*Asian Perspective 39 (2015), 591–605*

# Nuclear Energy Policy Issues in Japan After the Fukushima Nuclear Accident

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*The 2011 Fukushima nuclear accident has become a turning point for Japan, creating loss of public trust not only in nuclear safety but in overall energy policy. More than 80 percent of the public wants to phase out nuclear power eventually. On April 11, 2014, the Japanese government adopted a new National Energy Strategy that declares its intention to reduce dependence on nuclear energy while considering it one of the important base-load electricity sources. Regardless of the future of nuclear energy, Japan needs to face five key policy issues: spent fuel management, plutonium stockpile management, radioactive waste disposal, human resources management, and restoration of public trust. I discuss these critical issues and possible policy alternatives that Japan should pursue.* **Keywords:** *nuclear energy, spent fuel, waste disposal, plutonium stockpile, public trust.*

The Pacific Ocean earthquake and resulting tsunamis struck the Tohoku District and Fukushima Daiichi and Fukushima Daini Nuclear Power Stations of Tokyo Electric Power Company (TEPCO) at 14:46 local time on March 11, 2011. A nuclear accident unprecedented in both scale and time frame followed. Since then, 3/11 has been a day to remember for all nuclear experts not only in Japan but also the rest of the world.

Four years after the earthquake, many human and material costs remain. More than 120,000 evacuated residents in Fukushima are still living in temporary housing and are still uncertain as to when they can return to their hometowns. Although conditions at the Fukushima power stations have improved, it will take more than thirty years to remove melted fuel debris from the site and decommission the plant. Still, we need to draw lessons based on the knowledge and information available so far to assure the safety of existing nuclear facilities as much as possible and understand the possible implications for future nuclear energy policy.

My article summarizes the current status both on-site and off-site of the Fukushima Daiichi nuclear power plant, and reviews possible impacts on Japan's energy policy as well as on global nuclear power development. I identify key policy issues regardless of the future direction of nuclear power in Japan.

## Current Status and Future Prospects of the Fukushima Daiichi Nuclear Power Plant

### *The Problem of Contaminated Water*

On September 7, 2013, Prime Minister Abe Shinzo made a bold speech at the International Olympic Committee, saying, "Let me assure you the situation [at Fukushima] is under control. . . . It has never done and will never do any damage to Tokyo. There are no health-related problems until now, nor will there be in the future" (Reuters 2013). It was a reassuring speech, the technical basis of which was as follows:

- There are thirty-two radiation monitoring stations and eighty-five radiation monitoring points along the coast of the Fukushima, Ibaraki, and Chiba Prefectures. The Nuclear Regulatory Authority reports that the seawater contains 0.021 Becquerel per liter or less of cesium 134 and cesium 137—far below the acceptable standard of 10 Becquerel per liter.
- The contaminated water is limited to the area around the port near the Fukushima Daiichi Nuclear Power Station—an area that is no larger than 0.3 square kilometers.
- The annual radiation exposure from food and water is estimated to be lower than 0.01 millisieverts (Ministry of Economy, Trade, and Industry 2013).

However, TEPCO, the owner and operator of the Fukushima nuclear plant and the organization responsible for decommissioning the plant, has been struggling with the management of a huge amount of contaminated water. The water is steadily increasing

and some of it is leaking into the sea. The Ministry of Economy, Trade, and Industry (METI), which is supervising the decommissioning operation, announced on September 3, 2013, that the Japanese government would deal directly with the ongoing crisis by establishing an interministerial-level council, an intergovernmental liaison office near TEPCO's Fukushima site, and an intergovernmental council for coordination near the Fukushima site. The government also said it would provide $470 million in financial support (to install a frozen soil wall, estimated at $320 million, and to acquire multinuclide removal equipment, priced at $150 million) and would strengthen monitoring and risk-management efforts. The total cost of decontaminating the Fukushima Daiichi site is estimated to be around $10 billion (Suzuki 2014).

### *Decontaminating and Decommissioning Issues*

Contaminated water is just one of the unprecedented challenges that TEPCO and METI face. The so-called mid-to-long-term roadmap for decommissioning Fukushima Daiichi estimates that it will take at least thirty to forty years to finish the decommissioning project. The first stage is to remove spent fuel from the pools in all four units (in two to three years); the second stage is to remove the melted core debris from Units 1–3 (in at least ten years); and the third stage is to decontaminate the whole plant (in thirty to forty years).

Removal of spent fuel (1,331 spent fuel assemblies and 202 non-irradiated fuel assemblies) from the storage pool of Unit 4 was successfully completed on December 22, 2014. Operations to remove spent fuel from Units 1–4 are under way at this writing. For removal of melted cores, the information on melted debris is very limited and no one is sure where they are and what form they now take. It is not possible to get close to the reactor buildings of Units 1–3 due to high radiation and it is necessary to develop remote control equipment or sophisticated, radiation-resistant robots.

On April 1, 2014, TEPCO established a new company, the Fukushima Daiichi Decontamination and Decommissioning Engineering Company, as a dedicated institution to manage this huge,

complex, and challenging operation. An International Research Institute for Nuclear Decommissioning (IRID) was also established in August 2013 by METI, TEPCO, and other interested parties, including nuclear vendors and the Japan Atomic Energy Agency (JAEA). The institute's purpose is to promote necessary research and development efforts for decommissioning in general, but especially for the Fukushima Daiichi nuclear reactors.

### Loss of Public Trust

On February 24, 2015, TEPCO issued a press release saying that the source of high radiation levels in one of its drains came from a puddle of rainwater that had accumulated on the rooftop of Unit 2 at the Fukushima Daiichi Nuclear Power Station (TEPCO 2015). The drain leads to open seawater. It was thus suspected that contaminated water may have leaked into the sea, although TEPCO found "no substantial concentration rise" in the area's seawater (TEPCO 2015).

This is just one episode in a series of adverse events in Japan's nuclear industry that have been reported in the past four years. But this particular incident was worse than usual because TEPCO was aware of the high level of radioactivity in the drain but failed to notify the Nuclear Regulatory Authority or the local government. It was also very bad timing. After long negotiations with the local fishing industry, TEPCO was about to release some of the accumulated radioactive groundwater, which had been cleaned through a water treatment process, into the Pacific Ocean. On February 25, 2015, the local fishing industry association heavily criticized TEPCO. Sato Hiroyuki, the chairman of the Soma-Futaba Fisheries Cooperative Association, said that "trust has been lost" (Nihon Keizai Shimbun, 2015).

Lack of trust is a fundamental problem that underlies the challenges facing Japan's nuclear industry since 3/11. The public has lost faith in nuclear safety regulation. Faith has not been fully restored even after a new, independent Nuclear Regulatory Authority was established in 2012 and much tougher regulatory standards were introduced. According to polling conducted by

Professor Emeritus Hirose Hirotada of Tokyo Women's Christian University, the proportion of the public that wants to shut down all nuclear power plants immediately increased from 13.3 percent in June 2011 to 30.7 percent in March 2013. The same polling data also suggested that about 80 percent of the public still believed that serious nuclear accidents will happen again in Japan (Hirose 2013).

In the latest polling undertaken by *Nikkei Shimbun* in August 2014 (*Nihon Keizai Shimbun* 2014), the proportion of the public that opposes the restarting of existing reactors rose to 56 percent, an increase of four percentage points over previous polling on this question. The same poll indicated that 61 percent of the public is willing to accept higher electricity prices if existing nuclear power plants remain closed. Hirose's polling also suggested that government agencies were considered to be the "most untrustworthy" organizations of those that were listed. Thus, four years after the nuclear accident, the trust issue has yet to be adequately addressed by Japan's nuclear policy makers and the nuclear industry.

## Possible Impacts on Japan's Energy Policy

The economic impact of shutting down nuclear power plants is also significant. According to a study done by the Institute of Energy Economics in Japan, in fiscal years 2011 and 2012 about 3.6 trillion yen (around $36 billion) of extra payments were made due to the shutdown of nuclear plants. (The Japanese fiscal year starts in April and ends in March.) In the same period, declining energy demand contributed to about 1.2 trillion yen (about $12 billion) of savings. In addition, emissions of carbon dioxide in 2012 increased by about 70 million tons, or about 5.8 percent, from the 2011 level. That amount is roughly equal to the emission increase in the entire Middle East or India alone in 2012 (IEA 2013).

On April 11, 2014, the cabinet adopted a new Energy Basic Plan (METI 2014). The plan stated that the government will decrease its dependence on nuclear energy as much as possible.

But the plan also stated that nuclear power is an important base-load energy source and therefore that the necessary level of nuclear energy use should be maintained.

The METI Advisory Council set up one working group to reexamine the generation cost of nuclear power compared with other power sources, and another working group to determine the future energy mix target for 2030. On April 5, 2015, METI's new cost estimate for newly built nuclear power was reported to be about 1 yen/kWh more expensive than the 8.9 yen/kWh previously estimated by the government in 2012, but still believed to be less expensive than newly built fossil fuel power plants (*Nihon Keizai Shimbun* 2015b). On April 7, METI said it believes that so-called base-load electricity should supply about 60 percent of total power generation and that nuclear power, along with coal and geothermal, should be among the base-load power sources.

As for the energy mix target for 2030, another newspaper report indicated that METI was suggesting that the nuclear share of total power generation would be around 20 to 22 percent, which is a slight decline from 2010 (26 percent). The share of renewable energy would be around 22 to 24 percent. Maintaining the nuclear share at 20–22 percent is likely to require extending the forty-year lifetime operating period of current nuclear power plants or building new nuclear power plants. This policy has been criticized as being inconsistent with the goal of "reducing the dependency on nuclear power as much as possible" (*Asahi Shimbun* 2015a). In fact, the Ministry of Environment also published its future energy mix plan, suggesting that the share of renewable energy can be increased to 24–35 percent by 2030 (*Asahi Shimbun* 2015b).

## Policy Issues and Challenges for Japan's Future Energy Policy

Although the future direction of energy policy in Japan is still under discussion, some important issues need to be addressed regardless what happens with nuclear power. These are spent fuel

management, plutonium stockpile management, high-level waste disposal, human resources, and restoration of public trust.

### *Spent Fuel Management*

Even before the Fukushima accident, what to do with accumulating spent fuel on site at nuclear power plants was a major policy issue for nuclear utilities and the government. As of the end of 2011, about 17,000 tons of spent fuel were in storage, of which about 14,000 tons were at nuclear power plant sites and 2,900 tons were at the Rokkasho reprocessing plant. The total spent fuel pool storage capacity at nuclear power plant sites is about 20,630 tons, which means they are roughly 70 percent full (Takubo and von Hippel 2013). For some reactor sites, the pool will be full within a few years if reactors restart operation. The Rokkasho reprocessing plant, with planned capacity to reprocess 800 tons of spent fuel per year, has only one storage pool with a 3,000 ton capacity. The plant is currently shut down after a period of hot testing and repair of vitrification equipment, and it is not clear when the plant will start commercial operation due to new regulatory standards that should be in place by the end of 2015. Since the storage pool is almost full, unless the plant starts commercial operation it may not be able to accept additional spent fuel.

Another storage option is an away-from-reactor centralized storage facility at Mutsu City that is also under construction. Its capacity is 5,000 tons, but it is not yet fully operational and will accept only spent fuel from Tokyo Electric Power and Japan Atomic Power. Safe and secure dry cask storage on-site is technically possible, as proven at the Fukushima Daiichi site, where dry casks loaded with spent reactor fuel withstood the earthquake and tsunami without significant damage, and at the Tokai Daini nuclear power plant. But all local communities at nuclear power plant sites reject accepting further spent fuel storage on site.

In short, finding additional storage capacity (possibly dry cask storage) is a priority issue for nuclear utilities and the government. They need to increase the flexibility of spent fuel management, as uncertainty regarding reprocessing remains.

### *Plutonium Stockpile Management*

The basic policy for spent fuel management in Japan has been (and still is) reprocessing and recycling plutonium for energy use. Since plutonium can also be used to manufacture nuclear bombs, the Japan Atomic Energy Commission (JAEC) introduced a "no plutonium surplus" policy in 1991, and strengthened that policy in 2003 by introducing new guidelines to improve its transparency when the Rokkasho commercial reprocessing plant was expected to start operation. According to the guideline, utilities are supposed to submit a plutonium usage plan annually before they reprocess and recover plutonium. In short, the government's intention is to assure that Japan will not possess plutonium without plans for its use. However, in reality the plutonium usage program—recycling as mixed-oxide (MOX) fuel into existing reactors and, in the future, into fast breeder reactors—has been delayed significantly.

As of the end of 2013, Japan possessed about 47 tons of separated plutonium: 10.3 tons in Japan, and 36.3 tons in France and Britain where Japan has commercial reprocessing contracts (Japan Atomic Energy Commission 2014) (see Table 1). This is the largest stockpile among nonnuclear weapon states and could increase fur-

**Table 1 Japan's Stockpile of Separated Plutonium Compared to the UK and France, 2012–2013**

| | 2012 (kg) | 2013 (kg) |
|---|---|---|
| Stock in Japan (Pu total) | | |
| Reprocessing plants | 4,363 | 4,359 |
| MOX fuel plant | 3,364 | 3,364 |
| Stored at reactors | 1,568 | 3,109 |
| Subtotal (Pu fissile)[a] | 9,295 (6,315) | 10,833 (6,295) |
| Stocks in Europe (Pu total) | | |
| United Kingdom | 17,052 | 20,002 |
| France | 17,895 | 16,310 |
| Subtotal: Pu total (Pu fissile) | 34,946 (23,277) | 36,312 (24,130) |
| Total (Pu fissile) | 44,241 (29,592) | 47,145 (30,425) |

*Source:* Japan Atomic Energy Commission (2013, 2014).

*Note:* a. Fissile plutonium (Pu 239 and Pu 241) is typically about 60 percent of total plutonium, which includes nonfissile isotopes of plutonium (Pu 240 and Pu 242).

ther if the Rokkasho reprocessing plant starts operation and its plan for fifteen to eighteen reactors does not smoothly move ahead. Thus, if the Rokkasho plant starts operating, Japan's plutonium stockpile is likely to grow (Takubo and von Hippel 2013).

Meanwhile, due to heightened concern over nuclear proliferation and nuclear security, international attention on Japan's plutonium stockpile is also increasing. For example, the US-Japan nuclear working group of the Mansfield Foundation published its recommendations on nuclear energy policy for Japan in 2015, stating,

> The disposition of Japan's sizable plutonium stockpile is an outstanding issue that must be addressed regardless of whether or not Japan decides to move forward with nuclear power. . . . Absent a credible strategy for reducing Japan's plutonium stockpile, nonproliferation and security concerns will grow over time, undermining Japan's international leadership on nuclear nonproliferation. (US-Japan Nuclear Working Group 2014, 4; emphasis added)

In order to reduce such concern and to minimize proliferation and nuclear security risks, Japan may need to come up with a new plutonium management plan. I personally propose three new principles for plutonium management in Japan:

1. Demand first: Reprocessing should take place only when plutonium demand (use) is specified.
2. Stockpile reduction: Matching demand/supply is not good enough. The existing stockpile should be reduced before further reprocessing.
3. Flexible plan: The current Pu use plan (MOX recycling in sixteen to eighteen units) is no longer certain. Other options, such as Pu ownership transfer and disposition as waste, need to be pursued. Such options should minimize cost, transportation, and time required for disposal (Suzuki 2013).

### *High-Level Radioactive Waste Disposal*

Like many other countries, Japan has not found a final repository site for high-level radioactive waste (HLW). Since 2000, when the

Law on Specified Radioactive Waste (i.e., vitrified HLW) was passed and the Nuclear Waste Management Organization (NUMO) was established as the principal implementing institution for final disposal, none of the efforts to find even a single candidate for possible investigation has succeeded. Japan's approach was to wait for local communities to volunteer to be a candidate, but only one town (Toyo-town) volunteered. It later canceled the request due to strong public opposition. In 2010, JAEC issued a request to the Science Council of Japan (SCJ) for advice on how to improve public communication on HLW and achieve a possible breakthrough. On September 11, 2012, the SCJ recommended "fundamental reform" of Japan's HLW disposal policy. One recommendation that particularly attracted media attention was long-term "temporary storage" instead of direct "geological disposal," since the SCJ believes scientific knowledge is still too uncertain to commit to geological disposal in Japan (Science Council of Japan 2012).

The JAEC responded with its own policy statement on December 18, 2012 (JAEC 2012b). JAEC agreed with SCJ that the current HLW disposal program needed to be reviewed with fresh eyes but maintained the basic conclusion of its advisory committee report published in 1998 that recommended geological disposal as the most appropriate policy option. Still, the JAEC also agreed with the SCJ that constant review of the program is necessary and that "retrievability" and "reversibility" should be integrated into the disposal program. The JAEC also recommended that the government "establish an independent and functionally effective third party organization to provide suitable advice to the government and related parties in time" (JAEC 2012b).

METI set up two working groups on HLW disposal to review the HLW disposal program. One is to look at the whole process and programs including public participation, and the other is to review scientific knowledge on HLW disposal in Japan, especially after the 3/11 earthquake. Based on its findings (METI 2014), METI is now planning to revise its basic plan for HLW disposal, incorporating retrievability and reversibility in the HLW disposition program. Still, the future of the HLW disposal program is very uncertain.

Again, one fundamental issue is public trust. In 2015 the SCJ published a follow-up report to the one it published in 2013. In the new report, it reemphasized the importance of a "consensus building process" for HLW disposal and proposed convening a "national people's conference on radioactive waste" (Science Council of Japan 2015). It further proposed to use the period established by "temporal storage" (not "interim storage," which assumes that the final decision on HLW disposal has been made) for gaining national consensus. Whether such a proposal will be accepted by the government remains to be seen.

### *Securing Human Resources and Research and Development*

Since the future prospects of nuclear power in Japan remain uncertain, attracting young and capable talent to the nuclear energy field may be difficult. Furthermore, the demand for new tasks such as decommissioning Fukushima reactors is emerging. Therefore, it is important to secure human resources to meet new and challenging tasks in coming decades. In addition, research and development programs need to be reexamined with an eye to providing qualified personnel. In order to meet such challenges, JAEC published policy statements on human resources on November 27, 2012, and on research and development on December 25, 2012 (JAEC 2012a, 2012c).

For human resource management, JAEC recommended drawing a "human resource demand/supply map" so that "the related government agencies and demand side, including the nuclear industry, clarify when, in what areas and how much manpower is required based on operational plans" (JAEC 2012a, 2). This cannot be done by the government agencies but should be done by the related industry organizations as they probably have better knowledge and data. Other important recommendations are education based on lessons learned from the Fukushima accident; new education opportunities for midcareer experts; enhanced human resource development for nuclear safety, security, and safeguards; incentives for nuclear businesses to maintain human resources and secure human resources for maintaining the oper-

ation of domestic nuclear power plants; and human resource development for international deployment of nuclear energy and technology.

### *Restoring Public Trust*

As I have stressed, an important policy issue is to restore public trust, which is the factor most deeply affected by the Fukushima accident. JAEC issued a policy statement on this issue on December 25, 2012, listing four basic principles for restoring public confidence (JAEC 2012c). The first is accountability: It is important to explain the mission of individuals and organizations that tackle challenges to the public interest—what they do and why and how they do it. In other words, individuals and organizations should be aware of their primary responsibility to seek solutions to challenges, manage risks in the public interest, and be accountable for their plans and the results of their actions. They have an obligation to continuously explain to the public how their actions fulfill their responsibilities and their commitment to public well-being and safety.

Second is correct information disclosure, since explanations of disasters should be provided based on sufficient and correct information to the public on a timely basis. For example, in discussing a plant operator's actions for nuclear power safety, we should carefully explain the nature of the threat facing a facility, the operator's target, and how it intends to reach the target. In doing so, explanations using comparisons with other facilities are acceptable but must be done carefully. This is because evaluations should include all relevant factors, such as costs, environmental impacts, and stability; and comparison based on one point alone may be inappropriate, even if accurate. However, we should also note that speed is sometimes more important than accuracy. In that case, details should immediately be provided on what has happened and why, and what can be expected to happen in the future, while explaining uncertainties in such information and the range of possible outcomes.

The third principle is transparency: fairness and public involvement in the decision process. Fair decisionmaking should

be designed as the basis for administrative decisions, and in making the process open, opportunities for public participation in the process should be provided. The parties concerned should deeply appreciate that securing transparency means the public can view the decisionmaking process related to its interests, access relevant information, and provide input into the process. Based on this acknowledgment, the greater the public interest in a decision, the more carefully should it be involved at the earliest possible stage before decisions are made. Organizations involved should strive to give the public opportunities to express viewpoints. Administrative bodies should establish verifiable decisionmaking processes, with full and accessible documentation, from the creation of administrative documents and testimony from experts, interested parties, and the public, to final decisionmaking.

The fourth principle is easy-to-understand explanation, with emphasis on clarity and accuracy. Critics often point out that if the public cannot understand information released, it cannot be considered transparent, even if it is believed that transparency is attained in doing so. It is not easy to ensure that material is both accurate and comprehensible, but court decisions have long been written in ordinary Japanese. Administrators must not forget to check the processes of creating documents and preparing explanations using this perspective, thereby adding to their own education and training in this area.

## Conclusion

Nuclear energy policy after 3/11 needs to change, to reflect lessons learned from and the different priorities and tasks required after the Fukushima accident. The main tasks are decommissioning the Fukushima site and restoring lives and livelihoods for people in Fukushima and other affected areas; enhancing safety and security; managing spent fuel and the plutonium stockpile; disposing of nuclear waste; developing human resources; and most of all, restoring public trust. These are necessary changes regardless of the future direction of nuclear energy in Japan.

## Notes

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