Leadership & Democracy Lab

Political Risk Assessment

Japan's Nuclear Infrastructure: Risks and Mitigation Strategies

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Executive Summary

The 2011 Tohoku Earthquake and subsequent meltdown of the Fukushima Daiichi nuclear reactors remains one of the most significant events in Japan's recent history, especially due to its effect on Japan's energy policy. Prior to the 2011 disaster, the 2010 Basic Energy plan optimistically targeted nuclear share in Japan's energy production to increase from 30% to 50%. However, by the end of 2013 all nuclear reactors in the country were shut down as they awaited the implementation of safety procedures, since then, nuclear energy has barely reached a 6.4% share of Japan's power generation in 2021. A significant implication of the government's shutdown of Japan's 48 nuclear reactors was an increased reliance on carbon-intensive sources of energy to make up for the new gap left in the wake of nuclear energy. In the short-term, imports of liquefied natural gas (LNG) would rise by 12% between 2011 and 2014, and by 2020 Japan was firmly planted as the world's largest importer of LNG. As a result, Japan's energy self-sufficiency ratio has fallen from 20.2% in 2010, to 8.3% in 2016.

In response to a desire for more greater energy security and to the rising prices and decreasing supply of LNGs, Japan has begun reversing its earlier policy of phasing out the nuclear power entirely by 2040, as it now plans to have nuclear power account for 20-22% of their energy supply by 2030

This report compiles research from various primary and secondary sources to identify potential risks to the Japan's plan reverse its policy of phasing out nuclear power before 2040 and reinvest in nuclear energy generation. Additionally, this report provides mitigation strategies to neutralize the risks and allow for improvement. Although this report specifically looks to Japan's policies, we are certain looking at the viability of nuclear energy is of global significance in the face of the impending climate and energy crises.

The report consists of five sections, each looking at a different aspect to Japan's policy considerations:

Regulatory Risks: Case study of the regulatory issues faced by Japan following the Fukushima meltdown

Economic Risks: Economic factors impacting potential investment into nuclear power generation capabilties

Energy Resiliency: Environmental concerns regarding Japan's energy self-sufficieny

Technological Risks: Cybersecurity threats to critical nuclear infrastructure

International Risks: International pressures and opportunities for cooperation between nations

Regulatory Risks

Japan has been known for its peaceful pursuit of nuclear energy. Nuclear energy is an important base-load power in Japan since 2015 when the Ministry of Economy, Trade, and Industry of Japan identified this in their 2015 energy usage report.[1] However, several concerns emanate from the nuclear policy of Shinzo Abe as there are many risks associated with nuclear infrastructure in Japan, especially after the Great East Japanese earthquake and the Fukushima power plant incident in 2011.[2] It was classified as a level 7 nuclear accident on the International Nuclear Event Scale, and the only incident classified as such, alongside the Chernobyl nuclear incident.[3]

Based on more stringent new regulatory criteria, the Japanese government started to permit nuclear facilities to resume in August 2015. The public would not support the construction of any new nuclear power plants; thus the practical approach has been adopted: restart nuclear power plants under specific conditions before gradually lowering their use.[4] This is because it is difficult to eliminate nuclear energy at this time. The most important requirement was that in 2014, the Nuclear Regulatory Commission (NRC) passed an assessment based on newly established regulatory criteria, based on the lessons acquired from the nuclear catastrophe. The new regulatory rules, which Japan's ruling party has referred to as the strictest norm in the world, have significantly increased the protection against natural disasters like earthquakes and tsunamis.[5]

However, the development of evacuation plans for residents in the case of an accident has been left out of the new Nuclear Regulatory Authority's (NRA) criteria. Tokyo requested local governments create an evacuation plan for citizens living within a 30-kilometer radius of the nuclear power plant in reaction to the Fukushima accident.[6] This element, however, was "thrown" to the local governments and was not taken into consideration when the NRC reviewed the new criteria. This has been the main justification for the local authorities and citizen’s opposition to restarting nuclear plants. Planning for evacuation is crucial because restarting nuclear power stations essentially requires the local government's approval.

Japan's nuclear strategy is currently under threat from several factors. The first is the general lack of support for government policies, which makes it difficult and time-consuming for local governments to implement safety measures like evacuation plans.[7] Even local governments are not in favor of pursuing nuclear infrastructure due to the volatile nature of the

Figure 1. Fukushima Meltdown Aerial View

Japanese climate and the radioactivity caused by the Fukushima incident Japan may continue to swerve from its responsibilities if the political direction is not provided for public policy.[8]

The second is the system's unpredictability. The government has pushed for changes to the electric power system recently. There won't be any new nuclear power construction or reconstruction, though, because operators in the liberalized market strive to recover short-term investments.[9] The government's ambiguous nuclear fuel cycle policy has made matters worse. Regulations and litigation present the final source of uncertainty. The safety requirements contain several issues that are confusing but are crucial to operators. Nobody can predict how long it will take, for example, if a nuclear operator requests an extension to a 60-year operation. How long a nuclear power plant can function is difficult to anticipate due to frequent injunctive lawsuits and temporary dispositions.[10]

Another pertinent problem is how to envision nuclear power's future in light of the current policy that prioritizes "renewable energy" as the primary energy source, as both generate little carbon dioxide.[11] To aid Japan's decarbonization process, renewable energy is more likely to be the main source of energy by 2050 due to the fatal flaw in nuclear power that prevents the safe processing of spent nuclear fuel. All Japanese nuclear power stations may collapse that is that they may be stopped or decommissioned within 50 years if the development of the post-Monju fast reactor cannot proceed as anticipated and there is no chance of fixing the spent fuel problem.[12]

Nobuo Tanaka, former secretary-general of the International Energy Agency, has spoken about the importance of nuclear energy and in 2022 stated that there would be a possibility of " serious problems by the end of this year" if nuclear energy isn't pursued.[13] There was an emphasis on how the reactors should change from huge light water ones to tiny fast reactors. The government appears to be seriously considering his point of view. According to the Paris Agreement, the METI released a long-term strategic plan in April 2019 that included pursuing alternatives with the focus being on the development of small nuclear power plants to achieve a decarbonized society.[14] The concept also discussed using fast reactors and small-sized module furnaces to replace Monju versions.

12 million cubic meters of contaminated soil have been produced since the Fukushima nuclear catastrophe and have been held in 10 "intermediate storage facilities" in the Fukushima Prefecture; nevertheless, the final "destination" has not been determined.[15] Additionally, 170 tonnes of radioactive water have been daily drained out of the damaged reactor buildings, stored in tanks, and intended for burial.[16] However, by 2022, there will be no land available near the Fukushima site where the tanks can be placed. The radioactive water could only be thrown into the ocean and the Japanese government

Figure 2: Fukushima Plant Radioactive Contamination

has not yet disclosed any meaningful steps, even though Shinjiro Koizumi, the former minister of environment did release an initial plan of action.

The underestimation of the earthquake threat is proof that there are structural issues with catastrophe management and prediction. In the case of Japan and with the context of the Fukushima incident in mind, one of the first steps that can be taken to control or prevent any future nuclear incidents is the proper geographical survey and assessment of the area in which the nuclear reactors or infrastructures will be built.[17] Since the underlying geophysical phenomena are so complex, it is extremely difficult to accurately assess the risk of earthquakes and tsunamis. However, it is becoming more and more clear that the approach taken to evaluate the risks associated with the Fukushima Daiichi facility has serious errors. It necessitates the gathering of information about past and present earthquakes and tsunamis that have occurred in the vicinity of nuclear power plants to safeguard the facility against extremely rare extreme seismic occurrences that may only occur once every ten thousand years.[18]

There has to be a review system in place, with IAEA safeguards and checks, to ensure that nuclear infrastructure is up to date and complying with international safety norms as a whole. Japan is not the only country that emphasizes the condition of aging equipment during evaluations for reactor lifetime extensions.[19] The same is true for other cutting-edge nuclear programs. Measures for prolonging the lifespan of older reactors have been criticized by IAEA peer evaluations of some nations' national regulatory systems for neglecting other safety issues and being overly narrowly focused on plant aging.[20]

Other types of mitigation measures include conducting "stress tests" to evaluate nuclear power plants' designs against site-specific extreme natural hazards; adding extra backup water and electricity supplies; enhancing the protection of plants against extreme external events; and alterations and reforms to organizational and regulatory systems.[21]

The IAEA is a great source to use for checking safety standards and ideally, Japan and other countries wishing to pursue peaceful nuclear energy should involve the IAEA in their planning process as they are best equipped to handle different types of nuclear assessments. This includes assessing radioactivity levels, and recommendations on how to dispose of nuclear radioactive waste alongside addressing other fundamental issues that come with nuclear infrastructure in its entirety.

Economic Risk

Risk: Economic Dependence

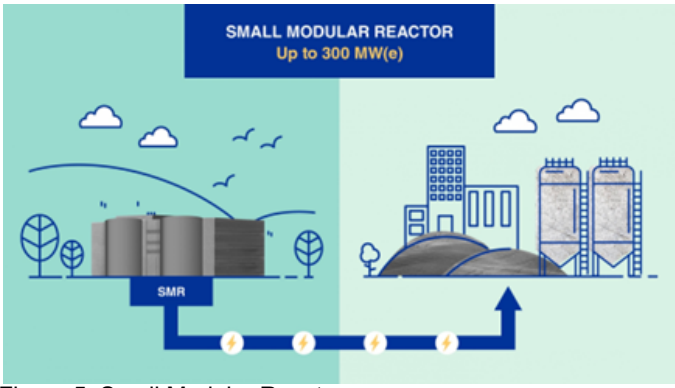


Figure 5. Small Modular Reactor

Infrastructure plans to upgrade existing nuclear plants into innovative light-water reactors and build new small modular reactor (SMR) plants heavily depend on Japanese industry, such as Mitsubishi Heavy Industries (MHI) and Hitachi. To develop the technologies, private industry players are collaborating with partners in the United States.[22] MHI is developing its technology through its joint venture with General Electric, Hitachi GE Nuclear Energy. Additionally, MHI will license its high-temperature gas reactor (HTGR) technology to TerraPower, a US startup. US-Japanese collaboration on the matter extends into the public sector, as the two governments have partnered to deploy SMR technology in Ghana.[23] A strengthened relation between the two countries has been a priority for Prime Minister Fumio Kishida, and has allowed the two to circumvent existing Russian and Chinese SMR technology.[24] However, in the face of increasing American protectionism, there is a risk of Japanese technological over-reliance on US partnerships. Recent US policies such as the Chips Act and the Inflation Reduction Act have exemplified a federal interest in protecting US industry.[25] The Japanese government conversely is lagging in its support of domestic industry, as key industry players such as MHI have expressed a desire for greater government funding. In addition to protecting Japan's domestic industry, increased government funding towards the nuclear industry would better position it in competition internationally. Current projections optimistically estimate commercialization of Japanese SMR and HTGR technology in the early 2030s. As countries globally aim to undertake similar projects, increased Japanese investment will ensure private industry's ability to meet these timelines and remain competitive globally.

Mitigation: Government Support

The nuclear industry's eleven-year inactivity means it will require significant government support to reinvigorate it.[26] Existing plants require upgrades to better meet safety standards, and a new plant will need to be built to replace the Fukushima nuclear plant, which will take a minimum of six to seven years. Within the past decade, more than twenty firms have been closed due to the lack of investment and subsequent revenue declines. Decreased revenues have translated to an inability to attract talent and high turnover rate of employees. Employees with the required industry knowledge are increasingly retiring, whereas new, skilled graduates are not interested in the industry. Moreover, the entire supply chain has suffered, as suppliers have experienced a lack of demand. Notably, Toshiba's suppliers of parts have discontinued components for nuclear reactors, as have the majority of others within the industry. Reactor makers such as MHI and Toshiba posit that Prime Minister Kishida's current announcement to revive the industry is not sufficient to revive all components of the industry, as it is not indicative of a long-term commitment. Government involvement in developing regulatory frameworks and propelling increased interest in the industry is essential. The cooperation of local authorities will be required to build new plants, and it is recommended that the federal government collaborate with private industry to detail regulation surrounding new SMR and HTGR technologies prior to commercialization. This is particularly salient as the majority of existing reactors which are planned to be updated are currently 30+ years old, and may legally operate for a maximum of 40 years. Regulation will need to be implemented prior to the transition to new reactors. It is additionally recommended that the government collaborate with private industry to spur greater employment interest.

Mitigation: Renewable Energy Diversification

Nuclear energy is dually a clean and risky energy alternative. Japan's current focus on increasing renewable energy investment, particularly regarding nuclear energy, is propelled by the country's 2020 promise to be carbon free by 2050.[27] Globally, the consensus surrounding nuclear energy has been favourable, as evidenced by the EU's acceptance of nuclear power as a suitable renewable energy, working in Japan's favour.[28] However, given Japan's history and the significant risk associated with the power source, it is critical that Japan does not over-emphasize the role of nuclear energy in achieving this target. This may be primarily achieved through Japan's infrastructure investment plans. Current plans to build HTGR plants are recommended as they produce hydrogen, which may be repurposed as an energy source through green hydrogen, alongside nuclear power. Increasing investment into these plants would extend the lifetime and usability of investments into nuclear plants, insulating Japan from the risk of global consensus shifting away from nuclear power. Moreover, it would better position Japan to compete internationally, as countries globally are focusing efforts on increasing investment in alternative renewable energies.

Energy Resiliency

Risk: Reliance on Imported Energy Resources

Japan is currently facing a significant energy security risk due to the countries reliance on imported liquified natural gas (LNG).[29] Approximately 98% of the nation's natural gas demand is satisfied by imported natural gas, a source of fuel that is vulnerable to supply chain issues, price fluctuations, and multiple other issues which could disrupt the Japanese populations access to reliable energy.[30] Japan is the world's second largest purchaser of LNG having purchased 74 million tonnes in 2021, a large proportion of which was purchased from Russia.[31] The ongoing conflict between Russia and Ukraine has threatened the availability of natural gas exports from Russia.[32] Japan primarily sources their LNG from Australia, which has recently announced plans to reduce LNG exports which would leave Japan vulnerable to an energy shortage.[33] As 39% of Japan's electricity is produced through a reliance on LNG, vulnerabilities to LNG supply could disrupt the lives of everyday citizens.[34] The decreasing availability of natural gas has caused import prices to skyrocket, leading to a consequent increase in the prices of transport fuels such as gasoline, widely impacting industry costs and electro-reliant consumers.[35] Already, citizens have been asked to conserve their electricity use during this winter season, when many rely on electricity for essential heating functions. Japan's high demand for LNG has also contributed to rising costs and made it more difficult for other nations, especially European nations, to acquire LNG.[36]

Mitigation: Improving Energy Independence

The Agency for Natural Resources and Energy gave Japan an energy self-sufficiency ratio of 12.1%, ranking 35th among the 36 countries studied.[37] As a method of stable energy production, nuclear energy allows nations to become self-sufficient in their energy production which is especially important during times when international natural gas availability is at risk.[38] As an example, France has been able to achieve energy self-sufficiency through a reliance on nuclear energy which generates over 70% of the nation's electricity.[39] Before the Tōhoku earthquake in 2011 which triggered the Fukushima nuclear disaster, Japan had a significantly higher energy self-sufficiency ratio of 20.2% due to functioning nuclear power plants, proving nuclear energy to be an effective tool in gaining energy independence.[40] Additionally, through domestic nuclear energy production, Japan would no longer be vulnerable to threats towards the countries energy supply chain which were highlighted following the 2019 attack in the Strait of Hormuz which is a transit route for a third of all petroleum products.[41] Overall, investing in nuclear energy is a proven pathway for Japan to become self-sufficient in it's energy production, providing stability to it's citizens and safeguarding the nation from unpredictable international threats to energy access.

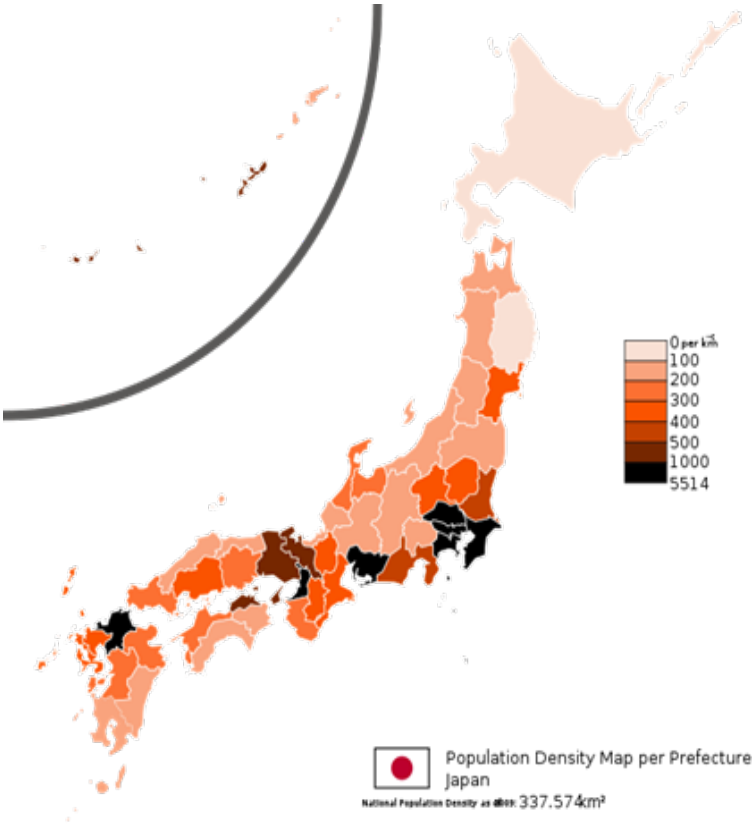
Figure 3. Liquefied natural gas (LNG) storage tanks and a membrane-type tanker at Tokyo power station

Mitigation: Easing Environmental Burden of Energy Production

Amidst the global climate crisis, a shift away from natural gas to nuclear energy would help combat climate change by reducing greenhouse gas emissions.[42] Compared to coal, natural gas emits 58.5% as much carbon dioxide, while nuclear energy generates no emissions.[43] As many of Japan's citizens and business are located near the Japanese coastline, these populations are highly vulnerable to sea level rises which occur as a consequence of

global warming and climate change.[44] The switch to nuclear energy from natural gas can help mitigate the consequences of climate change, ensuring the safety of Japanese citizens and providing a sustainable and self-sufficient method of energy production.

Figure 4. Japanese population density in 2009.



Technological Risks

Risk: Cybersecurity threats

In bringing back nuclear energy infrastructure to Japan after the Fukushima disaster in 2011, Japanese and international regulators need to be cognisant of new risks to individual human health and security. An emerging trend being seen throughout the security community is the presence of non-state and other state actors using malware software to hack into critical infrastructure. This is the major risk associated with the technology used to safely operate nuclear reactors. Like all artificial things, technology used to operate infrastructure has flaws that can threaten the technological integrity of a nuclear reactor. This is deeply concerning because if an individual or actor with malicious intent controls a nuclear reactor, they have the ability to wreak havoc on the population dependent on that energy supply. It threatens people who rely on electricity to live such as those in intensive care units. They could also cause another meltdown which would be costly in financial resources and tragic for the health of individuals. Despite attempts to build robust technology that ensures safe operation of nuclear reactors, chief administrators at power plants have become susceptible to cyber attacks. According to IBM, "cyberattacks are unwelcome attempts to steal, expose, alter, disable or destroy information through unauthorized access to computer systems."[45]

In Japan this most recently happened on January 2 of 2014 when a virus was sent into the computer and infected a system in the control room of the Monju Nuclear Power Plant. After the incident it was reported the Japan Atomic Energy Agency was not adhering to best practices. While the last attack was almost ten years ago, this risk remains a pressing issue.[46] Cyber criminals are getting better at accessing technology of critical infrastructure which is then held for ransom. While the attack was stopped in time before it reached reactor controls there is a large possibility that without the quick thinking of employees to stop the attack, the criminal could have gained access to critical infrastructure.

Mitigation: Hackathons and Mass Malware Detections

To mitigate human-made risks to Japanese nuclear infrastructure security, regulators may consider conducting hackathons. Hackathons are large or small scale events where individuals at cybersecurity firms hired by a client like Japan Atomic Energy Agency are instructed to try and gain access into the computer powering a nuclear power plant. In this case they may use any means necessary to test the robustness of malware detection and reporting software to identify and potential threats to security. Often what happens is once malware is released into a computer the employee of the cybersecurity firm measures the impact and then shows the client how to stop it in the future or fixes the system to eliminate this weakness. In either case, running software hacks by cybersecurity firms, administrators at Japan's new nuclear power plants can trust their technology more and make it safer. The other way to mitigate cyber crime is by introducing mass malware detection technology into the plants computer. In 2014, had Monju administrators and engineers had this type of reporting technology their ability to recognize, react and stop the malware (viral software) from influencing more components in the control room would have been stopped quicker and avoided another potential nuclear meltdown.[47]

Mitigation: The Power of International Law and Intelligence

Like all other crimes, cyber crime has become more prevalent under the Budapest Convention of 2004 and The International Code of Conduct for Information Security of 2015. This gives organizations like INTERPOL in Japan alongside other policing organizations the ability to stop and punish international and domestic threats relating to cybersecurity. Other ways to mitigate cyber attacks is by working with epistemic knowledge communities such as Japan's National Institute of Readiness and Strategy for Cybersecurity (NISC). These groups can provide academic guidance on how to best prevent these attacks from happening again. One of their

policy approaches to mitigating disaster includes "Strengthening Japan's Capabilities for defense deterrence and situational awareness."[48]

Mitigation: Better Training

In addition to addressing cyber security concerns of essential components of a nuclear power plant, another way to prevent cyber attacks is to create policy and protocols to make the transfer of information more secure. Similar to others, nuclear engineers also get spam and phishing emails that ask for their password. However, by teaching these employees how to identify these cyber threats and monitor for signs an attack is coming, individuals in the proximity of or working at the power plant.

International Risks

Japanese Nuclear Infrastructure in the International Political Environment

Japan's progressive leaps towards reactivating its nuclear infrastructure and further advancing its capabilities in order to achieve full energy self-sufficiency attracted significant international attention. While such attention can at times be progressive towards attaining the energy goals the nation has set for itself, it can also attract intrusive actions from other nations who may view the Japanese endeavour for energy self-sufficiency as politically threatening. As such, the following sections will strive to address possible risks and their related mitigations. Such risks span a variety of subject material, from foreign interventions in Japanese-lead nuclear research to the threats posed by the possible reapplication of such research to social, economic and even military initiatives. Nuclear advancement, whether for the purposes of energy production or for military armaments, is a matter that draws concern worldwide for varying reasons; and this is the idea that this section will strive to address in order to analyse the possible political repercussions of Japan's nuclear advance in the international political landscape.

Risk: Japanese-American Joint Nuclear Research and Development and Foreign Intervention

The modern history of Japan itself was shaped by its consistent dependence on foreign powers for sources of primary energy. Even today, Japan imports 90% of its primary energy needs from abroad.[49] As a result, it is clear why the Japanese energy sector would look to move away from foreign energy imports. In January 2021, a series of natural events and disruptions of international supply chains heading to Japan resulted in dozens of critical power shortages across the country.[50] Even the Japanese wind and solar infrastructure was insufficient for sustaining the sheer size of the energy demand in a first world industrialised country such as itself.

With such a long history of relying on external sources for primary energy, and possessing an energy network built largely of retired nuclear reactors - many of whom were put out of commission following the Fukushima incident in March 2011 - the shift of the Japanese mood towards becoming a nuclear reliant nation jarred the world. With a bold proclamation that the Japanese METI (Ministry of Economy, Trade and Industry) sought to reach 70% self sufficiency in energy by 2030, it is not difficult to imagine that nations possessing long standing economic and political ties to Japan as a result of over a century of its energy and technological dependence would seek to either stop the Japanese shift towards self-sufficiency, or may seek to become an integral part of it.[51]

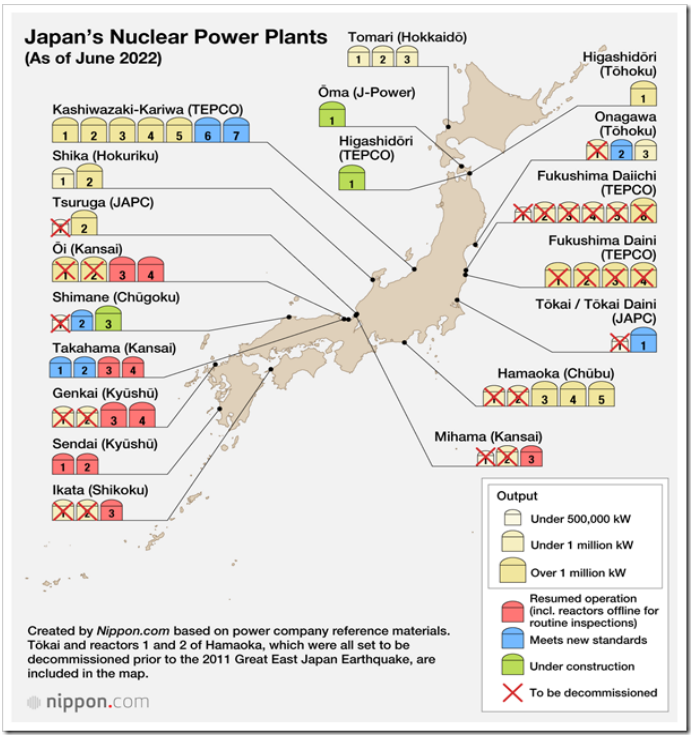


Figure 6. Japan's Nuclear Power Plants in 2022

An example of this is seen with the avid engagement with which the United States invested itself in advancing the Japanese nuclear infrastructure. While the casus belli for such a close cooperation was stated to be "...to support the deployment of… advanced reactor technologies in partner countries" and "...to achieve long-term climate goals, including net-zero emissions by 2050."[52] It is

simple to see that through such cooperation the United States may be seeking to integrate itself into the Japanese Energy Economy through both industrial and economic means. Utilising the sale of said advanced reactor technologies and by researching advanced plutonium based “speed” reactors, the United States is effectively setting itself up as an equal partner in research and development in the Japanese nuclear industry, allowing itself leverage in any decisions made regarding said technology and its implementation in the near future.[53]

The interference posed by countries - whether beneficial or harmful - is a risk that the Japanese METI will have to consider when proceeding with their bold plan to achieve 70% energy self-sufficiency by 2030. Following this are some mitigations that may possibly avert any foreign influences on future Japanese energy policy-making and may help to maintain Japanese nuclear independence.

Mitigation: Japanese-American Joint Nuclear Research and Development and Foreign Intervention

Here, several points will be presented explaining methodologies that can be used to mitigate any risks of foreign intervention and integration.

Regarding the current Japan-United States dealings related to the research and development of plutonium reactors and small modular reactors, Japan may ensure that these deals are kept exactly to what they are: research and development. As a developed country with a powerful industry and economy, the implementation of any newly developed nuclear technologies is something that Japan should be able to achieve of its own accord, without the intervention of any foreign powers. While it is to be noted that the United States and Japan share very close diplomatic and military ties, in the interest of attaining the previously mentioned energy independent future Japan will need to ensure that it maintains its sovereignty as the ruling government of its lands and the sole body which possesses the final say on how energy independence will be achieved.

When deciding on matters concerning subjects such as nuclear energy, current global affairs must be accounted for. As is common knowledge, nuclear energy research can be very easily repurposed to military uses, the greatest of which is nuclear weaponry. It must be kept in mind that just to the west and north-west of Japan lie two of the United States’ most ardent geopolitical opposition: the People’s Republic of China and the Democratic People’s

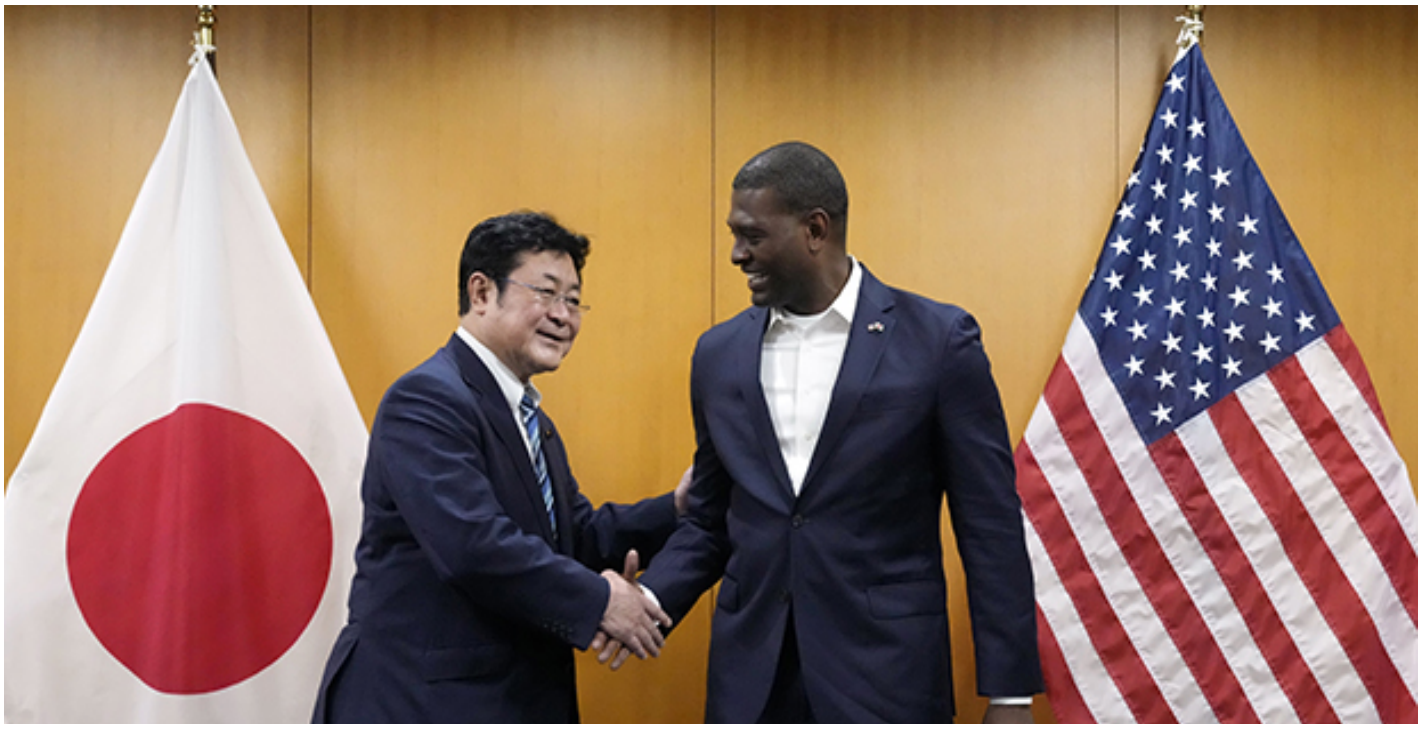


Figure 7. Japanese Minister of Environment Akihiro Nishimura and U.S. EPA’s Michael Regan

Republic of Korea. With growing Japanese-United States co-operation on a subject as sensitive as nuclear research, it is simple to see how the two nations can grow weary of a possible threat on their borders.

Japan will need to take this geopolitical situation into account prior to engaging any further in nuclear research alongside the United States. In order to ensure that relative peace is kept and to offset the wary and cautious nature of the PRC and DPRK, Japan will have to be very transparent about the nature of the research being done. It will have to show that it is - at its very core - an non-military infrastructural endeavour aimed at bettering the lives of Japanese citizens. Any form of ambiguity around the exact research being done may be sufficient to cause regional political concern that may escalate beyond necessary levels.

Should Japan follow these guidelines, possible foreign intervention and attempts at gaining control over the energy independent future that is being planned can be sidestepped, ensuring political security and possible prosperity for Japan and her people in the near future.

Risk: Possible Reapplications of Nuclear Research and Resources to Social, Economic and Military Initiatives

Nuclear fission energy is one of the most powerful sources of energy developed to date, with only nuclear fusion energy surpassing it in strength. Attached to its appealing strength is the non-polluting nature of the production process, resulting in manageable amounts of irradiated waste product. This results in lowered carbon dioxide emissions, and a factor that is much more significant politically: nuclear independence in possible geopolitical crises.

All these benefits make the usage of nuclear energy appealing to Japan, but the very nature of nuclear energy - its power, waste, and production - all allow it to be repurposed to a multitude of applications. These can range from rocket and aeronautical research to more advanced forms of energy production, and of course - nuclear weaponry.

The production of even more Weapons of

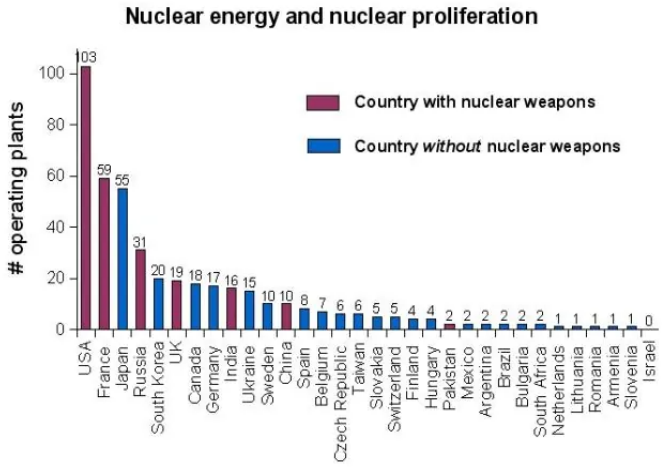


Figure 8. Intersection between nuclear energy and proliferation

Mass Destructions (WMDs) would result in a more and more destabilised geopolitical landscape, especially in the regional locality of Japan and its neighbouring countries. While there is no present proof of Japan intending to create WMDs from their nuclear research, the possibility still being present is still sufficient to create a sense of unease in Japan's opponents, and the opponents of Japan's allies. The reasoning behind this concern is in regard to the aforementioned irradiated nuclear waste; the byproduct of common nuclear energy generation is the unstable radioactive element plutonium which - as is commonly known - can be used to create nuclear weaponry of power ranging in several kilotons to even megatons. Even if Japan intends to cut any possible military ties to its nuclear infrastructure project, the development and possibility of military nuclear applications will be sufficient for Japan's political opponents and non-state actors to be wary and cautious around the nation.

Outside of nuclear application, the possible research benefits that can be yielded from Japan's research into nuclear energy generation range across a wide spectrum. Rocketry and jet sciences can move ahead at a significant rate as new methods of energy transference and maintenance are found and employed to aeronautical research, while a widely growing nuclear infrastructure will allow for the development of more eco friendly communities and highly energy efficient structures. Japan may even reach a point where it will be able to sell its energy and energy producing resources to other nations, providing a valuable boost to its economy and further

establishing its stance as a global power.

While all of this may sound incredibly beneficial to Japan, non-state actors may find the sudden rise and global autonomy of the nation threatening, as a new power growing on the horizon in a world stricken with geopolitical tensions. The arrival of a new powerhouse in the form of Japan may cause geopolitical ripples in the current status quo, forcing Japan into a stance where it must be able to navigate the political landscape formed by the world's superpowers, while maintaining its sovereignty and autonomy.

Mitigation: Possible Reapplications of Nuclear Research and Resources to Social, Economic and Military Initiatives

In order to mitigate the risk of the stigma around militaristic nuclear applications causing a wave of wariness and political discord, Japan must be very transparent regarding their intentions and how each product and by-product would be used in their production of nuclear energy. Ensuring that the radioactive by-products - especially those known to be used in atomic weaponry, such as plutonium - are disposed of or used in field unrelated to military technology, and making said uses transparently available will go a long way to ensuring that any possible military or political turmoil is avoided.

As for the increased geopolitical power this new nuclear infrastructure will yield Japan, some diplomacy will be required in order to mitigate further geopolitical risks. The advancement of Japan's infrastructure will be inevitable as a result of the nuclear research being conducted, and any major advancement in the short term will almost always result in the global eye being turned on the country in question. In order to ensure continued protection and peace, Japan will need to form diplomatic relations with powerful global non-state actors, as well as relations with its neighbouring powers. The establishment of said relations in regards to nuclear research and development will ensure that Japan will be safe on the political playing field, as well as on the geopolitical level. By advancing in nuclear energy alongside maintaining diplomatic relations with all major powers who concern themselves with Japan's advance will ensure that Japan can keep moving forward without having to face unneeded geopolitical turmoil, as well as being able to maintain its nuclear independence with little to no foreign intervention in its implementation of the nuclear energy initiatives.

Figure 9. Jennifer Granholm and Yasutoshi Nishimura discuss advanced reactor development

Figures

Figure 1. “Fukushima Disaster: What Happened at the Nuclear Plant?” BBC News. BBC, March 10, 2021. https://www.bbc.com/news/world-asia-56252695.

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Figure 3. Zuanzuanfuwa. "Japan Population density map," Wikimedia Commons, December 19, 2009. https://commons.wikimedia.org/wiki/File:Japan_Population_density_map.svg

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