PGS Nuclear News and Views: Commentaries

2019 Edition

Index

The Real Madrid Playing Field (December 13, 2019)

As this year's U.N. climate change conference in Madrid comes to a close, the mismatch between global aspiration and actuality is glaring and growing. The annual two-week conversation began with a bleak report on the growing emissions gap and closes with an alarming assessment that the previously inert arctic now is spewing carbon dioxide into the atmosphere as the permafrost warms.

Despite the red-hot rhetoric about the need to go faster and further in cutting greenhouse gasses, they actually have grown over the last decade. According to the U.N. report, these emissions must decrease by 7.6% every year over the next decade. This reversal will require incredible – and heretofore lacking – political and social fortitude. Instead, a new analysis indicates that governments are planning to produce 50-120% more fossil fuels by 2030 than is consistent with the Paris Climate Agreement targets of limiting global warming to 15.-2.0 degrees Celsius.

While many of the Madrid diplomats, experts, and activists keep advocating for more urgent action, the reality is that most nations haven't even made adequate pledges to meet the Paris agreement objective. According to one analysis , the major emitting nations, China, the U.S. and India, have made "insufficient" emissions reduction pledges.

As every sports fan knows, the ability to win the big contest is only as good as the players put on the field and the coaches that design the strategy and plans. On the climate playing field, it is clear that neither the preferred technologies nor the strategy are strong enough to win.

The International Energy Agency's director, Fatih Birol, has made clear that in his view , the global community does not have the luxury of choosing a favorite technology when the focus is on a "climate emergency".

The two grizzled global veterans of zero carbon emissions are hydro and nuclear power. They are aging and scarred. They work well but are largely unloved. But, in a real crisis effectiveness matters more than political popularity.

The newest technologies, wind and solar power, get all the zero-carbon attention. But, at present, these rookie power sources need strong back-ups because they can't yet compete at the highest levels. Advances in battery storage and hybrid renewable-clean continuous

power sources are two paths that can strengthen their contribution. But, it's not clear how long it will take for this support system to mature.

The new Director-General of the International Atomic Energy Agency (IAEA), Rafael Grossi, speaking in Madrid, said , "We should not see nuclear power and renewables as being in competition with one another…We need to make use of all available sources of clean energy." He noted that nuclear power can provide the back-up power that renewables require and "unlock" their full potential.

One approach to this new energy mix is next generation small modular and advanced reactors. Their promise is significant, but their development is still embryonic. By using non-traditional fuel cycles and coolants, these reactors can be deployed in interior and arid landscapes close to wind farms and solar fields to provide the backup power to those sources.

But there are a number of challenges to be addressed by the developers of the new technologies, national governments, and the IAEA. Foremost among these is ensuring that the next generation of nuclear does not pose a nuclear weapons proliferation danger or elevate security and safety concerns.

The role of next generation nuclear power is a challenge Grossi should tackle with gusto if he is truly concerned about the climate crisis and the sustainable role of nuclear energy in addressing it. It will help distinguish him as a "break the mold" maverick among bland, risk-averse international administrators. Getting all zero-carbon technologies off the bench, out of the penalty box, and onto the playing field is the ultimate prize in this global contest.

Climate Concerns Open Opportunities on Nuclear Finance (November 21, 2019)

Rising concerns about a warming planet are sustaining support for the financing of nuclear power projects, despite cost concerns about building large plants in economically developed nations. The European Union, United States, and Canada have all recently taken steps to preserve space on the zero-carbon agenda for existing and next generation reactors. The ability of these key countries to effectively compete with the state-backed financing of Russia and China for nuclear exports is critical for supporting geopolitical goals and global security.

In a somewhat contentious decision , the European Investment Bank's (EIB) board of directors agreed to cease funding for fossil fuel projects by the end of 2021. Taking aim at coal, oil, and natural gas, the EIB's energy funds now will be directed at "clean energy innovation, energy efficiency, and renewables." EIB's board agreed to include funding for new nuclear power projects in Europe as part of the suite of clean energy technologies. This reinforced a decision that it made years earlier . But the bank indicated that it would take a " cautious approach " to these projects.

Still, the EIB decision is significant and could set a precedent for other national export credit agencies and international finance banks.

One impact could be on the future lending mandate of the new U.S. International Development Finance Corporation (DFC). It is the successor to the Overseas Private Investment Corporation (OPIC). Six U.S. Senators recently wrote to the head of DFC asking that the new agency not replicate OPIC's "categorical prohibition" against supporting civil nuclear energy projects. To underscore their concern the Senators noted that, "Russia and China are increasingly using nuclear reactors as a tool for geopolitical purposes" and noted the importance of American "technologies and safeguards." U.S. military, policy and business leaders also urged Congress to support the long-term reauthorization of the Export-Import Bank as part of a strategy to counter the geopolitical influence of Russia and China, noting the vital importance of exerting U.S. influence on global nuclear safety, security, and non-proliferation.

In a highly divided U.S. political landscape, the future of nuclear power and its financing has been one notable area of bipartisan agreement. Two important pieces of legislation have already been signed into law that support the development of next generation reactors.

Other legislation that would move the process further, faster is still pending but supported by both sides of the aisle. Developing advanced nuclear reactors is a priority in the U.S. energy department budget.

In the meantime, Canada is forging ahead with the implementation of its SMR roadmap which is designed to make Canada a hub of small modular reactor research. Canadian Nuclear Laboratories (CNL) recently announced that it has selected four recipients of the Canadian Nuclear Research Initiative (CNRI). This initiative allows CNL to co-fund research and development on the selected technologies. The CNRI is in addition to CNL's process of preparing for small modular and advanced reactor demonstrations at one of its sites.

The continued global increase of greenhouse gasses has also provoked the U.S. Federal Reserve into considering the impact of climate change on its mission to ensure stability in the U.S. economy. The Federal Reserve Bank of San Francisco hosted a first-ever conference on the need for climate related research under its mandate. Speakers at the conference noted the impact of severe weather events on bank stability, power production, and economic growth.

In considering this new research, the Fed is already well behind some of its global counterparts. The Bank of England is stress testing its financial system against different climate scenarios. The European Central Bank is considering using environmental stability as a criterion for bond purchases. There also is already a Central Banks and Supervisors Network for Greening the Financial System. Global Green Bonds, which raise capital for projects with environmental benefits, have already exceeded $100 billion. However, none of those bonds have yet been used for nuclear projects. This is consistent with World Bank policy not to fund nuclear projects despite its objective of providing complete global access to electricity by 2030.

Export credit agency and World Bank prohibitions on nuclear project financing may historically have been easy to defend as the technology is undeniably controversial. But climate and geopolitical realities are beginning to overtake past rationales. The potential climate-induced destabilization of national economies and the global economy is a risk that central banks have embraced as a significant danger. Key countries including the U.S. and Canada, and the EU are defining nuclear power as part of a green response to the global zero-carbon objective. The government-financed nuclear industries of Russia and China are rapidly expanding their reach into all developing regions and nations, undercutting democratic country influence.

In the current international environment, placing the entire burden of nuclear financing on the private sector is a prescription for failure for the individual projects and for achieving global climate and security objectives. There must be government support paired with private sector funding if these technologies are, along with renewable energy, going to form the core of the green energy future. Some governments seem to finally be waking up to this reality.

Bridging the Gap on Climate, Nuclear and Security Policy (November 8, 2019)

As the news of climate change's global impact grows grimmer, the unwillingness of governments and some environmental advocates to embrace a full solution set for the problem grows increasingly inexcusable. It's time to bridge the climate-nuclear power-global security gap.

A new analysis signed by 11,258 scientists from 153 nations warned that humanity is now facing a "climate emergency" resulting from "insufficient progress" in reducing greenhouse gasses. This was preceded by another alarming assessment that triples the estimate of global vulnerability to increases in sea level. This as California is yet again burning intensely.

Recent academic studies , particularly by the Massachusetts Institute of Technology, have illustrated the value of nuclear power in meeting deep decarbonization objectives even as renewable energy will continue to thrive. Some well-known U.S. environmental and energy NGOs have come to accept the zero carbon value of existing nuclear power plants as they see global carbon emissions continue to rise and are facing the reality that while renewable energy will continue to grow, so will the global population and the demand for clean energy.

National governments and international organizations also are recognizing the climate value of nuclear power. A dozen countries have come together under the Clean Energy Ministerial to create the NICE Future initiative, that is designed to highlight the contribution of nuclear energy to global clean energy supply. The International Atomic Energy Agency (IAEA) convened an International Conference on Climate Change and the Role of Nuclear Power that examined in depth the role of nuclear power in reducing global greenhouse gasses. The International Energy Agency (IEA) has made the case that nuclear power is, and can continue to make, a significant contribution to a zero carbon world. And the Intergovernmental Panel on Climate Change (IPCC) has highlighted the value of nuclear power in reducing carbon while also raising concerns about its future viability.

Achieving a zero-carbon objective by mid-century or even the end of the century will be difficult and almost certainly will require a mix of technologies. Taking nuclear power offline prematurely will increase global emissions as it is the second largest zero-carbon energy source after hydropower and now accounts for more than half of America's carbon free electricity, the world's second largest emitter.

In advanced economies, existing large-scale nuclear reactors currently average 35 years old. These reactors were originally designed for a 40-year life. If life extensions are granted by regulators, some of these reactors could approach 60-80 years of operation by mid-century. Without life extensions, and replacement, their retirement could add an additional 4 billion tonnes of CO_2 emissions and require an additional $1.6 trillion investment to support a clean energy transition.

If renewables expand to roughly 40% of generation, as one MIT report predicted, they may then face cost increases, making the next generation nuclear power, small modular and advanced reactors (SM&AR), a viable complementary zero-carbon option. In theory, these reactors can replace the existing fleet as it retires, but the volume of these reactors would need to be significant as their power output is considerably lower. They also have the potential to address the cost, safety, waste, and security concerns that plague the existing nuclear fleet.

However, before these reactors can advance to the deployment stage, there are financial, regulatory, demonstration, and security issues that need to be addressed.

Because of the nascent nature of SM&AR development, the nuclear security "gap" policy issues have received little study. These include: analyses of the safeguards, security and geopolitical implications and requirements of SM&ARs; assessing the impacts and mitigation of emerging disruptive technologies on these reactors; and determining how to effectively and productively engage with Russia and China to preserve high global nuclear governance standards as these reactors enter deployment.

Without addressing these key issues in a timely fashion, it could inhibit the development and deployment of these technologies. And, it could provide an advantage for developers and exporter nations that do not have much invested in high levels of global nuclear governance.

Those that really want to achieve a zero-carbon world increasingly understand that there is no one silver bullet. Preserving existing nuclear capacity and paving the pathway for the next generation of reactors will create a more effective and flexible solution set. Bridging the climate-nuclear-security gap is a necessary step forward.

Responding to Nuclear Nervousness in the Middle East (October 25, 2019)

New developments in the Middle East are raising concerns about whether the region will become the world's next nuclear hot spot. While the escalating situation stokes international anxiety, it has not stimulated an effective, comprehensive nuclear security policy response.

The reality is that multiple nuclear facilities will be operating in several countries in the region inside of two decades. The challenges are potential nuclear weapons proliferation, the security of operating power plants, and the battle for geopolitical influence that results from nuclear exports.

The most glaring recent worry is the statement by Turkey's President, Recep Tayyip Erdogan, that he cannot accept continued restrictions on his country's development of nuclear weapons. Erdogan's complaint about nuclear restraint may be bluster, but Turkey is loosening its ties with its NATO allies, despite the fact that roughly 50 U.S. nuclear weapons are stationed at the Incirlik Air Base and that the security of these weapons is a concern .

In its turn away from its NATO allies, Turkey increasingly is siding with Russia in both foreign policy objectives and nuclear development. Russia is building the Akkuyu nuclear power plant on the Mediterranean coast of Turkey.

Other regional powers including the United Arab Emirates, Iran, and Egypt are operating or building new nuclear power plants, the latter two with Russian support. Iran also is raising weapons proliferation tensions by increasingly stepping back from the restrictions of the 2015 nuclear deal from which the U.S. has withdrawn.

Saudi Arabia, in part responding to Iran's nuclear advances, is pursuing a slow-moving tender for the construction of two new nuclear power plants. A gnawing question is whether the Saudi's will try to use the program as a cover to go nuclear . This concern has fueled a simmering dispute between the Kingdom and the U.S. over the non-proliferation terms of the agreement that is legally required for U.S. companies to provide the Saudis' with major nuclear reactor components and assistance.

The situation is further complicated because South Korea, the UAE's nuclear supplier and a contender for the Saudi reactors, may be prevented from reaching a deal as U.S. technology

used in their current reactors requires a U.S.-Saudi nuclear cooperation agreement. The Koreans are claiming independence from U.S. technology in their most recent reactor design, but this has created a dispute with the U.S., which rejects the claim. This fight has weakened a civil nuclear alliance between the two key countries that neither can afford and that may allow Russia or China to establish yet another nuclear beachhead in the Persian Gulf.

A new worry was created by the recent precision guided missile attack on Saudi Arabia's Abqaia oil facility and the inability of defenses to detect or defeat it. This could threaten existing and proposed nuclear facilities in the region and the weapons could potentially be launched by non-state actors raising terrorism risks. But, emerging disruptive weapons technologies like high speed, precision drones are a threat to any large, static critical infrastructure , and the challenge is in how to respond to, or deter, these attacks to which all nations are vulnerable.

It now is inevitable that several Middle Eastern nations will have nuclear power capabilities in the next two decades. But this reality does not seem to have resulted in a coherent nuclear security strategy for the region. Instead, policy making in individual issue silos persists.

There are several policies that should be considered in concert.

The U.S. needs to strengthen its position as a civil nuclear supplier in the Middle East. Achieving this alone will be difficult for a number of reasons. It can work most effectively by rapidly identifying a mutual accommodation with South Korea that allows both nations to operate as a nuclear supply team promoting high standards in the region.

The fuel cycle policy for the region's new reactors needs to be more coherent and realistic. Restricting nations from reserving the right to enrich uranium for reactor fuel may prove to be a pyrrhic victory if Iran solely retains the capability or it hands control to Moscow or Beijing who have ulterior geopolitical motives. There are approaches to enrichment and reprocessing that can keep the technology at bay in the region without explicitly banning it. But that will require deftness and compromise and there's undeniably risk associated with this approach if the oversight is not stringent.

The U.S. and its allies need to get much more serious about moving next generation advanced reactors into the deployment pipeline. The Middle East is a candidate area for these reactors which can address growing water scarcity concerns and provide distributed electricity to a growing population, potentially with lower proliferation and security risks.

The system of global nuclear security needs to be significantly improved. Emerging disruptive technologies like precision guided munitions, swarming drones, and cyberattacks need to be addressed as part of an overall critical infrastructure protection process, but their challenges affect all nuclear operating nations and require additional attention and more effective responses. When the IAEA convenes a special meeting on nuclear security early next year, policy responses to emerging threats need to be a priority.

The Nuclear-Climate-Security Conversation Gains Altitude (October 11, 2019)

The nuclear-climate-global security discussion has ramped-up in recent weeks, led by several high-profile international organizations responding to the growing global concern about the impact of increasing greenhouse gasses. But the debate is still balkanized with energy and technology garnering more attention than their security implications.

In Vienna, the International Atomic Energy Agency (IAEA) held a unique conference on the role of nuclear power in combatting climate change. The event was designed to assess the role of nuclear power in contributing to global clean energy objectives and the opportunities and challenges the technology faces in meeting these goals. Over 70 countries were represented, and the major speakers came from a mix of countries, spanning large nuclear operators like the U.S. and France to nascent nuclear nations like Egypt and Morocco.

The IAEA's Acting Director General, Cornel Feruta, captured the nuclear-climate conundrum in his opening remarks. Nuclear energy, he stated, "accounts for one-third of all low-carbon electricity generated today. That fact deserves to be better known." He further noted, "It is difficult to see how the goal of reducing greenhouse gas emissions can be achieved without a significant increase in the use of nuclear power in the coming decades."

However, Feruta also cautioned that, "like all technologies, nuclear power brings benefits and risks…and it is not always judged purely on the basis of scientific facts," a reference to persistent public concern about nuclear technologies. Other speakers noted the importance of cost competitiveness for nuclear power to continue its low-carbon contribution.

Hoesung Lee, Chair of the United Nations (U.N.) Intergovernmental Panel on Climate Change (IPCC) noted that in the uphill battle to hold the global temperature increase to 1.5 degrees Celsius above preindustrial levels, consistent with the Paris Agreement, "[C]limate change needs all the help it can get" and that nuclear power can contribute to decarbonization particularly over the next 30 years.

Fatih Birol, the Executive Director of the International Energy Agency (IEA) of the Organization for Economic Cooperation and Development (OECD) highlighted the, "growing and dangerous disconnect between climate emissions reports…and what is happening in real life." Drawing on IEA energy data, he noted that, "[W]e do not have the luxury to pick our favorite technologies," and that support for existing nuclear plants and new

technologies were required by, "those governments that take climate change and electricity security seriously."

Also entering the climate debate was the International Monetary Fund (IMF), which produced a new analysis calling for a dramatic $75 per ton tax on fossil fuel burning as the most effective approach to mitigate climate change. The IMF cautioned that, "[G]lobal warming is threatening our planet and living standards around the world…the window of opportunity…is closing rapidly." Unstated in the IMF assessment, but, clearly articulated by the IAEA's Feruta is the fact that "around 70% of the world's electricity comes from burning fossil fuels…and together with hydropower, nuclear is the only low-carbon source of energy that can replace fossil fuels for 24/7 baseload power," even as "wind and solar power will continue to grow."

While the IAEA and IMF were focusing on the energy-climate connection, several other new analyses were focused on the global security impacts of climate change. A new report by the Council on Foreign Relations clearly underscores that climate change can cause "financial market failures" and that its impacts on the financial viability of U.S. energy firms can cause "disruptions to domestic energy supply" which have global and national security implications. A prior assessment by the U.S. Federal Reserve identified how higher global temperatures will impact the U.S. economy. Meanwhile, a group of 64 senior military, national security, and intelligence officials presented a new plan that called on the U.S. to recognize climate change as a "vital national security threat" and offered recommendations for how to "prepare for and prevent" this danger.

The developments of the past few weeks are important and demonstrate that the nuclear-climate-security discussion is maturing, advancing, and elevating. However, it is still disjointed, with the global energy and nuclear technology discussion mostly divorced from its global security significance. The Global Nexus Initiative has been drawing these three critical issues into a collaborative framework for the past four years and the new voices in this conversation are welcome. It may be time to now join all the key stakeholders into a broad and effective coalition that in sum is more effective and comprehensive than its individual parts.

Gates Gets It, Leaders Should Listen (September 27, 2019)

Bill Gates gets that there is no real plan to address climate change. He made this point in the face of a tsunami of recent official declarations and street-level demonstrations bemoaning the worsening "climate crisis." Four years after the adoption of the Paris Climate Agreement , atmospheric carbon emissions continue to grow and environmental conditions are worsening.

In the meantime, the presidents and protestors made their points at the U.N. Climate Action Summit in New York and then retreated back to their comfort zones after committing to little concrete new action .

Gates makes several important points, the core message of which is that energy demand is growing, innovation is lagging, and fossil fuels remain tempting.

In Gates view, the future is "about energy intensity" and the realization that there is no "one path" forward to driving energy generation to a zero-emission level. In fact, ramping up dependence on zero-emission electricity may require an electric sector that its "almost three times bigger than it is today…[requiring] mind-blowing investments."

Gates outlined what a real plan to address the climate challenge would look like. First, it means looking at electricity generation, which now is roughly one-third of the carbon emission problem. He's also focused on "transport, industry, buildings, and land use/agriculture." He considers the underinvestment in energy R&D budgets a major inhibitor of innovation.

Not surprisingly, given his investment in TerraPower and previous comments, Gates noted that if "you don't have nuclear and if you don't have a storage miracle" for renewable energy sources, "it's very, very hard" to address the climate challenge.

But he is skeptical about the future of next generation nuclear power because of underinvestment, public fears, and erratic government policy. In fact, he came to Washington earlier this year to convince the Congress to make a billion-plus dollar investment in advanced nuclear reactors that he and others could match. Congress failed to act on this proposal despite the fact that a U.S. national security decision prohibiting U.S.

companies from cooperating with China on these technologies necessitates the creation of an acceptable alternative location for development and demonstration.

Gates estimates that the chance of technological success for these reactors is roughly 70% and the chance of public acceptance 40%, providing a "28 percent likely[hood]" of success. As far as funding, he notes that significantly more investment is required to drive the next generation of nuclear power. He laments that "you can't afford not to do it, but the world is crazy."

Part of that madness is the level of unpreparedness of both small modular and advanced reactor (SM&AR) exporters and purchasers to actually deploy and operate these new reactors.

One action that multiple governments should take now is to support a SM&AR Coordination and Resource Center. This can provide support for both sides of the purchase, strengthen the systems and structures required for safe and secure reactor operation, and streamline the path to deployment. The initial structure and content for this center can be developed in 18 months. Then it can be refined and expanded over the next 1-2 years. This would allow for the technology to mature in tandem with the necessary regulatory, governance, clean energy evolutions.

The U.N. meeting in New York was another reminder that the world does not have a real plan for addressing climate change. Global governments seem to be unwilling to acknowledge the trends that will continue to impact this challenge and are reluctant to make the innovation investments that are necessary to keep pace with accumulating carbon in the atmosphere. Bill Gates gets this reality and is offering ideas to reverse it. Leaders would listen to his plan.

Nuclear, Climate, and the Next Election (September 13, 2019)

The debate over the role of nuclear power in addressing climate change is heating up like the atmosphere. But it's amounting to a lot of hot air because it is not clear that America's foremost presidential aspirants and allied leaders fully understand the essential connection between these issues.

At a CNN Town Hall on climate change, 10 Democratic party candidates agreed that we are facing a crisis. But they split on whether nuclear power should have a role in combating a warming planet. Their views ranged from phasing out existing plants to increasing federal spending for next generation technologies. Generally, however, most were uneasy with the question and vague on the facts.

On the other side of the aisle, the current administration is thinking deeply about the role of nuclear power in the 21st century. It is trying to strengthen American exports, recognizes the geopolitical implications of nuclear power, and has created a working group of senior government officials to assess issues related to U.S. competitiveness in the nuclear fuel cycle. But, it does not believe that climate change is an existential threat, a crisis, or even an issue worth tackling. So, there is a major disconnect between the issues that need to be knitted together and, as a result, its policy framework is inadequate.

It's hard to argue with the fact that coal and natural gas account for 98% of carbon dioxide emissions from the U.S. electric power sector, which accounts for about one-third of total emissions from the country. Carbon-free electricity sources account for about 35% of U.S. electricity generation. Within that percentage, currently operating nuclear power plants in the U.S. account for about 56% of the carbon-free electric generation, renewables 22% and hydro power 21%.

Renewables will continue to grow, increasing their percentage of carbon-free power. But it is a long road to a zero-carbon world and doing it with renewables alone is likely to make it considerably tougher. Then there is the reality that the U.S. is only part of the carbon problem and the decisions of China, India , and many developing economy nations are going to have important impacts on how greenhouse gasses grow, or don't, in this century.

Missing from the CNN debate, and any of the candidate's responses, was the third key issue in the nuclear-climate connection – global security. It is the nexus of these three key issues

that represent the complete policy framework for considering the future of nuclear power and its implications.

If nuclear power is going to continue to contribute to limiting global carbon emissions, then it has to be protected against cyber, proliferation, and terrorist threats. If the future is smaller, remotely deployed reactors in developing economy countries, then the international community will require strong assurances that these reactors are being protected and operated consistent with high standards. The export of existing or next generation nuclear power plants is one front in the big power battle between the U.S., China, and Russia for geopolitical influence. The winner of this competition matters, as it very likely will have significant influence over the evolution of the nuclear governance system in this century – for better or worse.

The 2020 presidential election in the U.S. is an important watershed. But leadership contests are also occurring in key allied nations. There seems to be rolling prime ministers in the U.K. Canadian elections will occur this Fall. Japan is going to the polls in 2021. And South Korea and France will choose their leadership in 2022. Each of these nations has a critical role in global nuclear technology development, commerce, and geopolitics. At the moment, there is not strong consensus among them on the role of nuclear power in the coming decades.

Leadership from the U.S. is likely going to be required to bring these key countries together. But that will be difficult if there is not agreement on the right policy framework for how to position nuclear power as a global asset that promotes carbon reduction, innovation, and global security. Those seeking to lead the U.S. need to understand and act on this critical global issue intersection and work to bring allied nations along. Unfortunately, at the moment, they don't seem to be able to connect the dots.

Prizing Practicality over Ideology to Address Climate Change (August 28, 2019)

As the climate crisis worsens, and the evidence of its destructive impact becomes more vivid, the conflict over how best to address the challenge is throwing more heat than light. A recent article makes the case against a significant role for nuclear power as a carbon free response to the ravages of climate change. But, at the moment nuclear power is one of the world's most significant zero carbon energy sources. It does not make sense to fight an ideological battle over a technology that can significantly contribute to solving a problem that continues to grow worse.

A recent report makes the frightening case that climate change may significantly impact global food production. This at a time when the world population is projected to grow from 7.7 to 9.7 billion people by 2050. Similar alarms are being raised about how climate change will impact water availability and the global economy . Water availability and temperature are important to the effective operation of existing large reactors and some have been negatively impacted in recent years, taking carbon free power off the electrical grid.

While the rise of renewable energy is very welcome in the contest against climate change, it is currently not capable of supplanting all existing global fossil fuel energy production, nuclear generation, and the significant projected growth of an expanding and electrifying global population and economy. If significant battery storage and grid modifications can be achieved and scaled, that will be a significant positive advancement. But these technologies are not more virtuous than other carbon free generation sources including nuclear power when facing the climate crisis.

There are several significant arguments against nuclear power. Its long-lived waste, cost, and potential for nuclear weapons proliferation are undeniable and perennial problems that have been a struggle to manage. The potential exists for a new generation of reactors to make headway against these issues . And none negate it as an effective pillar in the climate combat strategy.

Also, there is little acknowledged toxic pollution from renewable technology manufacturing. A surprising new movie also makes the case that "green" technologies are not as pure as its makers wanted to believe when they began the project.

And, at least in the case of solar power, the panels need to be replaced at regular intervals. Existing nuclear reactors are in the process of being licensed for up to 60 years of operation and that may be extended to 80 years. Their land mass footprints are also smaller than either solar or wind.

The reality is that there are no easy and completely clean answers to powering the modern world. The growing demand for electricity combined with the impact of global transportation are driving emissions higher. The carbon growth is primarily in developing economy nations that need economic advancement and improvements in living conditions that approach or equal developed nations.

The global effort to curb carbon emissions has been grossly inadequate. There is no virtue in fighting against technologies that can reduce this concentration at a time of extreme need. The real goal is to solve the problem. That will be expensive and all the options have, and likely will continue to receive, subsidization and create toxic waste streams. No technology will be immune from having downsides.

Therefore, it is not realistic to remove nuclear power from the carbon combatting arsenal because, if the target is deep decarbonization by 2050 or even 2100, the battle cannot be won without it. It makes more sense to place practicality above ideology when facing down what many believe is an existential threat to mankind.

Rebuilding Nuclear Guardrails for New Realities (August 9, 2019)

The global nuclear guardrail system is being seriously challenged and steadily weakened. Built laboriously over numerous decades to manage a variety of nuclear risks, the arms control, non-proliferation, and nuclear security systems are flagging in the face of new realities, particularly intensifying geopolitical competition, emerging disruptive technologies, and evolving nuclear players.

Adapting to these new realities and rebuilding the eroding system of nuclear controls is essential for global security in this century. But the intellectual, political, and diplomatic tool kit that is required to achieve this goal needs to be significantly supplemented and previously reliable strategies for making progress updated. Unfortunately, there is not much evidence of this evolution.

Nuclear arms control's progression has not only come to a stop, its previous accomplishments are being reversed. The U.S.-Russian Anti-Ballistic Missile (ABM) and Intermediate Nuclear Forces (INF) treaties are gone. New START, which needs to be renewed by early 2021, may not get that extension, unconstraining the two largest nuclear arsenals on earth.

New technologies for weapon delivery, a frost in U.S.-Russian relations, uncertainty over how to deal with China and its nuclear weapons, evolving challenges to the security of space-based assets, and an expanding nuclear arsenal in states like India and Pakistan are all complicating any potential next phase of arms control.

It was difficult enough to pursue bilateral weapon constraints. But engaging multilaterally or in multiple bilateral arms control dialogues risks overwhelming the shriveled diplomatic capacity in the U.S. and exposing the equivocal political will of nations to seriously act on this agenda. That has a direct impact on the integrity of the Non-Proliferation Treaty (NPT), which requires progress towards nuclear disarmament by the major weapons states.

Beyond stalled disarmament, the international non-proliferation and security regimes are under significant stress from non-compliance, lack of threat consensus, and the evolution of civil nuclear energy.

North Korea continues to defy the international community and advances its nuclear weapons program despite intensive engagement by the U.S. and South Korea to reverse it. The Joint Comprehensive Plan of Action (JCPOA) has been abandoned by the U.S. and Iran has responded by exceeding some of its limits and threatening to break through others. Concern about the deployment of nuclear technology in unstable regions will stress the NPT and its safeguards system as well as expose the declining ability of the U.S. and its allies to influence the nuclear export market and strengthen its rules.

The introduction of next generation advanced nuclear reactors that are smaller, deployable in remote locations, and that use non-traditional fuel cycles is increasing the pressure to rapidly update the effectiveness of the non-proliferation and security governance systems. The international community has not responded to this need with any urgency.

International consensus on the nuclear terrorism threat remains elusive and there have been several steps backwards after significant progress. The U.S.-Russian threat reduction agenda, and particularly its focus on cooperative nuclear material security, has all but dissolved. The five nuclear security action plans developed under the four heads-of-state Nuclear Security Summits (NSS) were designed to propel further progress to prevent nuclear terrorism. But implementation has faltered. As a result, the global nuclear security system remains primarily voluntary, opaque, and vulnerable.

Global circumstances and challenges have significantly changed. The roster of nuclear needs has expanded and the system by which these existing and future challenges are being managed is increasingly sclerotic.

Significantly increased pressure is being exerted by new technologies that are outpacing controls and new players that want to make their own rules. The old arms control, non-proliferation, and nuclear security approaches and playbooks need to be updated. But there is little creative thinking about how to design this evolved system and little political focus on driving it forward.

Lamenting the demise of discarded agreements won't bring them back or prepare us for the future. It is time to stop mourning what has passed and focus on what needs to be created and how it effectively can be done. The international community needs to rebuild the global nuclear guardrails that address new realities.

Recharging Nuclear Security (July 30, 2019)

The Obama-era priority of strengthening global nuclear security and protecting all vulnerable materials has faded out like an old photograph. It was a unique and remarkable opportunity that launched four unprecedented heads-of-state summits in the U.S., Asia, and Europe. But its transformative potential was squandered.

It never built the durable bridge necessary for long-term engagement among the key stakeholders. It didn't push the policy bounds of what reticent nations would bear. It left critical emerging issues unaddressed. And it ended abruptly, handing the leadership baton back to the International Atomic Energy Agency (IAEA).

A new report makes clear that the IAEA's handling of the nuclear security mission is in need of significant improvement. The results of this analysis are predictable because the summits were intended to supercharge a vital issue that was languishing in the international bureaucracy.

Despite its significant value, the IAEA does not excel at dynamism and creativity. And its consensus-based approach allows nations opposing creative policy proposals to effectively smother new ideas. Its nuclear security activities are built on a small foundation of Agency financing and a much larger, unstable base of "extra-budgetary" contributions from individual nations, keeping the agenda off balance and vulnerable.

One hand-off from the Nuclear Security Summit (NSS) process was a series of action plans for five different international organizations and initiatives. But much of it has fallen flat without the forcing focus offered by world leader's attention.

Another enduring result was a collaboration among key nuclear security stakeholders in the non-proliferation and nuclear industry communities. This partnership has thrived and been expanded to include other key constituencies under the Global Nexus Initiative . But, the future effectiveness of global nuclear security requires more.

Strengthening global nuclear security requires that its agenda be expanded to enhance its relevance. The protection of nuclear materials and infrastructure from terrorist attack and exploitation remains vitally important. But the nuclear security agenda has become larger and more diverse in recent years.

Advances in emerging disruptive technologies including computing and cyber, materials science, UAVs and drones, artificial intelligence, and exotically fueled advanced reactors are rising security imperatives. The global community is not well prepared to respond to the implications of these new technologies. The negative consequences of that approach have already been demonstrated in the cyber security area.

The future of global competition is going to be defined by the race for technological superiority. The U.S. and its allies have some significant advantages at the moment. But they are failing to fully understand the important nexus of emerging and nuclear technologies. This poses a new and significant nuclear security challenge.

The global policy guardrails for these issues are going to be significantly influenced by those nations that are quick to analyze the implications and act to develop the required frameworks. This is especially important because the major nuclear powers are suspiciously circling one another on these and so many other issues. Creating international consensus in those circumstances will be very difficult.

There was a failure to fully exploit the potential of the last major push to strengthen nuclear security. That was a significant disappointment. The danger has now morphed and become more complex. Fading away from this challenge will be a significant risk to future global security.

Injecting Reality into the Nuclear-Climate Conversation (July 12, 2019)

In the hyper-polarized political, media, and factual environment in which we are increasingly living, it is rare to find an insightful, balanced analysis on the pathway to effective global decarbonization that cuts across parties, tribes and ideological battle lines. Bloomberg NEF, has delivered this message and it is worth reading and acting on, whether you are alarmed about climate change or just support clean energy and global stability.

The overriding reality is that the scale of the global decarbonization challenge is massive, whether the goal is to achieve it by 2030, 2050, or the end of the century. The most salient fact is that the electricity sector remains at the heart of any emissions reduction effort. The most challenging statistics are that fossil fuels account for 63% of electricity generation and "over the past 18 years, global energy-sector carbon emissions grew by more than 40%."

The Bloomberg analysis is brutally honest in its assessment of how these challenges can best be addressed.

Energy efficiency is important but likely inadequate based on its past history of reducing energy intensity.

Wind and solar power, after an investment of $3 trillion, provides a combined 7% of global electricity at present. To deliver a 20%-45% decrease in emissions via wind and solar, you would need to "add two to four times as much capacity in the next decade as has been added in the last two decades." Other scenarios require even greater volume, perhaps up to 5-10 times the current global capacity of wind and solar. This is not to say that it can't be done. But it hasn't yet been demonstrated.

The underlying theme in the Bloomberg analysis is that the world cannot afford to abandon current or future nuclear power if it hopes to meet its climate objectives. But, even with this positive assessment the future prospects for nuclear power are not on a trajectory for success.

The situation in Europe provides some instructive comparisons. The U.K. cut in half its CO_2 intensity by ramping up renewables to 34% of its power and maintaining its nuclear capacity. By contrast, Germany, in 2018 provided 36% renewable power but is shutting its nuclear power plants, resulting in CO_2 intensity that is twice that of the U.K. France, which

produces 72% of its power from nuclear generation has a CO_2 emissions intensity of less than half the U.K.

Sounds compelling, but there are serious challenges. In the U.S., for example, existing nuclear plants are shutting down because they cannot economically compete with cheap natural gas. Without a prioritization of emissions reduction, low cost wins in many American energy markets. There also are nuclear decommissioning and waste costs, which are significant.

Further, the cost to build new, large-scale nuclear plants in the U.S. or Europe are rising substantially and the political appetite for supporting these installations has been diminishing for decades. The price to build two new reactors at Vogtle in Georgia has doubled. The budget for the new Olkiluoto plant in Finland has tripled. They, like the Hinckley C plant in the U.K., are years behind schedule. Even in a major nuclear growth market like China, costs are rising, there is political and regulatory caution, and renewables are outpacing nuclear generation.

The question is whether small modular and next generation advanced reactors can help meet the world's clean energy challenge while keeping costs in check, offering safe operation, and preventing nuclear weapons proliferation. There are many challenges to overcome, including winnowing the field from dozens to the most promising designs. It also is essential to construct a free market economy financing model that will allow OECD nations to effectively compete for this new nuclear market against the state-backed companies in Russia and China and thereby blunt their geopolitical ambitions. And, a regulatory and governance system must be created that will ensure safety, prevent proliferation, and strengthen security .

There is a lot at stake in how the world manages its trajectory toward zero carbon. As Bloomberg notes, there are "tough choices and compromises to make." A good start is to take a break from the insular, validating bubbles in which many now live and get a grip on reality . There is no one silver bullet technology that will solve the problem. But, while the ideologues fight, the problem grows.

Embracing Risk to Position Next Generation Nuclear Energy (June 28, 2019)

The 1960's space race to the Moon was an extremely focused, ambitious, and risky national objective. That same level of national motivation and risk taking now needs to be applied to the clean energy technologies that will power the future. This is particularly important for underappreciated, emerging technologies that can complement renewable energy sources like small, advanced nuclear reactors.

Unfortunately, it is almost impossible to imagine the U.S. government laser focusing on this national, technical, and humanitarian clean energy objective. This is one example of what the government getting serious could look like. The more likely long-term scenario is dramatic but incremental change that scales up renewable energy while still leaving the world about 40% powered by fossil fuels in 2050.

The U.S. achieved Moonshot success because there was intense focus by the U.S. government, large expenditures on uncertain new technologies, partnership and innovation from the private sector, and personal risks taken by astronauts.

The New York Times reported that despite their national celebrity, astronauts could not get life insurance. So, they created "insurance covers" including signing commemorative envelopes for their families to sell if their lives were lost on a mission. Judged by this remarkable and noble yardstick, America's official risk appetite seems to have significantly decreased since Neil Armstrong became the first person to walk on the Moon in July 1969.

But as a new report makes clear, the U.S. has resurrected public-private partnerships to help it recover from its lagging position in space launch. The support that the U.S. provided to Space X has allowed it to become a global space launch leader, cutting deeply into the significant lead that Russia had just 5 years ago. The key to this success was that the federal government provided "cost sharing for research, development and demonstration, and act[ed] as a first customer."

The U.S. and its allies find themselves in a similar position in the civil nuclear environment. Once the world's leaders in the development, deployment and export of zero-carbon nuclear energy, they now find themselves fighting for a seat at the nuclear export table with a dominant Russia and an emerging China.

That situation can be reversed as new, small, advanced technology reactors emerge as the next wave of nuclear power. But much more needs to be done to underpin this repositioning.

The Russian and Chinese governments are actively supporting their next generation nuclear technologies and linking them to their geopolitical ambitions. It is difficult for any private sector company to effectively compete on this severely tilted state-dominated playing field. And the U.S. and allied governments are slowly coming to realize the implications of being on the sidelines. The loss of the next generation nuclear market to these two authoritarian nations will have significant geostrategic, global security, and non-proliferation consequences.

But, the private-public formula that made Space X soar is not yet being applied in advanced nuclear. The urgency is lacking despite a serious bipartisan push from Congress . Instead, there is a small stream of federal financing for advanced nuclear projects, a deferral to the private sector, and an unwillingness to plot a strategy for success.

But venture investors are not going to put real money into these technologies without a clear signal of long-term, deep-pocketed commitment from the U.S. government. As Bill Gates has made clear, private investors will match or exceed the government contribution but it must be much more substantial.

And, the U.S. will need to team up with its allies, particularly Canada, Japan and South Korea to pool resources, talent, and test beds and collectively develop effective governance structures for these new technologies.

Fifty years ago, Neil Armstrong stepped on the Moon. It was the culmination and validation of a decade of enormous risk taking. Over the next fifty years, one of the world's greatest human needs is to become carbon free. Achieving that essential goal will once again require embracing risk.

Advancing Nuclear Innovation: Responding to Climate and Security Challenges (June 17, 2019)

The Global Nexus Initiative (GNI) published an important and groundbreaking new analysis of the implications of advanced nuclear reactor technologies for responding to climate change and strengthening global security. Its findings are significant for U.S. and international policy makers because as the Washington Post pointed out on the day of the report's release, "nuclear remains a critical source of low-carbon emissions baseload electric power." Previously, the International Energy Agency noted that it will be very difficult to meet the Paris agreement's carbon dioxide reduction goals without expanding nuclear power.

The GNI report assessed advanced nuclear power from four perspectives: climate, non-proliferation, security, and geopolitics; and it proposed concrete, actionable recommendations. There were five primary results.

Advanced reactors are an important component of the global strategy to reduce carbon emissions to zero. Carbon emissions have climbed to their highest level ever based on NASA's assessment and are relentlessly rising. The space agency notes that fossil fuel burning at a business-as-usual rate will drive CO_2 levels to an extreme level. In order for advanced reactors to make a timely contribution to meet global energy and climate goals, they must be ready for deployment in the 2025-30 timeframe when older larger reactors likely will enter an accelerated decommissioning phase. The Congress is pushing these advanced technologies forward in rare bipartisan legislation.

Vital to the deployment of any civil nuclear technology is the prevention of nuclear proliferation. GNI determined that it had "high confidence" that any of the advanced reactor concepts can be effectively safeguarded to prevent nuclear weapons proliferation. But those safeguards measures will very likely be different from those applied to light-water reactors (LWRs). To ensure effective proliferation prevention, the safeguards must be designed into the reactor. This will avoid the difficult process of retrofitting a safeguards system to a new technology. However, in order to achieve "safeguards by design" the reactor development community and the experts from the International Atomic Energy Agency (IAEA) will need to begin substantive discussions quickly and engage often.

Also critical for advanced reactors is their ability to operate securely and prevent insider tampering and terrorist exploitation. A challenge for advanced reactors will be ensuring nuclear security if they are deployed in remote locations. Because of their smaller size, decreased power output, and industrial process applicability, these reactors may be used in developing economy countries and for processes including water desalination. Many of these nations are located in unstable regions, face terrorist threats, and are ranked low on the scale of effective governance .

As a result, fortifying global nuclear governance is a key recommendation from GNI. Advanced reactors present some unique new challenges and the international community needs to ensure that the nuclear governance system is strengthened to support these technologies. A "race to the bottom" on nuclear governance must be avoided. It cannot be a consequence of the conflict over market share among exporting nations. The effectiveness of the governance regime will have a direct impact on public confidence in these new reactors. A key part of that process must be comprehensively assisting nations interested in the new reactors so that they are prepared for their deployment and operation. This will require that exporting nations work with the IAEA and supplement their current programs.

The future of nuclear governance for advanced reactors will be directly impacted by the nations that are exporting these technologies. The geopolitics of nuclear export is a rising issue as the U.S., Russia, and China compete more intensively on the global stage. There are significant regulatory, safeguards and security developments that will be required for advanced reactors. Historically, the nations that dominate the export market have an outsized influence on these issues; in the past that had been the U.S. and its allies. Now, Russia is dominating LWR exports and China is looking to close that gap. The fight for the advanced reactor market is just beginning and which countries take the lead in that battle will have a direct influence on global security.

The world is at a unique point and facing numerous new challenges. A business-as-usual approach in any area of global importance is inadequate. Addressing the real-world challenges of this century requires creativity and measured risk taking, not a retreat to traditional comfort zones. A key part of this new environment is technological competition, including on the development and deployment of clean and distributed energy systems. This includes safe, secure, and proliferation resistant advanced nuclear reactors. The GNI analysis offers the first publicly available, comprehensive assessment of the safeguards, security, and geopolitical implications of these new reactors.

Failing on Climate and Losing on Geopolitics (May 16, 2019)

It has been a long time since anyone believed that Washington D.C. was America's hub of innovation and public policy creativity, but it has remained a place where national security matters. Unfortunately, as the parameters of American national security continue to cycle through a rapid evolution, our political leaders are too divided to clearly focus on the new challenges. This point is driven home in detail in a new book about a resurgent Cold War with Russia and China.

Energy and technology are now driving an interrelated series of new challenges. And America's global leadership is being systematically threatened, eroded, and intentionally ceded. A critical convergence of new issues revolves around low carbon energy. It is vital for addressing climate change, maintaining international influence, and strengthening global security.

But, the political debate on how to achieve a carbon-free future is just not serious. This despite the fact that the steadily increasing concentration of carbon dioxide in the Earth's atmosphere was last seen 3 million years ago .

The administration doesn't want to acknowledge the climate problem and the Democrats have put forth green plans that may satisfy some of their voters but are controversial and perhaps ineffective. Just the mention of a balanced climate policy that includes fossil fuel carbon capture and nuclear power creates a wicked backlash despite the fact that both are part of a realistic solution set.

The problem doesn't just exist at the federal level. Last week, the state of Pennsylvania threw in the towel on the remaining nuclear reactor at Three Mile Island despite the fact that it accounts for more carbon free energy than all the combined renewable energy sources in the state. It along with other reactors was being considered under zero-carbon energy legislation that would have propped up profitability. Similar legislation has passed in Illinois, New York, Connecticut and New Jersey as part of their zero-carbon objectives. Natural gas will substitute for the carbon free energy now lost to Pennsylvania.

Internationally, America's competitors for global influence are reveling in the decline of its nuclear capacity. And, domestically, the Congress is making their job easier because of

extreme skepticism of the administration and anger at Saudi Arabia. Legislation has been introduced to restrict the use of State Department funds to support the sale of nuclear technology to Saudi Arabia and to require a reporting to Congress on every application for nuclear export under Part 810 dating back to the Spring of 2015. Part 810 applications are needed to even begin discussion on nuclear technology with another country. They do not allow for the sale of nuclear materials or building of reactors. That is provided for under a nuclear cooperation agreement that must be submitted for congressional review.

Further complicating the situation is an extremely counterproductive fight between the U.S. and South Korea on whether a new version of the Korean APR-1400 nuclear reactor still contains American intellectual property and componentry. At stake is whether that reactor is subject to U.S. export laws. In an environment where it is estimated that Russia and China already have 60% of the global nuclear market, driving a wedge between two key nuclear export allies is politically, economically, and geo-strategically suicidal. Yet, the conflict has been dragging on since last year with no solution in sight.

There is a global leadership vacuum in the changing global security environment. The challenge from China and Russia is real and multifaceted. Key existential dangers like climate change and nuclear security are growing worse. These issues are deeply interrelated. But you would never know it if you looked for the innovative policies that are required to meet these realities.

Nuclear Security 3.0 (May 4, 2019)

There is no nuclear infrastructure now in Sri Lanka, but that nation will have a significant impact on the future of nuclear security. That is because, in the wake of the horrific terrorist attacks on its churches and hotels, former Admiral James Stavridis has declared that the world is now facing Terrorism 3.0. That means that global nuclear security policies and approaches need to be rebooted to Nuclear Security 3.0 to match the threat.

Stavridis notes that Terrorism 3.0 is defined as "globally dispersed, highly lethal, financially capable, deeply innovative," effectively using the internet to organize, and "seeking over time to obtain weapons of mass destruction" including cyber and radiological.

This danger is paired with dramatic innovation in weapons delivery technology. If the battlefield of the future will be defined by "swarms of intelligent machines [delivering] violence at greater volume and high velocity than ever before," then it can be projected that some of that technology will become available to terrorist organizations over time.

The nuclear security issue at its core is about preventing at nuclear facilities outsider attacks, insider sabotage and terrorist access to fissile and radiological materials. Each of those objectives is under stress from these terrorist and technological evolutions.

The cybersecurity challenge in the nuclear field is already well established, and while steps are being taken to address it, they are slow, reactive, and uneven. If swarms of intelligent machines deliver high-velocity violence in the future, it is not clear that the protective forces at nuclear facilities will be prepared for this, especially those that rely on local police as the response force. As small, geographically dispersed nuclear reactors make their way onto the electricity grid of developing nations, they must be adequately protected from potential terrorist exploitation.

The U.S. spearheaded a 50 plus heads-of-state Nuclear Security Summit process from 2010-16 to strengthen global nuclear security. Unfortunately, none of these issues – cybersecurity, intelligent machine weapon delivery, or advanced reactors – were on the agenda. This is a testament to how quickly the nuclear and technology environment is evolving. But it also was significantly influenced by the reluctance of the participating nations to move beyond prevailing nuclear threat profiles and protection standards. There was a severe lack of imagination and political courage.

The summits ended with a bridge to nowhere, and predictably the nuclear security issue has dropped like a rock on the global security priority list. The global security system largely remains a patchwork of uneven effectiveness governed by national regulations.

Like the protection of all vulnerable critical infrastructure, the nuclear security chain is only as strong as its weakest link. As the nuclear power environment evolves, with more floating reactors , deployments in contested territories , and remote siting of small reactors, new nuclear security challenges will arise.

The absence of U.S. leadership in response to these major evolutions is extremely problematic. Its main competitors, Russia and China, are not enthusiastic about highlighting potential vulnerabilities resulting from their technology. The global nuclear watchdog, the International Atomic Energy Agency, is hamstrung by the need for consensus among its members to make major security changes, and even those are non-binding.

If terrorism 3.0 is now a reality then we need to advance to nuclear security 3.0, and quick.

Disentangling Saudi Reactor Reality (April 18, 2019)

Game of Thrones apparently has switched locations from the Shivering Sea to the shimmering sands of Saudi Arabia. This is the unavoidable impression offered by a stream of speculation and palace intrigue over the potential sale of two nuclear reactors to the kingdom.

There are several threads that run through this highly-charged nuclear debate that should be disentangled. One is the belief that the U.S. is trying to end-run its own non-proliferation standards and approval processes. Second is the questioning of Saudi Arabia's desire for nuclear power. Third are the implications of Russia and China becoming the kingdom's nuclear supplier. And fourth is the value of the technology and standards of the U.S. and its allies in these nuclear builds.

The U.S. has had a trifecta of miscues in the Saudi process, providing ample fuel for critics.

It is clear that there was a very misguided effort in the early months of the new administration to get approval for a document that outlined how the U.S. could supply technology to Saudi Arabia. There was a suggestion that this could be done without consulting Congress. That would be illegal and also easily detected . The Congress is not blind, and whistleblowers would have come out of the woodwork, as they already have, to draw attention to efforts to circumvent congressional authority. The White House document was never acted on, but its existence cast a long and lingering shadow over U.S.-Saudi discussions.

That specter intensified because the administration took the unusual step of giving the Department of Energy rather than the Department of State the lead responsibility in negotiating the required 123 nuclear cooperation agreement. That upset the regular order in Washington and raised concerns about the forcefulness with which the U.S. would pursue strong non-proliferation commitments from Saudi Arabia. But high-level administration officials so far have made the right responses, pledging their commitment to achieving the Gold Standard or getting close to it.

A third strike for the administration's strategy was its decision not to make public, or to brief Capitol Hill on, the approval of seven Part 810 export applications from U.S. companies. These are necessary to initiate discussions on nuclear technology with Saudi officials. These companies were playing by the rules, not trying to circumvent them. Even

though they were not approvals to transfer technology as some have suggested, the opaque process fed into the negative narrative. This has led to a congressional backlash that, if acted upon, will further hobble already limping U.S. nuclear exports.

Complicating the situation are the serious mistakes that the Saudis have made. They may have legitimate reasons for wanting nuclear power. Their first step across the civil nuclear threshold will come later this year with the completion of an Argentina-produced research reactor. But statements about matching a potential nuclear weapons program by Iran, pushing back on U.S. nonproliferation demands, and an unwillingness to accept the IAEA's more intrusive inspection regime have raised real questions about their commitment to the peaceful use of nuclear power. The Khashoggi case has further curdled congressional support for the current Saudi leadership. This collectively has impeded the completion of a U.S.-Saudi nuclear cooperation deal and led to calls to end the negotiations.

Eagerly eyeing this smoldering landscape are Russia and China, both still in the running for Saudi Arabia's business. Neither is limited by a critical Congress or the need to adhere to America's high non-proliferation requirements. And both are financially backed by their governments and fully integrated into their geostrategic objectives. In the Middle East, Russia already has a nuclear foothold in Iran and an agreement with Egypt to build four large nuclear power plants among numerous other MOUs. Handing the Saudi nuclear business to either of these authoritarian governments will be self-defeating for the U.S., its allies, and their geopolitical objectives.

The other active nuclear supplier in the Middle East is South Korea, which is building four reactors in UAE that contain substantial U.S.-origin technical content. While Korea and the U.S. are now competing for the Saudi reactors, the kingdom's decision to push back its decision on the ultimate winner until 2020 (and likely after the U.S. presidential election) presents the time and opportunity for the U.S. and Korea to explore a joint reactor offer that would benefit both countries and global security. But it will take a significant political and diplomatic effort to reconcile the hard-charging corporate competitors in both countries to make this work.

The Saudi decision to pursue nuclear power has generated concerns, conspiracies, and the conflation of many separate issues into one dark narrative. But the Saudi delay in making a final decision has opened the opportunity for a rethinking of the competition. The U.S. and Korea together can counterbalance the influence of Russia and China in the region, offer some solace to a skeptical Congress that the U.S. is not going it alone, and provide a blueprint for future fruitful joint nuclear initiatives. Their technical capabilities are complementary, they have a collaborative nuclear history, and their democratic and nuclear

security credentials are an important barrier to the potential for proliferation. The real game is preventing a nuclear arms race in the Middle East.

China's Nuclear Export Strategy Clarifies and Concerns (April 5, 2019)

It has been clear for some time that China is angling to become the Amazon.com of nuclear commerce in the 21 st Century and a key part of its approach is nuclear reactor exports under its Belt and Road Initiative. This reality was highlighted by the head of China's National Nuclear Corporation (CNNC) at a recent nuclear summit. The Chinese-designed reactors for export span current light-water technology through next-generation advanced reactors.

China is pursuing a three-pronged strategy.

First, there is its own significant nuclear building program, that will make it the largest nuclear fleet operator by mid-century. At present, China accounts for about one-fifth of nuclear capacity under construction around the world.

Second, it is engaged with the U.K.'s regulatory authorities on its indigenous Hualong One reactor design. If approved, there is the potential to build and operate one and perhaps several of these reactors in the U.K., thereby proving its operational capability in a high regulation country and strengthening its export appeal.

Third, through its One Belt, One Road Initiative and Made in China 2025 programs, China is seeking to dominate advanced nuclear technology in the developing world. A high-temperature gas-cooled reactor is already under construction in China and it has committed $3.3 billion to a molten salt reactor test bed in the Gobi Desert.

China may also copy Russia's successful foreign sales playbook and offer to finance, build, operate, supply fuel, and take back the spent fuel from its exported reactors. This is a potentially potent challenge to Russia's current domination of the international reactor market because China has considerably more money available to lend to purchasers. China also could ratchet up the competition with Russia if it builds an industrial scale spent fuel reprocessing plant.

China's President Xi and France's President Macron met at the end of March to further discussions on potential cooperation on the reprocessing plant. There is a long-standing civil nuclear relationship between France and China dating back to the early 1990s.

While this plant could be used to manage China's own considerable spent fuel it also could reprocess spent reactor fuel from its exported reactors. That raises an important question about which country would own and have access to the separated plutonium produced from the fuel treatment process. The resulting "reactor grade" plutonium has been proven to be useable in a nuclear explosive .

This plutonium separation issue could be important in the volatile Middle East if Saudi Arabia chooses China as its supplier for the two reactors it plans to build. There is also a strong relationship link between Saudi Arabia, Pakistan, and China that raises uranium enrichment questions.

The U.S., Russia, France, and South Korea are the other competitors for the Saudi's business. But, the U.S. Congress has taken a number of actions to thwart the sale of U.S. technology in part because of legitimate weapons proliferation concerns, anger about Saudi actions, and suspicion of the Trump administration's handling of the negotiations.

But it is important to realize that the default alternative to America's technology is not South Korea's. Almost certainly South Korea would not be able to export the reactors it is currently building in the UAE without a U.S.-Saudi 123 nuclear cooperation agreement that would pave the way for U.S. technology export. There is significant U.S. technology in the Korean reactors. Without an agreement and its Congressional approval, France, China and Russia are the best positioned bidders for the Saudi's business.

The geopolitics of the global export nuclear market are shifting, and new dangers are emerging that may not be adequately apparent to, or appreciated by, nuclear experts and policymakers. Russia is dominant now, but China is making all the moves that are required to unseat it. Both nations' nuclear industries are state-controlled and fully integrated into their geostrategic objectives.

The U.S. is not in a strong position to stand alone in the nuclear market. Its industrial base has atrophied, its political institutions are divided and distrustful, and its export financing is in shambles. It can take actions to fix these flaws and it can partner with one or more close allies on sales opportunities. However, a decision – through intention or indifference – to fade away from the nuclear export arena will have consequences for the intensifying great power rivalry, the ability to win the vital global technology competition, and the future strength of global nuclear non-proliferation and security.

The U.S. is Slowly Getting in the Game (March 22, 2019)

The U.S. has woken up to the fact that Russia is aggressively advancing on the nuclear export playing field, that China is not far behind, and that this will impact American international influence and objectives for decades to come. Nuclear export is more than an economic issue. In this century it is about the formation of the geopolitical and geostrategic landscape and the preservation of strong nuclear non-proliferation and security standards.

Last month one of the State Department's big thinkers on nuclear issues outlined a new approach to nuclear exports that included the use of "non-binding bilateral political arrangements more akin to a memorandum of understanding (MOU) than a full 123 [agreement]." The goal is to connect with countries that are considering nuclear power and help them build the hard and soft infrastructure that is required to effectively operate the technology. If the country decided to move forward and desired U.S. technology, a formal 123 nuclear cooperation agreement could be negotiated and sent to the Congress for approval.

Undergirding this evolution in approach is a rejection of the "business as usual" model that allows authoritarian rivals of the U.S. to undercut the important non-proliferation and security limits that it incorporates into its nuclear cooperation agreements. If the U.S. cannot reach a 123 agreement with a country America's strong requirements can be circumvented.

This change in policy will attract attacks because it may look like a backtracking on the 123 process. But it is a reflection of reality. The international nuclear game has significantly changed, and the U.S. is playing catch-up. Russia has over 40 nuclear export MOU's in place around the world, and it controls half of all reactor construction and fuel supply agreements. China has a three-pronged strategy for civil nuclear domination that includes building reactors in the U.K., one of America's strongest allies.

The interplay between nuclear export and non-proliferation is highly charged, and it has been a source of intense conflict even with strong U.S. allies like Japan and South Korea.

Recently the focus has been on the competition to supply Saudi Arabia with two nuclear reactors. The U.S. is a contender along with Russia and China. But the Saudis are not making it easy to make a deal. There is pressure to apply the Gold Standard to any U.S.-Saudi deal,

which would ban the provision of uranium enrichment and spent-fuel reprocessing technology. If the Saudis pick a nuclear partner that is an American geopolitical rival, that will leave the U.S. on the sidelines, along with the strong non-proliferation and security standards it has long championed.

It is not clear if the consequences of failure in this challenging balancing act are well understood among nuclear policymakers and influencers. Certainly a tantalizing catnip cocktail of factors has led to questionable speculation that the administration is trying to circumvent the Congress and provide Saudi Arabia with the tools to manufacture nuclear weapons.

The reality is that nuclear export in the 21st Century is about more than energy technology transfer. With Russia and China gobbling up the current global nuclear market and making plans to dominate next-generation reactor technologies, the U.S. and its allies must adapt quickly and compete much more aggressively and nimbly. The alternative is to cede the future control of civil nuclear power to two countries that do not like to play by the rules.

Pentagon Preferences Will Impact Next Gen Nuclear (March 7, 2019)

The Pentagon is increasingly interested in small mobile nuclear reactors. It is reasonable to research this as a response to the need for reliable, portable, carbon-free power for bases and the battlefield. But, while the U.S. military usually gets what it wants, we should avoid an atomic flashback to the era when the needs and decisions of the nuclear Navy determined the designs of civilian nuclear plants. And we should use this opportunity to require that the defense department lead on strong nuclear governance, non-proliferation and security.

Three questions arise. First, will DoD drive next generation reactors more effectively into the global market? Second, will DoD dominance limit the future opportunity of more exotic advanced reactors? Third, is this a good idea for global security?

Early this year DoD issued a Request for Information (RFI) on small mobile nuclear reactor designs that can power forward bases. This was predicated on a 2016 Defense Science Board (DSB) task force report that examined the potential for small modular reactors to support forward and remote operating bases. That was spurred by language in a 2014 congressional defense bill. DSB recommended that the Army be designated as the leader for the assessment of these nuclear energy sources. Last year, the Army released a study on the benefits and challenges of mobile nuclear power plants that examined political, economic, social, technological, environmental, and legal/regulatory (PESTEL) issues.

Based on both reports, there is still a lot of work to be done on this nuclear option. But if DoD proceeds, will it propel the next generation nuclear industry?

The Army report clearly indicated a preference for very small modular reactors that are light-water cooled. There are examples of these reactors that are in various stages of design. Interestingly, the Army report notes that it does not have an interest in modifying reactors designed for commercial use for its military purposes because of the need to "ruggedize" the reactor. The RFI stated that it would down select 3 technology options and according to the Army Times, it seeks a demonstration by 2023 and an initial deployment at a remote site like Alaska or Guam.

Will the DoD preference for SMRs stilt the dynamic advanced reactor field?

At this point, the U.S. government has made a decision not to pick a winner among advanced non-light-water-cooled nuclear designs, but is supporting the R&D infrastructure for the burgeoning industry. However, the Army report considered advanced reactors using "more exotic cooling and/or moderating systems in their operation (e.g., liquid metal, molten salt, and high temperature gas)" to be a decade further behind SMRs and therefore, not ready for their needs. This assessment could influence the investment incentives for the more exotic technologies and impact the global market interest in them.

If the Pentagon proceeds, how will this impact global security?

To their credit, the DoD reports are not downplaying the potential risks and challenges associated with the field deployment of small mobile reactors. The Pentagon notes that land-based reactors would require additional legal authorities to operate in foreign nations, that regulatory authorities will have to be established or revised, and that there are safety, security and nonproliferation concerns.

The DSB task force did not consider any reactor designs using nuclear weapon grade uranium as a fuel in order to decrease proliferation dangers. And it did note that, if breached, the reactor could become "a dirty bomb." A number of these challenges were further detailed in a new article opposing the deployment. But both the DSB and Army determined that on balance there was value in moving forward the process of further assessing small mobile reactors.

The Pentagon has a history of developing and driving technology forward for military applications that then result in significant advances for the civilian economy. The internet and GPS are two prominent examples. The military's interest in next generation nuclear power can help to propel its preferred technology forward. But it also can limit the opportunity and financing for designs that it does not want. The Pentagon is a significant financial and political player and its preferences will weigh heavily as the technology sorts out. But while that happens it should lend its influence to ensure that the non-proliferation and security system for next generation nuclear systems are robust and effective. The last thing anyone needs is a radioactive bullseye on the battlefield.

A Next Generation Nuclear Alliance (February 21, 2019)

Will Saudi Arabia's future nuclear power program include a partnership with China and Pakistan? Or will the U.S. and its allies offer the Saudis a creative proposal that meets its energy needs and keeps a tight lid on nuclear weapons in the Middle East and beyond? A *Next Generation Nuclear Alliance* could meet these goals and check the growing domination of China and Russia in civil nuclear power deals around the globe.

The stakes couldn't be higher. A miscalculation could upend decades of non-proliferation progress.

Interviews on the margins of the recent Munich Security Conference sharpened the standoff between the U.S. and Saudi Arabia on their potential civil nuclear cooperation. A new congressional report raises questions about the depth of the political support for the U.S. alone to provide nuclear technology to the kingdom.

The U.S. is rightly pushing to ensure that the Saudis will not be able to convert their peaceful nuclear technology for weapons use. But the Saudis know that the technology they want is available through state-owned companies in Russia and China, countries that prize geopolitical influence as much as proliferation prevention. Those nations can offer incentives to reactor buyers that private companies and democratic countries cannot match.

Russia's strategy is working - a recent analysis stated that it currently controls 50% of the light-water reactor (LWR) construction and fuel supply market, while the U.S., Korea, France, Japan and China combined account for another 40%.

China is rising as a supplier while the U.S. is retreating - a trend some U.S. companies are trying to reverse . A look at China's proposed role in the U.K. nuclear program underscores its long-range nuclear supply strategy . It wants to prove its LWR technology in a high regulation country and then market it globally with attractive financing and geopolitical strings .

This advantage could carry into the market for next-generation reactors, which are smaller and less costly than LWR designs. Here too, state-backed companies will have an edge

because of their demonstration test beds, full range of financing, and commitment to integrating nuclear power export into their geopolitical strategy.

The domination of one or two countries in the next-generation reactor market will have serious implications for the governance structure for these nascent technologies. Historically, the dominant nuclear supplier significantly influences the non-proliferation, security and safety regimes. If it is Russia and China, will they prioritize these values to the same degree as the U.S. when it was the leader?

The very real potential for authoritarian nations to control international nuclear commerce in the 21st century should worry the U.S. and its allies and force them to rethink whether their cutthroat competition with one another still makes sense in the current international environment. A consortium model may offer a much better and more realistic option.

A *Next Generation Nuclear Alliance* beginning with the U.S., South Korea and Canada, and incorporating Japan, France, the U.K., and perhaps India could offer a mix of talents and capabilities that make this grouping a potentially potent counterweight to the nuclear supply advantages of Russia and China. One way to think about it is that some nations are better at the hardware of nuclear power – hot production and supply lines, while others excel at the software – design, governance, operations, regulation, and education. Together they can offer a package of technological, governance, financial, and security advantages that the international community may find very attractive.

There should be no mistake, a *Next Generation Nuclear Alliance* is a difficult, complex process to contemplate and there's no shortage of cold water that can and will be aimed at the idea. But if democratic values, governance leadership, and global security are nuclear export priorities in this century then it may be essential to pursue it.

Gates Goes to Washington (February 7, 2019)

Bill Gates recently visited Washington and invited the U.S. government to join in a vital joint venture to expand investment in next generation nuclear power, a technology he believes is " ideal for dealing with climate change."

Gates became a billionaire by predicting and serving the explosive market for personal computer software. His prescience helped catapult the U.S. as a global technology leader and both he and the country benefited greatly. Now he is a major investor in climate change response technologies, including an advanced reactor that is under development. He is willing to bring billions of his own money and raise even more from investors for this research area if the government significantly expands its commitment and financing.

The question is whether Washington can seize, or even see, the opportunity Gates has offered amid a striking crisis of strategic thinking in the Capitol. It may be difficult. We have an administration that is highly conflicted on the climate problem, freshman House members that see self-made billionaires as the public's enemy , and enthusiasm for a nascent Green New Deal that is reality -challenged.

Gates' initiative has already been doused with cold water . But next generation nuclear power is actually one of the few bipartisan issues in Washington that he has a foundation to build upon.

However, the future of nuclear power is burdened with an outdated policy framework and challenged by the expectation that market mechanisms alone can determine which energy technologies best serve the strategic goals of the nation.

An updated policy framework for the future of nuclear power has been developed by PGS. It identifies the contribution to reducing atmospheric carbon as a core argument for the technology. But the climate benefits alone are not sufficient to assure nuclear power's future. It needs to be paired with three other key benefits to the U.S. – strengthening geopolitical competitiveness, prioritizing innovation and technology, and leading on global security and governance. Together those four pillars create a compelling case that is difficult to deny.

The soft spot for nuclear power is the financial challenge . Current reactors are very expensive, next generation reactors are still in the research phase, and finding private

financing for either is tough. However, the time may now be right to rethink whether a purely market approach to nuclear finance is appropriate, just as Gates proposes.

Countries seeking to import major nuclear technologies want governments as participants in the deal. This was true in the case of the reactors South Korea sold to the UAE. It may be replicated in the vendor decision to be made by Saudi Arabia. Government financial backing is an integral element of Russia's reactor export strategy and it is leading all other nations in this enterprise. China is following suit. The potential domination of the global nuclear market by two geopolitical competitors is creating mounting concern in the U.S. and allied nations.

The struggle over nuclear financing in the U.K. may offer a model for future private-public partnerships. In order to try to save two new reactors to be built as part of its carbon reduction plan, the U.K. government was willing to take a one-third in equity stake in the project and provide the debt financing to complete the construction.

Despite its appeal that offer didn't work. But it did confirm a political reality – when a nation thinks a technology is in its core national interest it will find the funds for it. This has been the case in national defense for decades.

What Bill Gates is offering to Washington's warring political class is an opportunity to join together in a large private-public initiative that is clearly in the nation's interest. If successful it can contribute to carbon reduction, strengthen American technological innovation, and ensure that the country remains a leader in the global effort to prevent nuclear proliferation and improve nuclear governance.

This is a big picture proposal that rises above the small ball, zero-sum mentality that now dominates and debases our national debates.

Searching for National Intelligence (January 24, 2019)

The newly released National Intelligence Strategy identifying the top threats to the U.S. and the Department of Defense's (DoD) report on the military impact of climate change are a stinging and sobering one-two punch from the 21st Century. But, our national leaders in the White House and on Capitol Hill are too busy engaging in futile political trench warfare to notice or act.

The intelligence assessment explicitly states that, "the strategic environment is changing rapidly, and the United States faces an increasingly complex and uncertain world in which threats are becoming ever more diverse and interconnected." The challenges to the established international order are coming from Russia and China but also from the "increasingly isolationist tendencies in the West".

Emerging technologies and cyber threats are identified as a dagger threatening the heart of American life, "critical infrastructure, public health and safety, economic prosperity, and stability." Climate change, migration and increasing urbanization are straining the capacity of all governments to operate effectively and fracturing societies.

DoD's report is a detailed litany of the challenges climate change is posing for military bases and operations. It references but does not project how much worse the impacts will be as the climate crisis intensifies in coming decades.

The Pentagon is examining how it can reduce its carbon footprint and is considering small scale next generation nuclear reactors as one response. That could offer the added value of using military reservations as test beds for advanced reactors. And both the Congress and the president have approved legislation that can spur the development and deployment of these reactors. But that only addressed a part of the problem. What's missing is a "whole of government" approach.

PGS is proposing a Next Generation Nuclear Alliance with countries that support strong global security and non-proliferation standards and that are prepared to respond to the challenges of emerging disruptive technologies on nuclear infrastructure and operations. The diverse, multidisciplinary partners of the Global Nexus Initiative also are assessing and making recommendations for how smaller advanced nuclear reactors can be effectively safeguarded and secured in the face of rapidly evolving global changes and challenges. It is

these new “break the mold” partnerships and approaches that are necessary to manage the threats of this century.

The Balkanization of Washington’s policymakers and its policymaking apparatus – both official and non-governmental – is a significant impediment to effectively managing this new fused-threat environment. And that leaves many who are trying to push the system to wake up and adapt to these new realities unfortunately left to continue to search for signs of national intelligence in America.

Green New Deal Needs to Get Real (January 11, 2019)

The new democratic majority in the House of Representatives is pressing for action on a "Green New Deal" (GND) that would significantly cut carbon emissions and support clean technologies. At least in its initial iteration, its centerpiece is reaching 100 percent carbon-free electric generation in 12 years – but only using wind, solar and other renewable sources.

This GND idea is a significant opportunity to tackle multiple aspects of the climate challenge, but it can't be effective and attract the scale of political and public support that it needs if it is unrealistic.

Nuclear power doesn't make the GND list, even though it provides 56 percent of the emission-free electricity in the U.S., roughly triple the amount generated by hydropower and wind, and almost 19 times the amount produced by solar power.

New York Times columnist Tom Friedman, who first suggested a GND a decade ago, this week offered his vision for a zero-carbon electric grid powered by solar panels, windmills and batteries.

But, as the world moves toward a clean energy future, no one technology will be adequate to respond to the growing electricity demand in developing nations and the global need to decarbonize the transportation, manufacturing and agriculture sectors, which together account for almost 60 percent of the world's greenhouse gas emissions. California is starting to come to this realization. A report this week noted that the state's ambitious zero-carbon goal will be difficult to reach, and it raised questions about the costs and risks of an all-renewables approach.

The top global emitter of carbon, and the world's leading manufacturer of solar panels, China, is not making the bet that renewables alone can cut greenhouse gases. Instead, they are deploying significant new nuclear power at home and scaling their nuclear industry and fusing it with their geopolitical strategy to become the dominant source of global reactor supply in this century. The U.S. is facing significant geopolitical competition from China on multiple fronts including this one. A prudent GND would recognize that the U.S. has to remain a robust domestic nuclear energy producer and exporter if it is to repel a race to the bottom on global nuclear non-proliferation, safety and security standards.

Our view, as set out in our recent Four Pillars policy paper , is that any response to the climate change challenge must be comprehensive and include all clean energy and carbon remediation technologies –including non-carbon-emitting, safe and secure nuclear power. A single path approach will not adequately address the problem.

The United States has been a leader in responding to every significant global challenge for decades. It can and must rise to meet the serious challenges posed by climate change. A key element of that response must be a recognition that current and future nuclear energy sources and technologies have a vital role to play in supporting decarbonization. Nuclear power also has additional significant and important roles in strengthening U.S. geopolitical competitiveness, sustaining America's leadership on technological innovation, and improving global security and governance. These are significant and vital functions at the core of American strength and values. They should be reflected at the core of any GND.