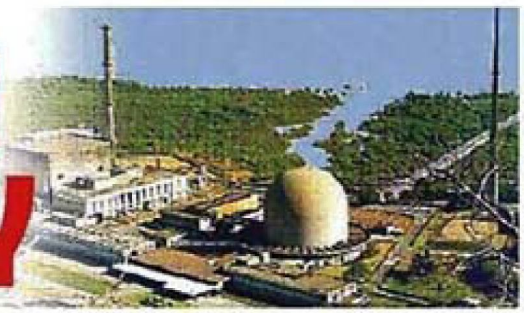
NUCLEAR SECURITY



A FORTNIGHTLY NEWSLETTER ON NUCLEAR DEFENCE, ENERGY AND PROLIFERATION FROM CENTRE FOR AIR POWER STUDIES

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CONTENTS

OPINION – Ted Nordhaus, Juzel Lloyd

Nuclear Resurgence

The Energy Security Case for Nuclear Power is Building: Recent months have marked a dramatic turnabout for the fate of nuclear energy across the developed world. As the Russian invasion of Ukraine turned post-pandemic energy shortages into a full-blown energy crisis, nuclear power plants slated for closure across Europe have been given an 11th hour reprieve. Japan has announced, after a decade of paralysis, that it plans to restart many of its reactors, which have sat idle since the nuclear accident at Fukushima Daiichi. France, which had launched plans to reduce its dependence on nuclear energy during President Macron's first term, reversed course and now plans to build six new reactors and a dozen more SMRs. The UK has launched an ambitious plan to build eight new reactors and 16 small modular reactors. Even anti-nuclear Germany has conceded to basic geopolitical energy realities and extended the life of the nation's last three operating nuclear power plants.

Recent months have marked a dramatic turnabout for the fate of nuclear energy across the developed world. As the Russian invasion of Ukraine turned post-pandemic energy shortages into a full-blown energy crisis, nuclear power plants slated for closure across Europe have been given an 11th hour reprieve.

The turn back to nuclear energy has been a ray of hope in an otherwise dark geopolitical landscape. Despite significant progress on the cost and feasibility of renewable energy, the energy crisis reminds us just how dependent the world remains on fossil fuels. Europe, arguably the wealthiest and greenest precinct of the global economy, and a region that has invested trillions over the past two decades to transition its energy economy to wind and solar energy, has been forced to engage in a wild scramble to replace Russian oil and gas with alternative sources of fossil fuel, importing liquefied natural gas from the United States and other regions, fast-tracking new pipeline projects from North Africa, and firing up mothballed coal plants to keep the lights on and its factories humming.

The picture is darker still across emerging market and developing economies. Europe is buying its way out of energy poverty. Many other regions of the world do not have the resources to do so. Soaring energy prices have

resulted in shortages, blackouts, and protests across the developing world and have pushed hundreds of millions back into extreme poverty. Meanwhile, the resulting spike in fertilizer prices has threatened harvests and raised the specter that famine, largely banished from even the poorest regions of the world in recent decades, might be back for an encore.

The Limits of Renewable Energy: Taken together, these developments suggest two interlinked conclusions. First, the world remains far too dependent on fossil fuels. Progress to reduce dependence on them and cut carbon emissions is real. But that progress has been limited to rising shares of renewable energy in the power sector, which accounts for only about 20 percent of energy use and emissions globally, along with incremental improvements to energy efficiency across the rest of the global energy economy, which remains powered almost entirely by fossil fuels.

Nuclear energy represents a potential solution to both problems, providing a firm source of electricity that can complement the variable sources of renewable energy on electrical grids, as it does in Scandinavia. It also features the ability to produce carbon-free heat as well as power for a range of industrial and other energy-intensive activities—from refining and fertilizer manufacturing to steel and hydrogen production—that are difficult to fully electrify.

Second, wind and solar energy alone will not be sufficient to break that dependence. Even in the power sectors of the wealthiest countries in the world, no economy has succeeded in getting much more than about a third of its electricity from wind and solar combined. Even the exception proves the rule. Green icon Denmark generates about 50 percent of its electricity from wind. But it is fully integrated into the much larger Scandinavian grid, which includes Sweden, Norway, and Finland and is dominated by hydroelectric power and nuclear energy. Denmark's vaunted wind energy accounts for only about 4 percent of total electricity generation annually across the Scandinavian grid.

Nuclear energy represents a potential solution to both problems, providing a firm source of electricity that can complement the variable sources of renewable energy on electrical grids, as it does in Scandinavia. It also features the ability to produce carbon-free heat as well as power for a range of industrial and other energy-intensive activities—from refining and fertilizer manufacturing to steel and hydrogen production—that are difficult to fully electrify.

To be relevant beyond generating electricity in the power sectors of technologically advanced economies, however, nuclear technology will need to change. Under the right economic and institutional circumstances, the large light-water reactor technology that has dominated the sector historically can be remarkably effective at replacing fossil fuels on electricity grids. France gets 75 percent of its electricity from nuclear energy, while Sweden and several other advanced economies get about 50 percent.

But large light-water reactors are complex technologies, requiring highly trained personnel to maintain and operate them. They have a large amount of fissile material in their core and so depend on a multiplicity of active safety systems to ensure safe operations. These, in turn, require sophisticated regulatory capabilities to ensure that the plants are operated safely. Large light-water reactors also need to be refueled regularly, every 18 months or so. This makes it more difficult practically to decouple reactor operations in any given locale from the nuclear fuel cycle, which raises a range of nuclear proliferation concerns.

Light-water reactors operating at lower

temperatures cannot meet heat requirements for many important industrial uses and so are limited to use primarily in the electricity sector. And even in that sector, they have limited ability to ramp up and down and so are not optimized for grids that have significant amounts of variable wind and solar generation as well.

Refining Nuclear: For these reasons, the nuclear sector will need to evolve in important ways if it is going to play a major role in addressing energy security and climate challenges in many parts of the world and beyond the power sector. Several new advanced reactor technologies are under development that are better suited to industrial uses and are being targeted to replace existing coal-fired energy production. China has connected its first high-temperature gas reactor to the grid, and it envisions that it will ultimately be a drop-in replacement for existing coal-fired power plants and will be used for other industrial purposes, such as hydrogen and chemical production. The United States has committed to building two advanced demonstration reactors this decade. One by X-energy will be designed to provide industrial heat and power; one by TerraPower is planned as a coal plant replacement and will feature an integrated molten salt energy storage system that will optimize it to back up variable wind and solar electricity generation.

Similarly, smaller and less complicated advanced reactors—more suitable to the energy development needs of countries without the technical know-how and institutional capabilities to maintain, operate, and regulate large conventional reactors—are currently in the development pipeline. New advanced technologies such as Oklo's Aurora reactor are applying for licenses in the United States and Canada. These very small reactors are sealed and don't require regular refueling, making them well suited for applications in which the entire reactor can be plugged into a grid or dropped into a remote off-grid location. These reactors can operate for years without refueling and can eventually be replaced by a new unit and sent back to a factory for refueling and refurbishment.

Innovation of this sort will be necessary if nuclear is going to play a significant role in many developing economies, and beyond the power sector, and extends well beyond the technologies themselves. New business models; new and more flexible regulatory, licensing, and export rules; and a revised global nonproliferation framework will be needed to fully realize the potential of these new technologies to provide low-carbon heat and power consistent with displacing fossil energy at global scale.

So too will be significant reconsideration of the long-running festival of hypocrisy that is climate development financing. While rich countries scramble to monopolize global fossil fuel resources in response to the energy crisis, the European Union, the Biden administration in the US, and the global climate movement have put pressure on the poorest nations in the world. With a fraction of the wealth, infrastructure, and technological capabilities, they are expected to achieve what the richest countries in the world cannot—power their economies without significant additional fossil fuel development—because of blanket bans on fossil fuel development financing in the name of mitigating climate change.

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Because most development banks exclude nuclear and hydropower, largely because of environmental objections from donor nations, climate development financing today in effect limits the poorest countries' development aspirations to the use of renewable energy. And while wind and solar energy have begun to gain a foothold in many poor countries, it is still very small and will do little to help these countries build passable roads, manufacture steel or fertilizer, or build modern housing and infrastructure in rapidly growing cities.

Powering Africa: If there is any place in the world that should be able to pursue an all-of-the-above energy agenda, it is sub-Saharan Africa, which

uses about the same amount of electricity as Spain despite having 18 times its population. More than 600 million lack access to electricity, clean cooking fuels, and modern transportation. The entire continent has only two factories capable of producing ammonia, the critical precursor of synthetic fertilizers, and lack of access to affordable fertilizers punishes small farmers, whose yields are five times lower than US or European farmers'.

Nuclear energy, like wind and solar, is not a panacea and can't solve all these problems. And new nuclear technologies designed and scaled to Africa's needs are at least a decade away. But numerous African nations, including Ghana, Kenya, Namibia, Nigeria, South Africa, Sudan, Tanzania, Uganda, and Zambia, have in recent years expressed significant interest in developing new nuclear plants. And any long-term pathway toward a prosperous and modern African future is likely to need them. Africa's population is expected to double by 2050, making it one of the most populous regions in the world.

Rolls-Royce is in early talks with the global industrial firm Ineos to provide industrial power for a Scottish oil refinery. These sorts of uses are exactly what makes nuclear energy so attractive. That's because refineries need constant power and unlike most renewable sources, nuclear produces that power 24 hours a day and seven days a week.

No less than in the richest countries, fossil fuels across Africa and much of the rest of the developing world are likely to remain a fact of life for many decades to come. Accelerating a transition away from them globally will require putting new low-carbon options on the table, not taking them away. Nuclear energy is without question one of those options. As the rich world reconsiders the value of the atom, a reconsideration of its potential to address the global development challenge, as well as the global climate challenge, is long overdue.

Source: https://www.imf.org/en/Publications/fandd/issues/2022/12/nuclear-resurgence-nordhaus-lloyd, December 2022.

OPINION – Jack Spencer

A Promising Sign for Nuclear Power in the United Kingdom

Is the Nuclear Renaissance real this time around? Of course, that question is impossible to answer, but reports from the United Kingdom at least show that there is an opportunity. *The Times* in the U.K. just reported that Rolls-Royce is in early talks with the global industrial firm Ineos to provide industrial power for a Scottish oil refinery. These sorts of uses are exactly what makes nuclear energy so attractive. That's because refineries need constant power and unlike most renewable sources, nuclear produces that power 24 hours a day and seven days a week. Even the U.S. Department of Energy acknowledges that nuclear power is by far the most reliable energy source we have.

Last year Rolls-Royce announced that it had established a new Small Modular Reactor business and that it raised nearly $235 million in investments toward developing its new 440-megawatt reactor designs. The consortium led by Rolls-Royce secured a further $250 million from the publicly-funded United Kingdom Research and Innovation. Putting aside the efficacy or legitimacy of public expenditures for private business, the nearly half a billion dollars does show significant private and public support for new nuclear power in Britain. Given the excessive regulatory and policy risks posed over the years, one can hardly blame private investors for wanting the government to put some skin in the game before risking their own capital.

Nonetheless, investing in nuclear makes a lot of sense. Nuclear is a unique and underutilized power source. Not only does it safely and securely produce clean, emissions-free electricity, but it's among the most versatile energy sources we have and can be used for a myriad of industrial applications. Nuclear could have significant economic benefits as well. Rolls Royce believes that its new reactor business could create up to

40,000 jobs and it anticipates that exports could exceed $300 billion. Some might argue that we've been down this road before.

It wasn't that long ago that similar headlines were popping up claiming that the world was on the brink of a nuclear renaissance. Like Rolls-Royce, companies around the world were issuing press releases about new investments and establishing new corporate partnerships to take advantage of emerging opportunities in nuclear power. But then it all fizzled. While the ultimate outcome of this apparent renaissance remains to be seen, some notable facts distinguish this trend from the aborted efforts of the recent past. First, unlike last time when the push for new nuclear was built around large, expensive reactors, this effort seems largely to be driven by smaller and potentially less costly technologies.

Though the Rolls-Royce reactor is not technically a small, modular reactor as generally understood, it is about half the size of most reactors operating around the world today. Other designs being offered, like NuScale's SMR, are much smaller and can be linked together as power demand rises over time. Second, Russia's invasion of Ukraine has brought greater appreciation for the reliability that nuclear power brings. Though nuclear fuel is sourced from around the world, uranium is plentiful and reactors only need to be refueled every 18-24 months.

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While uranium fuel is not cheap, per se, the relatively small amounts necessary to fuel a reactor means that you need way less of it and can keep larger amounts of it relatively handy should there ever be a supply disruption. Lastly, the world is finally waking up to the fatal flaws of an overreliance on renewables. Renewable energy sources may have good applications, but those should be identified by market demand and not foisted onto our power generation systems by political dictate. Doing so creates systemic instability and results in the power shortages currently being suffered in Europe and to a lesser extent in the United States.

So, this nuclear renaissance must be for real, right? Not necessarily. While much is different, much remains the same—at least in the United States. American nuclear power faces a significant regulatory burden, government remains a major obstacle to fixing our system for nuclear waste management, and meddling politicians and bureaucrats continue to have too much influence over the business of nuclear energy. With reform, this Nuclear Renaissance has a fighting chance. Without reform—good luck.

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Source: https://www.heritage.org/nuclear-energy/commentary/promising-sign-nuclear-power-the-united-kingdom, 01 December 2022.

OPINION – Matthew Teasdale

Why Managing the Nuclear Threat in Northeast Asia Matters

Overtaken by the war in Ukraine, bellicism on the Korean peninsula has taken a back seat in the international media, despite the very real rising nuclear threat. North Korea has fired more than 70 missiles this year – more than any previous

year – including two purported intercontinental ballistic missiles that have flown over Japan, the first such escalation in five years. While the Russian nuclear threat over Ukraine must also be taken seriously, managing the Korean nuclear threat would send a powerful signal that threats to international order need not be Europe-based to matter.

North Korea's nuclear weapons program is then the greatest threat to a rising Asian market that the United States has every incentive to protect and benefit from. The North Korean nuclear program poses challenges to the American order.

It's no secret that North Korea has traditionally represented a failure for American policymakers of all parties and ideologies. From Clinton to Biden, no American president has successfully brought about a limitation or reduction in nuclear weapons on the Korean peninsula. From the 1994 Agreed Framework that would have terminated Pyongyang's civil nuclear program, to the Six-Party Talks, to Donald Trump's reality TV show diplomacy, nearly every international initiative to denuclearize the Korean peninsula has seen, at best, only temporary success.

The United States should work with a nuclear North Korea rather than keep an exclusive focus on denuclearization. Opening a dialogue with Pyongyang can be the first step to convincing Kim Jong-Un that nuclear weapons are not the ultimate shield for his regime. With or without the nukes, North Korea can still be an actor in the international system if it chooses to be.

Chairman Mao Zedong once called the strategic relationship between China and North Korea "as close as lips and teeth," and warned that "if the lips are gone, the teeth will be cold." A valuable servant to Beijing, the hermit kingdom's nuclear threats are often a method for the latter to drive a wedge between Seoul and Washington while feigning consternation. All the while, the possibility of a regional war in Asia threatens to disrupt global stability and prosperity. The reality is that Asia is more and more the heart of the global economy and global power. The continent is projected to account for more than 50 percent of global gross domestic product and more than 40 percent of total consumption by 2040.

Out of 71 developing economies, McKinsey identified seven Asian economies as their sole long-term 'outperformers' who propelled themselves to middle-income and advanced stages along the ranks of Western Europe and the United States. North Korea's nuclear weapons program is then the greatest threat to a rising Asian market that the United States has every incentive to protect and benefit from. The North Korean nuclear program poses challenges to the American order. One reputed Korea observer writes that the North's development of nuclear weapons is more and more aimed at subjugating the South rather than self-defense. More than 70 percent of South Koreans are concurrently in favor of acquiring an independent nuclear arsenal.

Japan, too, is becoming more independent. Under the American nuclear umbrella since 1952, Tokyo is developing deterrence by denial capabilities including space-based missile defense systems and special warships equipped with ballistic missile defense systems. The nuclear umbrella, by contrast, offers a reactive deterrence by punishment. Former Japanese Prime Minister Abe even raised the prospect of hosting American nuclear weapons on Japanese soil in the wake of the war in Ukraine. Japan's three non-nuclear principles — to never possess, produce or permit the introduction of nuclear weapons — look more and more to be under stress.

The United States should work with a nuclear North Korea rather than keep an exclusive focus on denuclearization. Opening a dialogue with Pyongyang can be the first step to convincing Kim Jong-Un that nuclear weapons are not the ultimate shield for his regime. With or without the nukes, North Korea can still be an actor in the

international system if it chooses to be. If we engage more tactfully with the North, the road to total disarmament will likely be long, but so far, 30 years of the opposite has only facilitated a game of nuclear chicken.

Lowering tensions on the Korean peninsula will have a positive effect on the regional investment climate and reassure Asian governments nervous about seeming U.S. disengagement in the face of toxic Chinese nationalism. While the war in Ukraine rages on, American policymakers should not forget the critical North Korean flashpoint.

Maintaining peace in Asia must be a major priority for U.S. foreign policy going forward. Burgeoning economies like India and Singapore have grown by more than five percent annually for the past 20 years and are already prime markets for American investors. Lowering tensions on the Korean peninsula will have a positive effect on the regional investment climate and reassure Asian governments nervous about seeming U.S. disengagement in the face of toxic Chinese nationalism. While the war in Ukraine rages on, American policymakers should not forget the critical North Korean flashpoint.

Source: https://armscontrolcenter.org/why-managing-the-nuclear-threat-in-northeast-asia-matters/, 08 December 2022.

OPINION – Srinivas Laxman

How India's Nuclear Bomb Capability Rattled US in 1968

Canadian nuclear inspectors visiting the Canada-India Reactor (CIR) at Trombay in Mumbai in June 1968 were "unsettled" by data suggesting that India was heading towards the "development of a nuclear device", triggering strong US reaction and fears of an arms race. As per declassified documents published in Washington, the Canadians later told US diplomats that the reactor fuel had been irradiated at a level low enough to produce "weapons grade plutonium" and that, if India was seeking to produce plutonium, the reactor could generate up to 12kg a year.

The documents obtained by the US National Security Archive shed light on US policy in the early years of India's nuclear programme, before its first nuclear test in May 1974. These secret papers said India's top nuclear officials posed a significant challenge to US non-proliferation policy when they insisted that they could freely use plutonium produced in their reactors for a peaceful nuclear explosion (PNE).

A November 1970 US demarche to the Indian government said the "use of plutonium produced pursuant to US-Indian civil agreements for the manufacture of...PNE devices would be incompatible with such agreements and ... we would object most strongly to such use." In reply, Indian officials declared that they did not intend to develop nuclear weapons, but they had wide scope to use nuclear technology "for any peaceful purposes and to undertake whatever development is required for this".

Accordingly, a November 1970 US demarche to the Indian government said the "use of plutonium produced pursuant to US-Indian civil agreements for the manufacture of...PNE devices would be incompatible with such agreements and ... we would object most strongly to such use." In reply, Indian officials declared that they did not intend to develop nuclear weapons, but they had wide scope to use nuclear technology "for any peaceful purposes and to undertake whatever development is required for this".

The documents said: "A recently declassified June 1974 Interagency Intelligence Memorandum acknowledged that Washington had no evidence of Indian nuclear decision-making. But estimated that Indian policymakers had several major choices before them." "One was continuing nuclear development for peaceful uses, with no military purposes. If India made such a choice, technology developed for PNE would be eminently suited for

application to nuclear weapons developments should the decision be made."

Source: https://timesofindia.indiatimes.com/india/how-indias-nuclear-bomb-capability-rattled-us-in-1968/articleshowprint/96138980.cms, 11 December 2022.

NUCLEAR STRATEGY

CHINA

China Blasts US Report, Reiterates 'No 1st Use' Nuke Policy

China strictly adheres to its policy of no first use of nuclear weapons "at any time and under any circumstances," its Defense Ministry said on 6 December 2022 in a scathing response to a U.S. report alleging a major buildup in Beijing's nuclear capabilities. The Pentagon released an annual China security report that warned Beijing would likely have 1,500 nuclear warheads by 2035, and that it has provided no clarity on how it plans to use them.

China strictly adheres to its policy of no first use of nuclear weapons "at any time and under any circumstances," its Defense Ministry said on 6 December 2022 in a scathing response to a U.S. report alleging a major buildup in Beijing's nuclear capabilities.

That report "distorts China's national defense policy and military strategy, makes groundless speculation about China's military development and grossly interferes in China's internal affairs on the issue of Taiwan," ministry spokesperson Tan Kefei said in a statement. Tan accused the U.S. of being the "biggest troublemaker and destroyer of world peace and stability," and repeated that Beijing has never renounced the use of force to conquer self-governing Taiwan, a U.S. ally that China considers part of its territory.

Australia has said it will not seek to arm the submarines with nuclear weapons. Tan also accused the U.S. of having the world's largest nuclear arsenal, although that title is actually held by Russia, a close Chinese military, economic and diplomatic partner.

Tan did not directly address the report's allegations about a Chinese nuclear buildup, but blamed the U.S. for raising nuclear tensions, particularly with its plan to help Australia build a fleet of submarines powered by U.S. nuclear technology, which the French president has described as a "confrontation with China." Australia has said it will not seek to arm the submarines with nuclear weapons. Tan also accused the U.S. of having the world's largest nuclear arsenal, although that title is actually held by Russia, a close Chinese military, economic and diplomatic partner.

As of 2022, Russia possesses a total of 5,977 nuclear warheads compared to 5,428 in the U.S. inventory, according to the Federation of American Scientists. China currently has 350 nuclear warheads, according to the federation. China has long adhered to what it calls a purely defensive national security strategy, including a claim that it will never be the first to use nuclear weapons in a conflict. That stance has frequently been challenged at home and abroad, particularly if it comes to a confrontation over Taiwan.

"What needs to be emphasized is that China firmly pursues the nuclear strategy of self-defense and defense, always adheres to the policy of no first use of nuclear weapons at any time and under any circumstances, and maintains its nuclear force at the minimum level required for national security," Tan said in the statement, which was posted on the ministry's website. His remarks came days after Secretary Austin said the U.S. is at a pivotal point with China and will need military strength to ensure that American values, not Beijing's, set global norms in the 21st century.

Austin's speech on 3 December 2022 at the Reagan National Defense Forum capped a week in which the Pentagon was squarely focused on China's rise and what that might mean for America's position in the world. China "is the only country with both the will and, increasingly, the power to reshape its region and the international order to suit its authoritarian preferences," Austin said. "So let me

be clear: We will not let that happen." Austin said.

Austin...on 2 December 2022 was at a dramatic nighttime rollout of the U.S. military's newest nuclear stealth bomber, the B-21 Raider, which is being designed to beat the quickly growing cyber, space and nuclear capabilities of Beijing. The bomber is part of a major China-centric nuclear overhaul underway that the Congressional Budget Office has estimated will cost $1.2 trillion through 2046.

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Already-tense relations between Washington and Beijing soured even more in August when Pelosi visited Taiwan. China responded by firing missiles over the island and holding wargames in what was seen as a rehearsal for a possible blockade of the island. While the U.S. and Taiwan have no formal diplomatic relations in deference to Beijing, the U.S. maintains informal relations and defense ties with Taiwan, along with a policy of "strategic ambiguity" over whether the U.S. would respond militarily if the island were attacked....

Source: https://apnews.com/article/taiwan-china-beijing-nuclear- weapons-defense-policy-ed6faa3fbf16ed24637527d470849b 86, 06 December 2022.

RUSSIA

Ukraine War is Going to 'Take a While,' Putin Says as He Warns Nuclear Risk is Increasing

Nearly 10 months after his invasion of Ukraine began, Russian President Vladimir Putin on Wednesday (7 Dec) acknowledged that the conflict is "going to take a while," as he also warned of the "increasing" threat of nuclear war. Speaking at a meeting of Russia's Human Rights Council at the Kremlin, Putin said Moscow will fight by "all available means at our disposal," in what he insists on calling a "special military operation," but also said he saw no immediate need to mobilize more troops. "With regard to the protracted nature of the special military operation and its results, of course, it's going to take a while, perhaps," he said.

And without categorically ruling out the first use of nuclear weapons, Putin said he viewed the Russian nuclear arsenal as a deterrent rather than a provocation. "As for the idea that Russia wouldn't use such weapons first under any circumstances, then it means we wouldn't be able to be the second to use them either – because the possibility to do so in case of an attack on our territory would be very limited," he said. "Nevertheless, we have a strategy... namely, as a defense, we consider weapons of mass destruction, nuclear weapons – it is all based around the so-called retaliatory strike," he said. "That is, when we are struck, we strike in response."

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The Russian leader said that the United States' nuclear weapons were located in large numbers on European soil, while Russia had not transferred its nuclear weapons to other territories and is not planning to do so, but "will protect its allies with all the means at its disposal, if necessary." "We have not gone crazy. We are aware of what nuclear weapons are. We have these means, they are in a more advanced and modern form than those of any other nuclear country, this is obvious," he said. "But we are not going to brandish these weapons like a razor, running around the world."

Source: https://edition.cnn.com/2022/12/07/

europe/putin-ukraine-russia-nuclear-intl-hnk/index.html, 08 December 2022.

Putin Says Russia could Adopt US Preemptive Strike Concept

President Putin said on 9 December 2022 that Moscow could adopt what he described as a U.S. concept of using preemptive military strikes, noting it has the weapons to do the job, in a blunt statement amid rising Russia-NATO tensions over Ukraine. "We are just thinking about it. They weren't shy to openly talk about it during the past years," Putin said, referring to the U.S. policy, as he attended a summit in Kyrgyzstan of a Moscow-dominated economic alliance of ex-Soviet nations. For years, the Kremlin has expressed concern about U.S. efforts to develop the so-called Conventional Prompt Global Strike capability that envisions hitting an adversary's strategic targets with precision-guided conventional weapons anywhere in the world within one hour.

President Putin said on 9 December 2022 that Moscow could adopt what he described as a U.S. concept of using preemptive military strikes, noting it has the weapons to do the job, in a blunt statement amid rising Russia-NATO tensions over Ukraine.

"Speaking about a disarming strike, maybe it's worth thinking about adopting the ideas developed by our U.S. counterparts, their ideas of ensuring their security," Putin said with a thin smile, noting that such a preemptive strike was intended to knock out command facilities. He claimed that Russia already has commissioned hypersonic weapons capable of carrying out such a strike, while the U.S. hasn't yet deployed them. He also claimed that Russia now has cruise missiles that surpass their U.S. equivalents.

Putin was asked on 7 December 2022 at a Kremlin conference whether Russia could commit to forswearing a first strike and responded that such an obligation might prevent Russia from tapping its nuclear arsenal even if it came under a nuclear attack.

While Putin appeared to refer to conventional precision-guided weapons when he talked about possibly mimicking the U.S. strategy, he specifically noted that the U.S. hasn't ruled out the first use of nuclear weapons. ... In Washington, advisers to President Biden viewed Putin's comments as "saber-rattling" and another veiled warning that he could deploy a tactical nuclear weapon, according to a U.S. official who was not authorized to comment and spoke on the condition of the anonymity.

The official noted that Russian military doctrine has long stated that Moscow reserves the right to first use of a nuclear weapon in response to large scale military aggression. John Erath, senior policy director for the Center for Arms Control and Non-Proliferation, also viewed Putin's statement as yet another attempt to raise the nuclear threat.

"He doesn't quite say we're going to launch nuclear weapons, but he wants the dialogue in the U.S. and Europe to be, the longer this war goes on, the greater the threat of nuclear weapons might be used," Erath said. Putin was asked on 7 December 2022 at a Kremlin conference whether Russia could commit to forswearing a first strike and responded that such an obligation might prevent Russia from tapping its nuclear arsenal even if it came under a nuclear attack. "If it doesn't use it first under any circumstances, it means that it won't be the second to use it either, because the possibility of using it in case of a nuclear strike on our territory will be sharply limited," Putin said.

He elaborated on that answer on 9 December 2022, saying Russia's nuclear doctrine is based on the "launch on warning" concept, which envisions nuclear weapons' use in the face of an imminent nuclear attack spotted by its early warning systems. "When the early warning system receives a signal about a missile attack, we launch hundreds of missiles that are impossible to stop," he said, smiling. "Enemy missile warheads would inevitably reach the territory of the Russian Federation. But nothing

would be left of the enemy too, because it's impossible to intercept hundreds of missiles. And this, of course, is a factor of deterrence."

Russia's nuclear doctrine states the country can use nuclear weapons if it comes under a nuclear strike or if it faces an attack with conventional weapons that threatens "the very existence" of the Russian state. Since sending Russian troops into Ukraine in February, Putin has repeatedly said that Moscow was ready to use "all available means" to protect its territory and has rejected Western criticism of nuclear saber-rattling. "I understand that ever since nuclear weapons, the weapons of mass destruction have appeared, all people — the entirety of humankind — have been worried what will happen to the planet and all of us," he said.

Speaking on 9 December 2022 at U.S. Strategic Command, which has responsibility for the nation's nuclear weapons, Defense Secretary Austin said Putin's repeated threats were irresponsible. ...Austin said make no mistake, nuclear powers have a profound responsibility to avoid provocative behavior and to lower the risk of proliferation and to prevent escalation and nuclear war.

Source: https://abcnews.go.com/International/wireStory/putin-russia-adopt-us-preemptive-strike-concept-94876110, 10 December 2022.

Russia's Self-Defeating Move in Pausing Nuke Talks with US

Russia's announcement on 28 November 2022 that it would postpone arms control talks with the United States was yet another signal that its current leadership is choosing a path detrimental to arms control, de-escalation, and peace. Amid the ongoing war in Ukraine, resumption of bilateral talks and subsequent negotiations for a follow-on to the New START, remain a crucial avenue to maintain stability between the world's two largest nuclear powers.

Earlier this month, the United States and Russia announced plans to once again meet under the auspices of New START's Bilateral Consultative Commission (BCC), which last met in 2021. The treaty restricts the number of deployed strategic nuclear weapons to 1,550 each and was extended last year until 2026. The announcement raised hopes that arms control conversations would not be poisoned by Russia's invasion. While initially indicating that new dates would soon be announced, Russian Foreign Ministry spokesperson Maria Zakharova said that these talks could not be removed from "geopolitical realities."

Russia's announcement on 28 November 2022 that it would postpone arms control talks with the United States was yet another signal that its current leadership is choosing a path detrimental to arms control, de-escalation, and peace. Amid the ongoing war in Ukraine, resumption of bilateral talks and subsequent negotiations for a follow-on to the New START, remain a crucial avenue to maintain stability between the world's two largest nuclear powers.

This argument appears to be a nod to Russia's real reason for postponing the talks: Its war in Ukraine has gone disastrously wrong, and Moscow seeks to pressure the United States and its allies to decrease support for Ukraine by leveraging the West's obvious interest in the health of a treaty critical to international security. This move is yet another indication of Russia's growing desperation due to its military failures in Ukraine — a dangerous strategy destined to fail.

To Zakharova's point, a BCC meeting would take place within the context of certain geopolitical realities. President Putin's rhetoric around the potential use of nuclear weapons aims to exploit fears about potential escalation to further Russian war aims. Though the saber rattling has died down recently, the mere suggestion that Russia could use nuclear weapons highlights the importance of maintaining arms control dialogue between the United States and Russia, and with all nuclear-armed states.

Arms control agreements are not just about limits on arsenals and mutual verification. They also

help maintain channels of contact between would-be adversaries and preserve opportunities for de-escalation. Most bilateral and multilateral agreements include fora for discussion among the signatories as well as mechanisms to ensure mutual compliance. Examples include the NPT Review Conference, the INF Treaty's Special Verification Commission, and, of course, the BCC.

In the context of the Kremlin's war in Ukraine, both parties stand to benefit from the limits New START places on their respective nuclear forces and visibility into modernization efforts it enables through on-site inspections. Additionally, without New START, Russia may have the most to lose in a renewed arms race, considering a renewed arms build-up would likely involve the United States as well as China.

Both the United States and Russia have benefited from these fora in the past. For example, at the time it was negotiated, the INF Treaty eliminated an entire class of nuclear weapons and its consultative mechanism allowed for questions about compliance to be discussed. When this was no longer effective, Russian violations led to the treaty's collapse. In the context of the Kremlin's war in Ukraine, both parties stand to benefit from the limits New START places on their respective nuclear forces and visibility into modernization efforts it enables through on-site inspections. Additionally, without New START, Russia may have the most to lose in a renewed arms race, considering a renewed arms build-up would likely involve the United States as well as China.

The clock for New START is undeniably ticking. Given the state of Russia's economy, its military losses, and international isolation, it would benefit Russian leadership to rethink its current approach to arms control and reinvest in New START, before the clock runs out.

Russia's recent military setbacks and loss of skilled workers due to the war hinder its ability to compete in a future arms race. Reporting suggests some 350,000 people have fled Russia following the mobilization order to bolster dwindling army ranks. Internal Russian reports suggest fears of sanctions negatively affecting long-term growth.... Russian Deputy Foreign Minister Sergei Ryabkov blamed the postponement of the talks on U.S. officials' unwillingness to take "Russian priorities" into account. Ryabkov further claimed the United States was only interested in restarting on-site inspections and unwilling to discuss specifics about the weapons count under New START. Unsurprisingly, this is a red herring from the Kremlin.

On-site inspections, which have been paused since the beginning of the COVID-19 pandemic, are not contingent on a BCC meeting and could be restarted without one. The issues cited by Ryabkov about weapons counts, however, would be among those normally covered at a BCC — thus, if weapons counts were Russia's real issue, the Kremlin would want a BCC meeting. As other voices have pointed out, the clock for New START is undeniably ticking. Given the state of Russia's economy, its military losses, and international isolation, it would benefit Russian leadership to rethink its current approach to arms control and reinvest in New START, before the clock runs out.

Source: https://responsiblestatecraft. org/2022/12/05/russias-self-defeating-move-to-pause-new-start-talks/, 05 December 2022.

USA

Austin Says Strong Deterrence Enables US to Ensure Global Rules, Rights

..."These next few years will set the terms of our competition with the People's Republic of China, and they will shape the future of security in Europe, and they will determine whether our children and grandchildren inherit an open world of rules and rights, or whether they face emboldened autocrats who seek to dominate by force and fear," said

Secretary of Defense Austin during a keynote presentation on 3 December 2022 at the Reagan National Defense Forum in Simi Valley, California.

Deterrence is at the heart of the National Defense Strategy, which the Defense Department released in November 2022, Austin said. "We've got the right strategy and the right operational concepts," Austin said. "And they're driving us to make the right investments for our warfighters. So we're upgrading and honing and strengthening our armed forces for a changing world."

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...Austin laid out some of the efforts the U.S. military is undertaking to strengthen that deterrence, including that on land, air and at sea. In the fiscal year 2023 budget, Austin said, the Defense Department requested more than $56 billion for airpower. That is focused on the F-35 Lightning II, the F-15EX fighter, the B-21 Raider and other systems. "American airpower helps deter conflict every day, from joint exercises with our Indo-Pacific partners, to aerial drills with our allies to protect NATO's eastern flank," Austin said. Deterrence also happens on the ocean, he said.

There, the Defense Department is investing in construction of nine battle-force ships, and continuing to invest in the Ford-class nuclear-powered aircraft carriers and the Columbia-class ballistic-missile submarines. Just last month, he said, an American Ford-class nuclear powered carrier made its first transit to Europe.

Also included in deterrence are long-range fires — the kind finding success now in Ukraine. "Long range fires will be vital for contingencies in the Indo-Pacific as well," Austin said. "We're investing in land-based hypersonic missile batteries and in an air-launched hypersonic cruise missile. And the USS Zumwalt will become the first Navy platform to field hypersonics."

Perhaps the strongest deterrent, Austin said, is America's nuclear capability. And there's plenty of investment there as well, he told the audience. "Deterrence means a safe, secure and effective nuclear arsenal as the ultimate backstop to deter strategic attacks on our country and our allies, including NATO, Japan and the Republic of Korea," Austin said, adding that the fiscal year 2023 budget includes $34 billion to modernize the nuclear triad and to bolster nuclear command, control and communications. Austin called on Congress to pass an on-time appropriation to ensure the department gets the capabilities needed to further strengthen its deterrent capability.

Source: https://www.eurasiareview.com/05122022-austin-says-strong-deterrence-enables-us-to-ensure-global-rules-rights/, 05 December 2022.

The B-21 Raider was developed by US manufacturer Northrop Grumman, which makes the currently deployed B-2 stealth bomber. The company says the new strategic bomber is capable of delivering nuclear payloads and has advanced stealth capabilities which make it difficult for enemy radar to detect it. The aircraft can also be flown without a pilot.

US Unveils New B-21 Stealth Bomber

The US Air Force has unveiled a new B-21 stealth bomber which is expected to help strengthen US deterrence against China. An unveiling ceremony was held in California on 2 December 2022. The B-21 Raider was developed by US manufacturer Northrop Grumman, which makes the currently deployed B-2 stealth bomber. The company says the new strategic bomber is capable of delivering nuclear payloads and has advanced stealth capabilities which make it difficult for enemy radar

to detect it. The aircraft can also be flown without a pilot.

Defense Secretary Austin noted that the B-21 is the first strategic bomber that the US military has introduced in more than three decades. Austin said strengthening and sustaining US deterrence is at the heart of the national defense strategy. The administration of President Biden is working to modernize US nuclear capabilities as it remains on heightened vigilance against China's growing nuclear arsenal. The US Air Force plans to bring the B-21 into service in the mid-2020s and maintain a fleet of at least 100. US media say the new bomber is expected to play a core role in deterring China.

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Source: https://www3.nhk.or.jp/nhkworld/en/news/20221203_14/, 03 December 2022.

BALLISTIC MISSILE DEFENCE

RUSSIA

Russian Army Says Successfully Tested New Missile Defense System

Russia has successfully test-launched a new missile defense system at its Sary Shagan firing range in neighboring Kazakhstan, the country's Defense Ministry announced on 2 December 2022. "The anti-missile defense system is in service with the Aerospace Forces and is designed to protect against air and space attacks" the ministry said in a statement, without naming the system that was tested.

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"The new missile defense system, after a series of tests, confirmed its inherent characteristics, and combat crews successfully completed the task, hitting the conditional target with the specified accuracy," said Major General Sergei Grabchuk, head of the Aerospace Forces' anti-missile defense unit. The test is the latest in a series of test launches as Russia seeks to upgrade the missile defense system around its capital Moscow. In July 2020, it was announced that the Russian Army will deploy the next-generation S-500 hypersonic missile defense system to protect Moscow. Then-head of the Russian Aerospace Forces Sergei Surovikin — who was placed in charge of Russia's forces in Ukraine in October — claimed at the time that the S-500 system will be able to destroy satellites and hypersonic weapons in near space.

Following months of setbacks for the Russian military in its offensive on Ukraine, Defense Minister Shoigu on 30 November 2022 spoke in favor of using next-generation weapons in battle. Speaking at a government board meeting Shoigu added that state defense orders funding is expected to increase by 150% in 2023 to ensure the Armed Forces are provided with consistent arms and equipment supplies.

Source: https://www.themoscowtimes.com/2022/12/02/russian-army-says-successfully-tested-new-missile-defense-system-a79572, 02 December 2022.

USA–JAPAN

Russia's Highly Maneuverable Avangard Hypersonic Missile Impossible to Intercept, Expert Says Over New US, Japan Pact

Japan and the United States will conduct extensive joint missile technology research to intercept hypersonic glide missiles deployed by China and

Russia, reported Asia Nikkei on December 4. Russia has already deployed Hypersonic glide vehicles (HGVs), while China is said to have started using the DF-17, a ballistic missile capable of delivering an HGV warhead. According to the report, Japan's Defense Ministry will begin developing an anti-missile interceptor that can function at altitudes beyond current anti-missile defenses in 2023. Tokyo requires Washington's aid in developing technology that will enable rockets to alter flight trajectories, allowing them to zero in on maneuvering hypersonic targets during their ultra-high-speed approach. If the cooperation is successful, it is anticipated that the interceptor missiles will be installed on Japan's two Aegis air and missile defense system-equipped destroyers, which are scheduled to be put into service in 2027 and 2028, respectively.

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Earlier this year, it was first reported that Japan plans to increase collaboration with the US on research into counter-hypersonic weapons. Secretary of State, Blinken, confirmed in January that an agreement had been drawn up on R&D in emerging technologies, such as AI, directed energy weapons, quantum computing, space weaponry, and countering hypersonic missiles. Japan's ballistic missile defense system is divided into two sections. The first line of defense is the SM-3 interceptor missile fired from Aegis ships at sea. It aims to take down ballistic missiles beyond the atmosphere.

If the SM-3s are unsuccessful, Patriot PAC-3 surface-to-air missiles on the ground will try to bring the target down as it reenters the atmosphere at an altitude of 20 kilometers or less. The latest PAC-3 version is believed to be able to attack HGVs shortly before they strike a target, but because it is ground-based, its range of protection is limited.

The news regarding Japanese-US cooperation follows reports from last month that Tokyo intends to modify its current Type-03 intermediate-range guided missile air defense systems to intercept hypersonic missiles. The missile systems, which were developed in the 1990s and entered service in 2003, have an effective range of 50 kilometers, a speed of Mach 2.5, and a high-explosive warhead that is activated through a proximity fuse.

Despite the joint efforts of the US and Japan, a Russian military analyst predicted that neither Washington nor Tokyo would be able to create a missile that could take down the Russian Avangard hypersonic missile. According to Russian military analyst Alexei Leonkov, who spoke to RIA Novosti, it would be challenging to intercept Avangard because there is no way to foresee Avangard's flight path or manufacture a missile with a speed several dozen times faster than sound. ...

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The expert pointed out that to test such anti-missile systems, the US and Japan would need to build an adequate target, namely a maneuverable hypersonic combat unit (similar to the Avangard). But even the highly advanced military-industrial complex of these nations cannot construct something of that nature, he said. He explained that there is a more straightforward solution to this issue: shoot "catch-up" so that the missile mimics the target's movements and takes it down. But in this case, the anti-missile missile's speed must be 1.5

times faster than the target to catch up with it and intercept it. "Our Avangard develops a speed of 27 Mach numbers; the US-Japanese rocket should fly faster than the speed of sound by 40 times – this is simply unrealistic," he noted.

The expert stated that American hypersonic missile samples could reach a top speed of 5-6 Mach. On the other hand, according to its designers, the Avangard hypersonic combat unit may travel at a speed of 27 Mach, or approximately 33 thousand kilometers per hour, depending on the circumstances. The first regiment, equipped with a strategic missile system with a hypersonic gliding cruise unit "Avangard," joined the Yasnensky missile division in 2019.

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Source: https://eurasiantimes.com/russias-highly-maneuverable-avangard-hypersonic-missile-impossible-to-intercept-russian-expert-says-over-new-us-japan-pact/, 05 December 2022.

NUCLEAR ENERGY

AUSTRALIA

Coalition MP's 'Grassroots' Nuclear Power Survey Linked to Consulting Firm

A Coalition frontbencher conducting a "grassroots" survey about nuclear power is using a website registered by a business that helps an American small modular reactor company, records reveal. Ted O'Brien, the shadow minister for climate change and energy, issued a statement on 2 December 2022 saying he was "launching a grassroots community engagement program" under the banner "Time to Talk Nuclear".

He urged Australians to "join the conversation" by completing a short survey on the website, with the first question being: "What do you think could be the benefits of nuclear energy in Australia?" *Guardian Australia* can reveal the web domain was registered by Helixos Pty Ltd, a Sydney-based consulting company whose projects include "supporting the commercialisation of new nuclear energy technology".

Helixos lists the US company NuScale Power as one of its clients. Helixos says on its own website that NuScale Power "is reinventing nuclear energy and Helixos is helping them bring it to market". It adds: "Helixos also provides training for employees to become technology ambassadors and engage with stakeholders and the public."

... In that previous role, Kollar was "working to bring NuScale's small modular reactor to market through business plan development and clean energy outreach", according to a profile published in 2017. Kollar addressed a Global Uranium Conference in Adelaide during November 2022 on the topic "reaching net zero with nuclear energy". In tweets summarising her speech, Kollar said: "The time is now for Australians to have a conversation on nuclear energy and potentially overturn the ban."

...A source close to the matter said O'Brien's team had sought out Helixos, believing it was ideal for the job because of its familiarity with the topic of nuclear energy. But the source said O'Brien had come up with the idea of the survey and the questions, and paid for the work himself. In a written response, O'Brien said the purpose of the survey and the use of collected data had "all been openly and accurately communicated". "I'm personally paying for the grassroots community campaign 'Time to Talk Nuclear' out of my own back pocket because I think it's an important conversation to have with the Australian people," O'Brien said. "As we assess the prospect for nuclear energy moving forward, I will continue to seek assistance from people who are experts in the field." The vice-president of marketing and communications for NuScale Power, Diane Hughes, said: "Helixos does in fact provide services for NuScale Power.

...Helixos and Kollar were also contacted for comment. Helixos describes itself as a business that works "at the intersection of strategy consulting and technical advisory, specialising in cleantech commercialisation" and says it acts in line with the UN Sustainable Development Goals. ... Helixos states it worked with SMR Nuclear Technology Pty Ltd "to develop a proactive stakeholder engagement strategy" to "help achieve the main goal of having nuclear energy considered as part of Australia's future energy mix". ... Announcing the "grassroots community engagement program" on 2 December 2022, O'Brien said the starting point would be "an online survey that will open a two-way conversation with the Australian public about the benefits and concerns of advanced nuclear technology becoming part of Australia's future energy mix".

Helixos states it worked with SMR Nuclear Technology Pty Ltd "to develop a proactive stakeholder engagement strategy" to "help achieve the main goal of having nuclear energy considered as part of Australia's future energy mix".

"Other countries are reducing their emissions while keeping costs down and their network secure with nuclear energy," O'Brien said. "The question is - should we? Together with the Australian people, let's find out." The survey has only three mandatory questions, starting with views on the benefits of nuclear energy in Australia. It then asks what concerns, if any, the participant holds about nuclear energy, followed by any questions they might have. There is an optional section to "stay informed" by submitting an email address and postcode to O'Brien's team. O'Brien's website also sets out frequently asked questions such as: "Is nuclear energy clean?" The answer states: "Yes! Nuclear power's total life-cycle carbon emissions and raw material requirements are the lowest among other energy sources, even lower than wind and solar."...

Nuclear fusion reaction has a higher energy potential than all other energy sources. It can release nearly 4 million times more energy than chemical reactions like burning coal, oil or gas, and four times more than nuclear fission, the process currently used in all nuclear power plants around the world.

Source: https://www.theguardian.com/australia-news/2022/dec/04/coalition-mps-grassroots-nuclear-power-survey-linked-to-consulting-firm, 03 December 2022.

FRANCE

French Nuclear Output Rises above 40 GW for First Time in 9 Months

French nuclear output surpassed 40 GW for the first time in nine months this weekend as the country experiences a cold snap, in a sign that the resumption of three reactors was boosting production, grid operator RTE data showed. The head of the country's CRE energy watchdog had said that France's nuclear fleet, currently dragged down by maintenance and repair works, was expected to reach a production capacity of 40 GW "next month".

French nuclear output stood at 40.6 GW by 1100 GMT on 11 December, RTE data showed. It had risen above 40 GW for the first time since March 11. EDF has faced an unprecedented number of outages at its reactors this year, reducing nuclear output to a 30-year low, just as Russia's war on Ukraine hit Europe's energy supplies. The state-owned utility said it had ramped up output at three nuclear reactors following repairs and hoped to start corrosion repairs at its Penly 2 nuclear reactor in mid-January.

Source: https://www.reuters.com/business/energy/french-nuclear-production-surpasses-40-gw-grid-operator-2022-12-11/, 11 December 2022.

GENERAL

Can Nuclear Fusion Help Fuel the World?

...Nuclear fusion reaction has a higher energy potential than all other energy sources. It can release nearly 4 million times more energy than

chemical reactions like burning coal, oil or gas, and four times more than nuclear fission, the process currently used in all nuclear power plants around the world. Discovered in the early 20th century, fusion is seen as the future of energy by many policymakers, especially in Europe. But is nuclear fusion really a 'greener' alternative to what we're doing now, and how far have we come in generating electricity from this process?

... Sitting at the center of this industrial landscape, Pietro Barabaschi, the Director General of ITER, promises that the future of fusion energy is bright. He explains that generating fusion energy is like burning firewood.... In addition to being highly efficient, proponents say nuclear energy could dramatically reduce our dependence on fossil fuels. Nuclear energy itself is considered a carbon-free alternative to fossil fuels because its creation does not emit greenhouse gasses — its major byproduct is helium, an inert, non-toxic gas.

Further, deuterium is abundant in seawater, and scientists are trying to produce tritium using lithium in situ. Renewable energy sources like wind and solar alone cannot meet global baseline energy needs. Nuclear fusion, if successful, could provide well above that. While all of this sounds rosy, it is still a distant dream. For fusion to become a reality, we need a technological breakthrough in plasma physics.

...The sunshine and the warmth we feel on Earth is the result of fusion — the process occurs naturally in the core of the sun under extreme temperature and pressure. The challenge is to replicate what happens in the sun's core without the pressure arising from the gravity of the sun's heavy mass. In order to achieve fusion on Earth, gases need to be heated to extremely high temperatures of about 150 million degrees Celsius (270 million degrees Fahrenheit), around 10 times the temperature of the sun's core.

At this point, the gases become plasma, which is nearly a million times lighter than the air we breathe. All the protons, neutrons and electrons that compose it are separated. Fusion researchers have established that creating a plasma by heating a mixture of deuterium and tritium is the easiest way to achieve an environment to fuse and yield energy. At ITER, a device called the tokamak uses a strong magnetic field to confine the plasma used for fusion experiments.

In these extreme conditions, particles in this plasma collide rapidly, creating heat. But paradoxically, as the temperature rises even further, the collision rate — and therefore the heating effect — drops.... A meltdown like the one at Fukushima is unlikely to happen in a fusion reactor, says Gilles Perrier, head of safety and quality at ITER. In a fission reactor, there would be a radioactive core that would still need to cool if the reactor were to shut down. "In fission, the risk of an accident is much higher. In fusion, it is really low," Perrier says. He says safety in a fusion plant has three parts to it: Confinement of plasma, reduction of radiation exposure and prevention of tritium contamination.

The challenge scientists are grappling with now is how to produce this fuel at a larger scale.While it is a huge challenge, he is optimistic that the experimental reactor at ITER will be functional by the end of the decade and can help set up a demo power plant in the next 30 years.

The plasma is confined in a vacuum vessel. "Even in the worst-case scenario of a plasma leak, the impact will be confined to the site," he says. At this point, the most electricity scientists have been able to generate from fusion is 59 mega joules of energy over five seconds. That is about enough electricity to run a small light bulb for two months.

The challenge scientists are grappling with now is how to produce this fuel at a larger scale. Barabaschi says that going from a fusion experiment to an electricity-generating reactor is like going from burning some wood to a coal power plant. While it is a huge challenge, he is optimistic that the experimental reactor at ITER will be functional by the end of the decade and can help set up a demo power plant in the next 30 years.

At the end of the day, nuclear fusion technology will take time — which some scientists say we don't have. Fusion power certainly cannot solve the energy crisis this winter, and it won't help cut emissions soon. ...

Source: https://www.dw.com/en/can-nuclear-fusion-help-fuel-the-world/a-64004682, 06 December 2022.

New IAEA Tools Help Countries Select Suitable Nuclear Reactor Technologies

For countries looking to introduce nuclear power or expand their programmes, selecting the most suitable reactor technology can be a daunting process. Everything from site selection and performance requirements to economics and waste management must be taken into consideration and not every country arrives at the same conclusion. A new suite of support tools developed by the IAEA aims to make this easier.

Currently, around 30 countries are considering, planning or actively working to include nuclear in their energy mix as a way to achieve climate goals and further sustainable development. The updated publication and new tools will be used next year at an IAEA training workshop for nuclear newcomer countries, to be held in Abu Dhabi.

The newly updated publication Nuclear Reactor Technology Assessment for Near Term Deployment, part of the Nuclear Energy Series, refines the IAEA's methodology for nuclear reactor technology assessment (RTA) used to make informed decisions on the most appropriate nuclear power plant designs. It lays out the obligations and responsibilities integral to making an informed assessment....

"Reactor technologies are extremely complex, and come in so many shapes and sizes for all sorts of different needs, whether electrical or non-electrical," said Tatjana Jevremovic, Team Leader and Project Manager for Water Cooled Reactor Technology Development at the IAEA. "This new suite of tools can facilitate the process for countries seeking to determine which technology might be a best fit for them." said Tatjana.

Recent technological advances are incorporated into the new edition of the publication, with elements relevant to small modular reactors, nuclear-renewable hybrid energy systems and non electric applications, such as district heating and hydrogen production. The latest edition also provides examples of how to apply the methodology in an informed and accurate way....

RTA's technology-neutral, systematic approach evaluates the technical merits of the various nuclear power plant technologies available on the market or expected to be commercialized in the near future. RTA fits within the IAEA's Milestones Approach – a three-phase method providing advice and capacity building to enable countries to develop a national infrastructure for a nuclear power programme. Currently, around 30 countries are considering, planning or actively working to include nuclear in their energy mix as a way to achieve climate goals and further sustainable development. The updated publication and new tools will be used next year at an IAEA training workshop for nuclear newcomer countries, to be held in Abu Dhabi. Further workshops and training courses on RTA are planned for 2023 in Egypt and at the IAEA headquarters in Vienna.

Source: https://www.iaea.org/newscenter/news/new-iaea-tools-help-countries-select-suitable-nuclear-reactor-technologies, 06 December 2022.

POLAND

Support for Nuclear Energy in Poland Almost Doubles in a Year

There has been a large rise in support for developing nuclear energy in Poland, with 75% of the public now in favor, up from 39% last year. Only 13% are opposed, down from 45% in 2021. The findings come amid the energy crisis triggered by Russia's war in Ukraine and also as the Polish government moves forward with plans to develop the country's first nuclear power plants.... In the wake of the 1986 Chernobyl disaster in

neighbouring Ukraine, support among Poles for nuclear energy fell to just 20% in 1989. That led the government to in 1990 abandon the half-built attempt to develop Poland's first nuclear power station.

Over the last decade (following the Fukushima disaster in Japan), support has ranged between 34% and 40%, outweighed by opposition of between 45% and 53%. However, the latest poll, conducted last month, saw a jump to 75% support – by far the highest figure ever recorded – with opposition at just 13%. Even when asked if they would support the building of a nuclear power station near where they live, a majority (54%) were in favour and only (34%) against. The former figure has risen by 30 percentage points since last year and the latter has declined by the same amount....

In October, the Polish government picked the United States as its international partner in developing Poland's first nuclear plant, which is scheduled to open in 2033. Soon after, South Korea was chosen as the partner in a similar project being developed by a group of private and state-owned firms.

Meanwhile, three quarters (76%) of all respondents said that investing in nuclear is necessary if Poland is to move away from coal, which currently generates around 70% of its electricity. That was a sharp rise on the figure of 44% recorded last year. In October, the Polish government picked the United States as its international partner in developing Poland's first nuclear plant, which is scheduled to open in 2033. Soon after, South Korea was chosen as the partner in a similar project being developed by a group of private and state-owned firms.

Source: https://notesfrompoland.com/2022/12/05/support-for-nuclear-energy-in-poland-almost-doubles-in-a-year/, 05 December 2022.

USA

US Teases "Major Scientific Breakthrough" Amid Reports of Fusion Energy

The US Department of Energy said it would announce a "major scientific breakthrough" this week, after media reported a federal laboratory had recently achieved a major milestone in nuclear fusion research. *The Financial Times* reported that scientists in the California-based Lawrence Livermore National Laboratory (LLNL) had achieved a "net energy gain" from an experimental fusion reactor.

That would represent the first time that researchers have successfully produced more energy in a fusion reaction — the same type that powers the Sun — than was consumed during the process, a potentially major step in the pursuit of zero-carbon power.

Energy Department and LLNL spokespeople told AFP they could not comment or provide confirmation regarding the FT report, but said US Energy Secretary Jennifer Granholm would "announce a major scientific breakthrough".

The LLNL spokesperson added that their "analysis is still ongoing." "We look forward to sharing more when that process is complete," she said. The fusion reaction that produced a 120 percent net energy gain occurred in the past two weeks, the FT said, citing three people with knowledge of the preliminary results. The Washington Post later reported two people familiar with the research confirmed the development, with a senior fusion scientist telling the newspaper, "To most of us, this was only a matter of time." ...The LLNL fusion facility consists of almost 200 lasers the size of three football fields, which bombard a tiny spot with high levels of energy to initiate a fusion reaction.

Source: https://www.ndtv.com/world-news/us-to-announce-major-scientific-breakthrough-amid-nuclear-fusion-reports-3598437, 12 December 2022.

SMALL MODULAR REACTORS

CANADA

Ontario Breaks Ground on World-Leading SMR

Site preparation is now underway for Canada's first grid-scale SMR at Ontario Power Generation's (OPG) Darlington nuclear site. This work marks another milestone in the province's plan to build the reliable, affordable and clean electricity grid

needed to enable electrification and attract more investment in the province's economy. ...

In March 2022, Niagara-based E.S. Fox was awarded the contract to deliver early site preparation work, including water supply, electrical power, information technology and road services, paving the way for the SMR to be constructed by 2028. This work, valued at $32 million, will support over 100 new jobs in the Durham region. ... The new SMR at Darlington will be Ontario's first nuclear reactor build in a generation. This project alone will deliver 300 MW of electricity, which is enough to power 300,000 homes....

Source: https://news.ontario.ca/en/release/1002543/ontario-breaks-ground-on-world-leading-small-modular-reactor, 02 December 2022.

Linglong One, a multi-functional small modular and pressurized-water nuclear reactor, has begun its construction in South China's Hainan Province, China's Central Television reported on 4 December 2022. Linglong One is being built by the China National Nuclear Corporation based on China's independent research and intellectual property rights. It is also the world's first reactor of this type to be approved by the IAEA on the basis that it is built to serve the region's diverse power needs.

CHINA

China Begins Nuclear Island Installation of Land-Based SMR

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The CCTV report described the Linglong One "nuclear island" as the heart of the nuclear power plant. Other major facilities, including the power station's pressure vessel and steam generator, will be installed in the future, the report said. Commencing construction in July 2021, the Linlong One project is characterized as being highly secure, having short construction period, and flexible deployment among other advantages. It is expected to take about 58 months to finish the construction.

The reactor could be used as a distributed energy source, as well as meet other needs such as seawater desalination, regional heating, industrial heating and other purposes. Each set of Linglong One has a power capacity of 125,000 kilowatts, capable of generating one billion kilowatt-hours of electricity after going into operation. The Linglong One is an example of China's strengthened investment in energy projects, not only because the country is mounting efforts to guarantee energy supply in case of a power crunch, but also because China is actively pushing for the transition toward low-carbon and green energy sources...

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Source: https://www.globaltimes.cn/page/202212/1281048.shtml, 04 December 2022.

GENERAL

SMR Market Size & Share Worth $7.0 Billion by 2030

Global Small Modular Reactor (SMR) Market is expected to grow from US$ 5.7 billion in 2022 to US$ 7.0 billion by 2030; it is estimated to grow at a CAGR of 2.7% from 2022 to 2030. ...The global SMR market is driven by the growing need for clean, reliable and flexible power generation and helps in facilitating access to nuclear energy across diverse applications. The major players in the global SMR market are GE Hitachi Nuclear

Energy (US), Moltex Energy (Canada), NuScale Power, LLC. (US), Terrestrial Energy Inc. (Canada) and Westinghouse Electric Corporation (US).

The SMR market, by type, is segmented into light-water reactors, heavy-water reactors, fast-neutron reactors, high-temperature reactors and molten salt reactors. The light-water reactor segment holds the largest share of the small modular reactor market, and a similar trend is likely to continue in the near future.

Light-water reactor is the most commonly adopted SMR technology owing to the high degree of technological readiness and ease of licensing, as regulators and developers are familiar with this technology. These factors are expected to drive the market for this segment during the forecast period.... The report segments the SMR market, by deployment, into single-module power plants and multi-module power plants. The multi-module power plant segment is projected to hold a larger market share during 2022–2030. The growth of this segment is driven by the flexible operation of modules and ease of financing.

Multi-module power plants are designed to allow the addition of multiple reactors close to the same infrastructure and can be equipped with additional power units on the same site. The ability to add modules incrementally to meet the rise in demand reduces upfront investment and capital risks. The SMR market, by application, is categorized into power generation, desalination, hydrogen production and industrial application. The industrial segment of the SMR market, by application, accounts for the largest market share among all the other segments owing to the rapid industrialization in developing economies, especially in the Asia Pacific region.

Asia Pacific is estimated to be the largest and fastest-growing market for SMR during the forecast period. The region has been segmented, by country, into China, Japan, India, and South Korea. The growth of the Asia Pacific market is driven by the increasing investments for the deployment of SMRs in countries such as China and Japan.

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Furthermore, the country plans to promote the construction of Generation III coastal nuclear power plants and accelerate the development of SMRs and offshore floating nuclear reactors. In Japan, the government has made several policy reforms to accelerate the decarbonization of the energy sector. For instance, in December 2020, the Japanese government launched a new initiative called Green Growth Strategy to achieve carbon neutrality by 2050. ...

In a December 7 statement, Kazatomprom said that 30 tons of LEU had been sent by rail in the form of nuclear fuel assemblies (large bunches of fuel rods) to China where they had been "received by their end user," the China General Nuclear Power Corporation (CGNPC) .

Source: https://www.digitaljournal. com/pr/small-modular-reactor-market-size-share-worth-7-0-billion-by-2030, 09 December 2022.

NUCLEAR COOPERATION

KAZAKHSTAN–CHINA

Kazakhstan Sends First Nuclear Fuel Assemblies to China

A Kazakh-Chinese joint venture has made its first delivery of fuel assemblies to nuclear power stations in China, uranium giant Kazatomprom has said. The delivery is an important landmark in a growing atomic energy relationship between Beijing and Astana. In a December 7 statement, Kazatomprom said that 30 tons of LEU had been sent by rail in the form of nuclear fuel assemblies

(large bunches of fuel rods) to China where they had been "received by their end user," the China General Nuclear Power Corporation (CGNPC) ....

CEO Yerzhan Mukanov was quoted in the statement as saying the delivery had affirmed "the reputation of Kazatomprom as a reliable and preferred supplier in the global nuclear fuel market." While Kazatomprom has for some time been the world's largest producer of uranium, the joint venture with CGNPC has edged it forward in the production cycle. The uranium used for the fuel assemblies was "mined in Kazakhstan and processed at the Ulba Metallurgical Plant," the statement said, referring to a wholly Kazatomprom-owned facility that hosts Ulba-TVS LLP....

Prior to selling its stake back to Rosatom in 2020, Kazatomprom held a 12.5 percent share in the Novouralsk plant, known as the Ural Electrochemical Integrated Plant, via a joint Russian-Kazakh enterprise called Uranium Enrichment Centre (UEC). As part of the deal, Kazatomprom retained a single share in UEC in order to guarantee that it could still make purchases from the plant. Kazakh officials have on more than one occasion said they intend to observe Western-led sanctions against Russia since Moscow launched a full-scale invasion of Ukraine in February. Rosatom is not presently the target of any sanctions, much to Kyiv's chagrin. Moscow and Beijing are at any rate developing their own nuclear relationship. Back in September, Rosatom said it had delivered its first batch of nuclear fuel for a fast neutron reactor being built by China National Nuclear Corporation, China's other major atomic energy company, in the southern province of Fujian.

Source: https://eurasianet.org/kazakhstan-sends-first-nuclear-fuel-assemblies-to-china, 07 December 2022.

RUSSIA–BRAZIL

Rosatom to Supply Uranium Products for Brazil's Angra Plant

Russia's national nuclear company says its Internexco GmbH subsidiary and Brazil's state-owned Industrias Nucleares do Brasil (INB) have signed a contract to supply the Angra nuclear power plant from 2023 to 2027. It says the contract was the result of an open international tender that ended in August and it is "the first long-term contract with Brazil for the supply of enriched uranium products" for Rosatom. According to documents on the INB website the tender was for the "hiring company to supply 330,000 kg of U in the form of natural UF6 (natural uranium hexafluoride)". Rosatom added that it hoped the contract "opens access to the largest market for uranium products in the Latin American region".

Brazil currently has the two Angra reactors generating about 3% of its electricity and work is expected to resume shortly, after a seven-year break, on unit 3 of the Angra nuclear power plant near Rio de Janeiro. But it is looking to further expand its nuclear capacity - in January Brazil began the process of identifying sites for new nuclear power units it wants to have in operation by 2050.

Brazil and Russia already have ties within the nuclear energy sector - most recently, in October, Participações em Energia Nuclear e Binacional SA (ENBPar) and Russia's Rosatom signed a MoU which seeks to promote mutual cooperation in areas and activities related to nuclear energy. And an MoU was signed in 2017 by Rosatom and Brazil's Eletrobras and Eletronuclear to promote cooperation in nuclear power.

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Source: https://world-nuclear-news.org/Articles/Rosatom-says-to-supply-uranium-products-for-Brazil, 07 December 2022.

SOUTH KOREA–POLAND

Korea Signs Nuclear Fuel MoU for Poland's MARIA Research Reactor

The Korea Atomic Energy Research Institute (KAERI) plans to supply nuclear fuel for Poland's research reactor MARIA using high-density low-enriched uranium silicide (U_3Si_2) plate-shaped nuclear fuel manufacturing technology. KAERI Director Park Won-seok said: "The international community is looking for new nuclear fuel suppliers after the outbreak of the Ukraine-Russia war."

The MoU with Poland's National Centre for Nuclear Research sees the South Korean institute looking to supply two bundles of fuel for MARIA on a trial basis in 2024 for safety screening, to qualify for nuclear fuel supply in 2026. It is "the first case in which nuclear fuel developed with purely domestic technology is supplied overseas in the form of a lead test assembly.

The MoU with Poland's National Centre for Nuclear Research sees the South Korean institute looking to supply two bundles of fuel for MARIA on a trial basis in 2024 for safety screening, to qualify for nuclear fuel supply in 2026. It is "the first case in which nuclear fuel developed with purely domestic technology is supplied overseas in the form of a lead test assembly" KAERI said.

The U_3Si_2 fuel is part of a move towards nuclear fuel with low-enriched uranium because of safeguards concerns about using highly enriched uranium. To maintain high performance, KAERI "solved the difficult problem by developing the world's only centrifugal spray nuclear fuel powder manufacturing technology – a method of mass-producing fine and uniform spherical powder by melting uranium silicide at 2000 degrees Celsius and then spraying it on a disk rotating at high speed".

The institute says that using this method makes it possible to manufacture nuclear fuel plates with a high density of 5.3gU/cc or more. France, the USA and Korea are currently the only producers of high-density low-enriched uranium silicide plate nuclear fuel. From last December to the end of March this year, the institute conducted first stage performance verification of the fuel in the Belgian research facility BR2 which, it said, "confirmed that the self-developed nuclear fuel remains safe without exploding or leaking radiation even under extreme conditions where more than 70% of the fuel is burned".

... MARIA is the only operating nuclear reactor in Poland. The high flux research reactor - located at the Œwierk Research Centre about 30 kilometres south-east of Warsaw - is a water and beryllium moderated reactor of a pool type with graphite reflector and pressurised channels containing concentric six-tube assemblies of fuel elements. The 30 MWt reactor achieved first criticality in December 1974. It is currently licensed to operate until 2025 but is expected to continue operating until at least to 2030, with Poland's nuclear research centre saying it could operate for another 30 years, subject to sufficient funds for operating it and modernisation. It says one week of its production of radiopharmaceuticals supplies 100,000 patients with the means for diagnosis and therapy.

Source: https://www.world-nuclear-news.org/Articles/Korea-signs-nuclear-fuel-MoU-with-Polish-Atomic-En, 05 December 2022.

URANIUM PRODUCTION

CANADA

Canada's NexGen Eyes Large-Scale Uranium Production

Located in the southwestern Athabasca Basin of Canada's Saskatchewan region, NexGen's Rook I uranium project has the potential to significantly boost Canada's uranium production for many years to come and help meet anticipated global demand growth, said the company's founder and CEO, Leigh R Curyer. And once developed, Rook I

will be capable of producing up to 30Mlb/pa of uranium, which would be the equivalent of about a quarter of the world's total uranium production today, he added, meaning that Rook I can help replace production from Canadian mines that are coming offline between now and 2030.

Canada is one of the world's main producers of uranium, predominantly in the Saskatchewan region. And while small quantities of that uranium are supplied to domestic nuclear reactors, most is exported. Australia-born Curyer, who founded Vancouver-based NexGen over 11 years ago, is not hiding his excitement about Rook I. ...

NexGen, which bought the Rook I property from Toronto-based Mega Uranium in 2012, completed a feasibility study in 2021 and aims to complete front-end engineering design by the end of 2022. Permitting decisions are pending before a final investment decision can be taken. On June 21, 2022, NexGen announced it had submitted a draft environmental impact statement (EIS) to the Saskatchewan Ministry of Environment and the Canadian Nuclear Safety Commission (CNSC). The CNSC announced its acceptance of the draft EIS shortly after.

NexGen is continuing to advance the environmental assessment and licensing activities towards the submission of the final EIS and licence applications required from the provincial and federal regulators. The company also continues engagement with regulators and local communities. The public comment period closed on October 12. Curyer said the company had a "fantastic relationship" with local communities including Indigenous groups in the area. The EIS submission included letters of support for the Rook I project from the Clearwater River Dene Nation, the Buffalo River Dene Nation, and the Buffalo Narrows Dene Nation, all of whom have benefit agreements with NexGen that define the environmental, cultural, economic, employment, and other benefits to be provided to the communities in respect of the project.

If the development goes ahead, the permitting basis for the Rook I project is a 24-year operational period. Once production is up and running, the uranium will be exported to demand centres such as the US. ... Rook I is expected to be capital-intensive but with high rewards. The total initial capital cost for Rook I is estimated at $1.3 billion. Average annual after-tax net cash flow is estimated at more than $1 billion for the first five years, while the average for the 11-year period is estimated at more than $760 million per annum. Assuming uranium prices of $50/lb, which is NexGen's base case, Rook I's after-tax net present value would be C$3.45 billion while NPV would rise to C$4.87 billion if uranium prices were to reach $65/lb. Uranium may currently be hovering around $50/lb but prices have been volatile in recent months. ...

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Source: https://www.mining-journal.com/resourcestocks-company-profiles/resourcestocks/1443543/canada%E2%80%99s-nexgen-eyes-large-scale-uranium-production, 17 November 2022.

USA

Uranium Mine Gears Up Near Grand Canyon National Park

The Pinyon Plain Mine (formerly Canyon Mine) appears to be gearing up for uranium mining operations fewer than 10 miles from the south rim of the Grand Canyon. Hundreds more uranium mines could eventually be developed on federal public lands near Grand Canyon National Park if the Senate fails to pass Senate Bill 387, the Grand Canyon Protection Act.

Operators of the controversial uranium mine recently posted a job ad on Craigslist to recruit new miners, after its owner announced a deal that could ramp up operations at the mine as soon as

2023. Increased activity has been observed inside the mine fence. The Senate has only a few weeks left to pass the Grand Canyon Protection Act, which would permanently ban new uranium mines on more than 1 million acres of federal public lands near the Grand Canyon. The bill has already passed the House twice. ... There are nearly 600 active mining claims staked near Grand Canyon National Park. If the Senate fails to act, those claims could be developed into mines if the existing temporary mining ban is lifted or expires.

Source: https://biologicaldiversity.org/w/news/press-releases/uranium-mine-gears-up-near-grand-canyon-national-park-2022-12-07/, 07 December 2022.

NUCLEAR DISARMAMENT

ISRAEL

UN Says Israel Must Give Up Nuclear Weapons in Lopsided Vote

The UNGA affirmed that Israel must give up its nuclear weapons in a 149-6 vote taken on 7 December 2022. An earlier version of the text was approved in the UNGA's Fifth Committee in October with a 152-5 vote.... Those who opposed the resolution were: Canada, Israel, Micronesia, Palau and the United States. Liberia, which had been absent from the vote in October, changed its position and opposed the text. Another 26 countries, including India and many European states, abstained from the resolution which is part of an annual package of over 15 anti-Israel and pro-Palestinian texts the UNGA approves.

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The Jewish state is believed to be the only one of nine countries to possess nuclear weapons and the only one in the region, even though it has never admitted to having such an arsenal. The resolution presumes that Israel has such weapons. It calls on Israel to "not to develop, produce, test or others acquire nuclear weapons" and to "renounce possession of nuclear weapons." The resolution also called on Israel to accede to the NPT and to place all its nuclear facilities under comprehensive IAEA safeguards.... The resolution was put forward by the Palestinian Authority and 20 countries, including Israel's allies in the Middle East such as Egypt, Jordan, Bahrain, Morocco, Sudan and the United Arab Emirates....

Source: https://www.jpost.com/israel-news/article-724312, 07 December 2022.

NUCLEAR PROLIFERATION

IRAN

Biden's Iran Envoy: Sanctions are 'Not the Answer'

When President Biden was on the campaign trail two years ago, he promised that the United States would reenter the landmark JCPOA, known as the Iran nuclear deal, which the then President Trump pulled out of in 2018. Nearly two years into Biden's term, however, talks to reenter the deal have failed. Instead, Iran has enriched more uranium than ever before and elected a hard-line new President Raisi, who is less likely to engage in constructive dialogue with the West....

As the Biden administration's special envoy for Iran, Robert Malley (RM) is tasked with executing Washington's entire Iran policy, from its continuing sanctions on Tehran to attempts to reenter the JCPOA. I spoke with ...RM as part of FP Live, the magazine's forum for live journalism. What follows is an edited and condensed transcript of our conversation.

Foreign Policy (FP): So, how close is Iran to a bomb right now?

RM: It's a tough question to answer because there's how close they are to having enough fissile material enriched at weapons grade, and that is, as we've said, only a few weeks. That's a result of very dangerous choices that the Iranian regime

has made.

It's also the result of the reckless decision by the Trump administration to withdraw from a deal that was working. So, they're very close to having enough fissile material for a bomb. Weaponizing that takes longer, but it's much too close for comfort.

FP: It's fair to say that so far, talks between Washington and Tehran to try and revive the nuclear deal have failed. Why do you think that's the case?

RM: President Biden campaigned on a commitment that he would try to get back into the deal if Iran would reciprocate. If you ask any participant in the talks, they would say that the United States played a good faith role in trying to get back into the deal. We came very close many times, most recently in August. Each time, Iran stepped back and came up with some new demand, often one that had nothing to do with the nuclear talks—and most recently, having to do with inspections by the IAEA. This has suggested to us that the Iranian system is divided.

Each time we came very close, they were in deals that were presented not by us but by the three European countries—Germany, France, and the U.K.—and by Russia and China, no friends of ours in these circumstances. All of them said that the deal on the table was a fair one. Iran is the one that walked back and rejected it on more than one occasion. You'd have to ask them why.

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FP: Some of your critics would say that you and your team were ready to give the Iranians everything under the sun just to get back into the JCPOA. What do you say to them now that a deal seems so far away?

RM: The fact is that Iran didn't accept the deal. If they had everything that they had wanted, they would have said yes. What we were prepared to do was to lift those sanctions that were supposed to be lifted under the JCPOA and which had been put back into effect by the Trump administration.

Iran has rejected countless opportunities to come back into the deal. We've continued, as we've always said, preparing for a world with the JCPOA or without the JCPOA. We've continued to put pressure on Iran, to try to enforce our sanctions, to make sure that they are sanctioned for their support for terrorism, for the human rights violations, for the ballistic missile program, and for their nuclear program.

Iran has rejected countless opportunities to come back into the deal. We've continued, as we've always said, preparing for a world with the JCPOA or without the JCPOA. We've continued to put pressure on Iran, to try to enforce our sanctions, to make sure that they are sanctioned for their support for terrorism, for the human rights violations, for the ballistic missile program, and for their nuclear program.

The JCPOA is not on the agenda because of Iran's position. And we're continuing with our policy, which is to respond to all of Iran's destabilizing activities.

FP: You've said that there will come a point where a deal is no longer viable. What exactly is that point?

RM: Well, it's a technical question more than a political one. It's when our nuclear experts will tell us that the nonproliferation benefits of the deal don't warrant the sanctions relief that we would be offering. When we get to that point, the deal will be dead. But I do want to emphasize we're not spending our time now focused on the deal. Our focus is on what's happening in Iran and Iran's support for...Putin's war of aggression in Ukraine.

FP: How would you characterize Raisi as a president and as an interlocutor on a potential deal?

RM: It's clear that this is a hard-line regime. We're

seeing it every day. In terms of the deal, I've said many times the key negotiation that needed to take place was not so much between Iran and the United States but between the Iranian regime and itself because it seems that there were some elements who were interested in a deal and others who, for whatever reason, were not. And that's what caused the impasse that was created.

FP: Another criticism of the Biden administration has been that it simply took too long to get around to focusing on the JCPOA. Are there regrets about not acting more quickly?

RM: Within a month of President Biden coming into office, we made clear to the European Union that we were prepared to meet immediately to start negotiations. The Iranians then had all these conditions; they wouldn't meet in certain circumstances. Could we have moved faster? Could we have moved differently? I'll leave it to others to judge. But very quickly, we made clear what our position was, and then the stalling that took place was all on Iran's side.

FP: Talk us through the plan in place to stop Iran from becoming a nuclear power. Is a military option on the table?

RM: Our priority is diplomacy. It's the proven way. It's the best way. It's the most sustainable way to prevent Iran from acquiring a nuclear weapon. And that remains our preference. There are other tools that we're already using: international pressure of a kind that Iran has not experienced for many years. Remember, under the Trump administration, much of the world, including our three European allies in the negotiations, spent at least as much time blaming the United States as they were blaming Iran for its nuclear advances...

FP: By your own admission, Iran's closer to a nuclear bomb than it's ever been. There's a growing body of work that argues that Washington is overusing its power to sanction other countries and then force compliance upon the whole world. Critics of these sanctions say that first, the world is beginning to tire of following U.S.-led policies, which often disrupt local and regional alliances. And then second, sanctions often don't work; they just backfire.

RM: I think it's a very fair question. The U.S. Treasury Department took a stronger perspective in terms of the impact of sanctions and how they can be better constructed so they don't backfire and so they hurt the right people. And there are cases where sanctions have ended up hurting ordinary citizens as opposed to the leaders that we're trying to target. I think it's a very difficult balancing act.

I think we need to fine-tune our sanctions. It's not the answer. If it had been the answer, then Iran would not be advancing its nuclear program. We'd have different results in many countries across the globe. We owe it to ourselves to have an honest examination of how sanctions work and how they don't work in this particular case of Iran.

I'll be candid: I think we need to fine-tune our sanctions. It's not the answer. If it had been the answer, then Iran would not be advancing its nuclear program. We'd have different results in many countries across the globe. We owe it to ourselves to have an honest examination of how sanctions work and how they don't work in this particular case of Iran....

FP: Since we're back on the Iran nuclear deal, let's talk about the role of a new Israeli government led by Netanyahu, who famously pressured the United States to get out of the JCPOA in the first place. How does that change America's position regarding Iran?

RM: It's too soon to say. The government has not been formed yet. But I would simply note that when the Biden administration came into office, our counterpart was Prime Minister Netanyahu, and we dealt with them very openly and candidly. I think both sides tried to learn the lessons of what didn't work in 2015 and 2016 and try not to replicate some of what had happened then.

Now we're back with Netanyahu, and I expect we're going to have very close conversations. We know there may be some disagreements on Iran, but on the fundamentals—which is preventing Iran

from acquiring a nuclear weapon and making sure that we can counter its destabilizing activities across the region—there's a lot of commonality.

Source: https://foreignpolicy.com/2022/12/01/biden-iran-envoy-sanctions-robert-malley/, 01 December 2022.

Iran Claims Uranium Traces Found at Undeclared Sites Came in Waste from Abroad

Iran's nuclear chief has said traces of enriched uranium found on its territory by UN inspectors were brought into the country from abroad, disputing claims of secret nuclear activity. The UN's International Atomic Energy Agency, or IAEA, has for months been pressing Tehran to explain the presence of the nuclear material at three undeclared sites.

Atomic Energy Organization of Iran, Mohammad Eslami, said the traces came from waste brought into Iran from other countries. Eslami said the places visited by UN inspectors were a cattle farm, an abandoned mine and a landfill. "In the landfill, they took samples from the waste that entered Iran from different countries," the report quoted him as saying.

The discovery further complicated efforts to revive the 2015 Iran nuclear deal that has been hanging by a thread since the United States unilaterally withdrew from it in 2018 under then-president Donald Trump.

In remarks published by *Hamshahri* newspaper, the head of the Atomic Energy Organization of Iran, Mohammad Eslami, said the traces came from waste brought into Iran from other countries. Eslami said the places visited by UN inspectors were a cattle farm, an abandoned mine and a landfill. "In the landfill, they took samples from the waste that entered Iran from different countries," the report quoted him as saying. "This does not mean the place of discovery was a nuclear site or that it was an undeclared nuclear activity." "The waste came from Iraq and from other countries," Eslami said. "We have prevented the entry of much of this waste.... They were not nuclear substances from our own manufacturing but perhaps traces from previous use in the country of origin."

In a resolution, last month, the IAEA's board of governors deplored the lack of cooperation and "technically credible" answers from Tehran. As a result, the agency said it was unable to guarantee the authenticity and integrity of Iran's nuclear program. But Eslami said Tehran has "provided documented and argued answers to the request" of the UN nuclear watchdog. An IAEA delegation had planned to travel to Tehran in November, but the visit did not take place. ...

Source: https://www.timesofisrael.com/iran-claims-uranium-traces-found-at-undeclared-sites-came-in-waste-from-abroad/, 09 December 2022.

Iran Planning Massive Expansion of Uranium Capacity – UN Nuclear Watchdog

The UN nuclear watchdog has confirmed Iran is enriching uranium to 60% at a second plant, amid the breakdown of the nuclear deal with major powers. The IAEA said that Iran was also planning a massive expansion of its enrichment capacity. Iran said earlier that it had started to enrich uranium to 60% at the Fordo site, having already done so at its above-ground pilot plant at Natanz for more than a year.

The increased enrichment was seen as a significant addition to its nuclear programme. Enrichment to 60% purity is one short technical step away from weapons grade, 90%. Nonproliferation experts have warned in recent months that Iran has enough 60% enriched uranium to reprocess into fuel for at least one nuclear bomb.

Iran has always denied any ambition to develop a nuclear bomb, insisting its nuclear activities are for civilian purposes. The move was part of Iran's response to the UN nuclear watchdog's adoption of a censure motion drafted by western governments accusing it of non-cooperation. It also comes as talks have stalled to revive a 2015 landmark deal that curbed Iran's nuclear programme in exchange for sanctions relief.

... This month, the IAEA has said it believes Iran has further increased its stockpile of highly enriched uranium. Recently, the agency criticised Tehran for continuing to bar its officials from accessing or monitoring Iranian nuclear sites. A separate report said the IAEA director general, Rafael Grossi, was "seriously concerned" that Iran had still not engaged with the agency's inquiry into manmade uranium particles found at three undeclared sites. The issue has become a key sticking point in the talks for a renewed nuclear deal. It has been nearly two years since IAEA officials have had full access to monitor Iran's nuclear sites, and five months since IAEA surveillance equipment was removed.

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Source: https://www.theguardian.com/world/2022/nov/23/iran-planning-massive-expansion-of-uranium-capacity-un-nuclear-watchdog, 23 November 2022.

PAKISTAN

US Designates 6 Pakistani Firms for 'Unsafeguarded' Nuclear Proliferation

The United States has placed six Pakistani companies on its entity list for missile proliferation and unsafe-guarded nuclear activity. These companies were part of two dozen entities from countries like Russia, Switzerland, Latvia, Pakistan, United Arab Emirates, that were added to the Entity List of the US Commerce Department.

"Today, the Commerce Department's Bureau of Industry and Security (BIS) issued a rule that adds 24 new entities to the Entity List under 26 entries, applying stringent license requirements that will severely restrict these entities' access to commodities, software, and technologies subject to the Export Administration Regulations (EAR). These entities are added under the destinations of Russia, Switzerland, Latvia, Pakistan, UAE," the US Commerce Department's Bureau of Industry and Security (BIS) said in a press release.

Six Pakistan-based companies which are designed are Dynamic Engineering Corperation, Rainbow Solutions (Pakistan), Universal Drilling Engineers (Pakistan), EnerQuip Private, Ltd. (Pakistan), NAR Technologies General Trading LLC (Pakistan and UAE) and TROJANS (Pakistan and UAE).

Six Pakistan-based companies which are designed are Dynamic Engineering Corperation, Rainbow Solutions (Pakistan), Universal Drilling Engineers (Pakistan), EnerQuip Private, Ltd. (Pakistan), NAR Technologies General Trading LLC (Pakistan and UAE) and TROJANS (Pakistan and UAE).

These companies were added to the entity list for "unsafeguarded nuclear activity and missile proliferation related activities." "For the unacceptable risk of using or diverting items subject to the EAR for Pakistan's unsafeguarded nuclear activities, Dynamic Engineering Corperation has been added to the Entity List," BIS said in the statement. "Five companies are being added to the Entity List for their contributions to unsafeguarded nuclear activity and missile proliferation related activities that are contrary to the national security and foreign policy interests of the United States," the statement added. US Assistant Secretary of Commerce for Export Administration Thea Rozman Kendler said advancements in missile and nuclear technology must be vigorously protected from those who seek to cause harm and destruction at a global scale.

Source: https://theprint.in/world/us-designates-6-pakistani-firms-for-unsafeguarded-nuclear-proliferation/1256819/, 09 December 2022.

NUCLEAR SAFETY

BANGLADESH

IAEA Mission Reviews Bangladesh's Regulatory Framework for Nuclear and Radiation Safety as Country Embarks on Nuclear Power Programme

An IAEA mission said Bangladesh is committed to continuous improvement of nuclear and radiation safety. The mission also noted areas where improvements could be made to enhance the national nuclear and radiation safety regulatory infrastructure, as the country constructs its first nuclear power plant (NPP).

The Integrated Regulatory Review Service (IRRS) team concluded a 13-day mission to Bangladesh on 8 December 2022, the first IRRS mission to the country. It was conducted at the request of the Government of Bangladesh and hosted by the Bangladesh Atomic Energy Regulatory Authority (BAERA) in the capital Dhaka, to assess Bangladesh's regulatory framework for safety against IAEA safety standards.

The team, comprising 15 senior regulatory experts from Canada, Egypt, France, India, Japan, Malta, Pakistan, South Africa, United Kingdom and United States of America, as well as six IAEA staff members, reviewed the responsibilities and functions of the government and the management and activities of the regulatory body including authorization, review and assessment, inspection and enforcement, development of regulations and guides, and emergency preparedness and response.

Using IAEA safety standards and international good practices, IRRS missions are designed to strengthen the effectiveness of the national regulatory infrastructure, while recognizing the responsibility of each country to ensure safety. The team, comprising 15 senior regulatory experts from Canada, Egypt, France, India, Japan, Malta, Pakistan, South Africa, United Kingdom and United States of America, as well as six IAEA staff members, reviewed the responsibilities and functions of the government and the management and activities of the regulatory body including authorization, review and assessment, inspection and enforcement, development of regulations and guides, and emergency preparedness and response.

"The self-assessment and preliminary action plan provided by Bangladesh to the IAEA team in advance of the mission gave us the reference material needed for a comprehensive review of the country's regulatory infrastructure, across all nuclear and radiation facilities," said IAEA Director of the Division of Nuclear Installation Safety Anna Hajduk Bradford.

The mission included interviews and discussions with representatives from BAERA and the Ministry of Sciences and Technology. The team visited the BAEC TRIGA Research Reactor, the central radioactive waste processing and storage facility at BAERA, the Institute of Nuclear Medicine and Allied Science, the Square Hospital of radiotherapy and Bangladesh Industrial X-Ray, as well as the construction site of the country's first nuclear power plant, Rooppur NPP in Pabna, around 200 km west of Dhaka. When completed, Rooppur NPP will contribute a total of 2400 MW(e) to Bangladesh's energy grid.

... The IRRS team offered several recommendations to further enhance the regulatory framework for the effective oversight of facilities and activities. Recommendations and suggestions include:

- Establishing the national policy and strategy for safety in accordance with the IAEA fundamental safety objective and principles.
- Updating the legal framework for nuclear and radiation safety by commencing revision of the Nuclear Safety and Radiation Control (NSRC) Rules, which define the fundamental principles and rules for the protection of workers, the public and the environment.

· Developing BAERA's human resources plan to ensure that a sufficient number of trained, qualified, competent and certified staff are available to perform all its functions effectively.

Source: https://www.iaea.org/newscenter/pressreleases/iaea-mission-reviews-bangladeshs-regulatory-framework-for-nuclear-and-radiation-safety-as-country-embarks-on-nuclear-power-programme, 10 December 2022.

BOSNIA

IAEA Mission Reviews Bosnia and Herzegovina's Regulatory Framework for Radiation Safety

An IAEA mission said Bosnia and Herzegovina is working to enhance its regulatory system for nuclear and radiation safety, whilst noting specific areas for additional efforts including the allocation of sufficient human and financial resources for the country's regulator. The Integrated Regulatory Review Service (IRRS) team today concluded a ten-day mission to Bosnia and Herzegovina from 28 November to 7 December. The mission, conducted at the request of the Council of Ministers of Bosnia and Herzegovina, and hosted by the State Regulatory Agency for Radiation and Nuclear Safety (SRARNS), was carried out to review the national regulatory framework for nuclear, radiation, radioactive waste and transport safety.

Bosnia and Herzegovina does not operate any nuclear power plants. It uses radiation sources for industrial and medical applications. "This IRRS mission was successful thanks to the openness and transparency of the SRARNS," said Igor Sirc, team leader and Director of the Slovenian Nuclear Safety Administration. Sirc said "However, we found that SRARNS faces significant challenges related to human resources and there is an urgent need to address this issue.

Using IAEA safety standards and international good practices, IRRS missions are designed to strengthen the effectiveness of the national regulatory infrastructure for nuclear and radiation safety, while recognizing the responsibility of each country…. Team members observed a regulatory inspection at the Radiology Department of the University Clinical Center. They also visited the radioactive waste storage facility as well as the dosimetry laboratory of the Institute for Public Health.

A visit was also held at the Operational and Communication Centre of Bosnia and Herzegovina, to discuss emergency preparedness and response in the country. Bosnia and Herzegovina does not operate any nuclear power plants. It uses radiation sources for industrial and medical applications. "This IRRS mission was successful thanks to the openness and transparency of the SRARNS," said Igor Sirc, team leader and Director of the Slovenian Nuclear Safety Administration. Sirc said "However, we found that SRARNS faces significant challenges related to human resources and there is an urgent need to address this issue." …

They said the Council of Ministers should:

· Provide for adequate human and financial resources to SRARNS to fulfill its regulatory responsibilities and functions for safety.

· Revise and implement the policy for safety and the strategy for the radioactive waste management.

The team also recommended that SRARNS should:

· Apply a graded approach in its regulatory functions and further develop its management system.

· Revise some of the regulations on radiation protection, radioactive waste management, transport activities and emergency preparedness and response and develop additional guidance. …

Source: https://www.iaea.org/newscenter/pressreleases/iaea-mission-reviews-bosnia-and-herzegovinas-regulatory-framework-for-radiation-safety, 07 December 2022.

UKRAINE

Nuclear Monitors Near Accord on Ukraine Security Zone at Zaporizhzhia Plant

International nuclear monitors say they are closing in on an agreement between Ukraine and Russia that would set up a security zone around Europe's largest atomic energy plant, potentially easing

concerns about an accident. "We are getting closer to something that could be acceptable," Grossi, director general of the IAEA said in an interview on 2 December 2022 with Bloomberg Television. IAEA monitors are at the Zaporizhzhia nuclear power plant, whose six reactors are shut down after months of attacks, while Grossi tries to persuade the governments in Kyiv and Moscow to cease military activities around the facility.

Grossi, an Argentine diplomat, said he expects to sit down separately with President Zelenskyy and his Russian counterpart, Putin, in the near future to push negotiations forward.... The IAEA has "no information" that Russian forces may be preparing to retreat from the nuclear facility, said Grossi, although he added that his inspectors have "been hearing rumors" that Moscow might be contemplating a withdrawal. "In spite of all of these abnormal circumstances, the plants are viable," Grossi said. The reactors are "ready to be fired up" once they can be operated with safety and Ukraine's electricity grid is ready to transmit power. The IAEA is also preparing to widen its monitoring activities to Ukraine's three other nuclear plants after Russian attacks on the country's power grids forced them offline. Unlike coal or gas-fueled plants, nuclear reactors need a constant flow of electricity to run pumps used to cool nuclear fuel....

Source: https://www.bloomberg.com/news/articles/2022-12-02/iaea-nuclear-monitors-close-to-security-zone-around-ukraine-zaporizhzhia-plant, 02 December 2022.

The U.N. Security Council voted unanimously on 30 November 2022 to keep pressing all countries to implement a resolution aimed at keeping nuclear, chemical and biological weapons out of the hands of terrorists, black marketeers and others. The council resolution approved by a 15-0 vote extends the mandate of the committee monitoring implementation of the 2004 resolution on the threat of "non-state actors" obtaining or trafficking WMD for 10 years until 30 November 2032.

NUCLEAR TERRORISM

GENERAL

UN Votes to Press Countries to Stop Terrorists Getting Nukes

The U.N. Security Council voted unanimously on 30 November 2022 to keep pressing all countries to implement a resolution aimed at keeping nuclear, chemical and biological weapons out of the hands of terrorists, black marketeers and others. The council resolution approved by a 15-0 vote extends the mandate of the committee monitoring implementation of the 2004 resolution on the threat of "non-state actors" obtaining or trafficking WMD for 10 years until 30 November 2032.

It also continues support for the committee's group of experts. The resolution calls on the committee and the 193 U.N. member nations to take into account the use by non-government groups and individuals of rapid advances in science and technology to spread the use of these banned weapons. The council says in the resolution that it is "gravely concerned" at the threat of terrorism and the risk that non-state actors may acquire, develop, traffic in or use" nuclear, chemical or biological weapons, including by relying on advances in science and technology.

The April 2004 resolution was adopted in the aftermath of the 11 September 2001, terrorist attack on the United States to close what the then President Bush called a loophole that could allow terror groups to gain weapons of mass destruction. International treaties had targeted weapons proliferation by governments, but at the time there were no laws to prevent "non-state actors" such as terrorists, corrupt scientists, black market actors and others from obtaining WMDs.

The resolution requires all U.N. member states to adopt laws to prevent "non-state actors" from manufacturing, acquiring or trafficking in nuclear, biological or chemical weapons, the materials to make them, and the missiles and other systems to deliver them. It also requires all countries to

take measures to account for and secure all banned weapons, missiles and weapons material, and to develop border controls and step up efforts "to detect, deter, prevent and combat ... the illicit trafficking and brokering in such items."

... The resolution calls for the committee to conduct comprehensive reviews on implementation, including holding open sessions in five years and before it needs to be renewed in 10 years. And it calls on countries that have not submitted a report on steps they have taken or intend to take to implement the resolution to submit one "without delay." The council called for intensified efforts by the committee to promote full implementation of the 2004 resolution, saying more attention is needed, including on enforcement and finance measures, securing materials and national export and transshipment controls. ...

Source: https://www.devdiscourse.com/article/law-order/2271014-un-votes-to-press-countries-to-stop-terrorists-getting-nukes, 01 December 2022.

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NUCLEAR WASTE MANAGEMENT

AUSTRIA

IAEA Mission Says Austria Committed to the Safe Management of Radioactive Waste, Sees Areas for Improvement with Disposal

An IAEA team of experts found that Austria demonstrates commitment to the safe management of the predisposal of its radioactive waste, while also noting opportunities to enhance the regulatory framework and arrangements for eventual disposal. The Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) team this week concluded a ten-day mission to Austria....

Austria does not operate any nuclear power plants. Low- and intermediate-level radioactive waste is generated from the use of radiation sources in medical and industrial applications, as well as in science and research, including at the TRIGA Mark II research reactor in Vienna, and from the decommissioning of facilities and laboratories from past research and development activities....

The ARTEMIS team found that Austria has developed a comprehensive strategy for the safe and responsible predisposal management of radioactive waste until 2045. They highlighted the modernization of waste treatment facilities in Seibersdorf, the reconditioning of waste for handling, transport or storage and the interim storage of this reconditioned radioactive waste as examples of effective management. The team also encouraged the Austrian Federal Government to update its national strategy to include a consolidated implementation plan for waste disposal — the final step in the management of radioactive waste.

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... Mathilde Prevost, IAEA coordinator of the ARTEMIS mission to Austria, highlighted the establishment of the Austrian Board for Radioactive Waste Management in 2021 as a positive action. "The Board is seeking to find an optimal solution for disposal considering the latest scientific knowledge and socio-economic

aspects. This is a positive step towards the definition of a consolidated implementation plan for disposal."

In addition, main recommendations and suggestions provided by the team included:

· The Federal Government's consolidated implementation plan for disposal should include interim targets, allocation of responsibilities and governance processes.

· The Federal Government should ensure that coordination or implementation of the national programme for radioactive waste management is effectively separated from the regulatory oversight of safety.

· The BMK should revise regulations to clarify regulatory expectation on periodic safety reviews and licensing of decommissioning activities or disposal facilities. ...

Source: https://www.iaea.org/newscenter/pressreleases/iaea-mission-says-austria-committed-to-the-safe-management-of-radioactive-waste-sees-areas-for-improvement-with-disposal, 01 December 2022.

GENERAL

Small Modular Reactors aren't Difficult Nuclear Waste Generators

Many experts believe SMRs, which are generally classified as nuclear power reactors with an electrical output of 300 MW or less, offer great promise for supplying the world with carbon-free energy. Several SMR designs are under development by companies around the world including NuScale Power, GE-Hitachi, Terrestrial Energy, TerraPower, Toshiba, X-energy, and others. Among the benefits touted by proponents of SMRs are improved reactor safety features, quicker plant construction, and reduced costs for the units.

Yet, there has been some heated debate on the amount of nuclear waste that might be generated by a fleet of SMRs. In May 2022, findings from research conducted by a team that included a former U.S. Nuclear Regulatory Commission (NRC) chairperson and experts from Stanford University suggested SMRs will generate more radioactive waste than conventional gigawatt-scale nuclear units. That research was disputed by NuScale, which said there was "a factual error in the paper." Specifically, Jose N. Reyes, Chief Technology Officer and co-founder of NuScale, said, "The authors mistakenly assert that NuScale SMRs will produce significantly more spent nuclear fuel (SNF) than existing LWRs. The basis for this statement is their analysis of the NuScale 160 MW thermal core as opposed to the NuScale 250 MW thermal core implemented in NuScale VOYGR plants." Reyes noted at the time that NuScale's 250-MWt design has an average fuel burnup and a design basis maximum exposure that are within the values typically observed in the existing fleet of light water reactors. Now, NuScale has some independent research to support its claim.

All told, when it comes to nuclear waste, SMRs are roughly comparable with conventional pressurized water reactors, with potential benefits and weaknesses depending on which aspects you are trying to design for. Overall, there appear to be no additional major challenges to the management of SMR nuclear wastes compared to the commercial-scale large LWR wastes.

In November, Argonne National Laboratory (ANL) completed a study intended to evaluate the nuclear waste attributes of SMRs, with the results compared to a reference large pressurized water reactor (PWR). Dr. Taek Kyum Kim, manager of Nuclear Systems Analysis at ANL and lead author of the report detailing the studies findings, said, "All told, when it comes to nuclear waste, SMRs are roughly comparable with conventional pressurized water reactors, with potential benefits and weaknesses depending on which aspects you are trying to design for. Overall, there appear to be no additional major challenges to the management of SMR nuclear wastes compared to the commercial-scale large LWR wastes."

The ANL study, which was conducted with assistance from the Idaho National Laboratory, assessed the nuclear waste attributes of three small reactors: NuScale's VOYGR, TerraPower's Natrium, and X-energy's Xe-100 designs. VOYGR is a PWR design using the same type of ceramic fuel as found in larger LWRs, Natrium is liquid metal–cooled and uses a metal alloy fuel, and Xe-100 is a helium-cooled reactor that uses pebbles containing TRi-structural ISOtropic (TRISO) particle fuel.

The calculated nuclear waste from each was compared to nuclear waste metrics of a reference large PWR. The nuclear waste metrics used in the study addressed "front-end" wastes generated during the fuel manufacturing process, "back-end" wastes arising from the spent nuclear fuel (SNF), and "end-of-life" wastes from decommissioning of the reactors.

Concerning front-end waste, the report says depleted uranium (DU) mass is proportional to enrichment and inversely proportional to burnup and thermal efficiency. Compared to the reference PWR, VOYGR generates 23% more DU mass due to relatively higher fuel uranium enrichment (4.95% vs. 4.5%), lower burnup (49.5 GWd/t vs. 50.0 GWd/t), and lower thermal efficiency (31% vs. 34%) …. The ANL report says, assuming appropriate waste management system design and operational optimization, "there appear to be no major challenges to the management of SMR wastes compared to the reference LWR wastes."

Source: https://www.powermag.com/small-modular-reactors-arent-difficult-nuclear-waste-generators/, 07 December 2022.

Centre for Air Power Studies

The Centre for Air Power Studies (CAPS) is an independent, non-profit think tank that undertakes and promotes policy-related research, study and discussion on defence and military issues, trends and developments in air power and space for civil and military purposes, as also related issues of national security. The Centre is headed by Air Marshal Anil Chopra, PVSM AVSM VM VSM (Retd).

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