization, there is not yet a comprehensive and effective strategy for achieving that goal within a realistic window of opportunity.

The global nuclear turf fight is with two of the world's most ruthless regimes, Russia and China, both of which present significant challenges to U.S. global influence and power. Russia already controls much of the world's large reactor exports with $133 billion in foreign orders. China is establishing a beachhead for its technology in the U.K. and is currently constructing 4 reactors abroad.

As a recent U.S. government report noted, "the United States is entirely absent from [the] global new build nuclear reactor market with no foreign orders." That market is estimated at $500-740 billion over the next 10 years.

This absence may be mitigated, as the U.S. is negotiating with Poland and Romania on new large reactors, is still in the running for the perpetually postposed reactor tender of Saudi Arabia, and could pick up the pieces if China makes good on its threat to withdraw from a U.K. nuclear project.

But the future for large reactors is shrinking and the next phase of the nuclear export game is competition over smaller next-generation technologies. This market represents a clean slate for U.S. technologies, competitiveness, and principles. But, achieving control or significant influence in that market will require careful and comprehensive preparation now because reactors could be ready for deployment in a decade. Already, Russia has deployed a floating reactor and China is progressing on its high temperature gas-cooled pebble bed reactor. They will not relent in the fight for future global markets.

It is in the face of this persistent competition that U.S. strategy is showing its fissures. A recent webinar and other discussions have identified several key gaps.

There is no doubt about the dedication of America's energy and security agencies to the mission of resurrecting the nation's nuclear competitiveness. There is much more activity now than in the past, and government experts are tackling difficult structural problems.

However, two concerns have been identified. One is the need for a more effective weaving of agency activities in a comprehensive "whole of government" plan. The second is that the analytical and diplomatic foundation for the case against Russian and Chinese nuclear technology, and the responsive actions , are weak relative to the rising rhetoric about the danger.

Beyond government, the nascent next-gen reactor industry is fragmented, underfunded, and fiercely competitive. Without a clear strategy supporting deployment, it is focused on developing numerous technologies, hurdling the regulatory process, and identifying sustainable sources of High Assay Low Enriched Uranium (HALEU) fuel. With those concerns paramount, the industry has less bandwidth to worry about the international requirements and landscape into which its technologies may be deployed. Building that awareness, capacity, and market cultivation is critical but not yet a high U.S. priority.

However, developing an international strategy that prepares the global market for novel nuclear technologies is an essential linchpin in the pivot to market control.

The nation's most likely to be interested in these technologies will have small electrical grids, growing populations, and climate change challenges. Small reactor developers are looking for a larger market than traditional providers because the deployments will be distributed and the price per unit is projected to be lower.

The target nations also are nurturing developing economies and wrestling with effective governance. But as the pressure for clean, distributed energy increases, many of them are questioning the need for decades of preparation before obtaining their first reactor.

This situation mandates creative new thinking about public-private responsibilities, policies, and financing. Exporting nations and vendors are likely going to have to take more responsibility and provide more assistance to newcomer nuclear nations than was the case with previous generations of nuclear technologies. Financing probably will require deeper government involvement and risk mitigation. These evolutions need to be integrated into a sustainable cultivation and support strategy for purchaser nations that can pave the way for safe and secure deployment.

The international strategy also needs to include allied partners that can support both diplomacy and technology. The U.S. nuclear industry by its government's own assessment is in a weakened condition. Even small reactors that are advancing toward demonstration require foreign technology partners . And as the U.S.-China competition intensifies, and Europe and Canada grow increasingly irritated with China's arrogance, these allied

nations collectively will need to present a more unified front in favor of democratic principles, including strong nuclear governance.

The U.S. has made an important decision to reverse the erosion of its position in the international nuclear market for valid international security, geopolitical, and economic reasons. It may yet secure a few new large reactor sales, but the real game is in exerting strong control over the next generation reactor market. That window of opportunity is open now, but it will close quickly over the course of the next decade. To strengthen and hold its position for the future, the U.S. needs an effective, comprehensive strategy now. There is a lot of important activity at the moment but still plenty of disconnects that can short-circuit success.

U.K. Offers an Opportunity to Heal U.S.-Korea Nuclear Rift (June 16, 2020)

For about the last 18 months the U.S. and South Korea have been engaged in a highly unproductive freeze on their civil nuclear cooperation. But the recent threat by China to pull out of a nuclear deal in the U.K. because Prime Minister, Boris Johnson, is reconsidering Huawei's 5G communications network, presents an opportunity to heal the split and create a powerful partnership that can counterbalance Russia's and China's nuclear export ambitions.

This fight between close allies has its origins in the competition over the reactor tender put forward by Saudi Arabia. Both nations, along with France, Russia, and China, are in the running. The essence of the battle is over the U.S. content in the ROK reactor, the APR-1400+, which is based on a Westinghouse design. Korean executives contend this design is now completely indigenized with their technical content. Westinghouse and the U.S. government disagree. What began as a technical dispute has now hardened into a political standoff.

The truth is that the Saudi's are not going to move forward with their reactor tender until after the November U.S. election and even then, with oil prices in a COVID-fueled decline, they may decide to delay any decision much further. So, the root of the conflict has become a competition over a currently nonexistent business opportunity.

The reality is that the U.S. and Korea need one another as partners in the new civil nuclear landscape. While they are fighting, Russia has locked up new reactor deals in Egypt, Turkey, Hungary, and Belarus. And China is angling to assert its dominance in the future nuclear market.

The U.K.-China nuclear deal is an important opportunity for China General Nuclear (CGN) to build and operate its indigenous reactor, the Hualong One, in an OECD nation with a strong, independent nuclear regulatory authority. Success would strengthen China's ability to compete for large reactor sales in other nations. Both Russia and China could then effectively box out South Korea and the U.S. by wielding the state-financing weapon that underwrites their attractive nuclear package deals.

The U.S. has been warning the U.K. for several years about the political and security dangers of a long-term lock-up with China on nuclear power and other sensitive technologies.

Recently, U.S. officials ratcheted their concern about China having control over more than a quarter of Britain's electric supply, a message that has resonated with some U.K. officials.

In a remarkable statement this week, U.S. Secretary of State, Michael Pompeo, pledged that the U.S. is prepared to assist Britain in building nuclear power plants in response to China's "coercive bullying tactics." That was followed by a declaration from the U.S. International Development Finance Corporation (DFC) that it plans to allow financing for nuclear projects, a reversal of a ban applied by its predecessor organization, the Overseas Private Investment Corporation (OPIC). DFC explained its shift by citing the importance of zero emission energy, U.S. nonproliferation standards, and the need to offer "an alternative to the financing of authoritarian regimes."

But can the U.S. build these reactors alone? As the new report of the U.S. Nuclear Fuels Working Group (NFWG) has stated, "America has lost its competitive global position as the world leader in nuclear energy." Proposals for nuclear reactor co-financing are being surfaced.

The U.S. has been successful in helping push China out of a nuclear deal with Romania, and signed a nuclear cooperation Memorandum of Understanding (MOU) with that nation last Fall. Discussions on the potential construction of new U.S. reactors have been incrementally progressing, as they have been with another MOU partner, Poland . But this is occurring against the background of the struggle to complete construction of two reactors at Plant Vogtle in the state of Georgia, the first new builds in the U.S. in decades.

It is not clear that the U.S. has the muscle memory, workforce depth, and hot supply chains that would allow it to build several new reactors, likely the Westinghouse AP-1000, at home and abroad simultaneously without a strategic partnership. The most suitable partner is South Korea which has capabilities that complement U.S. strengths in the nuclear power field.

The Koreans are successfully constructing, on budget and roughly on schedule, four reactors in the United Arab Emirates (UAE). The process has not been flawless and there have been delays in certifying the first reactor for operation. But Korean industry has proven that it can successfully perform reactor construction, which has been a challenge for U.S. firms, and its supply chains are operating. The problem for Korea is that since the UAE deal a decade ago, it has not inked another major export agreement. Some of its major companies are suffering financially as a result.

The U.S. government has made the decision to reenter the international nuclear market and it is taking steps to strengthen its positioning. But decades of weak sales have impacted its readiness. The Korean government has made clear that it has a decreasing interest in domestic nuclear energy but supports its export. The strengths of each nation complement one another.

It makes little sense to sustain a conflict over a winner-take-all strategy for a shrinking number of large reactors sales. What makes more sense is to put the U.S.-Korea tension over the delayed Saudi bid on the back burner and look at the U.K. as a new opportunity for strategic partnership. That would address a number of the economic, clean energy, and geopolitical challenges that both nations face as well as giving a boost to global security.

A 5G Strategy for Next-Generation Nuclear Energy (May 29, 2020)

In March, the White House released a national strategy to secure fifth generation wireless technology, noting that it is essential to future security and prosperity. One of its four key pillars was "promoting responsible global development of 5G infrastructure" based on a set of guidelines developed multilaterally in Prague in 2019. This approach should be replicated in guiding the future of next-generation nuclear technologies.

The Prague standards were driven by concerns about China's major technology supplier, Huawei Technologies, the world's leading telecom provider, and its alarming relationship with Chinese government institutions.

There should be healthy concern about authoritarian government-provided high technology because in the current geopolitical environment it rarely is provided without strings attached or exploitable vulnerabilities. For example, a 2017 intelligence law asserts that Chinese organizations and citizens "shall" cooperate with national intelligence authorities.

Interestingly, the U.S. government has determined that it is necessary to work with like-minded countries to lead the "responsible" international deployment of 5G technology. This is a break with the withdrawal doctrine that has become attached to recent U.S. foreign policy.

One form that this engagement has taken is a bilateral U.S.-Poland agreement on 5G cooperation based on the Prague guidelines. The plan is to expand these agreements to other nations, particularly in Europe, where Huawei technology is under consideration.

There are several interesting aspects of this telecom diplomatic strategy that are applicable to the global competition over the deployment of next-generation nuclear energy technologies.

It is already well established that Russia and China are going to be significant competitors in the next-generation technology market. The U.S. has been active in discouraging countries from making nuclear deals with both nations by working to build "coalitions of caution." This is very consistent with its 5G strategy.

Also, the State Department has developed new approaches to civil nuclear cooperation that use non-binding Nuclear Cooperation Memoranda of Understanding (NCMOU). These agreements have been signed with Romania and Poland . They are being used to compete with the multiple nuclear MOUs signed with Russia and China around the world and are a tool for strengthening U.S. bilateral ties with key nations. Ultimately they may lead to the negotiation of formal bilateral agreements for nuclear cooperation. This approach also is similar to the 5G strategy.

But unlike its 5G strategy, the U.S. has not rallied its major allies in the civil nuclear space in a similar manner to the Prague approach. That method brought together 32 countries and resulted in a series of clear proposals for the future on policy, technology, the economy, and security.

A similar set of non-binding guidelines and principles for next-gen nuclear could and should be developed among " like-minded " nations. This could result in an evolved competitive model that provides an effective alternative to the state-backed packages of Russia and China, which offer project financing, operation, and waste management solutions. The strings attached to these sweetheart deals can be very toxic and the international community could decide which model provides the greatest long-term benefit and security.

A Prague approach for next-gen nuclear would need to move beyond OECD supplier nations to include the developing economy countries that are the likely markets for smaller reactors. Those nations mostly have limited experience in nuclear operation and oversight. This will require that exporting nations and industries offer deeper support for the development of effective hard and soft nuclear infrastructure. These efforts can be outlined in a new set of Prague-type principles and designed to be synergistic with the activities of the International Atomic Energy Agency (IAEA).

The emphasis placed on ensuring openness, transparency, and good governance in the deployment of 5G technologies is warranted because 5G will impact virtually every sector the global economy and the lives of every individual. But those same core principles also are applicable to the expansion of nuclear power.

Global security and prosperity will be strengthened by taking a Prague approach to building a responsible strategic framework for the next generation of nuclear energy. Avoiding it could strengthen the marketability of authoritarian government next-gen reactors and weaken the governance structure that is necessary for them.

The Necessity of Expanding the Nuclear Security Ecosystem (May 15, 2020)

The widespread wreckage created by the novel coronavirus offers an opportunity to rethink the status, trajectory, and responses to many global security issues. But, the future of nuclear security is particularly vital. In order to be relevant to the real world, the nuclear security silo needs to be connected to the larger ecosystem of global challenges.

The nuclear weapon and material guardrail systems are highly specialized and were created during and after the Cold War to manage nuclear weapons expansion and proliferation. They expanded after 9/11 to meet new challenges, particularly nuclear terrorism. Now these systems are under increasing pressure from a world in disarray and beginning to unspool .

There are a number of reasons for this, but it is difficult to ignore that the issue set is isolated and increasingly out of synch with how the world and its challenges are evolving. Unfortunately, the creation of modernized, multifaceted nuclear policy mechanisms, more suited for today's realities, is badly lagging.

One reason is a lack of adequate financing to support a creative, coordinated, and vibrant future-focused nuclear policy community. The scale of global philanthropic resources devoted to innovative nuclear weapons and security policy is less than $50 million per year. This creates an adversarial competition for limited resources and undercuts the need for effective community-building and collaboration. It also creates a constricted professional environment that creates barriers to entry and limits the advancement of young professionals, who are the lifeblood of the future.

By contrast, Amazon founder, Jeff Bezos, recently pledged $10 billion to fight the threat posed by climate change, an issue that already is well funded by philanthropies.

This mismatched scale of resources is dramatic, given that both issues pose existential threats to humanity. But it also reflects some realities. The public expects governments to effectively manage nuclear challenges, which they have, despite a number of close calls . They don't have a deep appreciation for the work or influence of nuclear experts outside the government. Much of this work is done behind the scenes by performing analysis, deciphering satellite images, engaging government officials, reading murky tea leaves to ascertain official nuclear policies and priorities, and analyzing technical ephemera.

By contrast, public and media interest in protecting the planet from climate change has grown in intensity, in part because it has political and celebrity leaders, and the mechanisms for addressing the concerns are tangible technologies, not paper policies.

But there is a significant crossover between the nuclear and climate issues that largely is being ignored. International security is now a complex confluence of military, diplomatic, environmental, technology, and economic issues. For example, developing economy nations, like China and India, are driving global carbon emissions, are nuclear armed, and have aggressive nuclear power plants. They and other developing nations must contend with growing populations, inconsistent access to electricity, and spiraling water and food crises. This is a package of interrelated issues to which nations increasing are seeking more than single issue answers and policies.

There is a clear nexus between the global climate and nuclear challenges of this century. But the pairing is non-traditional and alien to many. However, continuing a constrained scope of nuclear security very well may imperil the future of its policy community. The international environment continues to churn in unpredictable ways and adaptation is essential for survival.

Building a Better Nuclear Security Coalition Post-COVID19 (May 1, 2020)

The devastating blow from the novel coronavirus has upended many assumptions about global safety, security and preparedness. That disruption opens the opportunity for rethinking how the international community should plan for the mounting transnational challenges of the future, including ensuring global nuclear security.

A new report from the U.S. energy department is remarkably frank in its assessment that "America is losing its competitive global position as the world leader in nuclear energy and technology to state-owned enterprises." The main challenges are coming from Russia and China, with Russia astonishingly having morphed from Chernobyl to the global nuclear contractor of choice in a few decades.

The assessment of the Nuclear Fuels Working Group (NFWG) has several key recommendations. But two that stand out are the need to take a "whole-of-government" approach to supporting civil nuclear exports and strengthening U.S. leadership on next-gen nuclear technologies. These issues are intimately related, because it is unlikely that the U.S. can lead on next-gen reactors without a modernization of its past export approaches.

The offerings of the state-financed nuclear enterprises of other nations are very enticing, particularly to newcomer nuclear nations, because they provide a one-stop shop for the financing, construction, operation, and waste solutions that are at the heart of nuclear power's enduring challenges.

Equally important, and perhaps surprisingly, the DoE strategy document makes clear its view that the future of nuclear safety, security, and nonproliferation depends on, "a robust civil nuclear energy industry and technology leadership position" for the United States. In fact, the document asserts that the U.S. will "move into markets" now dominated by Russia and China and bring with it "strong non-proliferation standards."

This is a dramatic shift in emphasis on the nuclear energy export issue. While civil nuclear power and non-proliferation always have been inextricably linked, past generations of nuclear power export have relegated nuclear security issues to a separate, and some might suggest, second tier policy concern. This has raised hackles with nuclear non-proliferation professionals and helped to stoke animosity between that community and the nuclear industry.

Now the opportunity is being offered to bridge that nuclear security-commerce gap. But it is unclear if past combatants are willing to accept the offer to work together. The Global Nexus Initiative (GNI) pioneered this nuclear power-global security bridge building beginning five years ago. Its record of success underscores that there are significant areas of common concern and the need for cooperation between the nuclear industry and nuclear security communities. But there is a residual reluctance to embrace the value, and necessity, of this collaboration.

The problem with rejecting the opportunity to collectively build a strong nuclear security and non-proliferation system for next-gen reactors is that it is constructed on the outdated premise that the U.S. controls future nuclear developments. It does not, as the NFWG and reams of additional evidence have made clear.

The current gigawatt-sized nuclear market is largely Russia's. The next-gen market could be theirs and China's if there is not a strong U.S. counterweight. If the authoritarian governments corner this market, then the influence of the American and allied nation nuclear security policy community will be significantly diminished. And the balance of power inside international institutions like the International Atomic Energy Agency (IAEA) could shift toward undemocratic nations for the long-term.

So, in thinking about how the world is really evolving, rather than holding-on to how it once was organized, nuclear stakeholders need to come to grips with what really needs to be achieved over the long term and how that can best be done.

It is highly unlikely that the good governance nuclear policy community is going to stop Russia or China from developing and deploying small reactors, including providing them to small electrical grid nations in dangerous neighborhoods, without a competing product, effective marketing, and stronger security standards from America and its allies. You cannot fight something with nothing and expect to win.

Also, against the backdrop of the most polarized U.S. political environment in memory, next-gen reactors have generated bipartisan support. So, it is going to be difficult to hammer a wedge between Democrats and Republicans on the issue to gain political leverage.

Further, the need for carbon-free energy is not going to diminish with time and next-gen technologies can make contributions to that goal, particularly in smaller economy nations or if deployed at large scale. The impact of climate change on agriculture and water availability

is going to create new international conflicts and the Department of Defense (DoD) is looking to small reactors to power their future operations, creating additional nuclear policy complexities.

This is not the Cold War landscape or the post-9/11 environment. It is a new *World in Disarray* , and COVID-19 has proven that we are largely unprepared for it. While some things like novel coronaviruses can unexpectedly emerge, the future trajectory of nuclear energy is very clear. It includes small reactors, novel fuel cycles, and non-traditional deployment schemes for which current international safeguards and security guidelines are not well suited.

So, we can be caught unprepared for what we know is coming by doubling down on old battle lines or we can seize the opportunity to work together. The best bet is to build a new, multi-disciplinary, collaborative nuclear security coalition that is focused on creating the secure nuclear future that will address the real needs created by a challenging and increasingly unfriendly international environment.

COVID-19 Lessons for Next-Gen Nuclear Governance (April 16, 2020)

As the novel coronavirus rips across the global landscape, it would seem to have little connection to the governance regime required for the rapidly developing next generation of nuclear energy. But there are three essential connections – transparency, trust, and international cooperation.

A predisposition for opacity and a weak bond of trust are at the root of many persistent public fears about nuclear power. But there is the opportunity to effectively address and possibly ameliorate these issues as next-gen technologies move from development to deployment. To achieve that, the framework for the governance of these technologies needs to be developed early, be demonstrably effective, and generate strong support from responsible nuclear nations. Missing the opportunity to build this policy framework now will open the door to future problems and bad policy.

The leadership and degree of international cooperation, or competition, in the development of this nuclear governance framework is particularly important.

Small modular and advanced reactors (SM&ARs) are being pursued by a number of countries, including democratic allies like the U.S., Canada, U.K., and South Korea. They are facing off against the authoritarian governments of Russia and China. All developers are racing to move their designs to deployment while also trying to lock up future export markets.

An important target market of these reactors is decentralized, small grid, developing economy nations. For example, in Africa alone, one-third of the continent's nations are considering nuclear power. This has fueled growing alarm about Russia's and China's increasing economic ties with Africa and the potential that they will become the continent's preferred nuclear supplier. Concerns are focused on how nuclear inexperienced nations will be supported and how effectively nuclear proliferation, security, terrorism and other challenges will be addressed.

COVID-19 is relevant in this environment because it is a real-world example of how nations prioritize transparency and international responsibility in managing a transnational security crisis. The responses to the coronavirus offer some indication of how nations might prepare

for, and respond to, unexpected nuclear challenges in nations to which they have exported next-gen reactors.

China, for example, has faced serious questions about how transparent it was with the international community about the timeline, severity, and origin of the novel coronavirus. This apprehension is intensified by an analysis of the comprehensive social media machine that China has developed and deployed to shape to its advantage international media and public views on a host of issues. Russia's intentional disinformation campaigns against competitor nations are well documented and its powerful online influence ignited a U.S. political crisis .

As COVID-19 has illustrated, disinformation and delay can result in greater international danger and deaths. The handling of the virus outbreak and the communications capabilities of the centrally controlled governments raise worries about how much trust can be placed in their willingness to act transparently should a nuclear crisis arise involving their technology.

The other relevant COVID-19 issue is how nations exercise their muscle with major international institutions responsible for global wellbeing. In the COVID-19 case, there has been serious criticism about the influence China has exerted over the World Health Organization (WHO) and its pronouncements about the virus. This has eroded confidence in the objectivity and mission of the global health organization, despite its valuable mission.

The nuclear corollary to WHO is roughly the International Atomic Energy Agency (IAEA). As U.S. and allied nation nuclear exports have significantly declined, Russia has picked up the slack and China is nipping at its heels. These nations have significant nuclear export advantages across large and small technology platforms because they finance their nuclear industry, integrate their exports into their geopolitical strategies, and offer nuclear neophytes a one-stop shop. This package offers the potential for Russia and China to corner the global market for smaller next-gen reactors.

If successful in that strategy, they may exert increased influence in the IAEA commensurate with their civil nuclear strength. That is how the U.S. and allied nations operated when they were in control of the global nuclear market. And that's why it's vital for them to remain viable in the next phase of the global nuclear power game. Without a balance of influences in the IAEA, next-gen nuclear governance may be less effective and comprehensive than global circumstances demand. And that can lead to very unfortunate results.

COVID-19 is a nasty wake-up call that in a globally interwoven world, crises cannot be contained by borders alone. It illustrates that serious gaps remain in the ability of the

international community to collaborate in the face of transnational challenges. And it underscores that not all nations embrace the transparency that is required to build trust. These are important lessons from a painful period. They need to be incorporated into an effective, new framework for next-gen nuclear governance. That process should begin now.

It Pays to be Prepared (March 26, 2020)

In April 2018, I gave testimony to the now Bipartisan Commission on Biodefense that underscored the critical importance of the first sentence in its 2015 national blueprint report, "The United States is unprepared for biological threats." That assessment has now proven to be prescient.

The commission was not the first or the last expert group to make this assessment. But it is led by policymakers who have had responsibility to constituents, understand the severity of the threats the U.S. and the world face from pandemics and other biological dangers, and recognize the strengths and weaknesses of the domestic and international government systems in responding to them.

Unfortunately for all of us, we talked a lot about the systemic weaknesses without doing much to strengthen them when we had the chance. We can't let that happen again.

The devastating impact of the coronavirus will shock the U.S. system – and hopefully the world – into being better prepared for the next bio threats that inevitably will occur. But we can't repeat the pattern of seeing significant national security challenges on the horizon and observing them as they advance without adequately preparing the policies required to effectively address them.

This requirement also carries over to the nuclear field, where it is becoming increasingly clear that the next generation of smaller and exotically fueled nuclear reactors are advancing. But it is unclear if the world is prepared for them.

There are numerous signposts of next-gen reactor acceleration.

A first of its kind agreement was signed by the nuclear regulatory authorities in the U.S. and Canada to collaborate on technical reviews of advanced and small modular reactor (SMR) technologies. Ten reactor concepts are under evaluation by these regulators.

The Canadian government and its nuclear industry collaborated to publish an SMR Roadmap to chart a path for the deployment of small reactors. Canadian Nuclear Laboratories (CNL) is inviting demonstration projects .

The U.S. Department of Defense has awarded contracts to three companies to develop mobile microreactors and is assessing other small reactors for military base power.

The bitterly divided U.S. Congress has passed two laws with bipartisan support that are designed to advance next-gen nuclear technology and has increased the funding for these reactors. Congress also has provided about $100 million in support of the Department of Energy's plan to build a Versatile Test Reactor (VTR) to test advanced reactor fuels and materials. And additional legislation supporting the clean energy role of next-gen nuclear is progressing through the legislative process.

The first new U.S. small modular reactor is scheduled to be demonstrated at the Idaho National Environmental and Engineering Laboratory (INEEL) and a micro reactor may soon follow. The lab also has created a National Reactor Innovation Center to facilitate the construction and operation of innovative reactor concepts.

These actions indicate significant technological and political momentum. But the policy for this next generation of reactors is lagging this drive. It quickly needs to catch up for two reasons.

First, the policy framework for next generation reactors is going to be different than that which currently exists. The reactor fuels and coolants for advanced reactors are very different from those of most existing power reactors, while there is more commonality with SMRs. The smaller generating capacity of these reactors make them applicable for use in small grid, developing economy nations that do not have a history of nuclear operations. They also are applicable for use in remote areas and to support industrial processes. Also, DoD, outside of the nuclear Navy, has not been deeply involved in the use or operation of nuclear power systems. These issues raise many new questions that need to be answered, not pushed off into the future.

The second reason is that, because of the myriad new policy challenges, and controversy around some elements including the VTR, it is critical to have a balanced, effective policy framework in place as the technology accelerates through the development and demonstration phase to deployment. Already the green sprouts of questionable policy ideas are becoming visible. Bad policy can be counterproductive and could strengthen the ability of Russia and China to dominate this developing new market. If that happens, it is unclear if they will require the high levels of safety, security and safeguards that can instill global confidence in the deployment of these technologies.

There was no shortage of warnings of inadequate preparation for pandemics over the past 20 years. But they were largely ignored. Progress on small and advanced reactors is now clear. But it is a mistake to believe that the value of the technology will prevail without an

effective policy framework that will provide global confidence in its benefits. It pays to be prepared.

DoD Marches Forward with Micro Reactors (March 13, 2020)

The U.S. Department of Defense (DoD) continues to advance a dual-track pincer movement designed to deploy small, land-based nuclear reactors to support its missions. If one or both of its approaches are successful, it will have a significant impact on the future of small modular and advanced reactors, potentially driving out doubts about the viability of the technologies. But there are numerous technical, legal, policy, and geopolitical challenges as this process proceeds, and the U.S. needs to play a leading role in addressing them.

There are multiple motivations for DoD's interest in small reactors.

One, is the use in areas where U.S. forces are forward deployed. This can alleviate reliance on diesel fuel and its long and vulnerable supply lines. But it also can support the battlefield arsenal of the future including directed-energy (DE) and electromagnetic (EM) weapons that require "long endurance [and] energy dense power sources," according to Project Pele . DoD, in April 2019, issued a Request for Solutions under this project for the first phase of a "small mobile nuclear reactor." The project is being run out of the DoD Strategic Capabilities Office (SCO).

This week, it awarded three teams a total of almost $40 million to begin work on a mobile nuclear reactor with a power range of 1-5 megawatts. This decision begins a two-year design period that may result in one company being chosen to "build and demonstrate a prototype." The reactor's uniqueness, according to the project manager is in its mobility (40 metric ton weight limit), and safety (inherently safe with minimal operator involvement and using TRISO fuel . It also must be designed to minimize the risk of nuclear proliferation.

A second driver for DoD is powering domestic military installations. This parallel effort is being run by the office of the Undersecretary of Acquisition and Sustainment, and it is focused on a 2-10 megawatt reactor that could be built from commercial technology and be licensed by the Nuclear Regulatory Commission (NRC). The objective is to protect military installations from disruptions in the local power systems which could be subject to cyber or physical attack.

A third motivation is the challenge of nuclear geopolitics . The SCO director noted that "the United States risks ceding nuclear energy technology leadership to Russia and China" if it does not maintain its technological edge. In fact, the U.S. and its allies largely have ceded

the gigawatt-sized light-water reactor (LWR) market to Russia, which currently accounts for two-thirds of the reactors under construction around the world. China is positioning itself to eat into the Russian's lead in LWR exports, and both nations are gearing up for the battle for dominance over the next generation of smaller reactors.

In 2019, Russia launched a floating nuclear reactor with a power range of up to 70 megawatts, and China is considering building multiple floating nuclear power stations to support its bases in the South China Sea. This fight over next-gen nuclear power has significant implications for technological innovation, global competitiveness, international security, and clean energy.

A less publicized objective for the defense department is to decrease its liquid fuel usage and strengthen its contribution to clean energy and decarbonization. Defense activities consume roughly 30 terawatt hours of electricity per year and more than 10 million gallons of fuel per day. The expectation, according to DoD, is that this will continue to increase over time. But the department also is concerned about the impact of climate change on its infrastructure and missions. In a report requested by Congress the department identified numerous challenges it is facing from the effects of climate change.

The nuclear power initiatives that DoD is pursuing are largely being cast as support for its operations. But these projects will have implications beyond the Pentagon's missions. There are technological questions about the development and availability of the new types of nuclear fuels that will be required for these reactors. There are concerns about the legal requirements for basing micro reactors in foreign nations. There are apprehensions about how adversaries will respond to their battlefield deployment. And, the governance system for these reactors, including the safety, security and non-proliferation requirements, are not yet well developed or even fully understood. These are challenges that must effectively be addressed, and it will be in the interest of international security if the U.S. and its allies drive the resolution of these issues. If they fail, authoritarian competitors including Russia and China, can seize control of the next generation of nuclear technology and its governance system. That will not be a desirable development for DoD or anyone else.

Putting Air Under the Wings of Nuclear Security (February 21, 2020)

A perpetual problem for the community that cares about nuclear security and the prevention of terrorism is the struggle to make the issue pertinent for the public by connecting its importance with other significant global challenges. A refreshing new analysis has broken out of that box. It makes a strong case that the international nuclear security regime can, and needs to, learn lessons from the aviation sector, an industry that people in every country encounter every day.

At first glance, it may seem that aviation challenges are irrelevant to the protection of nuclear infrastructure and materials. Access to nuclear plants and materials is highly controlled and the security system is based on keeping the public out. Whereas commercial aviation welcomes billions of people per year onto its aircraft.

However, the World Institute for Nuclear Security (WINS) has produced a densely researched 9-volume series of documents which highlights that many aviation security best practices are transferable to the nuclear sector. It offers a 10-point plan that the International Atomic Energy Agency (IAEA) can adopt to create the necessary, real improvements to a global nuclear security system that is plagued by a lack of uniform requirements, practices, and evaluation.

One point of commonality between both sectors is their United Nations-affiliated organizations, the IAEA and the International Civil Aviation Organization (ICAO). These institutions set the international frameworks for security in their respective sectors. Other similarities include the fact that the state is accountable for security in both sectors through national regulators, both are considered part of the critical infrastructure in most countries, and that they face similar threats – physical attacks, cyber dangers, and insider sabotage.

But there also are critical differences between the IAEA and ICAO. The aviation organization has a stronger role in mandating and assessing the effectiveness of global aviation security than does the IAEA. Its role was considerably strengthened by its member states in the wake of the 9/11 terrorist attacks.

Nuclear security also was strengthened after 9/11 but no significant new nuclear security authority was provided to the IAEA by its member states. This is primarily the result of national sensitivities related to the state responsibility for nuclear security and a weak

international consensus that nuclear terrorism is a threat to the entire global community, not just nuclear-operating states.

Unlike ICAO, IAEA only offers guidance on nuclear security best practices. There is no international convention mandating standards of nuclear security, though there are binding agreements covering limited elements of the issue. Under the IAEA guidance, each nation can implement their recommendations, or not, and Agency evaluations of its effectiveness are voluntary.

By contrast, there is a Convention on International Civil Aviation that requires any deviation from its international standards be immediately reported to the authority which will then alert all other nations. ICAO also has the authority to conduct mandatory aviation security audits. Since 2002, ICAO has conducted over 430 security audits while the IAEA has completed 103. ICAO also certifies 35 regional training centers that employ demonstrably competent instructors and auditors. The IAEA networks a very important set of nuclear security support centers but does not certify their courses or instructors.

The conclusions of the WINS analysis are serious and sobering. It assesses that the IAEA is 20 years behind ICAO in adapting to the new realities of the international threat environment. It makes clear that a continued lag in strengthening the teeth of the nuclear security regime will impede the ability of nuclear power to contribute to addressing other global challenges including deep reductions in global carbon emissions.

The new Director General of the IAEA, Rafael Grossi, has the potential to be a transformative figure if he chooses to join nuclear security to other global challenges, including climate change. He has stated his intention to “transform our nuclear security guidance into mainstreamed norms.” And, he has recognized that nuclear power must have a place at the table where the world’s energy future is decided. That’s a good foundation for expanding the connection between these vital, and mutually dependent, issues.

Boris Can Bend the Curve on Climate and Nuclear Security (February 7, 2020)

This year will feature two bookend events that have the potential to significantly reshape how and whether the global community effectively attacks the entwined nuclear energy and climate change challenges. Next week, the International Atomic Energy Agency (IAEA) will hold an International Conference on Nuclear Security (ICONS) in Vienna. In November the 26th meeting of the United Nation's climate talks will convene in Glasgow, Scotland.

The ICONS event is the third of its kind and it has gotten less, not more, bold as it has matured. The focus is on "Sustaining and Strengthening Efforts" an anodyne objective that features a host of retread issues from the four head-of-state summits during the Obama era. It's not that the agenda is unimportant, it is an admirable collection of technocratic expertise and best practices with a strong focus on information exchange and international cooperation.

There also will be discussions of building a stronger nuclear security legal framework, but that is a secondary issue fraught with political controversy, and therefore likely to remain in limbo. Unlike nuclear safety, there is no international convention on nuclear security with binding, common requirements for signatory nations. Instead, the IAEA offers detailed nuclear security recommendations and an opaque regulatory review process that nuclear-operating nations are free to implement or reject. That does not offer adequate assurances to the global community in a rapidly evolving threat environment.

The real problem with the ICONS program is what's missing. There's no focus on the future of nuclear technology and the management of the challenges that it poses for global security and terrorism prevention. The next generation of nuclear power is going to be smaller, dispersed, and operate with novel fuel cycles. It most likely will be deployed in nations new to nuclear operations. The pattern of population growth, energy demand, and natural resource scarcity driven by climate change that make these new reactors attractive is primarily impacting developing economy nations in Africa, the Middle East and South East Asia. These can be dangerous neighborhoods.

The combination of nuclear operating inexperience and looming terrorism will place new burdens on the IAEA, as well as the nations and companies supplying these technologies, to ensure adequate safeguarding and security of the reactors. This is a set of issues the ICONS experts should be focused on because it's barreling down on them over the next decade.

If this was the IAEA's focus, it would be easier for British Prime Minister, Boris Johnson, to open the door at the Glasgow U.N. climate framework's Conference of the Parties (COP) to reframing the options for realistically responding to climate change, including the role of nuclear power. The Glasgow meeting is significant because it marks five years since the international climate agreement was completed in Paris in 2015. Since then, the globe has just grown hotter , along with the rhetoric about the need to address the climate crisis. The problem is that while the talk is hot, the action is not.

A perfect example is Japan. The 2011 accident at Fukushima traumatized the nation and led to a shut down of its nuclear plants, which once provided roughly a third of its electricity. While it has made a serious commitment to renewable energy, it is not enough for a major industrial power. As a result Japan now plans to build 22 new coal plants to drive its economy. A major competitor of Japan, China, continues to add coal capacity at a record pace . The major European industrial power, Germany, is ending its nuclear energy operations, dramatically ramping up renewables, but still won't meet its near-term carbon reduction objectives because of a continuing dependence on fossil fuels.

The U.K. by contrast has made a national decision that nuclear power is a key part of its climate change response. Johnson called for a "nuclear renaissance" soon after taking office. But the pathway is financially challenging, and it will potentially boost China's nuclear export ability by offering a test bed for its technology. This will complicate already stressful geopolitical tensions posed by Russia's increasing dominance of nuclear exports.

But if Johnson and allies, including the U.S., can firmly establish at the next COP that nuclear power is an essential contributor to effectively curbing atmospheric carbon, that could spur a renaissance in strengthening the safety, security and non-proliferation regime governing nuclear technology. That in turn, could open the door to a reevaluation by the global financial community and its international institutions that could alter the financing headwinds the nuclear industry and its innovators now confront.

The Prime Minister has stated that "urgent action" on climate change is required now. The opportunity in Glasgow to fundamentally alter the climate response equation so that it is much more effective is sitting in front of him waiting for his expeditious action.

Davos Dials in on Evolving Global Risks and Responses (January 27, 2020)

The World Economic Forum Annual Meeting in Davos, Switzerland, is a convenient punching bag for those who view its participants as part of the problem rather than the solution. But this year's meeting offered some important information on the re-ordering of global threats, the rising challenge of climate change, and the incremental crawl toward corporate environmental, social and good governance (ESG) objectives. While these may seem widely separated issues, they are in fact, very interrelated.

At the top of the long-term concerns in the new Global Risks Report is "climate action failure" followed by "weapons of mass destruction". Also prominent in the top 10 list of likely risks, was the failure of global governance. Those three themes – climate, WMD, and governance – are the nucleus of the modern global challenge. They must be tackled jointly and comprehensively.

The challenges posed by climate change was a major theme in Davos and there were a number of high profile and highly critical presentations on what the Secretary-General of the United Nations, Antonio Guterres, titled the climate war .

But Davos' emotional climate crisis rhetoric engendered a response that sought to refocus the fight on realistic pathways to achieve greenhouse gas reductions. One Washington Post column made the important point that "energy consumption is not a compartment of modern life; it is modern life...[and that] serious plans for the energy future must take the modern world into account." It noted that all "high yield" sources of energy must be pursued, including, "new and better nuclear reactors" and carbon capture and storage.

An essay in the Wall Street Journal, urged readers to "Ignore the Fake Climate Debate" that is driven by deniers and alarmists. It made the valuable point that economic growth is an important component of reducing energy consumption because it decreases poverty and drives technologies that can replace carbon intensive energy use. This includes replacing coal with natural gas, and expanding wind and solar power, and nuclear energy.

The role of nuclear energy in addressing climate change is clearly controversial despite the continued confirmation of its zero-carbon importance by the U.N. Intergovernmental Panel on Climate Change (IPCC) and many international experts. As the Post piece notes, should

we "assume that Chernobyl and Fukushima are the best that we can do," because the "nuclear plants of tomorrow" may offer advantages over existing technology.

The nuclear technology of the 2050s will not be the same as that which originated in the 1950s. But the expansion of nuclear energy, and particularly its introduction to new nations and regions, raises global security challenges. If misused or under-policed there is the potential for nuclear weapons proliferation.

This threat of, "two simultaneous dangers – nuclear war and climate change," are primary reasons why the Bulletin of the Atomic Scientists Doomsday Clock was pushed to 100 seconds from midnight, a decrease of 20 seconds over just the last year. As the Bulletin board notes, the intensifying of dangers is a response to "world leaders that have allowed the international political structure for managing them to erode."

But government is not the only answer to these global threats. The private sector also has a responsibility to strengthen the systems required to address existential dangers. At the 2017 Annual Meeting in Davos, its International Business Council issued a "Compact for Responsive and Responsible Leadership" that states, "society is best served by corporations that have aligned their goals to the long-term goals of society." This objective was furthered at the 2020 meeting by a new report that proposes a, "common, core set of metrics and recommended disclosures" that will allow the public to assess whether the corporate sector is living up to its ESG promises.

The private sector's full effects remain to be seen, but in advance of the Davos meeting, Microsoft announced that it will be carbon negative in its operations by 2030 and launched a $1 billion climate innovation fund that will "accelerate the global development of carbon reduction, capture and renewal technologies." This is in addition to the substantial resources Microsoft co-founder, Bill Gates, is putting into his next generation nuclear reactor. This announcement was complemented by the announcement by BlackRock's CEO that "[c]limate change has become a defining factor" in its investment business and that "Governments and the private sector must work together to pursue an [energy] transition that is fair and just."

The yearly Davos meeting is often portrayed as a contrived concert of virtue signaling that evaporates with wheels up at weeks end. But when focusing in on the real signals and less on the noise it becomes clear that there is a growing recognition that the global environment and its challenges are evolving and that the responses to them must be transformed.

There are realistic and effective responses to the climate and nuclear challenges that the world is facing. And it is encouraging that the private sector is willing to work with governments to develop them. But a third and necessary leg of this triangle is civil society. Its organizations and experts can cling to old battle lines that are worn and comfortable but are no longer defensible. Sanctimony won't solve any of the new global challenges. The private sector, governments, and civil society need to find their fulcrum of consensus and forge a collective response. This is the challenge Davos should take on next year.

Russia Rushing for Advantage in Climate Crisis (January 10, 2020)

When climate change-skeptical Russia approves a national action plan to address the ravages of global warming, international security antennae should shoot up. Especially because the Russian government is not masking its desire to use the "advantages" of climate change for its benefit. This highlights the unexpected global security twists that now are emerging from what widely has been managed as an environmental problem.

In response to the second hottest year on record in 2019 as well as at the end of the steamiest decade , Russia faces domestic threats from the melting permafrost of its vast arctic regions. This is in addition to the public health, agricultural, and economic impacts of a warming planet that are affecting virtually every nation.

But Russia shrewdly is looking to turn negative climate effects into positive opportunities to enhance its energy intensive economy and advance its geostrategic objectives.

One canvas on which a part of this strategy is being applied is in Germany. The German government decided after the Fukushima nuclear accident in 2011 to phase out all nuclear power. That made it more dependent on coal and natural gas. Natural gas is about 20% of its overall power production and roughly 60% of that amount is supplied by Russia. Coal comprises about 40% and renewables another 30% of the total. But the remaining 10% is provided by nuclear power production. This is scheduled to end by 2022 and coal is projected to phase completely out by 2038. That is a reduction in 50% of existing base load power generating sources in the next 18 years in the largest economy in Europe.

Germany is already behind on meeting its Paris climate agreement commitment to reduce its emissions by 40% and it is not clear if renewables can span the gap opened by these significant retirements. If not, natural gas likely will intensify as a workhorse fuel. This raises questions about the sustainability of the current German energy policy and the security implications of expanded Russian energy influence.

While Russia will willingly increase its supply of natural gas to Germany, it also is actively pursuing the export of its nuclear technology which can be used to reduce carbon emissions and take advantage of thawing arctic ice accelerated by warming temperatures.

The nuclear export effort is spearheaded by Rosatom, one of Russia's largest state-owned corporations. It has the significant advantage of operating with government financial subsidization and is an effective buttress to Russian geopolitical objectives.

Remarkably, Russia has recovered from one of the world's worst nuclear catastrophe's, Chernobyl, to lead in global nuclear exports just 30 years on. Russia currently supplies nuclear-related technology to 35 countries and is involved in 53% of international construction and operation agreements. Russia is the supplier in more nuclear technology agreements than the next four largest suppliers combined (France, U.S., Korea, and China).

While the primary focus of the Russian nuclear export strategy has been on the sale of large gigawatt scale reactors, it also is effectively angling for a dominant role in providing the next generation of small and advanced reactor technologies. These reactors have much lower power, and some are designed with exotic coolants that will allow for remote deployment away from water. These types of reactors may have significant applicability to developing economy nations with growing populations. Key regions with these characteristics include Africa, South East Asia, and the Middle East.

In 2018 Russia had contracts to build 22 nuclear reactors in nine countries over the next decade, including Bangladesh, China, India, Turkey, Egypt, and Iran. Russia also is actively pursuing Memorandums of Understanding (MOUs) for nuclear cooperation with a number of African nations, including Ghana, Kenya, Rwanda, Zambia, and Ethiopia.

In the meantime, Russia has launched a floating nuclear reactor for operation near the arctic circle. While the goal of this plant is to power a remote domestic region, it signals another step in Russia's geopolitical objective of exerting influence over the arctic and its natural resources as the ice cap melts.

The challenges posed by a warming planet are evolving in unexpected ways. The negative impacts of climate change may well offer new opportunities to Russia and other authoritarian nations to expand their economic, energy, and geopolitical boundaries. That will confront democratic nations with unique global security concerns that will require creative, collaborative policy making. Limiting climate change to the environmental problem silo is a major mistake. It has significant implications for global security, geopolitical competition, and nuclear expansion. Making and acting on those connections now can avoid more serious conflicts in the future.