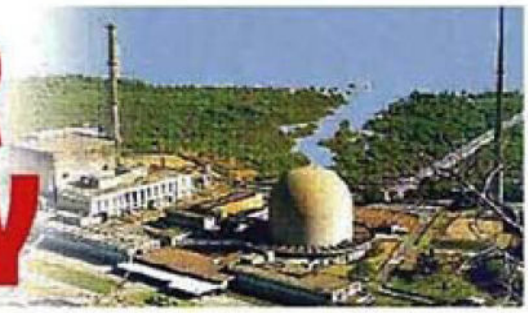
NUCLEAR SECURITY



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

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OPINION – Sitakanta Mishra

Atom for Space: Nuclear Propulsion for Interstellar Navigation

'Outer space' is fast becoming the new economic and strategic high ground. During the last few decades, prominent countries have ventured into outer space, and many of them dream of interplanetary missions. However, the biggest challenge for interstellar travel is the availability of reliable power sources for spacecraft propulsion, and onboard spaceship systems in the harsh environment of space. The great astronomer Carl Sagan once said that "one cannot travel fast into space without travelling fast into the future;" truly, without futuristic energy sources and propulsion technology, deep-space exploration would not be feasible. Radioisotope and nuclear-based propulsion technology is the promising gateway to outer space.

Today, spacecraft propulsion, power for onboard spaceship systems, and energy generation in extra-terrestrial voyages are mainly based on chemical and solar energy. But long-term space missions such as establishing and maintaining space stations, Lunar bases, Mars missions, deep-space exploration, or interplanetary missions require huge and uninterrupted power supply. For such missions, nuclear fusion propulsion is the next-generation energy solution as the atom is a source of high energy density and inexhaustible.

The great astronomer Carl Sagan once said that "one cannot travel fast into space without travelling fast into the future;" truly, without futuristic energy sources and propulsion technology, deep-space exploration would not be feasible. Radioisotope and nuclear-based propulsion technology is the promising gateway to outer space.

Technically, there are three possible key nuclear technologies for space propulsion: (1) Nuclear Pulse Propulsion (NPP) used for shorter trips with high acceleration but with lower propellant efficiency [currently not in use]; (2) Nuclear Thermal Propulsion (NTP); and (3) Radioisotope Electric Propulsion (REP). NTP uses a fission reactor to heat a liquid propellant: the heat converts the liquid propellant into gas, which expands through a nozzle to provide thrust to propel the spacecraft. With REP, the thrust is

produced by converting the thermal energy from a nuclear reactor into electrical energy. Currently, space programs are using the eighth generation of nuclear batteries called the Multi-Mission Radioisotope Thermoelectric Generator or MMRTG.

Interstellar or interplanetary voyages have long been a matter of science fiction, but it would not be far from a reality soon given the growing interest and research in harnessing nuclear technology for space application. Many countries today have deep-space exploration programs with nuclear propulsion technology experiments. Nuclear pulse propulsion was first developed as Project Orion by the Defense Advanced Research Projects Agency (DARPA), U.S. Department of Defense, in 1947. Between 1955 and 1972, the US spent more than $1.4 billion on developing nuclear rockets and related technologies.

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So far, NASA has only sent one nuclear reactor to space, on a satellite in 1965. Since 1965, the US has been using only Radioisotope Thermoelectric Generators (RTGs) in space exploration and not nuclear reactors. The high decay heat of Plutonium-238 or Strontium-90 enables its use as an electricity source in the RTGs of spacecraft. So far over 45 RTGs have powered 25 US space vehicles including Apollo, Pioneer, Viking, Voyager, Galileo, Ulysses, Cassini and New Horizons space missions, as well as many civil and military satellites. NASA's Mars rover was equipped with nuclear power-induced technology, which allowed its detectors to analyze the composition of Martian rocks. Also, NASA aims to test a 40-kilowatt microreactor on the moon by 2030.

The former USSR had a long history of successfully deploying "33 military reconnaissance and targeting spacecraft with nuclear reactors into low-Earth orbit from 1969 to 1988." In the post-Soviet era, Russia renewed its interest in the space application of nuclear energy, not only for propulsion systems but also for other equipment aboard large spacecraft for military requirements.

Project Daedalus was a study conducted between 1973 and 1978 by the British Interplanetary Society (BIS) to design a plausible interstellar spacecraft that could reach Alpha Centauri in more than four decades. A year ago the UK Space Agency (UKSA) awarded funding to the rocket company Pulsar Fusion to develop nuclear fission-based power systems. Meanwhile, the European Space Agency (ESA) is funding several studies such as the RocketRoll that will explore the use of nuclear propulsion for deep space exploration.

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Reportedly, Russian space agency Roscosmos is considering using the Zevs (Zeus) nuclear tug by 2030 to propel heavy cargo through deep space (Nuklon project) estimated at more than 4.17 billion rubles – to the Moon, then Venus and Jupiter, and also clean up space debris. The scheduled space tug, featuring a 500-kilowatt nuclear reactor and weighing up to 22 tons, will first fly to the Moon, where it will release a spacecraft that will go on to Venus, and "then use Venus as a gravity assist to deliver yet another spacecraft, which will make its long journey to Jupiter." The "Zeus" module would advance those efforts by using a 500-

kilowatt nuclear reactor to propel inter-planetary missions.

So far, Russia has flown more than 30 fission reactors in space. Its independent efforts in space nuclear power systems traced back to 1998, and during the presidency of Dmitry Medvedev, these efforts were proclaimed among the Kremlin's key priorities. Russia continues a special nuclear space programme "Through The Atom To The Stars" and Rosatom has played a crucial role ever since. Its expertise and technology could aid Moscow to develop a new space station by 2025. Today Russia, a leader in the global nuclear space race, is much ahead of all others.

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China is aggressively investing and working on a wide range of space technologies including nuclear propulsion designs to speed travel times in outer space, and to protect its various "cislunar" assets. Mainly China has relied on Russia for radioisotope units for its Chang'e-3 and 4 Lunar lander and rover missions, including an RTG for Yutu-2. However, China is now exploring breakthroughs and has proposals for indigenous reactors in its space missions, including the uranium-powered ACMIR.

India, on the other hand, is no way behind in the unfolding nuclear-propelled space race. The Chandrayaan-3 propulsion module orbiting the Moon is powered by nuclear technology. After its success, ISRO in collaboration with BARC has begun work on nuclear engines for its upcoming space missions. On January 28, 2021, ISRO's UR Rao Satellite Centre issued a call for proposals outlining a three-phase plan to create a 100-watt RTG.

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Gradually peaceful uses of atomic propulsion for space exploration are gaining momentum. To overcome the limitations of spacecraft speed and power demand for deep-space voyages, nuclear is undoubtedly the next space frontier. First, nuclear-based propulsion could speed up space travel ten times faster than light. Second, if harnessed for propulsion, nuclear fusion could revolutionize interstellar travel by providing a nearly limitless supply of energy, efficiency, and cost-effectiveness. Third, space flights would need to lift less fuel and reduce trip times. With this type of propulsion technology, the thrust may be lower but continuous, and the fuel efficiency is far greater, resulting in a higher speed and potentially over 60% reduction in transit time to Mars compared to traditional chemical rockets. Moreover, reduced time in space would also reduce the exposure of astronauts to cosmic radiation.

From all counts, the world is entering a new age of 'space geopolitics' and the "pathway to the stars runs through the atom", rightly says Michail Chudakov, head of the Department of Nuclear Energy at IAEA. Spaceborne fission would enable a single spacecraft to explore multiple targets in the outer solar system and even beyond which humans have always remained fascinated. Nuclear energy has the potential to fulfil this dream; it is just a matter of time and with the maturing of nuclear space technology, the sky won't be the limit for human beings.

Source: https://www.financialexpress.com/business/defence-atom-for-space-nuclear-propulsion-for-interstellar-navigation-3396514/, 16 February 2024.

OPINION – Jatin Nathwani, Ann Fitzgerald

Nuclear Waste Holds the Key to a Secure and Carbon-free Future

Relentless geopolitical tensions arising from conflicts in the Middle East, Ukraine and the South China Sea have threatened global trade flows and economic stability. National security concerns and energy security – tied together at the hip – continue to dominate the policy agenda with no signs of abatement. As a consequence, the climate crisis is drifting into the background, as the extraction of fossil fuels continues to be the default answer to the question of price stability.

The role of nuclear waste as an energy source, which can be repurposed and integrated into the energy supply mix, must be revisited. Based on the world's existing inventory of uranium, thorium, and used fuel, this resource can become a non-carbon source of affordable energy for every global citizen over the coming centuries.

But arguably, this time of crisis may be the best time to challenge the orthodoxy of our dependence on fossil fuels. The role of nuclear waste as an energy source, which can be repurposed and integrated into the energy supply mix, must be revisited. Based on the world's existing inventory of uranium, thorium, and used fuel, this resource can become a non-carbon source of affordable energy for every global citizen over the coming centuries.

Canada's nuclear waste exceeds the energy equivalence of Alberta's oil sands by a large margin, and the current available amount (approximately 60,000 tons, stored safely at licensed nuclear sites) can deliver a near-limitless supply of carbon-free energy. The twin threats of climate change and national security risks, compounded by geopolitical tensions, can be mitigated through the large-scale deployment of used nuclear fuel.

Canada's existing inventory of used nuclear fuel (also known as "high-level waste") remains an unacknowledged energy resource. Canada's nuclear waste exceeds the energy equivalence of Alberta's oil sands by a large margin, and the current available amount (approximately 60,000 tons, stored safely at licensed nuclear sites) can deliver a near-limitless supply of carbon-free energy. The twin threats of climate change and national security risks, compounded by geopolitical tensions, can be mitigated through the large-scale deployment of used nuclear fuel. What would otherwise be relegated to the category of "waste" can instead be recycled to create new economic value, sustaining a clean-energy future for decades to come while making coal, oil, and gas redundant.

Three interrelated reasons explain why this option has not already been developed to its full potential: the primary extraction of uranium and market-price signals have made it a relatively cheap resource, and therefore unappealing from a return-on-investment perspective; the technologies and solutions developed and established for the full recycling of nuclear waste were abandoned for political reasons; and, social perceptions of the long-term hazard of nuclear waste became the dominant narrative for opposition to nuclear power.

The safety of used fuel storage at existing nuclear facilities has been proven over the past six decades. In addition, Canada and other countries have developed technologies for the safe isolation of used fuel in permanent geological repositories. Notwithstanding the established technical capacity for the safety of this energy source, broad social acceptance still remains an open question. The framing of nuclear waste as an "unsolved" and "unsolvable" problem rests on a questionable premise. Opponents of nuclear energy have demanded this source of fuel

only be used if it carries "zero risk" for future generations. The goals of "intergenerational" equity and a desire to minimize burdens on our grandchildren have had a powerful appeal. Meeting the growing demand for clean energy without leaving an unaccountable legacy of debt to future generations has been a compelling proposition.

Thus, all national programs have emphasized that the geologic disposal of nuclear waste should make it irretrievable – buried in literal "tombs" where it can't be disturbed for thousands of years. But this "zero-risk" framework for nuclear waste is in fact an elegant philosophical trap, with huge potential for enormous disservice to future generations. If we take irreversible steps to make used nuclear fuel unusable, it will deny massive economic benefits to future generations. At its worst, the dominant social narrative pointing to nuclear waste as an unsolvable conundrum translates into an unfettered licence to inflict much larger harm on the planet's ecosystem through the continued use of fossil fuels.

The time has come to bring the nuclear waste debate in from the cold and make recycled nuclear waste a centrepiece of Canada's energy and national security strategies. The deep decarbonization of the Canadian economy, with nuclear, hydro, solar, wind and geothermal energies supplying the necessary heat and electricity to our industries and homes, is possible.

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Reaching a zero-carbon-energy future between 2050 and 2060 will require us to combine incremental steps and make bold decisions. We will need several building blocks to interlock, including policies, investment decisions and the successful executions of projects. Policy choices and market forces combined can foster the creation of critical intellectual property and patents that would contribute to, and influence, wider global efforts in this underutilized area, allowing Canada to prosper from these IP receipts in the future. The dominance of fossil fuels as low-cost sources of energy emerged over the course of 150 years, enabled by subsidies and tax treatments. We can do the same in detoxifying nuclear waste. A clean-energy future is within our grasp.

Source: https://www.theglobeandmail.com/opinion/article-nuclear-waste-holds-the-key-to-a-secure-and-carbon-free-future/, 20 February 2024.

OPINION – Spenser A. Warren

Is Russia Looking to Put Nukes in Space? Doing so would Undermine Global Stability and Ignite an Anti-Satellite Arms Race

Fresh U.S. intelligence circulating in Congress reportedly indicates that Russia is developing an anti-satellite weapon in space with a nuclear component. News reports speculating about what the weapon could be abounded after Rep. Mike Turner, R-Ohio, chair of the House Intelligence Committee, released a cryptic but alarming statement on Feb. 14, 2024, regarding the information, which he framed as a "serious national security threat." Some sources suggested a nuclear weapon. Others suspect a weapon that is nuclear-powered but not a nuclear warhead. The White House confirmed the following day that the Russian system under development is a space-based anti-satellite weapon and that if it were deployed, it would violate the 1967 Outer Space Treaty, which bans weapons of mass destruction in space. The Kremlin responded by dismissing the reports as a "malicious fabrication."

While the exact weapon remains unknown to the public, the events raise the specter of nuclear weapons in space at a tense time. Relations between the US and Russia are at their lowest in decades, and Russia is currently waging a war of aggression in Ukraine. As a scholar of nuclear

strategy, I know the U.S. reports come at a time when the nuclear world order is shifting significantly. China and others are expanding and modernizing their arsenals. Iran is close to being able to produce a nuclear weapon. Other countries may eventually want their own nuclear weapons. At the same time, several countries are developing new weapons to attack targets in space. This list includes Russia, the U.S., China, and India, although none currently field weapons in space.

The recent revelations about Russian space weapons raise the specter that countries may decide to deploy nuclear weapons in space at some point. Some have tried before. The U.S. and Soviet Union researched nuclear detonations in space during the Cold War.

Cold War Schemes: The recent revelations about Russian space weapons raise the specter that countries may decide to deploy nuclear weapons in space at some point. Some have tried before. The U.S. and Soviet Union researched nuclear detonations in space during the Cold War. In the late 1960s, the Soviets tested a missile that could be placed in low Earth orbit and be capable of coming out of orbit and carrying a nuclear warhead to Earth. Neither country placed nuclear weapons in space permanently. Both were parties to the Outer Space Treaty and the 1963 PTBT, which outlawed nuclear detonations in space. Moscow and Washington negotiated these treaties to contain the Cold War arms race. These treaties constrained behavior in the late Cold War. However, Russian violations of nuclear arms control treaties, as well as U.S. and Russian withdrawal from various treaties since 2002, suggest they may not in the future.

Nukes in Space: But why would a country want space nukes? There are a few reasons. Countries could point space-based nuclear weapons toward Earth. In theory, weapons from space could avoid early detection radars and missile defenses. However, there are significant disadvantages to firing nuclear weapons directly from space. Placing weapons in space to strike targets on Earth may have defensive or offensive motivations. Weapons that evade missile defenses might ensure nuclear deterrence. This is a defensive strategy intended to prevent aggression against the state that placed them in space. Alternatively, these weapons may help a country achieve a first-strike capability. A first strike requires the ability to destroy enough of an adversary's nuclear weapons – or the nuclear command, control and communications systems necessary to manage them – to prevent nuclear retaliation. Countries could point space-based weapons toward other regions of space, like the Russian weapon under development. This conjures images of nuclear weapons striking asteroids to defend Earth from a collision.

Placing weapons in space to strike targets on Earth may have defensive or offensive motivations. Weapons that evade missile defenses might ensure nuclear deterrence. This is a defensive strategy intended to prevent aggression against the state that placed them in space. Alternatively, these weapons may help a country achieve a first-strike capability.

Satellite Killers: The reality is less dramatic but no less worrisome. The most likely use would be to destroy an enemy's military satellites. Damaging navigation satellites would hinder an adversary's ability to fight a war. Both precision-strike weapons and ground-based forces rely on satellite constellations like GPS or the Russian GLONASS system to find and reach targets. Countries may also want the ability to destroy an enemy's space weapons, including space-based missile defenses. While no country has deployed these weapons yet, leaders may fear future capabilities and deploy space weapons first to hedge against this threat. Most dangerously, these weapons could destroy or damage satellites critical to an enemy's nuclear command, control and communications system, including early warning satellites that track missile launches and communication satellites that relay military orders. Nuclear weapons damage satellites

because of a wave of gamma radiation that is created by a nuclear detonation. This radiation damages critical subsystems within a satellite.

But such weapons produce significant drawbacks. A detonation would damage any satellites within range of the gamma radiation – including those of the attacking country, its allies and neutral countries. However, a space-based nuclear anti-satellite weapon may have some advantages over other options for attacking countries. Ground-based anti-satellite systems can only reach targets in low Earth orbit.

Even a nuclear-powered anti-satellite weapon in space would create a novel threat without a nuclear warhead. Such a device would have a greater range than anti-satellite weapons on the ground and could perform its mission over an extended period of time. Both factors would increase the number of satellites it could damage or destroy. Many of the satellites a country may want to take out are located at higher orbits beyond the range of ground-based systems. This is true for some of the U.S. systems that Russia may want to target. The Kremlin's interest in space weapons could be an attempt to reduce America's capability to fight a war; threaten nuclear command, control and communications systems; or hedge against space-based missile defenses. Alternatively, the Russian defense industry may drive their development for profit.

Space-based nuclear weapons increase the risk that a country would resort to nuclear weapons during a crisis. Both weapons pointing toward Earth and those aimed at targets in space create incentives to use nuclear weapons preemptively. The threat of either strike creates use-it-or-lose-it pressure, incentivizing a preemptive nuclear strike to limit the damage an adversary can do.

New Arms Race? Whatever their initial purpose, placing nuclear weapons in space could be destabilizing. While there is not a universally accepted definition of strategic stability, scholars frequently define it as a combination of crisis stability, based on the risk of nuclear escalation during a military crisis, and arms race stability – when countries can avoid actions and reactions that spiral into a costly and dangerous arms race.

Space-based nuclear weapons increase the risk that a country would resort to nuclear weapons during a crisis. Both weapons pointing toward Earth and those aimed at targets in space create incentives to use nuclear weapons preemptively. The threat of either strike creates use-it-or-lose-it pressure, incentivizing a preemptive nuclear strike to limit the damage an adversary can do. In turn, a preemptive nuclear strike would likely provoke further escalation, eventually ending in a total nuclear war.

Placing nuclear weapons in space could spark a new arms race. Because one purpose of space weapons is to destroy an adversary's space weapons, the U.S. may respond to Russian weapons with their own. Russia may then counter with new weapons to maintain its advantage. Others, like China, may react to American weapons, which could prompt a response from India, followed by one from Pakistan. Escalatory pressures and the threat of an arms race exist even if the first mover places weapons in space defensively. Introducing space weapons could create what international relations scholars call a security dilemma: actions that enhance one country's security but make another insecure.

Defensive and offensive weapons are often indistinguishable. The weapons that could enhance one country's security by hedging against space-based missile defense could also be used offensively against nuclear command, control and communications systems. Even if leaders in one country thought the other was acting defensively today, there is no way to know they will not act offensively tomorrow.

Source: https://theconversation.com/is-russia-looking-to-put-nukes-in-space-doing-so-would-undermine-global-stability-and-ignite-an-anti-satellite-arms-race-223702, 17 February 2024.

OPINION – Kamikawa Ryûnoshin

Promotion or Regulation? Blurred Lines in Japan's Nuclear Energy Policy

Japan's Nuclear Energy Policy: *From "Minimum Possible" to "Maximum Use":* On February 10, 2023, the cabinet of Prime Minister Fumio effected a major shift in Japan's nuclear energy policy. The Basic Policy for the Realization of GX (green transformation) represented an about turn from the more cautious approaches of the Abe Shinzô and Suga Yoshihide administrations. During both of the earlier governments, restarts of nuclear power plants were allowed under certain circumstances, but the stated long-term aim was to reduce Japan's dependence on nuclear energy. This essentially meant no new nuclear reactors would be built or existing sites upgraded.

The new GX Basic Policy straightforwardly states that, as nuclear power is one of the sources that "contribute to national energy security and are highly effective for decarbonization," it will be utilized to the maximum extent possible. The government has moved to develop and construct next-generation reactors, particularly on sites with decommissioned nuclear facilities.

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However, for already constructed nuclear power plants, generation costs are low and help lower electricity prices. Due to this, and because nuclear power plants also incur high maintenance and management costs during shutdown periods, Japan's power companies, wider industry, and the Ministry of Economy, Trade, and Industry have pushed strongly for the restart of offline nuclear power plants whose operations have been suspended until their operators can prove that they meet new regulatory standards.

The new GX Basic Policy functionally extends the permitted operational lifespan of existing nuclear power plants. The existing policy stated that plants could be operated up to "40 years in principle" and up to a maximum of 60 years, but now, any down time due to court or regulatory proceedings, such as the periods following the 2011 Fukushima Daiichi nuclear accident, will not count against this operational lifespan, meaning some nuclear facilities could operate beyond 60 years. The cabinet then codified the changes in the GX Decarbonization Power Supply Bill submitted to the Diet on February 28. The legislation was a package of amendments to five energy-related laws eventually enacted in May.

However, the trauma from the nuclear tragedy has not fully healed for the locals around Fukushima Daiichi Nuclear Power Station. Due to 880 tons of nearly impossible-to-remove fuel and debris on site, decommissioning shows no prospect of being completed before the initial estimate of 40 years. As of August 2023, 337 square kilometers of land across seven municipalities still cannot be inhabited, and 26,808 people remain displaced from their homes in Fukushima Prefecture. On August 24, ALPS-treated water containing radioactive tritium was discharged into the sea over the objections of the local fishing industry. Given the ongoing situation in Fukushima and remaining safety concerns surrounding the operation of nuclear power plants, why has Japan's nuclear energy policy changed so abruptly?

The Cautious Abe and Suga Administrations: The cost of nuclear power generation is not low if we consider full life cycle costs such as fuel reprocessing, radioactive waste disposal, decommissioning costs in addition to accident response and risk mitigation costs. Construction and safety costs have also risen significantly since March 2011. However, for already constructed nuclear power plants, generation costs are low and help lower electricity prices. Due to this, and because

nuclear power plants also incur high maintenance and management costs during shutdown periods, Japan's power companies, wider industry, and the Ministry of Economy, Trade, and Industry have pushed strongly for the restart of offline nuclear power plants whose operations have been suspended until their operators can prove that they meet new regulatory standards.

The government also never explicitly ruled out the construction of new power plants during the Abe and Suga administrations. Indeed, officials continued to cite nuclear power's ability to curb power generation costs, ensure a stable supply of electricity while increasing energy self-sufficiency, and contribute to climate change mitigation by decarbonize the Japanese economy. Furthermore, there was concern that by fully moving away from nuclear energy, Japan would run the risk of losing human resources and technological capabilities, falling behind in important areas like energy security and national competitiveness. This was particularly concerning as Russia and China looked to take the lead in the building of next-generation reactors.

Faced with this dire situation, public opinion also began to change on nuclear energy. According to a February 2022 *Asahi Shimbun* survey, opponents of restarting nuclear power plants fell below a majority for the first time.

However, fearing public opinion, both Abe and Suga maintained that they had no plans to builds new facilities on new or existing sites "at the current point in time." Public opinion remained hesitant about nuclear energy throughout their administrations up through the start of the Kishida administration, with support ranging between 28% and 32% and a consistently strong majority opposing restarts in *Asahi Shimbun* polling. The Suga administration followed this cautious approach and even appointed nuclear sceptics Kôno Tarô and Koizumi Shinjirô to important cabinet positions focused on the promotion of renewable energy. Prime Minister Kishida himself was also initially "not that enthusiastic" about pushing for a return to nuclear energy generation. In a 2021 book, Kishida wrote: "My opinion is that in the future we should reduce our dependence on nuclear generation and make renewable energies such as offshore wind, geothermal, and solar power the main sources of Japan's power."

Soaring Energy Prices, Weak Yen as Tailwinds for Nuclear: Japan's nuclear energy proponents were in for a more welcoming climate, though. As Western countries began to loosen COVID-19 pandemic restraints, economic activity began to ramp up. However, fossil fuel energy supplies and production could not keep up with consumption demand, and global prices soared. This prompted central banks to raise interest rates to dampen inflationary effects. Then, Russia's February 2022 military invasion of Ukraine made securing a stable supply of energy an even greater challenge globally. Tokyo, however, continued its expansionary fiscal and monetary policy. The rapidly weakening yen compounded Japan's situation due to the country's almost total reliance on imported sources of oil and natural gas. Inflation reached levels not seen in Japan for decades.

In addition to the cost of energy inputs, Japan has not been building newer, more efficient energy generation facilities fast enough to replace the country's inefficient and decommissioned fossil-fuel-fired power plants. Due in part to the Japanese government's decarbonization commitments, the result has been a reduced electricity supply capacity, even higher prices, and an increased risk of large-scale blackouts. Indeed, the government issued Japan's first-ever power supply alert in March 2022 for the TEPCO and Tôhoku Electric service areas.

Faced with this dire situation, public opinion also began to change on nuclear energy. According to a February 2022 *Asahi Shimbun* survey, opponents of restarting nuclear power plants fell below a majority for the first time. After his Liberal Democratic Party comfortably won the July 2022 House of Councillors election, Prime Minister Kishida was in the position to enjoy "three golden

years" where he would not have to face a national election unless he himself decided to call one. Japan's emboldened leader then held the first meeting of the GX Implementation Council on July 27 and began to move government policy toward building new nuclear power plants and/or extending the operating periods of existing facilities.

In December 2022, the *Asahi Shimbun* reported that Kishida's political secretary, Shimada Takashi, had at one point stated that upgrading or replacing nuclear power plants was now the policy of this government. Shimada is a former administrative vice-minister at METI and was also a TEPCO director after it was effectively nationalized. Within METI, voices grew louder that it was "now or never" for a decision on going back to nuclear energy. The Kishida administration soon began to actively promote the construction of new nuclear power plants, saying it was "better to build new facilities than rely on old ones." Public opinion on nuclear restarts continued to relax: The February 2023 version of the *Asahi Shimbun* survey found a majority of respondents now in favor of restarts (51%) as opposition dropped to 42%.

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The actual effects of these decisions will do little to resolve Japan's ongoing energy challenges in the near term, but nevertheless demonstrated the confidence of the government in using nuclear energy as a banner for its decarbonization efforts. Japan's power companies, wider industry, and METI had successfully exploited the current opportunity to shift Japan's energy policy back to a greater reliance on nuclear energy.

Achieving What Abe Could Not: Why, then, was it Kishida, who was initially skeptical of reliance on nuclear energy, and not former prime ministers like Abe, a nuclear proponent, that decided to take the risk of losing public support to lead Japan's charge back to nuclear energy use? Even before becoming prime minister, Kishida was known for lacking a political vision of his own. However, in December 2022, he announced several historic policy shifts. Not only did his government announce a pivot back to greater nuclear energy use within Japan's energy mix, Kishida also announced a potentially transformational shift in Japan's security policy with the revision of the three key security documents, a substantially increased military budget, and an official decision allowing Japan's Self-Defense Forces to develop "counterattack capabilities" for striking overseas military positions attacking Japan.

Kishida purportedly could not hide his exuberance, telling people around him that "I have done what even Abe could not do." Furthermore, at a press conference on January 4, 2023, Kishida described the historical character of his cabinet as one focused on confronting "head on" difficult and unresolved issues that the nation simply could not postpone. He then turned his attention to one of the most difficult—the declining birthrate—by saying he would develop measures "at a totally different level" from steps previously taken to ensure Japan could maintain its society as a whole.

Kishida did not become prime minister to implement any specific agenda. As political survival appears to be his primary goal, he is taking a pragmatic approach to prolonging his administration by developing a reputation for tackling difficult issues that cannot be postponed any longer. By doing so, he is looking to gain recognition within the government and LDP to increase his political capital and leverage.

Reprocessing and Disposal Issues: Numerous challenges remain even as the government pivots back to an energy policy based on maximizing the

use of nuclear energy. Some experts doubt whether the construction of new nuclear power plants can be realistically implemented. Costs are likely to be substantial for the next generation of nuclear reactors, such as the innovative light water reactors used in recent European nuclear power plants—estimates for these plants are up to ¥1 trillion. While people may support nuclear restarts in general, their attitudes change when the proposals are made to build new nuclear facilities close to them. Backlashes from local residents are likely to remain a roadblock. Concerns have also been raised about the substantial extension of the operating periods of plants, and whether effective safety regulations can be maintained as designs become outdated and equipment deteriorates.

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A traditional criticism levelled at nuclear power operations in Japan is the lack of a complete fuel cycle policy, where used fuel can be reprocessed and safely stored. This was supposed to be alleviated somewhat by the reprocessing plant in Rokkasho, Aomori. However, this facility is no longer expected to be completed, and a final disposal site for highly radioactive waste has not been decided. The "broken" nuclear fuel cycle in Japan looks certain to continue.

With Russia attacking and occupying a nuclear power plant in Ukraine, the possibility that nuclear facilities could become the target of a military or terrorist attack in the future seems all the more plausible.

In addition, municipalities surrounding existing plants have failed to formulate evacuation plans in the event of a complex nuclear accident, and even where such plans have been formulated, their effectiveness has been questioned. With Russia attacking and occupying a nuclear power plant in Ukraine, the possibility that nuclear facilities could become the target of a military or terrorist attack in the future seems all the more plausible.

The resumption of operations at existing facilities has also not progressed to the satisfaction of some in the ruling party and the business community. They have voiced their dissatisfaction with the Nuclear Regulation Authority in particular over the prolonged review process. However, many of the plants under review are in difficult environments or areas vulnerable to natural disasters, making it difficult to demonstrate safety. This is often compounded by mistaken data submitted by power companies when applying for restarts.

The Blurred Line Between Promotion and Regulation: More problematic is the decreasing sense of independence surrounding the NRA. This independence was called into question following the decision to substantially extend the maximum operating period. As of July 2022, former METI officials occupied the top three senior official positions in the NRA's secretariat: the secretary-general, deputy secretary-general, and chief engineering officer. Furthermore, it was revealed that in the process of formulating changes to Japan's nuclear legislation that officials from the NRA's secretariat and METI's Agency for Natural Resources and Energy discussed amendments without informing the NRA chair, as is required by law. The close relationship between METI and the NRA's secretariat appears to have deepened after a period of apparent NRA independence following its establishment in 2012.

Another problem arose in February 2023 as the NRA's commissioners deliberated on amendments to extend the life cycle of nuclear power plants while transferring administrative jurisdiction for

such decisions from the NRA (based on the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material, and Reactors) to METI (Under the Electricity Business Act). Commissioner Ishiwatari Akira opposed the proposal, saying that he did not believe the proposed changes improved safety or had any scientific basis. Despite Ishiwatari's opposition, the committee took the unusual step of voting on the proposal rather than forming a consensus. Eventually, a majority vote of 4 to 1 approved the draft amendments.

To make maximum use of nuclear energy, the Kishida cabinet has blurred the separation between the government's "regulation" and "promotion" responsibilities when it comes to energy policy. This separation was implemented in part based on the lessons from the nuclear accident following the 3/11 disaster and to reassure the public; undermining it might only make the future use of nuclear energy harder to justify and implement.

However, several committee members who voted in favor of the proposal later voiced their dissatisfaction with being rushed into a decision based on a deadline imposed from the outside. There was also unease with the deferral of plans to create concrete regulations for ensuring safety after life extensions up to the 60-year maximum and beyond as envisaged for some nuclear facilities. This outcome is the result of pressure exerted on the NRA by a government in a hurry to revise legislation.

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Source: https://www.nippon.com/en/in-depth/d00952/, 15 February 2024.

NUCLEAR STRATEGY

RUSSIA

Secret Documents Reveal Criteria for Russia's Use of TNWS

The British newspaper *Financial Times* obtained from "Western sources" a series of secret documents of the Russian armed forces regarding "hypothetical invasion scenarios of the China", containing details regarding Russia's doctrine on the use of nuclear weapons. According to the British newspaper, the documents reveal "a threshold for the use of tactical nuclear weapons lower than that publicly admitted by the Russia": Moscow's military doctrine would in particular provide for "the use of tactical nuclear weapons in the preliminary stages of a conflict with the major world powers".

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The *Financial Times* claims to have come into possession of "29 Russian military files created between 2008 and 2014, including war scenarios and presentations to naval officials discussing operational principles for employing nuclear weapons." The criteria defined by Russia for the use of atomic weapons - writes the newspaper - "vary from a hostile invasion of Russian territory to more specific scenarios, such as the destruction of 20 percent of the strategic missile submarines" of the Russian armed forces. "It is the first time that documents of this kind have been disclosed," he commented regarding the revelations in the British newspaper Alexander Gabuev, director of the think tank Carnegie Russia Eurasia Center, based in Berlin, according to

which the material emerges that Russia has set itself "a rather low threshold" for the use of tactical nuclear weapons.

Russian tactical nuclear warheads, which can be delivered via missiles launched from land, air and naval platforms, are designed for limited use in the event of conflicts in Europe or Asia, unlike the more powerful "strategic" nuclear weapons, which instead they would primarily constitute a weapon of last resort in the event of a conflict with the United States. Although the files obtained by the *Financial Times* date back more than ten years ago, experts consulted by the newspaper believe that the contents are still relevant within the scope of Russian military doctrine. According to the newspaper, the documents would also reveal "the deeply rooted distrust of China among the Russian security elite", despite the fact that since 2001 the Russian president Vladimir Putin has begun to forge an alliance with Beijing that includes a treaty prohibiting the first use of nuclear weapons.

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Source: https://www.agenzianova.com/en/news/Financial-Times-Secret-documents-reveal-Russian-tactical-nuclear-weapons-deployment-criteria/, 28 February 2024.

Putin Denies Plans to Deploy Nuclear Weapons in Space

Russian President Vladimir Putin has said that Moscow is "categorically against" the deployment of nuclear weapons in space. His remarks came during a televised meeting with his defence minister, who also denied Russia had any such plans. Last week US officials said Russia was developing a "troubling" new anti-satellite weapon which it was yet to deploy. US media reports said it was space-based and armed with a nuclear warhead.

White House spokesman John Kirby said the US administration was taking the development "very seriously" and that President Joe Biden had already ordered "direct diplomatic engagement with Russia" over the threat. Mr Putin called for international agreements on space weaponry to be adhered to and said Russia had offered many times to work jointly to strengthen them. "Our position is clear and transparent. We have always been categorically against the deployment of nuclear weapons in space and we are still against it," he said.

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Defence Minister Sergei Shoigu said: "Firstly, we don't have this [nuclear weapons in space]. Secondly, they know we don't have it...but they're still making a fuss." He repeated claims by Russian officials that the US pronouncements were a ruse to scare US lawmakers into passing additional Ukraine aid. A group of Republicans in the House of Representatives has been holding up an aid package including a vital $60bn (£48bn) for Ukraine for several months.

Mr Kirby has strongly rejected Moscow's claims. Speaking a day after House Intelligence Committee chairman Mike Turner – a senior Republican – issue vague warnings of a "serious national security threat", he told reporters that there was no immediate threat to the US public. "We're not talking about a weapon that can be used to attack human beings, or cause physical destruction, here on Earth," he said.

While space weapons sound ripped from the pages of science fiction novels, military experts have long warned that space is likely to be the next frontier of warfare in an increasingly technology-dependent world. They say Russia and China have been steadily developing military capabilities in space as they seek to catch up to the US. The three countries already have the capability to attack satellites around the world. But, in theory, they cannot use nuclear weapons there. All three are signatories of the Outer Space Treaty of 1967, which forbids countries from sending into orbit "any objects carrying nuclear weapons or any other kinds of weapons of mass destruction". But experts say the treaty provides no guarantee of safety in the current geopolitical climate because of Russia's tendency to disregard its treaty obligations.

The Iranian Defense Ministry unveiled an anti-ballistic missile defence system and a low-altitude air defence system, the official news agency IRNA reported. The domestically-developed "Arman" anti-ballistic missile system and "Azarakhsh" air defence system were unveiled in a ceremony in the Iranian capital Tehran attended by Defense Minister Mohammad-Reza Ashtiani.

The Arman system can be ready for operation in less than three minutes, he added. The Azarakhsh system, as noted by Ashtiani, is capable of safeguarding the nation's critical and vital facilities from drone and micro air vehicle threats. It uses an advanced three-dimensional radar system, an optical search system and very nimble cutting-edge seekers and is capable of destroying targets in the shortest time possible.

Source: Robert Greenall, https://www.bbc.com/news/world-us-canada-68346874, 20 February 2024.

BALLISTIC MISSLE DEFENCE

IRAN

Iran Unveils Homegrown Anti-Ballistic Missile, Air Defence Systems

The Iranian Defense Ministry unveiled an anti-ballistic missile defence system and a low-altitude air defence system, the official news agency IRNA reported. The domestically-developed "Arman" anti-ballistic missile system and "Azarakhsh" air defence system were unveiled in a ceremony in the Iranian capital Tehran attended by Defense Minister Mohammad-Reza Ashtiani.

Describing the two systems as great "defence industry achievements," the Iranian defence minister said the medium-range, high-altitude tactical Arman system could detect targets at a distance of 180 km and destroy them within a range of 120 km. The Arman system can be ready for operation in less than three minutes, he added. The Azarakhsh system, as noted by Ashtiani, is capable of safeguarding the nation's critical and vital facilities from drone and micro air vehicle threats. It uses an advanced three-dimensional radar system, an optical search system and very nimble cutting-edge seekers and is capable of destroying targets in the shortest time possible, he said, adding that the system can be deployed on various vehicles and utilised for operations day and night.

According to IRNA, the Arman system is equipped with homegrown Sayyad-3 missiles and has been developed in two versions - one equipped with a passive radar system and the other with an active one. The Azarakhsh system, as reported, utilises a radar and an electro-optical system for target detection, with its missiles being equipped with heat-seeking capabilities.

Source: https://menafn.com/1107869446/Iran-Unveils-Homegrown-Anti-Ballistic-Missile-Air-Defence-Systems, 19 February 2024.

EMERGING TECHNOLOGIES AND DETERRENCE

USA

AI Company Developing Software to Detect Hypersonic Missiles from Space

The Space Development Agency (SDA) selected California-based EpiSci to develop a software tool

capable of detecting hypersonic missiles in flight from satellite data, a challenging task given the extreme speeds of these weapons. ...The SDA, an organization within the U.S. Space Force, is building a network of satellites in low Earth orbit with the goal to provide global indications, warning, tracking, and targeting of advanced missile threats. As many as 100 missile-tracking satellites are projected to be part of this network.

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But in addition to having satellites in orbit, the SDA needs advanced software that can analyze the data collected by these sensors and identify targets in the clutter of objects in the atmosphere. That's what EpiSci hopes to accomplish under the $1.6 million two-year Small Business Innovation Research Phase 2 contract from SDA, announced Feb. 6. It will test its AI-powered software against data collected by low Earth orbit sensors to identify and track hypersonic threats. Samuel Hess, technical director at EpiSci, said the project is not without its hurdles.

To demonstrate hypersonic missile detection for SDA, the company will use Raytheon's missile defense simulators, Hess said. It will start with data from just one satellite and gradually add more. "Raytheon's simulation is extremely powerful. So they can actually simulate multiple satellites, and provide us video feeds from what that would look like.

Maintaining "custody" of these fast-moving targets across vast distances requires collaboration between multiple satellites and precise tracking algorithms. For this project the company is partnering with Raytheon Technologies, a large defense contractor with expertise in missile defense simulations and data analysis, that also is an investor in EpiSci. "As the hypersonic target maneuvers in flight, it's moving through different camera images, so how do you communicate that across the whole realm of satellites?" he said. "That's something that we need to work out."

Expertise in autonomous flight EpiSci specializes in AI for autonomous drones and to enhance combat pilots' performance. Some of these tools, for example, enable pilots to respond to threats faster and to "team" with unmanned aircraft. One of the company's strategic investors is Top Aces, a tactical aviation training company that uses EpiSci's technology to generate complex scenarios for pilots in training. To demonstrate hypersonic missile detection for SDA, the company will use Raytheon's missile defense simulators, Hess said. It will start with data from just one satellite and gradually add more. "Raytheon's simulation is extremely powerful. So they can actually simulate multiple satellites, and provide us video feeds from what that would look like." The challenge for EpiSci is to develop the right software algorithms, he said, to "actually detect these small targets over this large swath and also maintain custody of the targets in an area where other objects are flying, such as commercial aircraft."

Source: https://spacenews.com/ai-company-developing-software-to-detect-hypersonic-missiles-from-space/, 18 February 2024.

NUCLEAR ENERGY

BULGARIA

Bulgaria's Two US Nuclear Reactors to Cost Under $14 Billion

Bulgaria is insisting on a fixed price for the construction of two new Westinghouse AR-1000 nuclear reactors, which should not exceed $14 billion, according to an intergovernmental agreement on nuclear cooperation between

Bulgaria and the US signed in Sofia on Monday night. The new reactors will be built on the banks of the Danube, where the Kozloduy nuclear power plant is located. They will operate in parallel with the two Russian reactors until 2050. After 2050, the old Russian reactors will be decommissioned. "We think Bulgaria can be a regional leader in the field of nuclear research and a regional energy hub," commented Andrew Light, who is assistant secretary of energy for international affairs at the US Department of Energy.

Bulgaria is insisting on a fixed price for the construction of two new Westinghouse AR-1000 nuclear reactors, which should not exceed $14 billion, according to an intergovernmental agreement on nuclear cooperation between Bulgaria and the US signed in Sofia on Monday night. The new reactors will be built on the banks of the Danube, where the Kozloduy nuclear power plant is located.

Bulgarian Energy Minister Rumen Radev commented that the government wants to sign the contract for the construction of the new nuclear facilities at a fixed price, which should not exceed $14 billion. This is the biggest investment in the last 50 years for Bulgaria, which is expected to reach a GDP of just over €100 billion this year.

Until ten years ago, Bulgaria was planning to build a nuclear power station with two new Russian nuclear reactors delivered five years ago by Russia's Atomstroyexport, but the war in Ukraine changed everything. Now the plan is to sell the Russian reactors to Ukraine, which is considering paying for them with EU aid. The agreement between Bulgaria and the US covers cooperation in the installation of small modular reactors in industry, decommissioning of reactors, processing and storage of spent nuclear fuel, joint nuclear research and exchange of personnel.

Radev says that the new VII block of the Kozloduy NPP should enter into operation at the end of 2034.

Light commented that the benefits of building two new nuclear units far outweighed the billion-dollar investment. He added that it is about opening a huge number of new jobs and the development of Bulgarian experience in nuclear technologies, which will make the country a leader in the region. The price of electricity produced by the new reactors will be around €65/MWh which has led to criticism as the price is much higher than that of electricity from renewable sources. The Bulgarian government claims that the country cannot be left without baseload electricity after the Russian nuclear units are shut down.

On 2 February, the director of the NPP, Valentin Nikolov, announced that so far five companies had unofficially expressed interest in building the new reactors. Of these, only one is European – Electricite de France. The others are the US company Bechtel, with which Westinghouse is working on the AP-1000 projects in Poland and the Czech Republic, and Korea's Hyundai, with which Westinghouse is also working. The others are China's CNNC and the US company Fluor, which owns NewScale, a company developing small modular reactors.

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In an interview with Euractiv Bulgaria in October, Prime Minister Denkov said that Greece, Serbia and Northern Macedonia were interested in concluding long-term contracts for the purchase of electricity from the future units VII and VIII of the Kozloduy nuclear power plant. Asked whether it would be possible to obtain European funding for the construction of the new facilities, Denkov said that this was not a major issue as the project

was "quite promising" for the state from an economic point of view. He explained that Bulgaria will use the two new reactors as the base capacity of the energy system during the gradual phasing out of coal.

Source: https://www.euractiv.com/section/politics/news/bulgarias-two-us-nuclear-reactors-to-cost-under-14-billion/, 14 February 2024.

GENERAL

IAEA Designates First Collaborating Centre on Artificial Intelligence for Nuclear Power

The IAEA has designated the Center for Science of Information at Purdue University in the US as the first IAEA Collaborating Centre to support the Agency's activities on AI for nuclear power applications, including reactor design, plant operations, and training and education. Thanks to rapid progress in computational resources and data analysis tools, the nuclear industry has already started to benefit from AI, including with machine learning techniques that can streamline nuclear power plant operations and maintenance. AI is also supporting the development of advanced nuclear power technologies such as SMRs.

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"With more and more countries looking to nuclear energy to address climate change and sustainable development, this Collaborating Centre will provide much needed support for our Member States in using AI to advance the innovation driving the global nuclear sector," said Mikhail Chudakov, IAEA Deputy Director General and Head of the Department of Nuclear Energy.

The five-year Collaborating Centre agreement will support IAEA programmatic activities and knowledge sharing on advancements and innovation in AI for nuclear power. This includes Agency initiatives on benchmark exercises for developing confidence and community-wide acceptance of AI technology for nuclear power, establishing a "benchmarking hub" for coordination and data management, as well as other activities relevant to the development and assessment of AI technologies in collaboration with IAEA Member States.

AI offers the potential to optimize numerous processes within nuclear power plants. It could be used to bolster efficiency and ensure a steady electricity supply by adjusting power generation based on real-time data, including consumer demand, weather and equipment performance. Automation using robotics and AI systems could handle routine tasks, reducing the need for human input. AI could also improve fuel efficiency and maximize the energy output of reactors.

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"This Collaborating Centre will help build confidence in AI applications for high consequence systems, such as nuclear reactors. Without reliable quantification, the nuclear community's ability to realize the potential of AI will be diminished and this will negatively impact its ability to remain competitive in the energy market," said Hany Abdel-Khalik, Professor of Nuclear Engineering at the Center for Science of Information, which advances information theory through collaborative research and teaching. "AI may bring significant advancements to the nuclear power sector,

enhancing both efficiency and sustainability," said Tatjana Jevremovic, an expert with the IAEA's Nuclear Power Technology Development Section.

The Collaborating Centre agreement is part of recent IAEA efforts to strengthen support to countries interested in using AI for nuclear science and technology. A 2022 IAEA publication reviewed the challenges and priorities for future AI activities, including those relevant to nuclear power as well as nuclear sciences and applications, among others. The IAEA's International Network on Innovation to Support Operating Nuclear Power Plants (ISOP) is examining the regulatory and technical aspects of AI deployment. Several coordinated research projects related to AI are underway, with one set to launch on how AI and other innovative technologies proposed for SMRs can be secured. The agreement comes after the Agency recently designated the MIT Plasma Science and Fusion Center as the first Collaborating Centre focused on accelerating fusion research, with an emphasis on AI applications to advance the IAEA's AI for Fusion initiative.

Through the Collaborating Centres network, these organizations in Member States can assist the IAEA by undertaking original research and development and training relating to nuclear science, technologies and their safe and secure applications. With the newly designated Center for Science of Information at Purdue University Collaborating Centre, there are now 73 active Collaborating Centres worldwide.

IAEA Collaborating Centres: To promote the peaceful use of nuclear technologies, the IAEA collaborates with designated institutions around the world. Through the Collaborating Centres network, these organizations in Member States can assist the IAEA by undertaking original research and development and training relating to nuclear science, technologies and their safe and secure applications. With the newly designated Center for Science of Information at Purdue University Collaborating Centre, there are now 73 active Collaborating Centres worldwide.

Source: https://www.iaea.org/newscenter/news/iaea-designates-first-collaborating-centre-on-artificial-intelligence-for-nuclear-power, 20 February 2024.

INDIA

Govt Seeks Nuclear Power Investment Worth $26 Billion from Adani, RIL, Tata Group, Vedanta

The government will invite private firms to invest about $26 billion in in the nuclear energy sector to increase the amount of electricity from sources that don't produce carbon dioxide emissions, according to a report by news agency Reuters. The government is in talks with at least five private firms including Reliance Industries, Tata Power, Adani Power and Vedanta Ltd to invest around ₹44,000 crore each, according to the report. This is the first time that the government is pursuing private investment in nuclear power, a non-carbon-emitting energy source that contributes less than two per cent of India's total electricity generation. The funding would help India to achieve its target of having 50 per cent of its installed electric generation capacity use non-fossil fuels by 2030, up from 42 per cent now. The DAE and state-run NPCIL have held multiple rounds of discussions with the private companies in the past year on the investment plan. With the investment, the government hopes to build 11,000 MW of new nuclear power generation capacity by 2040, the report added.

The government will invite private firms to invest about $26 billion in in the nuclear energy sector to increase the amount of electricity from sources that don't produce carbon dioxide emissions, according to a report by news agency Reuters. The government is in talks with at least five private firms including Reliance Industries, Tata Power, Adani Power and Vedanta Ltd to invest around ₹ 44,000 crore each, according to the report. This is the first time that the government is pursuing private investment in nuclear power, a non-carbon-emitting energy source that contributes less than two per cent of India's total electricity generation.

NPCIL owns and operates India's current fleet of nuclear power plants, with a capacity of 7,500 MW, and has committed investments for another 1,300 MW. Under the funding plan the private companies will make the investments in the nuclear plants, acquire land, water and undertake construction in areas outside the reactor complex of the plants. However, the rights to build and run the stations and their fuel management will rest with NPCIL, as allowed under the law. The private companies are expected to earn revenue from the power plant's electricity sales and NPCIL would operate the projects for a fee, according to the report. The plan will not require any amendment to the India's Atomic Energy Act of 1962 but will need a final go-ahead from the DAE.

Under the funding plan the private companies will make the investments in the nuclear plants, acquire land, water and undertake construction in areas outside the reactor complex of the plants. However, the rights to build and run the stations and their fuel management will rest with NPCIL, as allowed under the law. The private companies are expected to earn revenue from the power plant's electricity sales and NPCIL would operate the projects for a fee.

Indian law bars private companies from setting up nuclear power plants but allows them to supply components, equipment and sign construction contracts for work outside of the reactors, according to the report. ...

Source: https://www.livemint.com/companies/news/govt-seeks-nuclear-power-investment-worth-rs-44-000-crore-from-adani-ril-tata-group-vedanta-11708420261429.html, 20 February 2024.

PM Modi Dedicates 2 Indigenously-Developed Nuclear Reactors in Gujarat's Kakrapar to Nation

Giving a boost to nuclear power generation through desi technology, PM Narendra Modi on Thursday dedicated to the nation two new indigenously-developed reactors at Kakrapar Atomic Power Plant in Gujarat. The two new reactors — unit 3 and unit 4 — are the first two in the series of 16 indigenous PHWR of 700 MW each being set up in the country.

... During his visit to the atomic power station in the evening, the PM inaugurated the two new reactors and also interacted with senior officials, including NPCIL chairman and managing director Bhuwan Chandra Pathak. Public sector entity NPCIL has designed, constructed, commissioned, and operated these reactors. Accompanied by Gujarat CM Bhupendra Patel and BJP MP from Navsari CR Paatil, the PM visited the main control room of the plant and understood different processes and other finer details from MD Pathak. The PM also briefly addressed scientists as well as senior officers at the plant and motivated them to continue their good work, officials said. ...

Built at a cost of more than Rs 22,500 crore, the KAPS-3 and KAPS-4 projects have a cumulative capacity of 1400 (700x2) MW and are the largest indigenous PHWRs. They are first of its kind reactors and with advanced safety features comparable with the best in the world. Together, these two reactors will produce about 10.4 billion units of clean electricity per year and benefit consumers of multiple states like Gujarat, Maharashtra, MP, Chhattisgarh, Goa and UT of Dadra and Nagar Haveli and Daman and Diu.

While these reactors have been built by NPCIL, the supply of equipment and execution of contracts have been taken care by Indian industries and companies, thus reflecting the true spirit of 'Make in India'. ...The new units 3 and 4

have been built adjacent to the existing ones. ... The launch of the two units at Kakrapar marks a significant milestone in the commercial evolution of the indigenously-developed PWHR technology. The unit capacity of PHWRs has progressed from 220 MW to 540 MW and now to 700 MW with near to full indigenous content.

India will add 18 more nuclear power reactors with a cumulative capacity to generate 13,800 MWe of electricity, taking the total share of atomic power in the energy mix to 22,480 MWe by 2031-32. This was announced by the NPCIL after Prime Minister Narendra Modi dedicated two home-built 700 MW nuclear power reactors at Kakrapar in Gujarat.

Source: Surendra Singh, https://timesofindia.indiatimes.com/india/pm-modi-dedicates-2-indigenously-developed-nuclear-reactors-in-gujarats-kakrapar-to-nation/articleshow/107924059.cms, 23 February 2024.

India to Add 18 More Nuclear Power Reactors with Total Capacity of 13,800 MWe by 2032: NPCIL

India will add 18 more nuclear power reactors with a cumulative capacity to generate 13,800 MWe of electricity, taking the total share of atomic power in the energy mix to 22,480 MWe by 2031-32. This was announced by the NPCIL after Prime Minister Narendra Modi dedicated two home-built 700 MW nuclear power reactors at Kakrapar in Gujarat last week. Presently, the NPCIL operates 24 reactors with a total capacity of 8,180 MWe. ...

By gender, a majority of men supported restarting the plants at 64 percent. In contrast, 42 percent of women were opposed, outnumbering the 36 percent in favor. By age group, support was the highest among those aged 18 to 29 at 73 percent. The ratio decreased with elderly respondents. Opposition was the highest among those aged 70 and older at 50 percent, decreasing with those in the younger age groups.

Source: https://economictimes.indiatimes.com/industry/energy/power/india-to-add-18-more-nuclear-power-reactors-with-total-capacity-of-13800-mwe-by-2032-npcil/articleshow/107987251.cms?from=mdr, 25 February 2024.

JAPAN

Asahi Poll: 50% in Favor of Restarting Idle Nuclear Plants

Nearly 13 years after the accident at the Fukushima No. 1 nuclear power plant, a new poll shows the support rate for restarting idle nuclear power plants in Japan is widening. The Asahi Shimbun poll found that 50 percent of respondents support resuming the plants, while 35 percent said they want them to remain offline. This marks the second consecutive year that the majority were in favor. The survey has been conducted annually since 2013, following the triple meltdowns at the Tokyo Electric Power Co.'s Fukushima No.1 nuclear plant, which was triggered by tsunami after the 2011 Great East Japan Earthquake. In each of the polls, roughly 30 percent of respondents favored restarting nuclear plants while 50 to 60 percent remained opposed.

However, the previous survey in February 2023 marked the first time the majority opinion flipped, with 51 percent in favor and 42 percent opposed. By gender, a majority of men supported restarting the plants at 64 percent. In contrast, 42 percent of women were opposed, outnumbering the 36 percent in favor. By age group, support was the highest among those aged 18 to 29 at 73 percent. The ratio decreased with elderly respondents. Opposition was the highest among those aged 70 and older at 50 percent, decreasing with those in the younger age groups.

The Asahi Shimbun conducted the national telephone survey on Feb. 17 and 18, more than a month and a half after the Noto Peninsula earthquake, which raised fresh concerns about nuclear disaster prevention. The quake damaged some facilities at the Shika nuclear plant, which is operated by Hokuriku Electric Power Co. When asked about the government's response to the Noto Peninsula quake, 42 percent of the respondents gave it a positive evaluation while 45 percent viewed it negatively. As for how prepared people feel their local communities are to handle natural disasters in their areas, 46 percent of respondents felt they were prepared.

Only 4 percent said "quite well" and 42 percent said "to some extent." Forty-nine percent felt unprepared, 38 percent said "not well" and 11 percent said "hardly at all."

Source: https://www.asahi.com/ajw/articles/15171725, 19 February 2024.

KENYA

Kenya Eyes 2027 Kickoff for Sh785bn Nuclear Power Plant

Kenya plans to begin constructing its first nuclear power plant in 2027 as it diversifies its energy generation amid rising demand and a zero-carbon push. According to the Nuclear Regulatory Authority Director for Partnerships and Public Awareness Edward Mayaka, the country is ready to fully adopt nuclear applications as it prepares to implement its first nuclear power plant by 2035. At the COP28, Mr Mayaka highlighted the potential of nuclear energy to greatly address climate change, as nuclear power plants, unlike fossil fuels, generate electricity through a process that produces virtually no direct carbon emissions. "This characteristic alone makes nuclear energy an attractive option for countries striving to reduce their carbon footprint," he said.

According to the Nuclear Regulatory Authority Director for Partnerships and Public Awareness Edward Mayaka, the country is ready to fully adopt nuclear applications as it prepares to implement its first nuclear power plant by 2035. At the COP28, Mr Mayaka highlighted the potential of nuclear energy to greatly address climate change, as nuclear power plants, unlike fossil fuels, generate electricity through a process that produces virtually no direct carbon emissions.

In March 2022, the government identified Kwale and Kilifi as the most preferred sites for the nuclear station due to their less likelihood of suffering earthquakes. The plant is expected to cost $5 billion (Sh785 billion) nuclear plant. "The first nuclear power plant of 1,000 MW is expected to be commissioned by the year 2027 and is expected to grow to 4,000 MW by 2035," officials said in their 2020 submissions to the National Environment Management Authority.

The nuclear agency said it was shopping for the most ideal reactor for Kenya. The modern nuclear reactors available in the market are large-sized devices in the range of 1,000 MW –1,750 MW with "proven design technology and performance records". This comes amid a renewed global interest in nuclear power, as several countries that were once opposed to initiating nuclear programs or planning phase-outs are now reversing course due to growing concerns about climate change.

Recent studies have found that the impacts of the nuclear shut-downs on power generation have significantly set back emissions reduction goals in these countries. A study on the German and Japanese phase-outs suggests that maintaining operation of their nuclear plants could have averted 28,000 air pollution-induced deaths and 2,400 metric tonnes of CO2 emissions between 2011 and 2017.

NuPEA expects four reactors of 4,000MW to be on site by 2035, which sets the total cost of the project at about Sh2 trillion – a signal that Kenya might be unable to finance its nuclear power program. A 2009 study by the Union of Concerned Scientists revealed that between 2002 and 2008 the cost estimates for new nuclear plant construction rose from at least Sh200 billion per unit to a maximum of 900 billion per unit, with overheads soaring higher in Europe.

Early last year, Kenya's nuclear project has received a major boost following the signing of a nuclear cooperation deal between Kenya and the US. According to the White House, the US-Kenya framework cooperation agreement would set out how the two countries will cooperate on peaceful uses of nuclear sciences such as those in energy, medical, agricultural fields, among others.

Is Kenya Ready for Nuclear Power? NuPEA expects four reactors of 4,000MW to be on site by 2035, which sets the total cost of the project at about Sh2 trillion – a signal that Kenya might be unable to finance its nuclear power program. A 2009 study by the Union of Concerned Scientists

revealed that between 2002 and 2008 the cost estimates for new nuclear plant construction rose from at least Sh200 billion per unit to a maximum of 900 billion per unit, with overheads soaring higher in Europe. It is against this background that energy experts from Italy and Germany, which are increasingly shifting towards green electricity, urged Kenya to reconsider its plan saying the country was better off developing more geothermal wells, solar parks and wind farms. Long construction periods (about 10 years), and costly decommissioning of plants at the end of their lifespan, have dissuaded many countries from investing in nuclear energy.

Electricity Demand: But in an unexpected shift, several countries are now betting on nuclear energy to meet their rising electricity demands – with a third of the nearly 30 nations considering nuclear power being in Africa, according to the IAEA. Egypt, Morocco, Ghana, Kenya, Sudan, Niger, and Nigeria have engaged with the IAEA to evaluate their readiness to adopt a nuclear program, with Zambia, Uganda, and Tunisia considering the option.

2,500MW Nuclear Plant: South Africa, the only African country that operates a commercial nuclear power plant, is also harbouring some high voltage ambitions with the planned construction of a 2,500MW nuclear plant to enhance its power generation capacity. Algeria is also planning to build a nuclear energy power plant to take advantage of the massive uranium assets in the country, believed to be about 26,000 tonnes. Africa's interest in nuclear energy comes despite evidence that renewable energy options such as solar and wind provide a cheaper and greener way to raise electricity production.

Source: https://www.constructionkenya.com/8303/kenya-nuclear-power-project/, 14 February 2024.

MOROCCO

Morocco's Energy Minister: Nuclear Energy is Catalyst to Sustainable Development

Nuclear energy has much to offer Morocco's sustainable development agenda, according to Morocco's Energy Minister Leila Benali. Speaking at a press conference in Munch, Germany on Monday, Benali emphasized the potential of peaceful nuclear technologies to contribute to various priority areas outlined in the country's new development model, including economic growth, human development, and regional resilience. The annual meeting of the National Liaison Officers (NLO) and National Coordinators of the Regional Cooperation Agreement for Africa in the field of Research, Development, and Training in Nuclear Science and Technology (AFRA NC) of the IAEA.

The integration of nuclear energy and related technologies into the key sectors of agriculture, healthcare, water resource management, and industry is part of Morocco's forward-looking strategy. The minister further recalled the country's efforts to ensure nuclear safety and security, as well as radiation safety, to support its long-term vision for sustainability and comprehensive development.

She explained that the integration of nuclear energy and related technologies into the key sectors of agriculture, healthcare, water resource management, and industry is part of Morocco's forward-looking strategy. The minister further recalled the country's efforts to ensure nuclear safety and security, as well as radiation safety, to support its long-term vision for sustainability and comprehensive development. Morocco has adopted a proactive approach to developing its legislative and institutional framework in regards to nuclear energy, Benali said. She continued on to cite the establishment of the National Center for Nuclear Energy, Sciences, and Technologies in 1986, followed by the operation of the research reactor, TRIGA Mark II, in 2003.

She also highlighted the enactment of Law No. 142-12 in 2014, which focuses on nuclear and radiation security, and the establishment of the Moroccan Agency for Nuclear and Radiation Safety (AMSSNuR) in 2014 to ensure compliance with safety standards. The country has equally forged

multiple partnerships with the IAEA since joining in 1957. Benali praised the positive tangible results of the recent national framework program (2018-2023) with the agency, which facilitated the implementation of 20 projects across various social and economic sectors. In June 2022, AMSSNuR concluded a five-year training program with the IAEA to assist the Moroccan authority in developing a national regulatory framework, building human resource capacity, and structuring a nuclear risk management strategy.

Nuclear reactors are the most powerful source of energy, with the highest capacity factor - a measure of energy input - across the board. While solar energy's capacity factor is at 24.9%, nuclear energy's capacity factor is set at 92.5%, towering above natural gas' 56.6%.

After investing in capital-intensive wind and solar energy-generating projects, Morocco plans on turning to nuclear energy to ensure its future energy security. "We now need a national stance to initiate producing electricity from nuclear energy," Benali said. Nuclear reactors are the most powerful source of energy, with the highest capacity factor - a measure of energy input - across the board. While solar energy's capacity factor is at 24.9%, nuclear energy's capacity factor is set at 92.5%, towering above natural gas' 56.6%. However, nuclear plants pose a significant environmental risk if not managed properly, as they produce radioactive waste, which can remain radioactive and lethal to human contact for over a thousand years.

Despite promises of support and investment, the government's plans for SMRs remain obscure, casting doubts on their role in the future energy mix. The Environmental Audit Committee has voiced strong criticisms, citing the unclear strategy as a significant obstacle for the nuclear industry. This ambiguity not only undermines industry confidence but also raises questions about potential cost implications for taxpayers.

Source: https://www.moroccoworldnews.com/2024/02/360932/moroccos-energy-minister-nuclear-energy-is-catalyst-to-sustainable-development, 20 February 2024.

UK

UK's Nuclear Strategy Faces Criticism: Uncertainty Looms for SMRs

The UK government's nuclear strategy, specifically its approach to SMRs, faces mounting criticism from MPs for its lack of clarity and the ensuing uncertainty in the nuclear sector.

A Murky Vision for Nuclear Power: MPs have expressed serious concerns about the timeline for SMR projects, potential waste management issues, and the overall vision for the sector. Despite promises of support and investment, the government's plans for SMRs remain obscure, casting doubts on their role in the future energy mix. **The Environmental Audit Committee** has voiced strong criticisms, citing the unclear strategy as a significant obstacle for the nuclear industry. This ambiguity not only undermines industry confidence but also raises questions about potential cost implications for taxpayers.

Hinkley Point C: A Cautionary Tale: The ongoing saga of Hinkley Point C serves as a stark reminder of the challenges and uncertainties surrounding UK energy policy and developments, especially in the face of the climate crisis. Initially greenlit in June 2016, the project's funding was divided between the government, EDF, and China General Nuclear (CGN). However, in a surprising turn of events, CGN withdrew its funding in December 2022, leaving the government to shoulder the shortfall in investment. Furthermore, the opening of Hinkley Point C has been delayed until at least 2029, with the projected cost ballooning from £25 billion to at least £35 billion—a staggering increase that has raised eyebrows and ignited debates on the feasibility of nuclear power as a sustainable and cost-effective solution.

The Future of UK Nuclear Power: With the UK government aiming to have 24 gigawatts of nuclear capacity by 2050, the choice lies between additional large-scale reactors like Hinkley Point C or a combination of large and SMRs. However,

the escalating costs and delays associated with Hinkley Point C have cast a long shadow over the nuclear sector. The current state of affairs raises pressing questions about the future of nuclear power in the UK, especially in light of the climate crisis and the need for sustainable and reliable energy sources. As MPs and industry experts grapple with these concerns, the search for clarity and a coherent strategy becomes ever more urgent. As of February 15, 2024, the UK government faces a critical juncture: to address the concerns surrounding its nuclear strategy and provide a clear path forward, or risk further uncertainty and potential setbacks in the nation's quest for a sustainable energy future.

As MPs and industry experts grapple with these concerns, the search for clarity and a coherent strategy becomes ever more urgent. As of February 15, 2024, the UK government faces a critical juncture: to address the concerns surrounding its nuclear strategy and provide a clear path forward, or risk further uncertainty and potential setbacks in the nation's quest for a sustainable energy future.

Source: https://bnnbreaking.com/politics/uks-nuclear-strategy-faces-criticism-uncertainty-looms-for-small-modular-reactors, 14 February 2024.

SMALL MODULAR REACTORS

EUROPE

Small Modular Reactor Alliance Launched in Europe

The European Commission has launched the Small Modular Reactor Alliance to accelerate the development and deployment of SMRs in Europe by the early 2030s. With SMRs expected to represent the next generation of nuclear technology and a considerable research effort well underway, the Alliance is intended to help coordinate further developments with closer cooperation among the involved stakeholders to deliver the technology in the fastest and most efficient way. In particular the Alliance, the latest of the region's industrial alliances, is aimed to reinforce the nuclear supply chain in Europe by identifying and addressing gaps in its manufacturing and innovation capacity.

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Specific terms of reference include supporting SMR project promoters to develop, demonstrate and deploy their projects in the EU market and beyond and establishing ways to inform and engage potential industrial users of SMRs, such as energy-intensive industries, hydrogen producers and urban districts. The Alliance also is tasked to focus on facilitating and coordinating projects to address future research and innovation needs and establishing a nuclear skills academy as well as promoting public engagement about SMRs. "[The] launch of the EU Industrial Alliance on small modular reactors will bring together the technology side and energy companies to make the most of safe and versatile new nuclear technologies," said commissioner for energy, Kadri Simson, at the launch. "We want this Alliance to deliver benefits in very practical terms – through full engagement on nuclear safety, using European supply chains and by boosting innovation for new technologies."

The launch of the Alliance, while long mooted, comes following an EC communication on Europe's 2040 climate target, which highlighted the need for all clean energy technologies, including nuclear, to deliver on it. To achieve its goals, the Alliance will be required to formulate a strategic action plan, together with technology roadmaps, to identify inter alia the most promising and cost-effective SMR technologies,

investment barriers and future needs for research. Other potential actions include establishing ways to engage potential SMR industrial users of SMRs and strengthening exchanges between project promoters and regulators in the EU. The call for membership is now open and running to April 12 for applications from stakeholders including vendors, utilities, specialized nuclear companies, financial institutions, research organizations, training centers and civil society organizations. An inaugural general assembly for the Small Modular Reactor Alliance is expected in late spring.

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Source: https://www.power-eng.com/news/small-modular-reactor-alliance-launched-in-europe/, 13 February 2024.

JAPAN

Japan Demonstrates Floating Seismic Isolation System for SMRs

A team led by the Japan Atomic Energy Agency has concluded a series of large-scale demonstration tests for an innovative new floating seismic isolation system intended for pairing with small modular reactors to enable siting feasibility, including in areas of high seismicity. The series of tests - which ran from 29 January to 9 February - used a 1/15-scale mockup of the structure of a SMR plant design (measuring 9 metres in length, 3 metres wide and 5 metres high) floating in a water tank mounted on the world's largest shaking table, operated by the National Research Institute for Earth Science and Disaster Resilience (NIED) in Miki City, Hyogo Prefecture, Japan.

Japan's proprietary floating seismic isolation system (FSIS) technology is focused on the use of a series of air cavities for seismic response damping and associated orifices for energy dissipation of seismic motion as seismic isolators in a structural platform paired to the base of an SMR plant that floats in a water pool. JAEA says it is a passive system with design adaptable to a broad range of site seismic conditions and capable of reducing the seismic response of the paired SMR in the horizontal and vertical directions.

NIED and IHI Corporation, a major nuclear equipment vendor, cooperated with Japan Atomic Energy Agency (JAEA) in the testing. The seismic waves input to the shaking table are based on some of the largest earthquakes observed, including the March 2011 Great East Japan Earthquake. Multiple accelerometers installed on the floating body and in the surrounding water pool measure the characteristic response of the floating seismic isolation structure and demonstrate its seismic isolation performance.

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JAEA claims the system provides such effective and omnidirectional seismic isolation that it is expected to yield increases in design margin and enhanced design standardisation for an SMR because the seismic damping will permit a single reactor/ seismic isolation pairing design to be safe against seismic hazards even for sites with challenging seismic design conditions. "The FSIS paired reactor plant is

supported by buoyancy while the isolators of the cavities and orifices resist seismic load," JAEA said. "The effective and relatively simple concept is intended to greatly enhance both safety and reliability for the paired SMR."

The tests are part of a national project funded by Japan's Ministry of Economy, Trade and Industry through its nuclear energy innovation programme (NEXIP). In parallel, the project is evaluating specific safety and regulatory approaches to pairing of the FSIS and SMR plant concepts in cooperation with industry partners. The data acquired in the current tests will be used for validation of the seismic design and safety analysis methods for the FSIS-paired SMR concepts.

JAEA and its industry partners have begun pre-application engagement with the US NRC with the expectation that JAEA's industry partners will eventually submit a Standard Design Approval application for an SMR design paired with the FSIS. The current test will provide supporting data for the regulatory engagement. The NRC observed the tests in progress and audited quality assurance program for the FSIS testing. The FSIS is potentially deployable with reactors of any type and with a plant containing single or multiple reactor units, JAEA said. The FSIS paired SMR design concept as described by the JAEA will withstand the terrestrial ground accelerations associated with high seismic risk zones that may not be suitable for conventional nuclear plant construction. ...In February last year, Japan's Cabinet approved a policy that calls to develop and construct "next-generation innovative reactors." Under the new policy, Japan will also collaborate with overseas projects by maintaining and strengthening domestic supply chains and contributing Japan`s technology and expertise.

The FSIS is potentially deployable with reactors of any type and with a plant containing single or multiple reactor units, JAEA said. The FSIS paired SMR design concept as described by the JAEA will withstand the terrestrial ground accelerations associated with high seismic risk zones that may not be suitable for conventional nuclear plant construction.

Source: https://www.world-nuclear-news.org/Articles/Japan-demonstrates-floating-seismic-isolation-syst, 12 February 2024.

SLOVAKIA

Slovakia's SMR Timescales Outlined as Project Phoenix Gets Underway

A feasibility study, as part of the US-funded Project Phoenix, is looking into the potential for SMRs in Slovakia with an indicative timeline to 2035. Project Phoenix was announced by US Special Presidential Envoy for Climate Kerry (pictured above) at the COP27 climate conference in 2022 and aims to support energy security and climate goals by creating pathways for coal-to-SMR power plant conversions while retaining local jobs through workforce retraining. The first recipients, announced in September last year, were the Czech Republic, Poland and Slovakia, with Slovenia added earlier this month.

Slovenské elektrárne has now announced that staff from Project Phoenix implementation partners, Sargent & Lundy, have visited Slovakia to carry out the initial phase of a field survey of sites for the feasibility study on the construction of SMRs in the country. They visited Slovenské elektrárne's Bohunice and Mochovce nuclear power plants and the Nováky and Vojany coal-fired plants.

The study begins with rating/excluding sites against serious constraints such as "seismicity, unsuitability of the geological subsoil or surroundings, lack of cooling water. This is followed by a survey of suitable sites and selection of the most suitable ones. In the next phase, the most appropriate SMR technologies for each selected site are assessed. Finally, a licensing plan and a capital cost analysis of the alternatives is prepared".

The analysis will also factor in the purpose of the SMR, such as electricity, heating, cogeneration and existing infrastructure and also "other socio-economic and environmental factors that may influence the final choice of sites". According to Slovenské elektrárne, the aim is to complete the feasibility study in 2025, with the initial SMR

design and licensing process running from 2026 to 2029, with procurement of major components from 2030 to 2033 and "implementation project, construction, commissioning" in 2035.

... Slovakia currently has five nuclear reactors generating about half its electricity, with one more reactor under construction. The first two, at Bohunice, went into commercial operation in 1984 and 1985 respectively, while Mochovce 1 and 2 were connected to the grid in 1998 and 1999, respectively. Construction of Mochovce 3 and 4 began in 1986 but was halted in 1992. It was later restarted and Mochovce 3 entered service in 2023, with work continuing on Mochovce 4.

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Source: https://www.world-nuclear-news.org/Articles/Slovakia-s-SMR-timescales-unveiled-as-Project-Phoe, 15 February 2024.

NUCLEAR COOPERATION

CANADA–UK

Canadian-British Partnership for Fusion Development

The United Kingdom Atomic Energy Authority (UKAEA) and Canadian Nuclear Laboratories (CNL) have signed a collaboration framework agreement to partner on the development of technologies in relation to the management of tritium, an isotope of hydrogen used as fuel in fusion energy. A key focus of the partnership will be on hydrogen isotope management within the fusion fuel cycle, safely removing, processing, and reinjecting fuel to the plasma in a continuous manner. Hydrogen isotope management is an essential part of the fusion fuel cycle - tritium needs to be separated from other hydrogen isotopes in the exhaust gas so that it can be recycled and reused as a fusion fuel. Tritium is rare in nature, so managing tritium efficiently is crucial to fusion energy's commercial viability.

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The first project under this collaboration will involve samples of candidate materials for isotope separation being analysed at both CNL's facilities in Chalk River, Ontario, and UKAEA's facilities in Culham, Oxfordshire. The UKAEA and CNL agreement establishes a framework in which the two organisations will conduct joint research projects, facilitate personnel secondments, share expertise for consultancy services, and work together to provide services to the fusion industry.

Both UKAEA and CNL facilities will also be leveraged in this partnership to advance tritium technologies required for fusion applications, including the design of tritium processing plants, tritium-compatible materials development, tritium breeder blanket technologies, tritium decontamination, and analytical equipment and the modelling of tritium handling processes. ...

This agreement complements the signing of a MoU by the UK's Energy Secretary, Claire Coutinho, and Canadian Minister of Energy and Natural Resources, Jonathan Wilkinson, at the IAEA's Ministerial Meeting in Paris. The MoU aims to enhance collaboration on key focus areas, including research and development, regulatory harmonisation, and skills and workforce development.

Source: https://www.world-nuclear-news.org/Articles/Canadian-British-partnership-for-fusion-developmen, 15 February 2024.

FINLAND–POLAND

Poland/ Finland Companies Sign Agreement on New Nuclear Programme

Finland-based TVO Nuclear Services (TVONS) and Fortum have signed a two-year framework agreement with Polish Polskie Elektrownie J'drowe (PEJ), a state-owned company responsible for the construction project of the first nuclear power plant in Poland. The companies will support PEJ in the development of operation and maintenance processes of Poland's first nuclear power station. TVONS and Fortum will provide technical support for the licensing and design phase of the station and help PEJ develop it capabilities to become an operator of a nuclear power plant. PEJ is responsible for the preparation of the investment process for the construction of the first Polish nuclear power station in Pomerania.

Finland-based TVO Nuclear Services (TVONS) and Fortum have signed a two-year framework agreement with Polish Polskie Elektrownie J'drowe (PEJ), a state-owned company responsible for the construction project of the first nuclear power plant in Poland. The companies will support PEJ in the development of operation and maintenance processes of Poland's first nuclear power station.

In November 2022, Warsaw chose Westinghouse to supply its AP1000 reactor technology for the three-unit facility. The first unit is scheduled to be online in 2033 as set in Warsaw's 2020 nuclear energy programme while the start of construction is earmarked for 2026. TVONS is a subsidiary of Finnish nuclear power company Teollisuuden Voima Oyj, which owns and operates the three-unit Olkiluoto nuclear power station. Finland-based Fortum owns and operates Finand's only other nuclear power station, the two-unit Loviisa.

Source: https://www.nucnet.org/news/finland-companies-sign-agreement-on-new-nuclear-programme-2-2-2024, 13 February 2024.

RUSSIA–VENEZUELA

Russia, Venezuela Agree to Boost Nuclear, Oil Cooperation

Lavrov said after talks in Caracas with his Venezuelan counterpart Yvan Gil that the special attention was paid to trade and economic relations as there are a lot of opportunities in these fields, according to Tass news agency. The negotiations held in October on various fields such as oil production, development of gas fields, agriculture, medicine and pharmaceuticals, space exploration and information and communication technologies were discussed, he said. Lavrov said that the talks also focused on the peaceful use of nuclear energy and the two sides agreed to cooperate in this domain as well. During his trip to Caracas, the Russian Foreign Minister also met with President Maduro and Vice President Rodriguez. After his visit to Venezuela, Lavrov will depart for Brazil where he will take part in the G20 ministerial summit in Rio de Janeiro.

Source: https://en.irna.ir/news/85393486/Russia-Venezuela-agree-to-boost-nuclear-oil-cooperation, 21 February 2024.

NUCLEAR DISARMAMENT

GENERAL

China Urges Largest Nuclear States to Negotiate a 'No-First-Use' Treaty

States with the largest nuclear arsenals should negotiate a treaty on no-first-use of nuclear weapons against each other or make a political statement in this regard, the Chinese foreign ministry's arms control department said. Director general of the department, Sun Xiaobo, called on nuclear states to fulfil their "special and priority responsibilities" on nuclear disarmament according to the U.N. CD, which seeks to prevent nuclear war, official news agency Xinhua said.

During the forum's weekly meeting in Geneva on 26 Feb, Sun said the body should define a roadmap or timetable for an international legal instrument that would protect non-nuclear-weapon states from the threat of nuclear weapons. "Nuclear-weapon states should negotiate and conclude a treaty on no-first-use of nuclear weapons against each other or make a political statement in this regard," Sun said.

China and India are currently the only two nuclear

powers to formally maintain a no first use policy. Russia and the United States have the world's biggest nuclear arsenals. Sun also called for a universal, non-discriminatory, non-proliferation, export control order to address global security challenges, and promote more compliance in the field of biochemistry to maintain the authority of the arms control treaty system.

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The U.N. disarmament forum should also respond to emerging scientific and technological challenges such as artificial intelligence, outer space and cyber, he said. Sun described the international strategic security situation as facing new challenges, and that countries with the strongest military power have repeatedly "broken treaties" in order to "seek their own absolute superiority".

Source: https://www.reuters. com/world/china-urges-un-define-roadmap-exempt-non-nuclear-states-nuclear-threat-state-2024-02-28/, 28 February 2024.

As Vatican, Others Urge Disarmament, Russia Reportedly Working on Space-based Nuclear Weapon

The US has new intelligence about new Russian capabilities concerning a space-based nuclear weapon that could threaten the U.S. satellite network, according to multiple reports. The development underscores the greater urgency that the Vatican and Catholic prelates have given to warning of the need for global nuclear disarmament.

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The New York Times reported [Feb. 14] that the U.S. government has informed Congress and its allies in Europe that Russia has made advances on a new, space-based nuclear weapon designed to target the U.S. satellite network. Russia does not appear close to deploying the weapon, the report said, meaning the threat is not immediate. But if deployed, the technology could "destroy civilian communications, surveillance from space and military command-and control operations by the U.S. and its allies," the Times reported. The report also raised alarm that Russia is preparing to abandon the Outer Space Treaty of 1967, which bans all nuclear weapons in space.

Reports of the new intelligence came after Rep. Mike Turner, R-Ohio, chair of the House Intelligence Committee, issued a cryptic statement Feb. 14 warning about a "serious national security threat," urging President Biden to "declassify all information relating to this threat so that Congress, the Administration, and our allies can openly discuss the actions necessary to respond to this threat." Other lawmakers pushed back, arguing there was no cause for public alarm. In a joint statement later the same day, the chairman and vice chairman of the Senate Select Committee on Intelligence, Sens. Mark R. Warner, D-Va., and Marco Rubio, R-Fla., pushed back, saying their committee "has the intelligence in question, and has been rigorously tracking this issue from the start."

... The Catholic Church has long opposed the use of or the development of new nuclear weapons as intrinsically immoral, and has been calling for nuclear-armed nations, including the U.S., to join international agreements that would ban these weapons. In a Jan. 22, 2024, statement marking the third anniversary of the Treaty on the Prohibition of Nuclear Weapons, U.S. Archbishops John C. Wester of Santa Fe, New Mexico, and Paul D. Etienne and three Japanese prelates wrote that "no nuclear weapons powers or their allies have

stepped forth to support the treaty, even as the geopolitical climate continues to deteriorate and the risk of nuclear accident, miscalculation, or war increases." "The nuclear-armed states have a moral obligation to hear the voices of the majority of the world and to listen to those who are threatened by annihilation at the decision of any one of the nine leaders of the nuclear weapons states," they said. ...

Source: https://angelusnews.com/news/world/russia-nuclear-weapon-threat/, 16 February 2024.

NUCLEAR WASTE MANAGEMENT

BELARUS

Belgian Research Groups Develop Furnace to Treat Nuclear Waste

In an effort to tackle the challenge of decommissioning nuclear plants and managing radioactive waste, Belgian researchers are developing a pioneering metal smelting furnace to reduce the radioactive waste content in metals. The initiative is a collaboration between Swiss Federal Centre for Nuclear Research (SCK CEN) and the Centre for Metallurgical Research (CRM Group). Their joint venture, announced earlier this week, marks a significant step in responding to the need for effective solutions to radioactive waste and materials.

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This will become increasingly important due to the decommissioning of nuclear power plants around the world. Belgium aims to carve a niche in this emerging industry. In an interview with L'Echo, Guido Mulier, a dismantling expert at SCK CEN, explained that in each reactor, there are about 500 tons of low-level radioactive waste. "Our goal is to reduce by 97% the proportion of these that will have to be stored in permanent nuclear waste facilities."

Managing Director of SCK CEN Peter Baeten told L'Echo about the importance of understanding the metallurgical behaviours under extreme temperatures: "Metals from nuclear power plants are already melted in furnaces but there are a lot of constraints. Here, we will try to reduce them by combining our radiological expertise with that of the CRM in steelmaking." Funding for the Smeld project, amounting to €13.4 million, has been allocated from the European recovery plan, with €3.4 million earmarked for prototype construction and €10 million for research activities.

In a recent statement, Thomas Dermine, the Secretary of State for Recovery who played a pivotal role in facilitating the collaboration between the research partners, underscored the economic potential of reactor decommissioning, estimating an opportunity worth €1.2 billion to €1.4 billion for each reactor. "Assuming that the furnace works and that the business plan holds up, we could be ready for the industrial stage before 2030," Baeten said.

The project aligns with the principles of circular economy, as the purified metals devoid of radioactive contamination are slated for use in the steel industry, reinforcing the concept of sustainability and resource efficiency. In summary, the collaboration between SCK CEN and CRM Group represents a significant stride towards addressing the challenges of nuclear waste management, while also fostering industrial growth and sustainability in Belgium and beyond.

Furthermore, the project aligns with the principles of circular economy, as the purified metals devoid of radioactive contamination are slated for use in the steel industry, reinforcing the concept of sustainability and resource efficiency. In summary, the

collaboration between SCK CEN and CRM Group represents a significant stride towards addressing the challenges of nuclear waste management, while also fostering industrial growth and sustainability in Belgium and beyond.

Source: https://www.brusselstimes.com/belgium/927192/belgian-research-groups-develop-furnace-to-treat-nuclear-waste, 18 February 2024.

CANADA

Opposition Grows Against Proposed Nuclear Waste Disposal Site Near Ottawa River

Proposal for a Nuclear Waste Disposal Site Raises Concerns: The Canadian Nuclear Safety Commission (CNSC) has approved a controversial proposal for a nuclear waste disposal site near the Ottawa River. However, the project faces strong objections from several First Nations and municipalities in Ontario and Quebec. The proposed site is located on the traditional territories of the Kebaowek First Nation, which claims that the government has failed to secure consent for the project. A judicial review has been submitted to challenge the project's approval, and opponents are rallying Parliament Hill seeking support.

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Details of the Disposal Site: The nuclear waste disposal project, known as the Near Surface Disposal Facility (NSDF), is a seven-storey radioactive mound approved by the CNSC. The facility is designed to provide a permanent disposal solution for up to 1 million cubic metres of solid low-level radioactive waste. Approximately 10 per cent of the waste volume is expected to come from other AECL owned sites or commercial sources, including Canadian hospitals and universities.

Concerns Over Radioactive Material and Safety Measures: Despite the CNSC's approval, the nuclear waste disposal site has raised several concerns, especially regarding the levels of radioactive material slated for disposal. Initially, Canadian Nuclear Laboratories (CNL) proposed the facility to accept both intermediate and low-level waste. However, in 2017 the proposal was revised to only accept low-level waste. Critics point out that about 90 per cent of the intermediate-level waste inventory at federal sites was reclassified as low-level between 2016 and 2019. Concerns also extend to the potential long-term environmental impacts. The NSDF is designed to last 550 years, but opponents argue that it poses risks of radioactive materials leaching into the environment.

Claims of Lack of Consultation and Consent: The Kebaowek First Nation and several citizens groups have launched court challenges against the construction of the NSDF. They allege that the CNSC has failed to uphold its duty to consult and protect the constitutionally protected and inherent rights of Indigenous Peoples. The proposed site is located within Algonquin Nation traditional land, adjacent to Kebaowek's title territory.

Call for Federal Government Intervention: First Nations leaders are calling on the federal government to oppose the nuclear waste disposal site as they believe it threatens their rights and the safety of drinking water. They have also called on the government to halt funding for the project, which they claim will remain hazardous for thousands of years. As the opposition grows, a rally on Parliament Hill is being organized to garner support against the project. The proposed nuclear waste disposal site near the Ottawa River has undeniably sparked a heated debate. As the legal challenges continue, the decision's impact on the rights of First Nations, environmental safety, and the future of nuclear waste disposal in Canada remains to be seen.

Source: https://medriva.com/health/environmental-health/opposition-grows-against-proposed-nuclear-waste-disposal-site-near-ottawa-river/, 14 February 2024.

FINLAND

Finland to Have 1st Operational Nuclear Waste Repository; Transparency, Dialogue Key to Gaining Understanding from Residents

Selecting the final disposal site for highly radioactive waste is an issue for countries with nuclear power plants, and only a few countries have decided on such sites. Finland has made the most progress as it decided on a disposal site in 2000 and began construction on the world's first geological repository in 2016. It is set to become operational in the mid-2020s. Finland spent more than 30 years before starting construction.

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The company responsible for the disposal of nuclear waste selected about 100 possible locations. Area surveys were conducted in five municipalities that consented to be a disposal site for nuclear waste, and the municipality that was ready to accept the waste was selected. The company proactively disclosed information to residents and held a series of small gatherings to create dialogue. In the end, many residents are said to have given their approval for the project. Sweden finalized selecting a disposal site in 2009. The government approved the plan in 2022 with the aim of starting operations in the late 2030s. Similar to Finnish operators, Swedish operators made efforts to gain understanding from residents by visiting local communities during their farming and dairy work breaks, and discussed the project.

The acceptance of disposal sites in northern Europe is due in part because of the public's high level of trust in the government, operators and regulatory authorities. Referring to the Nuclear Waste Management Organization of Japan, Matsuoka said, "NUMO has also set up a forum to discuss [the issue] with residents, but it is mostly one-sided from NUMO.

In France, a nuclear powerhouse that generates about 70% of its electricity using nuclear power, the government agency responsible for building a repository applied for permission in 2023. In the US, the government took the initiative and selected a site in Nevada in 2002. The Energy Department applied to build a repository, but the administration of then U.S. President Obama, who came into office in 2009, suspended the project. The review process still remains halted.

According to Waseda University Prof. Shunji Matsuoka, an expert on geological disposal issues who specializes in environmental economics and policy studies, the acceptance of disposal sites in northern Europe is due in part because of the public's high level of trust in the government, operators and regulatory authorities. Referring to the Nuclear Waste Management Organization of Japan, Matsuoka said, "NUMO has also set up a forum to discuss [the issue] with residents, but it is mostly one-sided from NUMO." Matsuoka added, "In order to foster understanding and trust regarding the disposal [of nuclear waste] in Japan, which has experienced the Fukushima No. 1 nuclear power plant accident, among other incidents, it is necessary to incorporate knowledge, opinions and case studies from other sources to gain understanding from residents."

Source: https://japannews.yomiuri.co.jp/world/europe/20240215-168862/, 15 February 2024.

JAPAN

Two Hokkaido Municipalities Named Candidates for Next Nuclear Waste Site Survey

Two municipalities in northern Japan have been named as candidates for the second stage of a government process to select a final disposal site

for high-level radioactive waste. The Nuclear Waste Management Organization of Japan, or NUMO released a draft report on the so-called literature survey, which is the first part of its three-stage investigation. Suttsu Town and Kamoenai Village, both in Hokkaido, took part in the survey, which started in November 2020. The draft report says all areas of Suttsu and the southern part of Kamoenai, except for a 15 kilometer radius from the summit of Mount Shakotan, a volcano, are candidates for the second stage of the process, which involves boring surveys, and other studies.

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A scientific map the government produced in 2017 estimates an unfavorable condition in the southern part of Suttsu due to the presence of an active fault. But the draft report did not exclude the area from the list of candidate sites for survey, saying active faults and other conditions should be examined in detail later in the survey. A law requires the final disposal site for high-level radioactive waste from nuclear plants to be buried more than 300 meters underground.

The industry ministry plans to receive an official report after months of debate based on the draft by a panel of experts. The focal point after the official report will be whether the mayors of the two municipalities and the governor of Hokkaido will agree on advancing to the second stage, a preliminary investigation. Hokkaido Governor Suzuki Naomichi has made it clear that he will oppose the survey, citing a prefectural ordinance against accepting nuclear waste.

Source: https://www3.nhk.or.jp/nhkworld/en/news/20240213_22/, 13 February 2024.

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