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CENTRE FOR AIR POWER STUDIES

OPINION – Josh Smith

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## Caught between China and the US, Asian Countries Stockpile Powerful New Missiles

Asia is sliding into dangerous arms race as smaller nations that once stayed on the sidelines build arsenals of advanced long-range missiles, following in the footsteps of powerhouses China and the United States, analysts say. China is mass producing its DF-26 - a multipurpose weapon with a range of up to 4,000 kilometres - while the United States is developing new weapons aimed at countering Beijing in the Pacific. Other countries in the region are buying or developing their own new missiles, driven by security concerns over China and a desire to reduce their reliance on the United States. Before the decade is out, Asia will be bristling with conventional missiles that fly farther and faster, hit harder, and are more sophisticated than ever before - a stark and dangerous change from recent years, analysts, diplomats, and military officials say....

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Such weapons are increasingly affordable and accurate, and as some countries acquire them, their neighbours don't want to be left behind, analysts said. Missiles provide strategic benefits

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such as deterring enemies and boosting leverage with allies, and can be a lucrative export....

### **Homegrown Missiles:**

According to unreleased 2021 military briefing documents reviewed by Reuters, U.S. Indo-Pacific Command (INDOPACOM) plans to deploy its new long-range weapons in

“highly survivable, precision-strike networks along the First Island Chain,” which includes Japan, Taiwan, and other Pacific islands ringing

the east coasts of China and Russia.

The new weapons include the Long-range Hypersonic Weapon (LRHW), a missile that can deliver a highly manoeuvrable warhead at more than five times the speed of sound to targets more than 2,775 kilometres (1,724 miles) away. An INDOPACOM spokesman told Reuters that no decisions had been made as to where to deploy these weapons. So far, most American allies in the region have been hesitant to commit to hosting them. If based in Guam, a U.S. territory, the LRHW would be unable to hit mainland China.

Japan, home to more than 54,000 U.S. troops, could host some of the new missile batteries on its Okinawan islands, but the United States would probably have to withdraw other forces, a source familiar with Japanese government thinking said, speaking anonymously because of the sensitivity of the issue. Allowing in American missiles - which the U.S. military will control - will also most likely bring an angry response from China, analysts said....

Japan has spent millions on long range air-launched weapons, and is developing a new version of a truck-mounted anti-ship missile, the Type 12, with an expected range of 1,000 kilometres. Among U.S. allies, South Korea fields the most robust domestic ballistic missile programme, which got a boost from a recent agreement with Washington to drop bilateral limits on its capabilities. Its Hyunmoo-4 has an 800-kilometre range, giving it a reach well inside China.

"When the U.S. allies' conventional long-range-strike capabilities grow, the chances of their employment in the event of a regional conflict also increase," Zhao Tong, a strategic security expert in Beijing, wrote in a recent report. Despite the concerns, Washington "will continue to encourage its allies and partners to invest in defence capabilities that are compatible with coordinated

operations," U.S. Representative Mike Rogers, ranking member of the House Armed Services Committee, told Reuters.

**Blurred Lines:** Taiwan has not publicly announced a ballistic missile programme, but in December 2020 the U.S. State Department approved its request to buy dozens of American short-range ballistic missiles. Officials say Taipei is mass producing weapons and developing cruise missiles such as the Yun Feng, which could strike as far as Beijing....

South Korea has been in a heated missile race with North Korea. The North recently tested what appeared to be an improved version of its proven KN-23 missile with a 2.5-ton warhead that analysts say is aimed at besting the 2-ton warhead on the Hyunmoo-4.... As proliferation accelerates, analysts say the most worrisome missiles are those that can carry either conventional or nuclear warheads. China, North Korea and the United States all field such weapons....

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Source: <https://www.reuters.com/world/asia-pacific/caught-between-china-us-asian-countries-stockpile-powerful-new-missiles-2021-07-20/>, 20 July 2021.

**OPINION – Marc Pilisuk**

**Nuclear Weapons: Rising Danger**

After a war has ended, historians, elected officials, and faith leaders, no less than the people involved, often raise doubts over whether the outcomes were worth the many horrific costs. But mourning diminishes over time and life for the survivors goes on. Such a recovery from destruction is no longer assured or even likely in the age of nuclear weapons. World leaders, however, continue to play the game of war in ways that risk the war that could end life on earth.

Recent U.S. actions in Asia are bringing us closer to such a war. The U.S. has long held agreements with many countries, including South Korea, permitting launch facilities for nuclear missiles. Now the U.S. is engaging in a program of assisting Japan in the development of missiles capable of launching nuclear warheads. The Japanese constitution bans the development and deployment of such weapons. But escalation of threats by U.S. and Chinese officials may threaten this longstanding policy.

This potential for Japan to launch weapons of mass destruction comes at a time of increasing presence of U.S. warships in the South China Sea. China was cruelly devastated by Japan in World War II, something effectively forgotten in the U.S. but not in China. Indeed, a Chinese Communist Party video, still not confirmed as Chinese policy, threatens repeated nuclear attack on Japan in response to anticipated military provocations.

This would amount to a departure from China's long-term policy of "no first use" (of nuclear weapons). Incredibly, the U.S. has not yet committed itself to a "no first use" policy and has expanded its own nuclear weapons development programs. The recognition of potential danger from such development was clearly visible in the multi-lateral agreement preventing such activity in Iran. The U.S. withdrew its treaty obligations under the Trump administration and has still not been able to revive the agreement.

History in the atomic era contains several examples in which deficiencies in communication during periods of hostility and threats almost led us inadvertently into the launch of a nuclear war. The atomic scientists who monitor the level of risk have moved the nuclear doomsday clock closer to

midnight. Massive expenditures for nuclear weapons development have produced tactical weapons more likely to be used and high yield weapons with destructive capacity far exceeding those used to destroy Hiroshima and Nagasaki.

These weapons continue to provoke adversaries, making us less secure. U.S. military policy, resulting in 800 military bases in 80 countries, has not brought us security. We live in a world in which the other greatest threats to life come from global warming and pandemic illness. To combat these threats international cooperation is needed.

We have developed a framework for such cooperation through the World Health Organization

and other agencies of the UN. They have not been perfect but strengthening international collaboration in defeating pandemics and in radically reducing climate chaos may prove to be an insurance policy against falling into a nuclear war. When the reach of weaponry is global the reach of our relationships must be too.

This is far better than relying upon military powers to demonize competitors and continuing to see

threats and force as a way that supposedly sane leaders can vie for competitive advantage. Building back better should mean the goods of life, not the instruments of death. An appropriate agenda would start with rejecting first use of nuclear weapons, ending the budget for nuclear weapons, ending the idea

that wars are ever moral alternatives to peaceful conflict resolution and demanding that our government rise to a level of mature diplomacy with all nations.

Negotiations toward zero nuclear weapons should be underway already, something that inspection technology makes practical and doable. We should

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lead and should incentivize all nuclear powers to join. This is literally a mortal threat to humankind. Well-meaning military strategists are mired in a very dangerous game. They must be reminded that destroying our planet in a nuclear war would be a betrayal of everything we hold dear.

*Source: Marc Pilisuk is Professor Emeritus at the University of California, a faculty member at Saybrook University. <https://www.ptleader.com/stories/nuclear-weapons-rising-danger-marc-pilisuk,76370?>, 29 July 2021.*

**The Chalk River nuclear facility in Ontario, where the CANDU model got its start, became a global contributor to many international nuclear technology projects. Today, Canada's nuclear sector includes 19 reactors powering approximately 15 per cent of the country. Ontario, with 95 per cent of the country's reactors, generated 60 per cent of its own electricity from nuclear power plants in 2020.**

**OPINION – Krystle Wittevrongel**

**Canada's Future Leaders Must See Nuclear as More Friend than Foe**

In 1950, Canada faced a difficult choice between the desire to be a leader in the development of nuclear energy technology and the fear that such technology would bring the end of the world a little closer. Despite concerns related to the bombing of Hiroshima and Nagasaki, Canada elected to be in the vanguard.

As a result, world-class CANDU reactors were developed in this country and exported around the world. The Chalk River nuclear facility in Ontario, where the CANDU model got its start, became a global contributor to many international nuclear technology projects. Today, Canada's nuclear sector includes 19 reactors powering approximately 15 per cent of the country. Ontario, with 95 per cent of the country's reactors, generated 60 per cent of its own electricity from nuclear power plants in 2020.

Yet today, this positive narrative has largely been

flipped on its head. Due, in part, to anti-nuclear messaging from activists and certain politicians, the development of this technology has stalled, and with it, so has Canada's capacity to compete as a global leader in the development of clean nuclear energy.

This is unfortunate when we consider some of the challenges, we face today that were poorly understood in the post-war era. Nuclear energy represents one of the cleanest, most sustainable sources of power in a context in which reducing emissions has become a

universal goal. But whereas nuclear energy once seemed to be the next logical step in Canada's energy policy despite warnings about its destructive potential, today, nuclear power ironically gets a bad rap even though it may offer a way of avoiding destructive climate-related effects.

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In 2050, Canada's future leaders must see nuclear as more friend than foe. Ignoring its potential as a fast track to adapting away from greenhouse gas-emitting technologies and resources would be a missed opportunity. Turning a blind eye would also be increasingly unpopular as more and more people are becoming

convinced of the dangers of climate change.

Admittedly, there are drawbacks to nuclear power, such as waste disposal. While manageable today, this will present more of a challenge as nuclear infrastructure grows to supply more than just 15 per cent of our electricity. Still, with Ontario already relying on nuclear for most of its power generation, Canada has only produced enough total spent fuel waste to fill the equivalent of a

half-dozen hockey rinks to the height of the boards.

Many experts also believe that the technology is still in its infancy and may present risks when exported to countries that are not bound by international treaties which limit their capacity to produce nuclear weapons (think of China, India, Pakistan, South Africa, and North Korea in the 20th century). Yet these concerns seem marginal at best when we consider that Canada has a unique profile on the world stage: a reasonably high GDP per capita, a large pre-existing system for nuclear waste disposal, and a peace-oriented foreign policy guided by nuclear non-proliferation treaties.

Not only should there be flexibility for the government to invest in nuclear projects from now until 2050, but regulations should be relaxed to allow for the development of ever-smaller reactors. And indeed, Canada has already started to invest in the development of SMRs. This is an exciting way for this clean energy technology to avoid the enormous state-subsidized start-up costs associated with larger reactors. With most experts pointing to cost as the largest barrier to a nuclear future, shrinking reactors could be a significant part of the solution.

In addition, nuclear energy can also potentially save lives in the immediate future. In 2020, the COVID-19 pandemic exposed Canada's lack of capacity and capability when it comes to producing pharmaceuticals domestically. Therapeutic radionuclides produced here could offer a path forward and allow Canada to escape some of its current dependence on other countries for life-saving treatments.

Source: <https://www.thespec.com/opinion/contributors/2021/07/23/canadas-future-leaders-must-see-nuclear-as-more-friend-than-foe.html>, 23 July 2021.

**OPINION – Imran Hassan**

**Strategic Stability & Restraint in South Asia**

The interplay of global power competition and nuclear weapon states sharing disputed borders continue to make South Asia one of the most volatile regions in the world today. February 2021 marked two years since the 2019 India-Pakistan Pulwama-Balakot crisis, as well as the start of the most recent ceasefire on the LoC. While the two countries have reportedly maintained the ceasefire for the past five months, the situation is still far from normal. There are no substantial arms control measures in place between India and Pakistan and existing confidence building measures are aging.

Escalatory doctrines, including India's Cold Start Doctrine (CSD) which seeks space for limited conventional war under Pakistan's perceived nuclear thresholds, carry the grave risk of escalation to nuclear level. Durable peace in the region rests on a Strategic Restraint Regime (SRR), which would include mechanisms for dispute resolution, nuclear restraint, and maintaining a conventional military balance.

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It would be unrealistic to contemplate peace and stability in South Asia without resolving territorial disputes, agreeing on reciprocal measures for nuclear restraint, and establishing a mechanism to bring balance between conventional forces. This can only be achieved through a sustained process of dialogue and realization that such

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restraint offers mutual benefits. In October 2020, Pakistan reiterated its call for an SRR in South Asia. Revisiting an SRR would also provide a viable option to address emerging technologies which are adding a new layer of complexity to strategic stability in South Asia. The advent of disruptive technologies in the region such as hypersonic glide vehicles, BMD systems, canisterization of ballistic missiles like the Agni-V, and the nuclearization of the Indian Ocean, has potential to offset deterrence equilibrium in the region.

**The Role of Global Actors:** Strategic instabilities between India and Pakistan are deeply linked with the contemporary geopolitics. As the world gradually moves towards multipolarity, the United States is seen as struggling to maintain its global pre-eminence amidst a rising China and resurging Russia. Further, the emerging fifth age of technological development has pushed the United States, Russia, and China to place arms control on the backburner—with the arms control structure between the United States and Russia standing only on the recently renewed New START treaty. The intensifying competition for pre-eminence and hegemony affects the global strategic scenario and South Asia. An SRR, which would focus on bilateral arms control and restraint, is critical for contextualizing India-Pakistan arms control measures outside an increasingly unstable geopolitical environment....

India has emerged as a major beneficiary of this competition through cooperation with both the United States and Russia. Cooperation between India and the United States took off following the 2005 Indo-U.S. Nuclear Deal and India's NSG waiver in 2008, since then India and the United States have signed multiple defense, trade, and intelligence sharing agreements including the Defense, Technology and Trade Initiative in 2012,

the Logistics Exchange Memorandum of Agreement (LEMOA) in 2016, the Communications Cooperation and Security Agreement (COMCASA)

in 2018, and the Basic Exchange and Cooperation Agreement (also known as BECA) in 2020, which compliments the LEMOA and COMCASA agreements for military cooperation and support. With Russia, cooperation has included the acquisition of state of the art S-400 Missile

Defense System, Akula class nuclear powered attack submarines, and a joint venture for the nuclear-capable BrahMos supersonic cruise missile. Inter alia these developments and agreements have a cascading effect on Pakistan's security.

Consequently, Pakistan seeks to indigenously develop technological solutions—such as SRBMs and a sea-based deterrent—to offset the resulting asymmetries, which are potentially dangerous for Pakistan's deterrence credibility, while also diversifying its foreign policy options and maintaining ties with China. The bid to maintain conventional balance has also involved joint ventures of advanced multirole combat aircraft (JF-17) and advanced attack submarines (Hangor class).

**South Asia's Strategic Asymmetries:** Beyond the global environment, regional growth and

development in South Asia is hampered by a set of challenges including the historical animosity between India and Pakistan and their divergent political and strategic aspirations shape South Asian security imperatives. Although India and Pakistan recently entered into a ceasefire on the LoC, Kashmir remains a core issue between the two countries and is likely to remain a nuclear flashpoint particularly following the abrogation of Article 370 and 35A of the Indian Constitution. At the doctrinal level, the offensive Cold Start, that seeks to explore space for sub conventional and

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limited warfare under the nuclear overhang, creates concern about India's intent to carry out pre-emptive attacks. The conventional imbalance is also a cause of concern for Pakistan, as India has also become the second largest arms importer of the world.

On nuclear posture side, Pakistan has long doubted India's policy of NFU, which has been exacerbated as India appears to be taking global pulse over the pros and cons of removing the shroud of NFU with statements made by political figures including India's current Defense Minister that bring the doctrine into question. Recent technological and force posture developments suggest that New Delhi may be weighing its strategic options regarding a pre-emptive nuclear doctrine that would rely on counterforce targeting. On the developmental side, there is visible qualitative and quantitative military build-up, which has not only strained the deterrence equilibrium but also runs contrary to New Delhi's claimed doctrinal position of credible minimum deterrence. Indian weapon development and modernization far exceeds any reasonable requirements for maintaining a credible and minimal deterrence posture around NFU policies. Such developments can only be required if a state is pursuing nuclear warfighting doctrines and comprehensive first strike to support pre-emption.

While some experts have pointed to the "strategic chain" of U.S.-China-India-Pakistan cascade dynamics as the driver of this competition, as well as the China-centric focus of India's force modernization, from Islamabad's vantage point, India's modernization efforts appear much more South Asia specific. U.S. and regional experts in a recent report by the Stockholm International Peace Institute acknowledge: "India talks China, but acts Pakistan." For this reason, the bulk of India's conventional and nuclear forces are viewed as Pakistan specific and do not contribute to its deterrence relationship with China.

Pakistan seeks strategic balance at the minimalistic level of armament for credible deterrence. While reports indicate that Indian and

Pakistani nuclear warhead count is in close proximity and project arms racing in South Asia, a recent study by the Belfer Center paints a different picture, noting that the full-capacity of India's fissile material—including unsafeguarded stockpiles which are weapon usable—would support as much as 2,686 nuclear warheads. This capacity is attributed to India's 2008 NSG waiver, which enables New Delhi to meet all its energy needs through international cooperation while freeing the domestic fissile material for possible weapons development.

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In context of growing nuclear asymmetries in South Asia, Pakistan is expected to adhere to unilateral restraint. However, Pakistan has not been left room for such restraint. India's development of a BMD

system led Pakistan to demonstrate MIRV capability in response, nuclearization of the Indian Ocean pushed Pakistan to develop sea-based nuclear deterrent, and India's CSD left Pakistan with no choice but to develop SRBMs. Pakistan's various proposals to India included non-development of BMD system which would have foreclosed the requirement for MIRVs and Indian Ocean Nuclear Weapons Free Zone would have obviated the need for sea-based nuclear deterrent. Pakistan is exercising strategic restraint, but capabilities at bare-minimum level of armament remain imperative for Pakistan to maintain its credibility of deterrence. Pakistan has been open to arms control measures, which include building confidence and introducing a SRR. Some ideas consistent with this regime that have been proposed in Track II settings may be worth exploring further. Lack of reciprocity has only aggravated regional instability. As a responsible nuclear power, Pakistan maintains modest force posture and rationality in its nuclear doctrine.

**The Way Forward:** The SRR offers a pathway for reducing Indian and Pakistani dependence on external powers and takes the great power factor out of the security calculus. The SRR has three interlocking elements: conflict resolution, nuclear and missile restraint, and conventional balance

which should be pursued in tandem owing to the interlocking nature of these proposals. The proposal includes conflict resolution through a sustained and result-oriented dialogue; measures for nuclear restraint and conventional balance; maintenance of nuclear weapons on low-alert status; non-acquisition or deployment of BMD systems; avoidance of a nuclear, missile, or conventional arms race; and, continuation of nuclear test moratoriums. India, however, remains reluctant to engage on these issues driven by aspirations of global power status and de-hyphenation with Pakistan. However, if India remains embroiled in regional disputes, pursuance of global ambitions will remain a challenge.

The unresolved Kashmir issue remains a major bone of contention between India and Pakistan, unless it finds a plausible solution, durable peace in the region will remain elusive. Likewise, the conventional imbalance becomes a key driver for vertical nuclear proliferation and geostrategic instability. History is also evident that arms control measures help reduce tensions and bridge trust deficits amongst rival states. The SRR proposed by Pakistan bears all these contours essential for holistic peace and stability in the region. In the absence of these measures, South Asia will drift towards instability and preventing nuclear disasters will become a growing challenge.

Source: <https://southasianvoices.org/strategic-stability-restraint-in-south-asia/>, 22 July 2021.

**OPINION – Michael Mazza**

**Three Scenarios for China’s Evolving Nuclear Strategy: Implications for the Taiwan Strait**

The PLA is building 120 new missile silos on the outskirts of the Gobi Desert, raising a new question about the future of Chinese nuclear forces and China’s approach to wielding them. Answers to those questions, which may not become clear for some time, could have

significant effects on US-China strategic stability. In the meantime, it is worth thinking through the role that nuclear weapons play in the Taiwan Strait, a factor that is too often overlooked in analyses of the likelihood of a conflict in the Strait and the courses such a conflict might take.

A comprehensive assessment of nuclear dynamics surrounding the Taiwan Strait would consider nuclear force modernization efforts and doctrinal revisions in both China and the United States, and perhaps in Russia and India as well. Such an assessment would likewise take account of changes in conventional force structure and posture, missile defense capabilities, and conventional threats to strategic forces... .

**China’s Current Approach: A Brief Overview:**

China has long maintained a relatively small nuclear arsenal and a nuclear strategy that M. Taylor Fravel and Fiona S. Cunningham have described as “assured retaliation.” Assured retaliation, they write, “uses the threat of inflicting

unacceptable damage in a retaliatory strike to deter an adversary from attacking first with nuclear weapons. That is, following a first strike, China would still have enough weapons to retaliate and impose unacceptable damage on its adversary.” Chinese nuclear strategists have long held that maintaining a credible ability to hit only a handful of enemy cities in a retaliatory strike was sufficient to deter nuclear use or the threat of nuclear use against the People’s Republic of China. Along with this assured retaliation posture, China has maintained “dual pledges”: that it would never use nuclear weapons first (called no first use, or NFU), and that it would never use nuclear weapons against non-nuclear states.

The PRC is currently growing its nuclear arsenal; it is also modernizing and diversifying its delivery systems. There has been a debate in recent years about the future of China’s nuclear strategy, and in particular about the value of NFU. Today, China’s nuclear force structure remains consistent with “assured retaliation” and authoritative statements

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do not suggest that there has been a doctrinal overhaul. There are reasons to suspect that China may one day set aside “assured retaliation” and NFU. But for now, PLA doctrinal writings include just one campaign for the use of nuclear forces: a “nuclear counterstrike campaign,” which “describes how China would execute a nuclear strike after it had been attacked with nuclear weapons.”

**Scenario 1: China Maintains a Strict Interpretation**

**of No First Use:** It is possible that China’s NFU policy is sincere and that Xi Jinping and other members of the Central Military Commission have no intention of using nuclear forces unless China is attacked first with nuclear forces. In this scenario, China’s leaders would be confident they have conveyed that clearly to the United States. Washington would recognize those efforts, but remain somewhat skeptical of the NFU pledge. Should conflict erupt in the Taiwan Strait, Washington might be less inhibited in conventional escalation, and be more aggressive in targeting Chinese territory—though probably taking care to avoid striking intercontinental ballistic missiles and their enablers. US forces might proceed cautiously in escalating conventional attacks on conventional Chinese military targets, as they feel about for any potential limits to China’s NFU commitment.

A key question in this scenario regards what type of nuclear signalling Washington would engage in. Would it seek to convey that it may “go first” in response to PLA strikes on American bases in allied countries, on bases on US territory in the Pacific (e.g., Guam), on American critical infrastructure (e.g. cyber attacks on the electrical grid), or on civilian and dual-use satellite

systems (e.g. GPS)? Or does the United States see such attacks as the price it will have to pay for a nuclear-free conflict involving attacks on the PRC itself?

A strict Chinese NFU policy, especially if the PLA maintains a secure second-strike capability, makes heightened violence at the conventional level more likely. Despite the likelihood of a bloody conflict, however, reduced concerns about nuclear escalation could make China more comfortable

launching military action against Taiwan in the first place. On the other hand, strict NFU binds Beijing’s hands in ways that make it more difficult to deter American intervention and to potentially avert a disastrous defeat if a war goes poorly for the PLA. Given the importance that

Chinese leaders place on unification, they are unlikely to enter into a conflict under such conditions.

**Scenario 2: China Maintains a “Squishy”**

**Interpretation of No First Use:** As noted, in recent years there has been a debate within China about the future of the NFU policy, with some strategists arguing for a looser interpretation of “first use.” For example, some argue that the NFU policy

should not prohibit a launch-on-warning posture or that it should not prohibit China from using nuclear weapons in response to conventional attacks on its nuclear forces. If Chinese leaders come to embrace such thinking, the scenarios under which they would consider nuclear use could expand significantly.

American military planners must also consider the possibility that even if a “loose” NFU policy was sincere, it might not hold in particularly stressful circumstances.

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In this scenario, China would adhere to a less restrictive NFU policy and there would be reasonable doubt in Washington—perhaps intentionally stoked by official Chinese statements and documents—that Beijing would refrain from nuclear use even if it is at risk of losing a war over Taiwan’s fate. China would be more likely to engage in robust nuclear signaling in the event of a conflict: for example, sending ballistic missile submarines to sea, mating warheads with land-based missiles, raising the alert status of its missile forces, and issuing warnings via the media or directly to US officials. Under these conditions, the United States would likely be far more cautious in conducting conventional strikes on Chinese territory in the event of conflict, especially if the circumstances under which NFU holds are ambiguously defined. US forces, for example, might strictly limit themselves to operations along China’s southeastern coastline, eschewing deep strikes and avoiding PLA Rocket Force command and control nodes. The PRC might likewise exercise restraint in attacks on US and allied territory, and especially on the 50 states, out of concern that nuclear escalation will be more difficult to avoid.

A “squishy” Chinese NFU policy could bound the conventional fight in a Taiwan Strait conflict scenario, in particular instilling caution in Washington regarding actions that threaten the Chinese Communist Party’s hold on power. The result could be a fight more or less contained to the western Pacific and China’s eastern seaboard—a fight more likely to become a numbers game and in which China can better take advantage of interior lines and thus one that favors the PRC, at least in the short term.

This is perhaps the ideal scenario for China, and arguably the most realistic of the three presented

here. A looser interpretation of its NFU policy could (from Beijing’s perspective) helpfully shape the American approach to fighting a war in ways conducive to Chinese interests, and might even deter American intervention in the first place. Nuclear escalation is more likely in this scenario than in the first one—but so is Chinese victory, given the advantages China can bring to bear in a localized fight, even without nuclear use.

It is worth noting, however, that heightened concerns about Chinese nuclear use in this scenario could, somewhat paradoxically,

lead the United States to contemplate early strikes on PLA nuclear forces. This will be especially true if Washington assesses that Beijing has been unsuccessful in fielding a secure retaliatory capability. In other words, the nuclear dynamics that would pertain under a looser Chinese NFU policy are considerably more prone to destabilization.

**Scenario 3: The Death of NFU:** Finally, it is possible, particularly as Chinese nuclear forces evolve, that NFU turns out to be little more than a slogan—in which case Beijing would have no intention of abiding by its NFU pledge in the event of a conflict, and Washington would have little expectation that China would do so—or that

Beijing formally abandons the pledge. In this scenario, China may also include nuclear use in its campaign plans.

In this case, the United States would not only be hesitant to strike Chinese territory, as in the preceding scenario; it would also have concerns about a much lower Chinese threshold for nuclear use. Those concerns would become especially pronounced if China were to undertake a significant expansion in the size of its nuclear arsenal.

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American planners would have to worry, in particular, about nuclear strikes on US regional bases or on carrier strike groups at sea. And while it is true that lack of an NFU policy does not imply a first use policy, Chinese investment in capabilities like the dual-use DF-21 and DF-26 raise the prospect that a doctrine inclusive of nuclear warfighting could be in China's future.

For the United States, having to grapple with nuclear strikes on assets in the region would present a significant challenge. The use of nuclear weapons against US bases in allied countries, for example, could trigger "nuclear umbrella" commitments, and the United States might struggle to settle on a proportionate response (or a disproportionate one) to nuclear use against naval forces at sea. This would be a potentially very different fight for Taiwan than the one often imagined, and one in which there could be substantial pressure for the United States to employ counterforce capabilities and resort to first use of nuclear weapons.

China might think such an approach is far more likely to convince America to leave Taiwan to its own devices and more likely to ensure victory if America does intervene. After all, quick nuclear strikes on US regional assets could devastate America's ability to operate in the western Pacific, presenting Washington with a menu of unappetizing choices (to put it mildly). But, of course, things might not play out as Beijing might imagine. If the United States did come to Taiwan's defense in these circumstances, Beijing and Washington might find themselves performing a highwire act to avoid a nuclear exchange.

The main point: Analyses of the likelihood of

conflict in the Taiwan Strait, and of the course such a conflict might take, too often overlook the role nuclear weapons are likely to play. The content and fate of China's "no first use" policy is just one factor that will significantly shape outcomes in the Taiwan Strait.

Source: <https://www.aei.org/articles/three-scenarios-for-chinas-evolving-nuclear-strategy-implications-for-the-taiwan-strait/>, 14 July 2021.

**OPINION – P. Nevitt, K. Gogan, E. Ingersoll, S. Milne**

### **Nuclear's Transformative Role in Delivering Net Zero**

It is impossible to overestimate the scale of the challenge ahead for the UK in reaching net-zero by 2050. With a range of low-carbon technologies in the mix, visualising the country's future energy landscape is no simple task. System-wide, forward-thinking analysis, however, helps paint this picture.

In June 2021, NNL, the UK's national laboratory for nuclear fission, along with our expert teams at Energy Systems Catapult and Lucid Catalyst, published the UK Energy System Modelling report - a ground-breaking new publication that gives a comprehensive insight into the role nuclear can play in decarbonising our energy system.

Commissioned by AFCP as part of the Department for Business, Energy and Industrial Strategy's (BEIS) GBP505 million (USD692 million) Energy Innovation Programme, the report

considers, for the first time, how advanced nuclear technologies can and should be used alongside other nuclear and low-carbon technologies to evolve the UK's energy system.

**American planners would have to worry, in particular, about nuclear strikes on US regional bases or on carrier strike groups at sea. And while it is true that lack of an NFU policy does not imply a first use policy, Chinese investment in capabilities like the dual-use DF-21 and DF-26 raise the prospect that a doctrine inclusive of nuclear warfighting could be in China's future.**

**Analyses of the likelihood of conflict in the Taiwan Strait, and of the course such a conflict might take, too often overlook the role nuclear weapons are likely to play. The content and fate of China's "no first use" policy is just one factor that will significantly shape outcomes in the Taiwan Strait.**

**Why Nuclear has been Missing from Modelling**

**So Far:** Nuclear has long been under-represented in mainstream energy system modelling. The reason for this is twofold.

Firstly, there is a lack of understanding about what drives cost in nuclear construction. Too often, nuclear technology is presented as being expensive in the first instance and retaining a high fixed cost. In reality, any nuclear build undergoes substantial programmatic cost reduction and, when combined with innovative delivery and deployment models, can be delivered at low costs.

**Too often, nuclear technology is presented as being expensive in the first instance and retaining a high fixed cost. In reality, any nuclear build undergoes substantial programmatic cost reduction and, when combined with innovative delivery and deployment models, can be delivered at low costs.**

Secondly, the broad applications of nuclear technology beyond electricity generation are yet to be fully considered and embraced by the energy sector. Not only can nuclear technologies be deployed to generate electricity but also to produce hydrogen, heat and synthetic fuel. It is critical that this multiplicity in nuclear’s potential roles is accounted for in any modelling going forward.

**What the UK Energy System Modelling Report Tells Us:**

Completed using the policy-neutral cost optimisation model, Energy System Modelling Environment (ESME), our findings fill a gap in publicly available data and represent a crucial assessment of the central role of nuclear in ensuring we meet our national climate change targets.

To achieve net zero we need to vastly increase production of three zero-carbon energy vectors - electricity, hydrogen and district heat. The report assesses how a range of technologies might work together to do this. In this analysis, levels of nuclear deployment were consistently significant

and included roles across all three vectors.

Looking first at electricity generation, the modelling shows that excluding nuclear - a constant energy source - from the energy mix results in a substantial increase in grid capacity to compensate for times when other intermittent sources are unable to produce energy. By replacing nuclear with renewable sources, for example, grid capacity grows from around 100-140 GW to over 200 GW. Not only does this represent additional cost to the energy system, for the required additional generation, as well as associated transmission infrastructure, but also risk that such scale of deployment is feasible. Therefore, diverse pathways such as those modelled here - which include nuclear technologies - serve a critical role in de-risking and lowering the cost of the transition.

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Nuclear and wind are shown to be the main technologies to ensuring our energy system has the ability and importantly, the capacity, to generate flexible, affordable and reliable emissions-free power for homes and businesses at the

necessary scale.

For the second of our key energy vectors - hydrogen - there are many production options but few that are high volume, low cost and low carbon footprint. To therefore decarbonise hydrogen production, our modelling suggests that nuclear technologies can bring hugely valuable additional energy services to achieve affordable and timely net zero.

In scenarios where speculative technologies such as Carbon Capture Storage (CCS) 99% carbon

capture rates are not available, this means a combination of thermochemical hydrogen from advanced nuclear, electrolysis and biomass with CCS (95% capture rates). Where speculative measures are available, our analysis shows that advanced nuclear operation can shift away from hydrogen production and be successfully prioritised towards power generation - demonstrating its flexibility as a highly economical energy source.

**Light-water nuclear Small Modular Reactors, Gen III+ and advanced nuclear systems are all effective solutions. While costs are dominated by piping installation, siting options for smaller systems may enable shorter connecting pipes which in turn would lower costs for many networks.**

Thirdly, for district heat generation, scenario analysis suggests that heat supply from nuclear can be a very cost-effective option when deployed in cities at scale; Light-water nuclear Small Modular Reactors, Gen III+ and advanced nuclear systems are all effective solutions. While costs are dominated by piping installation, siting options for smaller systems may enable shorter connecting pipes which in turn would lower costs for many networks.

**Advanced technologies are being commercialised now and will be coming to market in the late 2020s - it's vital that markets are ready for deployment at scale, which means appropriate licensing authorities, policy makers, investors, supply chain and customers need to be preparing now.**

What is clear across the hundreds of scenarios we have modelled is that nuclear, as part of the energy mix, has a high option value and can contribute to achieving net zero at least cost to society. Excluding low carbon nuclear energy significantly increases the complexity and risks of failing in what is already an immensely difficult challenge. Combining nuclear and renewables proves to be highly complementary, while de-scoping, de-risking and lowering costs of the overall system.

**The Next Steps: Fuelling Net Zero:** We are under no illusion that achieving net zero will be easy. On the contrary, we recognise that it is going to be tough and will require cooperation from across the energy sector. Nuclear is already the single largest and most reliable zero-carbon

energy source in the UK and advanced technologies hold even more potential for generating clean hydrogen, heat and electricity. Advanced technologies are being commercialised now and will be coming to market in the late 2020s - it's vital that markets are ready for deployment at scale, which means appropriate licensing authorities, policy makers, investors, supply chain and customers need to be preparing now.

So how can we make sure our ambitions for nuclear are supported? Off the back of this transformative modelling, NNL has performed detailed fuel cycle modelling using its ORION capability. This research is what underpins NNL's report, Fuelling Net Zero: Advanced Nuclear Cycle Roadmaps for a Clean Energy Future, also published in June this year. These comprehensive roadmaps set out two main fuel cycle opportunity areas that the UK can evolve to help meet its clean energy ambitions: Advanced Fuels Development and Advanced Fuel Cycle Technologies. They enable government and industry to plan strategically for how we can capitalise on our existing nuclear capability and develop a zero-carbon energy system.

At a time when society is waking up to acting on the environmental crisis our planet faces, there is a growing public consciousness about the role each and every one of us can play towards net zero. But behaviour change alone will not be enough; with nuclear the UK can meet its net-zero goals on time....

Source: <https://www.world-nuclear-news.org/Articles/Viewpoint-Nuclear-s-transformative-role-in-deliver>, 21 July 2021.

NUCLEAR STRATEGY

CHINA

**‘We will Use Nuclear Bombs’: China Threatens Japan over Taiwan Intervention**

Amid a massive scale up of geopolitical tensions in the Indo-Pacific region, the Chinese Communist Party (CCP) has threatened Japan with “nuclear response” and “full-scale war” if the island nation interfered with Beijing’s interests in Taiwan. The video message, which was aired by a state media channel, pointed out Japan as the only exception to China’s long-standing policy to not use nuclear weapons against non-nuclear countries. “We will use nuclear bombs first, we will use nuclear bombs continuously. We will do this until Japan declares unconditional surrender for the second time” the video purportedly claimed.

It was later deleted from Chinese social media platform Xigua after hitting 2 million views. However, users were quick to make copies and upload them to YouTube and Twitter, according to Taiwan News. China’s threats come soon after comments by Japanese officials two weeks ago about Taiwan’s sovereignty, with Deputy Prime Minister Taro Aso stating that Japan should “defend Taiwan”, *The Japan Times* said. Beijing claims complete sovereignty over Taiwan despite both countries being governed separately for over seven decades. Taiwan has continued to operate as a democratic country with around 24 million people, and is located off the southeastern coast of mainland China.

Source: <https://www.timesnownews.com/international/article/we-will-use-nuclear-bombs->

*china-threatens-japan-over-taiwan-intervention/788019, 21 July 2021.*

**A New Tunnel is Spotted at a Chinese Nuclear Test Site**

China appears to be expanding its sprawling nuclear weapons testing complex in the nation’s western desert. Satellite imagery shared exclusively with NPR show a possible new tunnel being dug and fresh roads added at the site, known as Lop Nur, where China has tested its nuclear weapons in the past.

**Japan as the only exception to China’s long-standing policy to not use nuclear weapons against non-nuclear countries. “We will use nuclear bombs first, we will use nuclear bombs continuously. We will do this until Japan declares unconditional surrender for the second time.**

“This is new construction linked to areas that have in the past supported nuclear test activities,” says Renny Babiarz, vice president for analysis and operations at AllSource Analysis, a private geospatial analysis firm that spotted the tunnel using satellite imagery from the commercial company Planet.

But Babiarz adds that it remains far from clear what the tunnel will be used for. China has not conducted full-scale nuclear testing since the 1990s, when it and the world’s other major nuclear powers entered into a voluntary moratorium on testing. The Chinese government, and other nations including the U.S., have continued to test the non-nuclear components of nuclear weapons — sometimes underground.

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In an e-mail, Liu Pengyu, a spokesperson for the Chinese Embassy in Washington, D.C., declined to comment on the site itself, but he said that China “stays committed to the nuclear testing moratorium.” He also objected to “unacceptable U.S. allegations” that the Chinese Government was in any way trying to undermine the CTBT, an unratified treaty that remains the basis for the global pause to nuclear testing.

The news of the new tunnel comes after two

separate groups turned up giant nuclear missile fields under construction in other parts of the country earlier in the month. "Over the past year-and-a-half, China has constructed at least two large facilities, each with more than 100 missile silos," says Jeffrey Lewis, a professor at the Middlebury Institute of International Studies in Monterey, who announced the discovery of the first field earlier this month. "China had 18 silos prior to this." ...

Source: Geoff Brumfiel, <https://www.npr.org/2021/07/30/1022209337/a-new-tunnel-is-spotted-at-a-chinese-nuclear-test-site>, 30 July 2021.

**BALLISTIC MISSILE DEFENCE**

**RUSSIA**

**Putin Touts Russia's Hypersonic Nuclear Weapons at Naval Parade**

President Vladimir Putin used a Navy Day parade to deliver his latest reminder of Russia's military muscle, touting the nation's hypersonic nuclear weapons at a ceremony in his hometown of St. Petersburg. "Today the Russian navy has everything it needs to defend our homeland, our national interests," Putin said in a speech in front of a monument to the fleet's founder, Peter the Great. "We can locate any enemy, whether they're on, under or above the water. And if required, deal them an unavoidable strike."

More than 50 vessels and 4,000 troops took part in the parade ahead of the navy's 325th anniversary in October. As well as destroyers, submarines and assault vessels, the Prince Vladimir, a Borei-A class nuclear-powered ballistic missile submarine, was on display for the first time. The event took place without spectators as Russia wrestles with a new

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spike in Covid-19 cases due to the delta variant.

**Russia-Defence-Navy-Politics:** In his speech, Putin praised Russia's rapid rise to naval power.

From the rudimentary vessels of Peter's Day, the navy now possesses "the latest hypersonic precision weapons systems, that have no equivalent in the world, and which we constantly and successfully improve," he said. In June,

Putin accused the U.S. and U.K. of staging a "provocation" in the Black Sea that saw Britain's HMS Defender engaged in a stand-off with Russian ships and fighter jets off the coast of Crimea. Russia said it used bombs and gunfire in "warning shots" to force the vessel to leave waters the U.K. and its allies don't recognize as Russian territory after Putin's 2014 annexation of the strategic peninsula from Ukraine.

Putin stoked fears of a new arms race three years ago when he unveiled new nuclear weapons in his regular state-of-the-nation address. At the start of 2021, the last remaining nuclear-arms treaty between the U.S. and Russia got a five-year extension, when Putin and U.S. President Joe Biden agreed to prolong the so-called New START in their first exchange since Biden

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took office.

Source: <https://www.bloomberg.com/news/articles/2021-07-25/putin-reviews-naval-parade-touts-russia-s-hypersonic-weapons>, 25 July 2021.

**USA**

**Tucson-Based Raytheon Unit Creating Stealthy New Nuclear Cruise Missile**

Raytheon Missiles & Defense recently won a \$2 billion Air Force contract to take the next step in developing the Long-Range Standoff Weapon or

LRSO, in a program expected to be worth some \$10 billion to the company over time. By around 2030, the LRSO is expected to replace the AGM-86B Air Launched Cruise Missile, the latest version of the nuclear-capable missile used since the 1980s. Though many program details remain classified, the LRSO is expected to have the latest in radar-evading stealth technology to defeat sophisticated air defenses.

Raytheon was picked to build the LRSO in April 2020, when the Air Force in a surprise move chose Raytheon as the prime contractor over a bid from Lockheed Martin months before a decision was expected. Each company had been awarded competitive LRSO technology-development contracts of about \$900 million in 2017, with the work expected to stretch into 2022. On July 1, the Pentagon announced that the Air Force Nuclear Weapons Center at Eglin Air Force Base, Florida, had awarded Raytheon an initial \$2 billion contract for the engineering and manufacturing development phase of the LRSO program, to build and demonstrate a missile ready for full production by February 2027.

**Digital Design:** Over time, contracts to produce 1,000 LRSO missiles could reach \$10 billion, congressional budget researchers estimated in 2017. Planned upgrades to a thermonuclear warhead slated for use on the LRSO could cost at least \$10 billion. Raytheon declined to comment in detail on the LRSO program, referring questions to the Air Force, and many program details remain classified. In a statement to the Star, Paul Ferraro, vice president of Air Power at Raytheon Missiles & Defense, credited the company's selection as sole-source contractor on the program to a focus on "digital engineering" and close collaboration with the Air Force....

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**was flown aboard B-52 bombers as part of the nation's air-based strategic nuclear deterrent from 1990 until it was formally retired in 2012. Production orders for the advanced cruise missile were cut drastically in the early 2000s to help comply with a Russian arms-reduction treaty, and the Air Force later dropped planned life-extending upgrades to missiles in service amid reliability concerns.**

During an investor day presentation for parent company Raytheon Technologies Corp. in May, Raytheon Missiles & Defense President Wes Kremer broke down how the company is using extensive computer simulations to virtually "fly" LRSO components millions of miles a day. "Every single night, this code is compiled, the updates are made, the inputs from our vendors are made and we fly that missile 6 million miles in the highest threat

environments in the world in a completely virtual environment," Kremer said. The next morning, he said, Raytheon engineers and Air Force program officials can review the data and compare it to key measures such as of survivability, range and the probability of a successful mission.... Raytheon, which makes many of the nation's front-line missile systems, is no stranger to cruise missiles — guided surface-attack missiles that typically fly and maneuver at low altitude to avoid radar detection. The company, the Tucson region's biggest employer with more than 13,000 local workers, has supplied the Navy with the combat-proven Tomahawk Land Attack Missile for decades.

Raytheon also produced the last attempted upgrade to the AGM-86 Air-Launched Cruise Missile: the AGM-129 Advanced Cruise Missile, a nuclear-tipped weapon originally developed by General Dynamics and later acquired by Raytheon with other missile lines from Hughes Aircraft in 1997. AGM-129 Advanced Cruise

Missile Raytheon's AGM-129 Advanced Cruise Missile was originally developed by General Dynamics and was in service from 1990 to 2012.

**U.S. Air Force:** The AGM-129, which featured a radar-evading stealth design, and navigation systems similar to Raytheon's Tomahawks, was flown aboard B-52 bombers as part of the nation's

air-based strategic nuclear deterrent from 1990 until it was formally retired in 2012. Production orders for the advanced cruise missile were cut drastically in the early 2000s to help comply with a Russian arms-reduction treaty, and the Air Force later dropped planned life-extending upgrades to missiles in service amid reliability concerns.

**Cash, Criticism:** Meanwhile, the LRSO program has won the support of the Biden administration, which has requested \$609 million in funding for the development program in fiscal 2022. But in its markup of the fiscal 2022 defense budget released July 13, the House Appropriations Committee proposed cutting the LRSO budget request by \$28 million, to \$581 million, while requiring quarterly budget updates. The Senate Appropriations Committee has yet to complete its markup of the defense spending bill.

Critics including former Defense Secretary William Perry and groups such as the Arms Control Association and the Project for Government Oversight's Center for Defense Information have said the new nuclear-tipped cruise missile is unnecessary and could be destabilizing, since current conventional cruise missiles could be mistaken for a nuclear version and spark unintended nuclear war. In 2017, nine Democratic senators including Sen. Diane Feinstein moved to delay LRSO funding as the Trump administration completed its Nuclear Posture Review, which subsequently endorsed the LRSO. Other critics say the weapon is redundant in light of other land-attack options and is too costly. But the Air Force and some defense analysts say the LRSO is a necessary component of the "nuclear triad" of weapons that also includes submarine-launched ballistic missiles and land-based intercontinental missiles.... The LRSO is being designed to be

carried not only by the B-52 but also the new B-21 Raider, a stealthy, bat-wing bomber set to begin replacing the B-2 Spirit stealth bomber around 2027.

**The LRSO will likely fly at subsonic speeds and feature a stealthy design, with "low observable" features such as airframe shapes and surface angles designed to deflect signals away from radar emitters, and signal-absorbing materials.**

**Flying Unseen:** Though details of the Pentagon's requirements for the LRSO, as well as Raytheon's design, remain under wraps, the LRSO will likely fly at subsonic speeds and feature a stealthy design, with "low observable"

features such as airframe shapes and surface angles designed to deflect signals away from radar emitters, and signal-absorbing materials....

It is expected to have a range of at least 1,500 miles and will carry the W80-4 thermonuclear warhead, an upgraded version of a relatively small low to intermediate yield warhead in service since 1981. Roughly 31 inches long and about a foot in diameter, the W80 can be set to achieve a blast equal to 5 or 150 thousand tons, or kilotons, of TNT. The atomic bomb that devastated Hiroshima, Japan, in 1945 carried the explosive power of 20 kilotons of TNT.

**Nuclear science and technology can be a key enabler for countries to achieve the United Nations (SDGs) in several social, economic and environmental areas, improving people's lives, tackling the consequences of climate change and supporting several aspects of the post-pandemic recovery.**

Source: [https://tucson.com/business/tucson-based-raytheon-unit-creating-stealthy-new-nuclear-cruise-missile/article\\_e0884d54-e365-11eb-993d-3b8ea5027866.html](https://tucson.com/business/tucson-based-raytheon-unit-creating-stealthy-new-nuclear-cruise-missile/article_e0884d54-e365-11eb-993d-3b8ea5027866.html), 23 July 2021.

## **EMERGING TECHNOLOGIES AND DETERRENCE**

### **GENERAL**

#### **Nuclear Techniques Can Support Climate Adaptation and Post-COVID Recovery**

Nuclear science and technology can be a key enabler for countries to achieve the United Nations (SDGs) in several social, economic and environmental areas, improving people's lives, tackling the consequences of climate change and

supporting several aspects of the post-pandemic recovery.

At a virtual side event on the margins of the United Nations High-level Political Forum (HLPF) on Sustainable Development in July 2021, experts from Malaysia, Nigeria, Peru and the IAEA discussed how nuclear science and technology have helped in the development of crops that are more resistant to drought and salinity. They also discussed how a climate-smart approach to soil and water management could increase food production and accelerate their economic recovery in the post COVID-19 period.

Climate change is no longer an environmental issue, but it is a major development and survival issue.... Climate-smart agriculture is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. With the support of IAEA and FAO experts, nuclear applications are deployed to relieve populations under stress from shrinking water sources, invasive pests or simply a changing climate.

...“Climate change is no longer only an environmental issue, but it is a major development and survival issue,” said Shyful Azizi B. Abdul Rahman, a researcher at the Malaysian Nuclear Agency’s Agrotechnology and Biosciences Division and a long-time collaborator with the IAEA’s technical cooperation programme. “Challenges such as soil degradation, water scarcity and the current pandemic are making rice production a daunting task, but we have been able to release two new mutant rice varieties to nearly 50,000 Malaysian farmers in 2020, which increased their yields and doubled their incomes.”

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**Nuclear and isotopic techniques are also applied to investigate and understand the world around us. With support delivered through the IAEA technical cooperation programme, scientists and researchers around the world can closely scrutinize how climate change is affecting the quality of soils, the recharge rate of groundwater or the prevalence of contaminants in our air.**

Nuclear and isotopic techniques are also applied to investigate and understand the world around us. With support delivered through the IAEA technical cooperation programme, scientists and researchers around the world can closely scrutinize how climate change is affecting the quality of soils, the recharge rate of groundwater or the prevalence of contaminants in our air. This information is used by decision makers to craft new policies, which prioritize sustainability and align closely with national development goals.

In facing the challenge of climate change, “isotope hydrology allows us to scrutinize the ‘fingerprints’ of water molecules, and their component elements, hydrogen and oxygen,” said Jodie Miller, IAEA Isotope Hydrology Section Head. “We can see where the water has come from, how long has it travelled, how old it is and much more. This information, in turn, allows us to better understand and manage our water resources.” Held annually since 2013, the HLPF meets for eight days to review activities, achievements and experiences in global efforts to attain the SDGs. The Forum meets each year under the auspices of the UN Economic and Social Council and adopts political declarations.

*Source: <https://www.iaea.org/newscenter/news/how-nuclear-techniques-can-support-climate-adaptation-and-post-covid-recovery>, 16 July 2021.*

### **Emerging Technologies and Nuclear Stability**

In June 2021, the Centre for Science & Security Studies (CSSS) at King’s College London published a report on the impact of emerging technologies on crisis stability.... The starting point for this

report is that policymakers need a new way of thinking and talking about emerging technologies and nuclear risk. There is a widespread tendency to discuss potentially disruptive technologies either as an abstract, monolithic risk category or via individual cases that supposedly represent the entire category. Neither approach is advancing the conversation on which technologies could impact nuclear stability, and in what ways. This report attempts to better structure this conversation by asking three questions:

- Which emerging technologies are most likely to escalate a crisis?
- How can policymakers and scholars better understand this impact?
- Which risk reduction measures could mitigate any potential risks of emerging technologies, while also capitalising on benefits and opportunities?

Before getting into the findings of the study, it is important to first clarify our terms. The term 'emerging technologies' is imperfect, but it has currency with policymakers. Sceptics levy criticism that the term 'emerging technologies' is imprecise and even ahistorical. After all, what is 'emerging' about hypersonic weapon

systems, if engineers designed the Silbervogel (Silver Bird) hypersonic boost-glide missile in Nazi Germany? What is new about lethal autonomous weapon systems, considering that autonomy and automation have diminished human control over the use of force since the 1970s? Finally, 'cyber' remains novel only in a relative sense and would otherwise appear to have thoroughly emerged,

prompting experts to suggest we retire the ubiquitous and arguably meaningless moniker.

I argue that the term 'emerging technologies' does more to represent a community of experts and body of literature than it does to represent a fixed and unchanging group of technologies. While the term is vague and amorphous, so are the technologies that fall under it. Some suggest that its vagueness is constitutive of the concept and part of the appeal

**The term 'emerging technologies' does more to represent a community of experts and body of literature than it does to represent a fixed and unchanging group of technologies. While the term is vague and amorphous, so are the technologies that fall under it. Some suggest that its vagueness is constitutive of the concept and part of the appeal.**

...I contend that emerging technologies are affecting the nuclear realm in three ways: Technological change is accelerating, and the locus of innovation has shifted towards private actors. Technological innovation is outpacing nuclear policymaking. Nuclear risks are rising, but there is no clear path forward for risk reduction. So, which technologies are most likely to escalate a conflict past the nuclear threshold? And how can policymakers and scholars alike better understand this impact?

**The report identifies ten technologies with the potential to impact crisis stability in the next ten years. These are: AI-powered cyber operations; AI for intelligence, surveillance, and reconnaissance (ISR); deep-fake technology; directed energy weapons; hypersonic missiles; kinetic anti-satellite (ASAT) capabilities; Rendezvous and Proximity Operations (RPO) in space; satellite jamming and spoofing systems; small satellites ('smallsats') for ISR; and swarm robotics.**

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(ASAT) capabilities; Rendezvous and Proximity Operations (RPO) in space; satellite jamming and spoofing systems; small satellites ('smallsats') for ISR; and swarm robotics.

Evidently, this is a heterogenous group of technologies, spanning multiple operating domains, at different maturity or Technology

Readiness Levels (TRL), with different barriers to implementation, and will impact different elements of the global nuclear order to varying extents and in varying timescales. Policymakers need a way to compare different technologies in terms of common parameters to determine where a state should allocate its limited resources.

Clustering the technologies enables us to identify similarities and differences in the ways these technologies might impact crisis stability.... Technology clusters can help policymakers to understand which technologies are most likely to escalate an ongoing crisis past the nuclear threshold, in what ways, and what can be done to mitigate these risks.

**Cluster 1: Distort.** The technologies in Cluster 1 (i.e., deep fake technology and satellite jamming and spoofing systems) were assessed by experts as capable of interrupting data flows and distorting the information landscape. This cluster is the most concerning in terms of nuclear risk, due to its potentially high impact and high feasibility of implementation. These technologies are likely to escalate an ongoing crisis in a nonlinear fashion. Suggested risk reduction measures include a holistic approach to combatting deep fakes through detection, legislation and education, protection of space-based assets linked to early warning or communications through security by design and holistic resilience approaches, and multilateral approaches to emerging space threats by encouraging responsible space behaviours.

**Cluster 2: Compress.** The technologies in Cluster 2 (i.e., kinetic anti-satellite capabilities, AI-powered cyber operations, hypersonic missiles, Rendezvous and Proximity Operations, and swarm robotics) affect the pace of conflict and could compress decision-making timelines. Suggested risk reduction measures include more 'traditional' arms control, a strategic cyber no first use policy,

and nationally assured space situational awareness.

**Cluster 3: Thwart.** The technology in Cluster 3 (i.e., directed energy weapons) can credibly thwart or blunt a nuclear attack. However, augmenting defence may also be destabilising if it has the intended or ancillary effect of diminishing a country's second-strike response. Suggested risk reduction measures include limiting the number of directed energy weapons that can be deployed and norms against placing directed energy weapons in space.

**Cluster 4: Illuminate.** The technologies in Cluster 4 (i.e., AI for ISR and smallsats for ISR) provide more accurate and comprehensive data flows to decision-makers. This technology cluster presents an opportunity for augmenting crisis stability. The suggested risk reduction measure is a commitment on behalf of nuclear weapon states not to target each other's nuclear command, control, and communications infrastructure.

**Bridge-building between NWS and NNWS. Nuclear weapon states (NWS) and non-nuclear weapon states (NNWS) should work together to address the risks that emerging technologies pose to crisis escalation, as they have for disarmament verification.**

Broader risk reduction recommendations for nuclear possessors and non-possessors. In addition to cluster-specific recommendations, the report proposes broader risk reduction measures for nuclear possessors and non-possessors. This includes: Cooperation with the private sector, to reflect the changing defence industrial model. It is critical that private actors are aware of how their commercial products (i.e., dual-use commercial off-the-shelf technologies) could become an unwitting part of another state's foreign policy objectives. Bridge-building between technology and policymaking, for example, providing incentives to recruit into government from the private sector to stay at the cutting edge of innovation.

Bridge-building between NWS and NNWS. Nuclear weapon states (NWS) and non-nuclear weapon states (NNWS) should work together to address

the risks that emerging technologies pose to crisis escalation, as they have for disarmament verification. Developing confidence-building measures to increase trust between P5 members. Confidence-building measures (e.g., regular dialogue, information sharing, best practice exchanges, and scientific cooperation programmes) could help create and sustain mutual understanding and trust between P5 members.

Using emerging technologies to support nuclear risk reduction. New technologies offer potential benefits to stability, as highlighted by Cluster 4, but also distributed ledger technology for nuclear materials control, image recognition for verification activities, metadata for geolocation, and AI and synthetic environments for improved military planning and wargaming.

**Strategic Dialogue.** High-level dialogues such as the proposed relaunching of a bilateral US-Russia dialogue focused on “ensuring predictability,” reducing the risk of nuclear war, and setting the stage “for future arms control and risk reduction measures.” To ignore emerging technologies increases nuclear risks...

Source: <https://www.apln.network/analysis/commentaries/emerging-technologies-and-nuclear-stability>, 19 July 2021.

## NUCLEAR ENERGY

### BRAZIL

#### **Nuclear Science to Control Mosquitoes, Generate Clean Energy a Key Focus of Director General Grossi’s Visit to Brazil**

Brazil is a key IAEA partner, and the exchange of knowledge between the Agency and Brazilian experts in the peaceful uses of nuclear science can benefit both and beyond, Director General Rafael Mariano Grossi said during his visit to the

country, where, among others, he saw an IAEA-supported project to use a nuclear technique to combat mosquitoes that transmit Zika and dengue, and visited the Angra dos Reis nuclear power plant. The week-long visit, Mr Grossi’s first to Latin America since he took office in 2019, kicked off in the city of Recife, where he participated in insect releases as part of an IAEA-supported programme to use the Sterile Insect Technique (SIT) to control mosquitoes in the neighbourhood of Brasilia Teimosa.

The SIT is a type of birth control for insects, where male insects are mass reared and rendered unable to reproduce using radiation. They are then released in large numbers to mate with wild females, resulting in no offspring and therefore contributing to a decline in the mosquito population over time. The method has been used for decades to control agricultural pests such as the Mediterranean- and Screwworm flies and has recently been developed against mosquitoes.

The project implementing partner, Moscamed Brasil, is one of the first SIT facilities in the world to mass rear sterile *Aedes aegypti* mosquitoes for release, targeting two municipalities in the Brazilian states of Bahia and Pernambuco which were particularly hard-hit by Zika in 2016. The IAEA has provided support to Moscamed Brasil since 2005 and facilitated the transfer of a gamma cell irradiator in recent years to scale up the production of sterile insects.

...Since October 2020, between 250 000 and 350 000 sterile males have been released weekly over a 60-hectare surface area. The releases – the first in an urban setting – have already resulted in a 19 percent reduction in the wild mosquito population in the area. Moscamed Brasil was designated an IAEA Collaborating Centre in 2018, and now provides experts and training for countries such as Mauritius, South Africa and Thailand in various SIT projects.

Mr Grossi also visited the Regional Centre of

**The SIT is a type of birth control for insects, where male insects are mass reared and rendered unable to reproduce using radiation. They are then released in large numbers to mate with wild females, resulting in no offspring and therefore contributing to a decline in the mosquito population over time.**

Nuclear Sciences at the Pernambuco State University as well as its Nuclear Science Museum, which does a fantastic job in demystifying nuclear technology and promoting STEM education, he said. On July 23, Mr Grossi visited Brazil's only nuclear power station at Angra dos Reis, on the coast between Rio de Janeiro and Sao Paulo. The plant has two operating reactors with a total capacity of 1 884 MW(e), with a third one under construction, and provides around 2.1 percent of Brazil's electricity. In 2020, Brazil adopted a national plan that considers an increase of 10 gigawatts in the nuclear installed capacity in the country by 2050....

On July 24, Mr Grossi visited the Nuclear and Energy Research Institute (IPEN) at the University of Sao Paulo. The institute works in several areas related to the nuclear sciences and runs the country's first research reactor. It also carries out research into the industrial applications of radiation, such as to sterilize community face masks, modify plastics and preserve cultural artifacts, and will be responsible for running Brazil's 30 MW multipurpose research reactor, which will aid the country in the use of radiopharmaceuticals to diagnose and treat diseases such as cancer.

Source: <https://www.iaea.org/newscenter/news/nuclear-science-to-control-mosquitoes-generate-clean-energy-a-key-focus-of-director-general-grossis-visit-to-brazil>, 23 July 2021.

## **CHINA**

### **China's Power Crunches to Worsen without More Nuclear and Hydro**

China needs to accelerate its build-out of energy sources such as nuclear and pumped-hydro to stave off worsening power crunches in its

industrial centers, according to a government-backed think tank. Some of the big cities that have recently suffered power outages when summer demand for air-conditioning peaks are likely to see widening shortfalls in energy supply, according to the China Electric Power Planning and Engineering Institute, in a report covering China's energy needs through 2025.

China's main energy source, coal, will very gradually be phased out even as electricity demand increases as the economy

grows. Nuclear and pumped-hydro are particularly useful as back-ups to the intermittent power generated by other clean energy sources like wind and solar. Pumped-hydro is one of the oldest forms of storing energy. During times of excess power, pumps are used to push water up an incline. When more energy is needed, gravity pulls the water back through a turbine that generates electricity.

**Missed Targets:** The institute attributed the intensifying shortages of power during periods of peak demand to China's failure to meet targets for new plants. By 2020, it had built only about three-quarters of the capacity planned for both nuclear and gas, which is cleaner than coal but still emits carbon. For pumped-hydro, only half the target was

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**Other manufacturing hubs on the eastern coast, and cities in landlocked central China, could face shortfalls of similar size, according to the report. The solution involves adding at least 20 GW of nuclear and 31 GW of pumped-hydro power, bringing the totals to 70 GW and 62 GW respectively by 2025.**

met. The major population cluster of Beijing-Hebei-Tianjin alone could see a 25 gigawatt shortage by 2025 - the equivalent of about two dozen nuclear power plants. Other manufacturing hubs on the eastern coast, and cities in landlocked central China, could face shortfalls of similar size, according to the report. The solution involves adding at least 20 GW of nuclear and 31 GW of pumped-hydro power, bringing the totals to 70 GW and 62 GW respectively by 2025, the think tank said. China's power demand will continue to grow through 2045, though the pace will slow as the nation increasingly adopts electrification, according to the institute. An average annual

increase of 3.9% is expected by 2025, before falling to 2.6% by 2035. That compares to the 18% growth seen in the last five months, a particularly rapid rise because of the economy's strong rebound from the pandemic.

Source: <https://www.bloombergquint.com/china/china-s-power-crunches-to-worsen-without-more-nuclear-and-hydro>, 23 July 2021.

### **Zhangzhou 1 Pressure Vessel Passes Factory Acceptance Tests**

The reactor pressure vessel (RPV) was designed by China National Nuclear Corporation's (CNNC's) Nuclear Power Research & Design Institute. A contract was signed with China First Heavy Machinery Company Limited (CFHI) in 2016 for the manufacture of the RPV for Zhangzhou unit 1.

A meeting was held on 22 June, 2021 during which the component was officially accepted. Nuclear Guodian Zhangzhou Energy Company Chairman Chen Guocai, Vice President Tang Chuanbao of the Nuclear Power Research & Design Institute, and China Nuclear Power Engineering Corporation Project Manager Yu Long attended the meeting and jointly witnessed the acceptance.

China's Ministry of Ecology and Environment issued construction licences for Zhangzhou units 1 and 2 on 9 October, 2019 to CNNC-Guodian Zhangzhou Energy Company, the owner of the Zhangzhou nuclear power project which was created by CNNC (51%) and China Guodian Corporation (49%) in 2011. The licences are valid for 10 years. Construction of unit 1 began one week after the issuance of a construction licence, with that of unit 2 starting in September 2020.

In May 2014, the local government gave approval for Phase I of the Zhangzhou plant, comprising two AP1000 units. The National Nuclear Safety Administration gave approval in December 2015 for the AP1000 units and confirmed site selection

in October 2016. Construction of Phase I had originally been expected to start in May 2017. However, CNNC subsequently decided to use the Hualong One design instead. Two more units are planned for Phase II of the plant and a further two proposed for Phase III.

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CNNC began construction of two demonstration Hualong One units at its Fuqing plant in Fujian province in May and December 2015, respectively. The first of these, Fuqing 5, was connected to the grid on 27 November last year, having achieved first criticality on

21 October, and entered commercial operation on 30 January this year. Fuqing 6 is expected to begin operating by the end of 2021.

Construction of two demonstration Hualong One (HPR1000) units is also under way at China General Nuclear's Fangchenggang plant in the Guangxi Autonomous Region. Those units are expected to start up in 2022. CNNC has also started construction of the first of two Hualong One units at Taipingling in Guangdong. Two HPR1000 units are under construction at

Pakistan's Karachi nuclear power plant. Construction began on Karachi unit 2 in 2015 and unit 3 in 2016; the units are planned to enter commercial operation in 2021 and 2022.

Source: <https://www.world-nuclear-news.org/Articles/Zhangzhou-1-pressure-vessel-passes-factory-accepta>, 23 July 2021.

*Zhangzhou-1-pressure-vessel-passes-factory-accepta*, 23 July 2021.

### **China Adding Finishing Touches to World-First Thorium Nuclear Reactor**

China is moving ahead with development of an experimental reactor that would be the first of its kind in the world, but could prove key to the pursuit of clean and safe nuclear power. According to local news reports, the Chinese government intends to finish building a prototype molten salt nuclear reactor in the desert city of Wuwei in the

**The Chinese government intends to finish building a prototype molten salt nuclear reactor in the desert city of Wuwei in the coming months, with plans to establish a number of larger-scale plants in similar settings thereafter.**

coming months, with plans to establish a number of larger-scale plants in similar settings thereafter.

With an ability to generate power while producing very minimal carbon emissions, nuclear reactors have a clear upside when it comes to the sustainable generation of energy. But there are very valid reasons the technology hasn't been widely adopted across the world, many of which stem from the reliance on uranium and plutonium for fuel. Not only is uranium expensive and rare, it can also be used to build nuclear weapons. These reactors also generate radioactive waste that needs to be safely stored, and carry the very real risk of catastrophic meltdown, as seen at Fukushima in 2011.

Since the 1940s, scientists have been exploring an alternative known as molten salt reactors, which promise a far safer way forward. In place of uranium and plutonium, these reactors use the widely abundant, silvery metal thorium, which cannot be easily used to make bombs. Furthermore, these reactors would operate in a way that doesn't pose the same dangers as conventional ones.

This is because instead of solid fuel rods, thorium is dissolved in molten salt that is flowed through the reactor at high temperature. In this form the liquid salt acts as a coolant and there is no need for high-pressure water cooling systems, and if there is an accident and the fuel is exposed to air, it quickly cools and turns solid. Compared to a conventional nuclear reactor that can quickly cloud vast areas in radioactive material, this significantly limits the potential contamination of the surrounding environment.

Despite its promise, advancing the technology behind molten salt reactors has been slow going.

Experiments were carried out in the US in the 60s and 70s, and then in Asia and Europe. More recently, we saw a research group in the Netherlands kick off experiments aimed at turning the technology into an industrial-scale source of energy.

**Government scientists hope to use it as a springboard for the development of larger thorium molten salt reactors that generate up to 100 MW, which are planned for several other desert locations and could each provide enough power for 100,000 inhabitants. Construction on the first commercial reactor is expected to be complete by 2030.**

In recent times, China has been leading the charge. In 2011, its government approved plans for a thorium molten salt reactor in the desert city of Wuwei, in the province of Gansu, and tasked its scientists with developing the technology to run it. Now, as reported by the South

China Morning Post, construction on the two-megawatt prototype reactor is due to wrap up next month and the first tests could begin as soon as September.

If these plans are realized, the facility would become the first operational thorium molten salt reactor anywhere in the world. Government scientists hope to use it as a springboard for the development of larger thorium molten salt reactors that generate up to 100 MW, which are planned for several other desert locations and could each provide enough power for 100,000 inhabitants. Construction on the first commercial reactor is expected to be complete by 2030.

The plans are grand but the fine details remain light on, particularly relating to the technical obstacles that have plagued the technology in the past. One major issue molten salt reactors have to contend with is corrosion, with the radioactive molten salt prone to eating away at piping or other components.

Another relates to the processes that drive the generation of energy. Conventional nuclear reactors are able to split atoms of uranium in a way that results in a chain reaction and continual

energy production, whereas thorium doesn't contain enough fissile material to do this all on its own. This means it needs to be mixed with uranium anyway, or another material that help trigger the necessary reactions.

This means that a thorium nuclear reactor has never been proven on a commercial scale before, and plenty have doubts that one ever will be. In any case, China's scientists have been spearheading research and development in the area since the project kicked off a decade ago, so perhaps they are finally ready to show their hand.

Source: <https://newatlas.com/energy/china-world-first-thorium-nuclear-reactor/>, 20 July 2021.

## **ITALY**

### **Italians Do Not Rule Out Future Use of Nuclear Energy**

One-third of Italians are in favour of reconsidering the use of nuclear energy in the country, according to the results of a public opinion poll conducted on behalf of *Comitato Nucleare e Ragione*. More than half of respondents said they would not exclude the future use of new advanced nuclear technologies. *Comitato Nucleare e Ragione* (Committee on Nuclear and Reason) said it commissioned the poll "in order to feel the pulse of Italian people about nuclear energy, given the renewed international attention on this energy source in the context of decarbonisation and climate targets."

The survey, conducted by polling firm SWG, questioned 800 adults between 16 and 18 June. According to the results, 33% of respondents said they supported the use of nuclear energy in Italy, a similar proportion to a survey conducted in 2011. Men and young people were found to be most in favour....

The main reasons given for supporting nuclear energy include: improved safety of new technologies; potential contribution to Italy's

energy security; and low carbon emissions. Those opposing nuclear power mainly had concerns about radioactive waste management and the possibility of accidents at nuclear plants. When asked about the use of new reactor designs, 56% of respondents said they would not exclude the use of new nuclear technologies, with 7% saying they are "absolutely necessary" and 22% saying they are "promising and should be considered." 28% of respondents said new technologies should be rejected. More than half (53%) of respondents did not favour the European Commission including nuclear energy in the sustainable finance taxonomy, with 30% supporting its inclusion.

In response to being asked how informed they were about nuclear energy, only 6% of respondents said they were well-informed, with 35% saying they had sufficient knowledge. The remainder said they were little or not at all informed. Trieste-based Comitato Nucleare e Ragione was established in April 2011, following the accident at the Fukushima Daiichi nuclear power plant. It was founded as a cultural and no-profit organisation by young physics researchers and students of the University of Trieste and other European research centres.

Italy operated a total of four nuclear power plants starting in the early 1960s but decided to phase out nuclear power in a referendum that followed

the 1986 Chernobyl accident. It closed its last two operating plants, Caorso and Trino Vercellese, in 1990. In late March 2011, following the Fukushima Daiichi accident, the Italian government approved a moratorium of at least one year on construction of nuclear power plants in the country, which had been looking to restart its long-abandoned nuclear programme. In a poll held in June of that year, 94% of voters rejected the construction of any new nuclear reactors in Italy.

Source: <https://world-nuclear-news.org/Articles/Italians-do-not-rule-out-future-use-of-nuclear-ene>, 22 July 2021.

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## JAPAN

### Japan Goes Nuclear in Bid to Stay Cool during Summer Olympics

Japan has rebooted extra power plants, including a long-dormant nuclear reactor, and taken other steps to avoid a power crisis as temperatures soar and demand for cooling surges, especially in Tokyo, where the Olympics began on 23 July, 2021. With the world's eyes on Tokyo as it hosts the Summer Games amid worries over risks posed by the coronavirus pandemic, Japan wants to avoid any recurrence of the electricity crisis suffered during the winter, when power companies urged customers to ration usage to prevent blackouts.

Earlier in July, Kansai Electric Power (9503.T) restarted another reactor, the fifth to be restarted in Japan since January, including a 44-year-old unit that had been shut for ten years. Japan has nine reactors operating, the highest number since the Fukushima atomic disaster led to the shutdown of Japan's nuclear industry. A gas-fired plant and a coal plant have also been brought online ahead of schedule. The increased generating capacity gave the industry ministry confidence that electricity supplies would be sufficient.... Japan's power grid has faced periods of intense strain in the decade since the Fukushima disaster, and the government has introduced more competition into the sector and more renewables into the mix. But Japan still relies heavily on fossil fuels, especially LNG and coal, which have to be imported.

Adding to pressures on the sector, many old oil and coal power plants are being shut down in Japan as liberalization forces cost cuts, and pressure to reduce CO2 emissions makes them unviable. The industry ministry warned in May of the risk of power crunches during peak summer demand and told utilities to secure adequate generation capacity along with LNG stockpiles....

As summer progressed, some tightening in supply was evident as spot electricity prices for the Tokyo

area have doubled in July, 2021. On July 20, the country's weather bureau issued heat-stroke alerts for a fourth consecutive day. By midday, the temperature in Tokyo was 34 degrees Celsius, and there are forecasts for a hotter than usual summer. Japan's grid monitor (OCCTO) estimates excess generation capacity in the Tokyo area at 5% for July and 3.9% for August. Excess capacity below 3% could lead to supply shortages and possibly even blackouts. OCCTO has started a new monitoring programme using LNG inventory data from major generators to gauge how much electricity supply could be available at peak demand periods, and help to anticipate fuel shortages... .

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Source: <https://www.reuters.com/business/energy/japan-goes-nuclear-bid-stay-cool-during-summer-olympics-2021-07-20/>, 21 July 2021.

## SOUTH KOREA

### Second Korean Investment in a Week for NuScale SMR

Under its agreements with NuScale and Fluor, Samsung C&T will draw upon its nuclear construction experience in the South Korea and the UAE to serve as a strategic partner to Fluor and other potential project participants. "The company's expertise and investment in NuScale will be invaluable as we seek to bring this revolutionary clean energy technology to market," NuScale Power Chairman and CEO John Hopkins said.

"Samsung C&T is delighted to invest in and explore global carbon-free power opportunities together with NuScale Power and Fluor Corporation, leading companies in the SMR nuclear business," Se Chul Oh, Samsung C&T's Engineering & Construction Group president and CEO, said. "SMR technology is next-generation with eco-friendly energy and this agreement is a crucial step to Samsung C&T to achieve future substantial growth."

Fluor Group President of Energy Solutions Jim Breuer welcomed Samsung C&T's capabilities, experience and global footprint in the deployment of NuScale's SMR technology. "This investment and partnership with Samsung C&T is aligned with Fluor and NuScale's long-term strategy to create the preeminent SMR value chain and investor syndicate," he said....

The NuScale Power Module is a pressurised water reactor with all the components for steam generation and heat exchange incorporated into a single integrated unit. In August 2020 it became the first - and, so far, only - SMR to receive design approval from the US Nuclear Regulatory Commission.

Source: <https://www.world-nuclear-news.org/Articles/Second-Korean-investment-in-a-week-for-NuScale-SMR>, 23 July 2021.

## **UK-CHINA**

### **UK Looks to Remove China's CGN from Nuclear Power Projects**

Britain is exploring ways to remove China's state-owned nuclear energy company China General Nuclear Power Group CGN) from all future power projects in the UK, the *Financial Times* reported on 25 July, citing people familiar with the plans. The change in Britain's stance could affect the Sizewell C nuclear energy project in Suffolk, England, that France's EDF (EDF.PA) is scheduled to build with backing from CGN, and proposals for a new plant at Bradwell-on-Sea in Essex, the newspaper said.

Source: <https://www.reuters.com/world/uk/uk-looks-remove-chinas-cgn-nuclear-power-projects-ft-2021-07-25/>, 26 July 2021.

## **USA**

### **US Benchmarking Study Reflects Decarbonisation Efforts**

Carbon dioxide emissions from the USA's 100 largest power producers fell 10% between 2019 and 2020, according to the latest in a series of benchmarking studies dating back to 1997. Nuclear accounted for over half of the zero-carbon resources which together generated about 38% of US electricity in 2020.

Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States is a collaborative effort between non-profit organisation Ceres; Bank of America; power producers

Entergy and Exelon; and the Natural Resources Defense Council (NRDC). It is authored by M. J. Bradley & Associates. The latest report is the 17th in the series which uses publicly reported data to compare the emissions performance of the 100 largest power producers in the USA. Together, they account for more than 80% of the sector's electricity generation and reported air emissions.

The decrease in power sector CO2 emissions is the largest year-on-year decrease since the report was first released in 1997, and 2020 power plant CO2 emissions were some 40% lower than their peak in 2007. The coronavirus

pandemic may have been a contributing factor to the 2020 figures, the authors said, but the longer-term trend has been driven by factors including energy efficiency improvements and the displacement of coal by natural gas and renewable energy resources.

For the fifth consecutive year, natural gas was the leading source of electricity generation in the USA, accounting for 40% of generation, followed by nuclear (20%). Zero-carbon resources together

**The NuScale Power Module is a pressurised water reactor with all the components for steam generation and heat exchange incorporated into a single integrated unit. In August 2020 it became the first - and, so far, only - SMR to receive design approval from the US Nuclear Regulatory Commission.**

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generated about 38% of US electricity, an all-time high. Nuclear provided 52% of the combined zero-carbon electricity generation, renewables 29% and hydro 19%....

The share of clean electricity in the US generation mix will need at least to double by 2030 to meet goals set by the present US administration of 80% carbon-free energy by 2030 and 100% by 2035, Starla Yeh, director of the Policy Analysis Group in the Climate & Clean Energy programme at NRDC, said.

*Source: <https://www.world-nuclear-news.org/Articles/US-benchmarking-study-reflects-decarbonisation-eff>, 21 July 2021.*

## **URANIUM PRODUCTION**

### **GREENLAND**

#### **Greenland Plans to Reimpose Ban on Uranium Mining**

The new Greenland government (Naalakkersuisut) is preparing to outlaw uranium mining, reinstating and strengthening a ban that the national assembly had overturned in 2013, local media reported on 12 July. A month-long public consultation period began on 2 July for a proposed bill that would prohibit uranium mining as well as the feasibility studies and exploration activities that must be completed before a mining project can be considered for a licence to begin operation.

The new government, is hoping for a reinstatement of what was known as the zero-tolerance policy, to ensure that "Greenland neither produces nor exports uranium". When the original ban was lifted, Australian firm Greenland Minerals launched efforts to establish a rare-earth mine at Kuannersuit (also known as Kvanefjeld), in southern Greenland, which is currently in the final stage of the approval process. However, the mine is located in an area that is high in uranium, and residents of nearby Narsaq

fear that activity there would release radioactive dust that would settle on the town....

In May, shortly after taking office, mining minister Naaja Nathanielsen, the, sought to allay concerns that opposition to uranium mining would not extend to other mining and that it would ensure that Greenland Minerals got a fair review during the Kuannersuit approval process. At the same time, she made it clear that Naalakkersuisut would be working to find legal ways to ensure that uranium mining never takes place. ...

On 5 July, Greenland's Ministry of Mineral Resources released a draft bill banning uranium mining and exploration and limiting the amount of uranium present as a by-product in any mining operations to 100 parts per million, which would prevent the Kvanefjeld operation going ahead. The bill is out for public consultation until 13 September.

The project, being developed by Greenland Minerals with Chinese partner Shenghe Resources, seeks to exploit one of the world's largest deposits of rare earth metals and uranium near the small township of Narsaq. Greenland Minerals has been working to develop the Kvanefjeld mine since it acquired an exploration licence for the

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area in 2007, and it achieved a significant milestone in December last year when its environmental impact assessment for the project was finally accepted for public consultation.

However, the advancement of the mine triggered a breakdown of Greenland's governing coalition resulting in a snap election that effectively served as a referendum on the issue. The Danish-language newspaper Sermitsiaq referred to the outcome as a "decision to give Greenland Minerals the red card," 37% of voters backed the pro-independence, green-leaning Inuit Ataqatigiit (Community for the People) party, which had adopted an explicit policy to stop the mine and reinstate a uranium mining ban in Greenland....

Meanwhile, Greenland's 56,000 residents, around 90% of whom are Inuit, enjoy a largely pristine natural environment, where hunting and fishing are key forms of traditional culture, and increasing Western influence is seen as a cause of social problems, including a very high suicide rate. Opponents of the Kvanefjeld mine dispute its promised benefits and point to the potential for contamination of the local environment through dust, leaks and spills.

While reactions to the project were initially mixed, Mongabay reported that the results of one study suggested that dissatisfaction with Greenland Minerals' consultation process and lack of transparency had increased opposition to the mine. Also an expert report published by Greenlandic and Danish NGOs in 2017 concluded that Kvanefjeld, the first open-pit uranium mine to be located on an Arctic mountain top, was not environmentally sustainable and threatened the health of the local population.

In March 2021, an opinion poll commissioned by government agency Innovation South Greenland found that while 52% of people surveyed across Greenland favoured mining in general, 71% opposed the Kvanefjeld mine. Opposition in southern Greenland, where the project is located, stood at 86%. The mine was a key issue in the April election and the victory of Inuit Ataqatigiit (IA), replacing the long-time ruling party, Siumut, which had given preliminary approval for Kvanefjeld.

However, Greenland Minerals has hinted at legal action against the new government if its project is stopped. At the company's annual general meeting (AGM) in Perth, Australia, in May, managing director John Mair suggested that international NGOs and local media were

responsible for politicising uranium and turning public opinion against the mine. He told shareholders the company would "engage" the new government "to understand what the specific issue points are, from their perspective"....

Source: <https://www.neimagazine.com/news/newsgreenland-plans-to-reimpose-ban-on-uranium-mining-8919307>, 22 July 2021.

**In March 2021, an opinion poll commissioned by government agency Innovation South Greenland found that while 52% of people surveyed across Greenland favoured mining in general, 71% opposed the Kvanefjeld mine.**

reimpose-ban-on-uranium-mining-8919307, 22 July 2021.

## **NUCLEAR COOPERATION**

### **BANGLADESH-SOUTH KOREA**

#### **South Korea to Supply Research Reactor Technology to Bangladesh**

South Korea's Ministry of Science and ICT said on 15 July that the Korea Atomic Energy Research Institute (Kaeri) had won a deal worth \$3.88 million to export nuclear reactor technology to Bangladesh. Kaeri signed an agreement with the Bangladesh Atomic Energy Commission (BAEC) to deliver digital instrumentation and control systems for the Bangladesh Training and Research Reactor (BTRR) by January 2023, according to the Ministry.

Kaeri will provide and install the digital systems, which are responsible for monitoring and controlling the nuclear reactor and safely halting its operations should there be any problems. The 3 MW TRIGA BTRR, which became operational in

**Kaeri signed an agreement with the Bangladesh Atomic Energy Commission (BAEC) to deliver digital instrumentation and control systems for the Bangladesh Training and Research Reactor (BTRR) by January 2023, according to the Ministry.**

1986, is undergoing modifications to update its ageing analogue systems. The agreement is the sixth research-based nuclear technology export for South Korea since it won a deal to build a research nuclear reactor in Jordan in 2009. It has also provided technology to Greece, Thailand, Malaysia, and the Netherlands.

The agreement is seen as a stepping stone for further collaboration between Kaeri and BAEC,

including future research reactor development in Bangladesh. South Korean Ambassador to Bangladesh, Lee Jang-Keun said he anticipates an early signing of the proposed memorandum of understanding between Kaeri and BAEC and meaningful progress in the discussions between the governments for the conclusion of a bilateral agreement on peaceful nuclear cooperation.

Source: <https://www.neimagazine.com/news/newssouth-korea-to-supply-research-reactor-technology-to-bangladesh-8912216>, 21 July 2021.

## **NIGERIA–RUSSIA**

### **Nigeria Reactivates Russian-Nigerian Joint Coordination Committee**

Nigeria's Federal Government on 15 July inaugurated the reconstituted Russian-Nigerian Joint Coordination Committee (JCC) on National Atomic Energy. Boss Mustapha, the Secretary to the Government of the Federation, said the reconstitution of JCC was to resuscitate the relationship between the two countries in cooperation for the peaceful use of nuclear energy. However, he recalled that within the framework of Nigeria's bilateral relation with the Russian Federation, a number of Inter-governmental Agreements (IGAs) had been signed between the Nigeria Atomic Energy Commission (NAEC) and Russian State Nuclear Corporation Rosatom.

He said that the move was for cooperation in the design, construction and decommissioning of nuclear power plants on the territory of Nigeria. "In addition to these IGAs, two broad based Project Development Agreements (PDAs) were also signed," he said. "As a follow-up, a number of meetings have been held in Nigeria, Russia and Austria to discuss the roles and responsibilities of the two parties involved in the implementation of the various elements of the agreements. "It is for this reason that the JCC for both Nigeria and the Russian Federation were constituted in the first instance." He added that the JCC members

will be fully briefed on their tasks and responsibilities based on the Terms of Reference (TOR) they are all advised to be very conversant with. Mustapha said that JCC was put in place to allow for effective negotiations, particularly focused on ensuring that Nigeria was not subjected to any unfair trade agreements during the process of Nigeria's engagement and discussions with Rosatom.

He listed other responsibilities of the JCC to include implementation of all agreements with the Russian Federation, to supervise the activities of the Joint Working Groups in

the following thematic areas of nuclear power infrastructure, human resources management, financing and contracting scheme, among others.

In his acceptance speech on behalf of JCC, Dr Nazir Bello, Director, of the Nigerian Nuclear Regulatory Authority, promised to support the committee to achieve its mandate. The terms of reference of the committee include:

- To provide a broad framework for Cooperation with the Russian Federation in the Peaceful uses of Atomic Energy.
- To participate in the design, construction, operation and decommissioning of both an NPP and multi-purpose research reactor.
- To ensure dynamic monitoring and implementation of all agreements with the Russian Federation.
- To supervise the activities of the Joint Working Groups in the following thematic areas: Nuclear Power Infrastructure; Human Resources Management; Financing and Contracting Scheme; Technical Aspect of Construction; Nuclear Technology Applications; and Nuclear Regulatory Framework.
- To ensure that Nigeria is not subjected to any unfair trade agreement during the process of

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negotiation with Rosatom.

- To work hard and to make sure that the interest of Nigeria is paramount, and to ensure that Nigeria plays its role in the implementation of various elements of the agreements.

- To have a unity of purpose during negotiation in order to ensure that Nigeria is not defrauded in the implementation of the agreement....

Source: <https://www.neimagazine.com/news/newsnigeria-reactivates-russian-nigerian-joint-coordination-committee-8910594>, 20 July 2021.

## **USA-GHANA**

### **US and Ghana Sign Memorandum with a Focus on Nuclear**

The US and the Republic of Ghana have signed a Memorandum of Understanding Concerning Strategic Civil Nuclear Cooperation (NCMOU). The NCMOU aims to improve the two countries' cooperation on nuclear energy and strengthen their diplomatic and economic relationship.

**Cooperation in nuclear energy, science and technology between the US and Ghana can lead to significant contributions to clean energy, agricultural improvements, clean water, advanced medical treatments, and more.**

Dr C.S. Eliot Kang, Senior Official for Arms Control and International Security, signed for the US, and Kwaku Ampratwum Sarpong, Deputy Minister for Foreign Affairs and Regional Integration, signed for Ghana. The US and Ghana have an enduring diplomatic relationship, which includes long-standing cooperation in the fields of security, energy and commerce. Cooperation in nuclear energy, science and technology between the US and Ghana can lead to significant contributions to clean energy, agricultural improvements, clean water, advanced medical treatments, and more.

Nuclear Cooperation MOUs are diplomatic mechanisms that strengthen and expand strategic ties between the US and a partner country by providing a framework for cooperation on civil nuclear issues and for engagement between experts from government, industry, national laboratories and academic institutions. Since

2007, the various administrations in Ghana have supported the effort to improve the country's energy security to provide leadership and resources to facilitate the nuclear power programme.

Source: <https://www.esi-africa.com/industry-sectors/future-energy/us-and-ghana-sign-memorandum-with-a-focus-on-nuclear/>, 15 July 2021.

## **NUCLEAR PROLIFERATION**

### **IRAN**

#### **Biden Admin Accuses Iran for Delay in Nuclear, Prisoner Swap Talks**

The Biden administration lashed out at Iran on 17 July for accusing it of delaying a proposed prisoner swap to force a quick resumption of indirect nuclear talks. The State Department slammed as outrageous comments made by Iran's deputy foreign minister who alleged the US and Britain were holding the swap hostage to the negotiations over salvaging the 2015 Iran nuclear deal, known as the Joint Comprehensive Plan of Action or JCPOA.

In a pair of tweets from his verified account, Seyyed Abbas Araghchi said the nuclear talks in Vienna could not resume until Iran's hardline president-elect is inaugurated in early August. We're in a transition period as a democratic transfer of power is underway in our capital, he said. The nuclear talks must thus obviously await our new administration. This is what every democracy demands, Araghchi said. He added that the US and Britain need to understand this and stop linking a humanitarian exchange ready to be implemented with the JCPOA.

Keeping such an exchange hostage to political aims achieves neither, said Araghchi who is Iran's chief negotiator at the Vienna talks. Ten prisoners on all sides may be released if US&UK fulfil their part of deal. A sixth round of nuclear talks ended

in June without agreement ahead of Iran's presidential election won by Ebrahim Raisi. The US has repeatedly said it is ready for a seventh round as soon as Iran is ready while also calling for the immediate release of American citizens detained in Iran.

In response to Aragchi's remarks, State Department spokesman Ned Price categorically rejected the claim, denied there was already an agreement on a swap, and said the US was prepared to continue talks on prisoners even while waiting for the resumption of the nuclear negotiations. These comments are an outrageous effort to deflect blame for the current impasse on a potential mutual return to compliance with the JCPOA, Price said.

...Price did not address Aragchi's claim that Iran is in the midst of a democratic transfer of power but he did decry his reference to the US and Britain holding the prisoner exchange hostage." He said it is the Iranian government that has been unjustly detaining four innocent Americans for years." Price said indirect talks on the detainees had been progressing in the context of the Vienna nuclear negotiations and the delay in restarting that process is not helping....

The Biden administration has been trying to reverse former President Donald Trump's 2018 withdrawal from the nuclear deal and has offered sanctions relief in exchange for Iran returning to full compliance with its obligations. As the Trump administration stepped up its maximum pressure campaign against Iran by re-imposing sanctions that had lifted under the initial deal, Iran stepped up its violations of the agreement by running advanced centrifuges and increasing uranium enrichment and heavy water production. It has also refused to answer questions from the UN's atomic watchdog about potential violations of other nuclear commitments.

Source: <https://www.business-standard.com/article/international/biden-admin-accuses-iran->

[for-delay-in-nuclear-prisoner-swap-talks-121071800092\\_1.html](https://www.business-standard.com/article/international/biden-admin-accuses-iran-), 18 July 2021.

## **NORTH KOREA**

### **US Seeks 'Reliable, Predictable' Way Forward with N. Korea**

The United States is seeking a "reliable, predictable and constructive" way to secure progress in stalled denuclearisation talks with North Korea, U.S. Deputy Secretary of State Wendy Sherman said on 23 July.

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Sherman made the remarks following a meeting with South Korean Vice Foreign Minister Choi Jong-kun in Seoul on the second leg of her Asian tour. The two sides discussed how to reopen negotiations after North Korea brushed off the Biden administration's proposals for talks, casting a cloud over prospects for dismantling its nuclear and missile programmes.

...  
Source: <https://www.reuters.com/world/asia-pacific/us-seeks-reliable-predictable-way-forward-with-north-korea-2021-07-23/>, 23 July 2021.

## **NUCLEAR DISARMAMENT**

### **AUSTRALIA**

#### **Bayside Council Supports Nuclear Prohibition**

Bayside City Council has become the 11th Council in Victoria to join the call for the Australian Government to sign and ratify the United Nations (UN) Treaty on the Prohibition of Nuclear Weapons. In a unanimous decision at the July 2021 Council Meeting, Bayside Councillors declared their support and are now calling on the Australian Government to sign the Treaty without delay. "Nuclear weapons pose a threat to communities throughout the world, and we believe all people, including our residents, have the right to live in a world free from this threat," Mayor Cr Laurence Evans said. "Any use of nuclear weapons, whether

deliberate or accidental, would have catastrophic, far-reaching and long lasting consequences for people and the environment.”

Australia has not signed or ratified the Treaty, despite committing to pursue nuclear disarmament under the 1970 nuclear Non-Proliferation Treaty. “It’s time for Australia to sign and get on the right side of history,” Cr Evans said. Part of the Council resolution includes writing to the Foreign Affairs Minister, and the local Federal member of parliament, advising of Council’s support to the Treaty. It was also resolved that Council will take steps to ensure that funds administered by Bayside City Council are not invested in companies that produce nuclear weapons. ...

Source: <https://www.miragenews.com/bayside-council-supports-nuclear-prohibition-601949/>, 26 July 2021.

## **NUCLEAR TERRORISM**

### **GENERAL**

#### **IAEA Begins Construction of Training Centre to Counter Nuclear Terrorism**

The Director General of the IAEA, Rafael Mariano Grossi, on 12 July broke ground for a new facility that will help strengthen countries’ abilities to tackle nuclear terrorism in areas such as the illegal trafficking of nuclear material and the physical protection of facilities and major public events.

The IAEA Nuclear Security Training and Demonstration Centre will be located at the IAEA facility in Seibersdorf, 30 km south of Vienna, and is scheduled to be operational in 2023. “This Centre will help us in supporting countries to remain ahead of the curve in guarding against nuclear terrorism,” Grossi said. “It will reinforce the central role the Agency plays in this area of international importance.” The Agency has been offering training in nuclear security since the early 1970s. Requests for such training, however, have

increased in recent years due, in particular, to the 2016 entry into force of the Amendment of the CPPNM – the most significant international legal instrument in the fight against nuclear terrorism. In addition, the need to support member states in the protection of nuclear material has become greater as more countries embark on nuclear power programmes or start construction of research reactors.

**The Centre will provide more than 2000 square meters of specialised technical infrastructure and equipment. Hands-on training will be conducted on demonstration systems and virtual reality environments. These platforms will emulate security systems used at nuclear power plants, research reactors and border crossings.**

The Centre will provide more than 2000 square meters of specialised technical infrastructure and equipment. Hands-on training will be conducted on demonstration systems and virtual reality environments. These platforms will emulate

security systems used at nuclear power plants, research reactors and border crossings. Participants will practice procedures on access and alarm controls, inspect physical protection systems, better understand computer security risks, and learn how to sweep an area for radioactive material during major public events, among other activities. Exercises at the training centre will also strengthen capabilities in radiological crime scene management and nuclear forensics.

The Centre, and the multi-purpose building that will house it, has so far drawn over €11.3 million in extra-budgetary funding, indicating strong support from IAEA member states to the Agency’s work in nuclear security. Saudi Arabia pledged €8.3 million, the UK €2 million and the USA €1 million. “Thanks to the great generosity of our donor countries this new facility will expand the topic areas covered by the IAEA’s Seibersdorf complex,” Grossi added. The IAEA Seibersdorf facility houses eight nuclear applications laboratories working in food and agriculture, human health, environmental monitoring and assessment, as well as two safeguards analytical laboratories for nuclear verification. The IAEA opened the facility at Seibersdorf in 1962 with fewer than 40 staff members and has since significantly expanded it as demands for its diverse services increased.

Some 250 staff currently work at the facility.

*Source: <https://www.neimagazine.com/news/newsiaea-begins-construction-of-training-centre-to-counter-nuclear-terrorism-8896130>, 14 July 2021.*

**NUCLEAR SAFETY**

**BULGARIA**

**IAEA Concludes Long Term Operational Safety Review of Bulgaria’s Kozloduy Nuclear Power Plant**

An IAEA team of experts on 15 July completed a review of long term operational safety at the Kozloduy Nuclear Power Plant (NPP) in Bulgaria. The SALTO (Safety Aspects of Long Term Operation) review mission was requested by the Bulgarian Nuclear Regulatory Authority (BNRA). Kozloduy NPP, Bulgaria’s only nuclear power plant, has two pressurized-water reactor units in operation with an installed power of approximately 1000 MWe each. Unit 5 went into commercial operation in 1987 and Unit 6 in 1991. The 9-member SALTO team focused on aspects essential to safe Long Term Operation (LTO). The operation licenses of the two units have been extended until 2027 and 2029, respectively. Units 1 to 4 have been shut down and are being decommissioned.

During the 6-15 July mission, the SALTO team reviewed preparedness, organization and programmes related to LTO based on the relevant IAEA safety standards. The review team found plant staff to be professional, open and receptive to suggestions for improvement. “The team observed that the operator is implementing measures for safe LTO,” said team leader and IAEA Nuclear Safety Officer Gabor Petofi. “Most ageing management and LTO activities already meet IAEA safety standards. The SALTO team encourages the plant to further improve its LTO

related performance and to address the mission’s findings.”

The team comprised experts from the Czech Republic, Slovakia, Spain, and the UAE, and three IAEA staff members. It identified good practices that will be shared with the nuclear industry globally, including: The plant implements comprehensive annual visual inspections of civil structures to identify ageing effects at a very early stage. The plant cooperates with technical universities and high schools to support future staffing needs for the long term operation period.

The plant uses comprehensive information systems to monitor and evaluate the risk of loss of tacit knowledge. Tacit knowledge is non-recorded, non-formalized knowledge, for example, experiences and insights by long-standing plant workers. This strategy ensures the preservation of this important resource for LTO.

**Most ageing management and LTO activities already meet IAEA safety standards. The SALTO team encourages the plant to further improve its LTO related performance and to address the mission’s findings.**

The team also provided recommendations and suggestions to support the operator in further enhancing safe LTO: Fully complete implementation of the equipment qualification programme to confirm reliable safety performance. Complete an ageing management review for all of the NPP’s mechanical structures, systems and components to effectively manage ageing effects. Fully implement ageing management programmes to monitor the condition of low voltage cables and to verify whether important cables are still reliable....

**The plant uses comprehensive information systems to monitor and evaluate the risk of loss of tacit knowledge. Tacit knowledge is non-recorded, non-formalized knowledge, for example, experiences and insights by long-standing plant workers. This strategy ensures the preservation of this important resource for LTO.**

The plant management expressed a determination to address the areas identified for improvement and announced that it would continue cooperation with the IAEA in implementing safe LTO and ask the Government of Bulgaria to request a SALTO follow-up mission in 2023. The team provided a draft report to the plant management and to the Bulgarian Nuclear Regulatory Authority (BNRA) at the end of the mission. The plant management and BNRA will

have an opportunity to make factual comments on the draft. The IAEA will submit a final report to the plant management, BNRA and the Bulgarian Government within three months....

Source: <https://www.iaea.org/newscenter/pressreleases/iaea-concludes-long-term-operational-safety-review-of-bulgarias-kozloduy-nuclear-power-plant>, 16 July 2021.

## NUCLEAR WASTE MANAGEMENT

### CHINA

#### China Begins Construction of its First Underground Research Laboratory for High Level Waste Disposal

China has begun constructing its first underground research laboratory in the Gobi Desert, to determine the area's suitability for future geological disposal of high level radioactive waste (HLW), including spent nuclear fuel, generated in China's 51 operational nuclear power plants. Its construction follows more than three decades of research with the support of the IAEA.

Scientists will use the laboratory to characterize and assess the geological, hydrological, geochemical and engineering characteristics of the rocks at the site. China has been working on identifying a suitable site for a HLW repository since 1985, and since 1999 those efforts have been supported by the IAEA. ...

The country's strategy for HLW disposal consists of three stages, with stage one – laboratory studies and preliminary site selection – completed in 2020. The second stage, underground in-situ testing, is set to take place from 2021 to 2050, following the construction of the underground research laboratory. The final stage – the construction of the disposal facility – is planned to take place from 2041 to 2050, assuming the in-situ testing confirms the area's suitability. High-level radioactive waste can remain radioactive from thousands to hundreds of thousands of years. The internationally accepted solution for

its safe and secure long term management is geological disposal in a facility several hundred metres underground. A geological disposal facility is under construction in Finland.

As part of the support from the IAEA, under the technical cooperation programme, 35 Chinese and 11 international experts took part in a six-week virtual expert mission earlier this year to provide input, guidance and recommendations to support plans for the in-situ laboratory. ...

The virtual mission took place from 25 February to 9 April. In a series of 14 online, interactive meetings, the experts reviewed and assessed the plans for the construction of the underground research laboratory. They also reviewed the preparations being made for the development of a safety case for the disposal facility as well as for stakeholder engagement...

Source: <https://www.iaea.org/newscenter/news/china-begins-construction-of-its-first-underground-research-laboratory-for-high-level-waste-disposal>, 23 July 2021.

**During operation of Chernobyl 1-3 from 1977 to 2000, more than 21,000 used RBMK fuel assemblies accumulated at the station. They are now stored in the ISF-1 wet used fuel storage facility. But ISF-1 was not designed for long-term fuel storage, and its service life expires in 2035. All the stored assemblies must be transported from IFS-1 to a new dry storage facility, IFS-2, using a special transport container.**

### RUSSIA

#### Chernobyl's IFS-2 Milestone

During operation of Chernobyl 1-3 from 1977 to 2000, more than 21,000 used RBMK fuel assemblies accumulated at the station. They are now stored in the ISF-1 wet used fuel storage facility. But ISF-1 was not designed for long-term fuel storage, and its service life expires in 2035. All the stored assemblies must be transported from IFS-1 to a new dry storage facility, IFS-2, using a special transport container. Construction of the ISF-2 facility was funded by an international donor fund, the Nuclear Safety Account, managed by the European Bank for Reconstruction and Development (EBRD). ISF-2 cost €400 million and was financed with contributions from Belgium, Canada, Denmark, the European Union, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Russia, Sweden, Switzerland, Ukraine, the UK and the USA.

The project began in the late 1990s but was stalled

when the technology provided was shown to be inadequate to meet the facility's functional and regulatory requirements. US-based Holtec took over the IFS-2 project in 2011, after demonstrating to the EBRD and State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) that it had the technologies to deal with Chernobyl's RBMK fuel. Holtec then started work to develop a fully functional store using the legacy systems, structures and components supplied by Areva, and by acquiring replacement systems from France, Germany, Italy, the USA and elsewhere.

Holtec handed over the ISF-2 complex to the owner, Chernobyl Nuclear Power Plant, in December 2019. In September the following year it received a permit to carry out hot testing of the facility. Hot testing was completed on 14 December 2020, after the second double-walled shielded canister (DWC) was loaded into the IFS-2. The first canister had been placed in storage on 18 November. "With the successful transfer of the first two filled DWCs to ISF-2 in November — December 2020 and the licence for operation provided by Ukraine's Nuclear Regulatory Inspectorate on 26 April 2021, 35 years from the day the horrendous accident struck Chernobyl, we commissioned one of the world's largest and most complex dry interim storage facilities," said Riaz Awan, vice president for Ukraine Operations at Holtec.

In April Balthasar Lindauer, EBRD's director of nuclear safety, welcomed the milestone and described it as "a major step forward in the transformation of the Chernobyl site." And on 8 June this year, ChNPP officially announced that it had started a 10-year period during which it will transport the spent nuclear fuel from the old storage facility to the new one, where it will be stored for at least 100 years. Once all fuel has been transferred to the new ISF-2 facility, the existing wet fuel storage facilities, which have been in service well past their initial design life, will be decommissioned, marking another major step towards increased nuclear safety at Chernobyl. All fuel loading operations will be monitored by the IAEA and the State Nuclear Regulatory Inspectorate of Ukraine.

**Once all fuel has been transferred to the new ISF-2 facility, the existing wet fuel storage facilities, which have been in service well past their initial design life, will be decommissioned, marking another major step towards increased nuclear safety at Chernobyl.**

**Innovative Technology:** The challenges at Chernobyl spurred Holtec to develop several innovative technologies, such as the double-walled canisters. These render any risk of leakage seven orders of magnitude less likely than the risk level required by regulations in the US, which are similar to most other regulatory regimes. Among other innovations, Holtec is using its forced gas dehydrator to extract the last trace of entrained moisture from the fuel for guaranteed storage safety and it is using extruded Metamic tubes to dissipate residual heat from the used fuel

efficiently.

Holtec has also commissioned a purpose-built hot cell (one of the world's largest), among other innovations. Germany-based Bilfinger Noell GmbH supported Holtec with comprehensive services in planning, design, qualification, engineering, manufacturing, delivery, refurbishment and commissioning of this large hot cell at the ISF-2. Inside this hermetically sealed room, all work takes place automatically or remotely, as personnel are not permitted in the cell.

Once they reach the hot cell, the fuel assemblies, which are around 10 meters long, are dismantled into three parts. During this process, the fuel assemblies are suspended vertically in a device specifically developed for the purpose. They are dismantled at the central rod using a specially designed saw. This is a demanding process because, for safety reasons, the cutting blade cannot come into contact with the actual fuel. The extension rod is removed for handling outside of ISF-2 (radioactive material). The fuel bundles are placed in fuel tubes (a fuel tube is a non-leak-tight cylinder designed to accommodate fuel bundles) and are subsequently packed into Holtec's double-walled canisters. The fuel assemblies are also completely dried in the forced gas dehydrator process (above) specially developed by Holtec to prevent water from causing long-term damage to the canisters.

Finally, 93 fuel assemblies separated into 186 fuel bundles are placed into fuel tubes, then loaded into DWCs which, after complete drying, sealing

and backfilling with helium, are stored individually in concrete enclosures in the ISF-2. ...

Bilfinger Noell says its scope comprised the process technology for the remote operation of the hot cell with auxiliary rooms, including a special cutting machine, machines for the transport of fuel assemblies and canisters, enclosures, suction devices, shielding windows, manipulators, double-lid airlocks for fuel assemblies and 200l drums, small-part airlocks, transport carts for shielding casks and 200l drums, wall

penetrations with a remote operating plug system, various remote operating gripper systems for crane operation, lighting, a video system, a drum measurement station, the main filter system, shielding plugs, a shielded docking device for the special cask and a system for the complete dismantling of fuel assemblies, if necessary.

Source: <https://www.neimagazine.com/features/featurechernobyls-ifs-2-milestone-8917532/>, 21 July 2021.

**UK**

### **UK NDA Rationalises Waste Management**

The UK's Nuclear Decommissioning Authority

(NDA) said on 12 July that the Low Level Waste Repository Ltd (LLWR) had become an NDA subsidiary after its ownership was transferred from UK Nuclear Waste Management Ltd (UKNWM). It represents the latest NDA-owned site to move to subsidiary status and follows a similar

transition at Dounreay Site Restoration Ltd in March.

NDA CEO David Peattie said: "LLWR becoming a subsidiary is a significant milestone in building a stronger NDA group. We are transforming the way that we work across the estate, with a focus on

sharing and collaboration, while also maximising the strength and scale of the group. The move to make LLWR an NDA subsidiary is a step towards the creation of a single group waste division early next year. NDA said this will bring together the NDA's waste management expertise, including LLWR and Radioactive Waste Management, growing capability and simplifying how the group operates to deliver greater value for the taxpayer.

Source: <https://www.neimagazine.com/news/newsuk-nda-rationalises-waste-management-8919303>, 22 July 2021.

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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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