



FAS | **Suggestions about Japan's Nuclear Fuel Recycling Policy Based on U.S. Concerns**

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Table of Contents

Introduction.....	3
U.S. Experts’ Opinions about Japan’s Nuclear Energy Policy	4
<i>Opinions about Japan’s nuclear energy policy after Fukushima nuclear accident</i>	4
<i>Opinions about Japan’s recycling policy</i>	4
<i>Opinions about Japan’s R&D approaches towards the future</i>	5
What Can (and Should) Japan Do To Solve Its Problematic Recycling Policy?	7
<i>What can (and should) Japan do based on the opinion that Japan should end its recycling policy?</i>	7
<i>What can (and should) Japan do based on the opinion that Japan should balance its production and consumption of plutonium?</i>	8
<i>What can (and should) Japan do based on the opinion that Japan should decrease its overall amount of plutonium as much as it can?</i>	10
<i>What can (and should) Japan do based on the opinion that Japan should explore all possibilities, especially about spent fuel disposal, and opinions about Japan’s R&D approach towards the future?</i>	10
Conclusion	12
Endnotes	13

Introduction

To date, Japan's peaceful nuclear energy use has taken the form of a nuclear fuel recycling policy that reprocesses spent fuel and effectively utilizes the plutonium retrieved in light water reactors (LWRs) and fast reactors (FRs). With the aim to complete recycling domestically, Japan has introduced key technology from abroad and has further developed its own technology and industry.

After India's nuclear test in 1974, the United States, a leader in the field of nuclear energy use, enforced a policy of nonproliferation, influencing other countries' policies. However, in 1988 after discussions on Japan's nuclear energy use, the United States and Japan signed a nuclear cooperation agreement, in which the U.S. government permitted Japan's promotion of recycling activities. [1] Through efforts to obtain the understanding of the international community regarding peaceful nuclear energy use such as its aggressive acceptance of IAEA safeguards, Japan has become the only non-nuclear weapon state with full recycling technology and facilities. [2]

However, Japan presently seems to have issues regarding its recycling policy and plutonium management. All of the spent fuel in Japan has been stored as future energy resources. Some spent fuel has been reprocessed at commercial reprocessing plants in Europe and a testing plant in Japan. Consequently, 7.3 tons of separated fissile plutonium (Puf) in Japan and 24.5 tons of Puf in Europe have been accumulated as of the end of 2014. [3] In addition, a commercial reprocessing plant in Japan is under construction and is expected to start operating in 2018. [4]

All of the separated plutonium retrieved by reprocessing is planned to be consumed in nuclear reactors. But, because of the Fukushima nuclear accident in 2011, all of Japan's nuclear reactors have been stopped. After the Fukushima nuclear accident, the Nuclear Regulation Authority (NRA) was established in 2012 and new regulations were introduced requiring safer and more secure operations of nuclear reactors. Since then, although Japanese electric power companies have made efforts to restart nuclear reactors as soon as possible, only two nuclear reactors have restarted as of 2015, with the approval of the NRA and the consent of local governments. Because restarts of nuclear reactors are difficult, slow, and unforeseeable, it is unclear how Japan's plutonium consumption will be affected in the future.

Because of recent increasing risks of terrorism and nuclear proliferation in the world, the international community seeks much more secure use of nuclear energy. All of the countries that store plutonium (which can be used for making nuclear weapons) must make the best efforts possible to decrease it. Taking this into account, concerns about Japan's problem of plutonium management have been growing in the international community and Japan's accountability for its recycling policy is essential.

In this paper, I analyze U.S. experts' opinions and concerns about Japan's problem and consider what Japan can (and should) do to solve it.

U.S. Experts' Opinions about Japan's Nuclear Energy Policy

In order to know what the United States is concerned about regarding Japan's nuclear energy policy including its recycling policy, I collected opinions of about a dozen U.S. experts from industry, academia, think tanks, and government-related organizations, mainly through interviews.

Opinions about Japan's nuclear energy policy after Fukushima nuclear accident

1. ***Japan should restart nuclear reactors as soon as possible to solve the problem of climate change.*** Many U.S. experts believe nuclear energy is a major energy resource that can help to solve the issue of climate change, so Japan needs to continue producing nuclear energy.
2. ***Japan should be very careful about nuclear energy use. Rather, it should develop renewable energy use.*** Some experts, who are anxious about nuclear energy safety and security, are adverse to nuclear energy use and instead advocate the development of much safer and cleaner energy resources.

Opinions about Japan's recycling policy

1. ***Recycling has no value in the economic sense today.***
2. ***Recycling causes nuclear proliferation and security risks.*** Most of U.S. experts insist that the idea of recycling was built on an (incorrect) assumption of scarce uranium resources. They insist that because today's and foreseeable prices of uranium are cheaper than the price to use plutonium, recycling has no economic value or advantage. [5] In addition, they claim that recycling has inherent risks related to proliferation, such as plutonium (the material used to create a nuclear weapon) theft. Although no U.S. experts whom I have talked to are concerned about the risk that Japan is currently making nuclear weapons with its stored plutonium, some of them point out that the mere capability of making nuclear weapons creates stress with other countries in Asia.
3. ***The value of recycling can be different from country to country. There might be a value in Japan due to its dense population in such a small region, therefore making spent fuel disposal in Japan more difficult than in the U.S.***
4. ***Although recycling has value, we don't yet have enough technology to use plutonium or other trans-uranic materials fully today.*** Some U.S. experts think that recycling has significance under certain conditions, such as high difficulty of nuclear waste disposal or achievement of strong technological basis.
5. ***Japan should stop its recycling policy.*** Some experts in the nonproliferation community, especially those who are strongly concerned about the risks of plutonium, insist that Japan should stop its recycling policy because recycling has no economic merits and causes nuclear proliferation and security risks.
6. ***If Japan continues its recycling policy, Japan should solve the problems below:***

- a. *Japan should balance plutonium production and consumption.*
- b. *Japan should decrease the amount of plutonium as much as it can.*
- c. *Japan should operate the commercial reprocessing plant in Rokkasho after solving these problems.*

Most of U.S. experts are eager to reduce the amount of Japan's plutonium. Based on the fact that restarts of nuclear reactors in Japan are slow and that Rokkasho Reprocessing Plant (RRP) is planned to start in 2018, they are concerned about the possibility that the amount of Japan's plutonium may continue to increase without a credible plan of consumption for the future.

7. *Japan should have a more transparent recycling policy plan.* Some experts suggest that Japan should not only declare that it will not have any excess plutonium, but that it will also show a detailed plan about plutonium management.
8. *Japan should explore all possibilities, especially spent fuel disposal options.* Some experts suggest that it is important for Japan to maintain its "once-through" option of spent fuel disposal, even while it continues its recycling policy, because Japan may not have enough reactors to burn all of the plutonium in the future.

Opinions about Japan's R&D approaches towards the future

1. *Japan should seek alternatives to mixed oxide (MOX) fuel for plutonium disposal.* Experts who are opposed to Japan's recycling policy insist that Japan should seek to dispose plutonium without burning it as MOX fuel. They are also concerned about the U.S. plan to dispose excess plutonium from dismantled nuclear weapons by making and burning MOX fuel. They suggest that the U.S. and Japanese governments should cooperate on this issue.
2. *As long as Japan continues its recycling policy, it should be involved with the development of FR technology. Japan can promote development of much more secure technology of reprocessing.* Japan aims to achieve two things by recycling. The first is to gain fissile plutonium as an energy resource by transmuting non fissile uranium. The second is to decrease the volume and toxicity of nuclear wastes by burning long half-life material. LWR is not as efficient for these purposes, so FR is preferable. That is why some experts suggest that there should be a strong connection between recycling policy and FR, and why Japan has promoted R&D on FR technology. Some experts also suggest that it is adequate to do R&D to look for the much safer and more secure reprocessing technology that doesn't separate pure plutonium if Japan continues its recycling policy.
3. *Japan should enhance its storage capacity of spent fuel, particularly with the use of dry cask storage technology.* Some experts point out that an urgent risk of the lack of spent fuel storage ability is a driving force to the early operation of a commercial reprocessing plant. In order to avoid this risk, they suggest that Japan should increase its capacity of interim spent fuel storage, using a dry cask storage system, which is very safe and cheap.

4. ***Japan should promote R&D on advanced nuclear reactors.*** Some experts vow that the world is moving towards much safer and cheaper nuclear reactors. This worldwide trend is related to their construction by many countries that have essentially no experience of operating nuclear reactors, necessitating the creation of a new type of reactor with inherent safety features that can be stopped safely and automatically without well experienced operators in case of accidents. Advanced reactors are expected to satisfy both safety and lower cost concerns.

5. ***Japan should promote R&D on renewable energy technology.*** Because Japan is completely certain that the achievement of cheap, safe, and clean renewable energy resources is ideal, it needs to promote R&D in this field.

What Can (and Should) Japan Do To Solve Its Problematic Recycling Policy?

One of the goals of this article is to consider what Japan's options are in regards to its challenging recycling policy. This section will focus on U.S. experts' opinions on recycling, and I will consider potential routes that Japan can take based on them.

What can (and should) Japan do based on the opinion that Japan should end its recycling policy?

1. ***It is not realistic for Japan to stop its recycling policy at present.*** After the Fukushima nuclear accident in 2011, Japan discontinued all of its nuclear reactors and considered its future policy on nuclear energy use. After discussion, the Japanese government decided on the continuation of nuclear energy use and recycling, formulated in its *Strategic Energy Plan* of 2014.

We can understand how Japan thinks about recycling from the *Strategic Energy Plan*. First, although it is said that recycling has no economic value today, Japan has discovered that it has significance in other ways. In its *Strategic Energy Plan*, it is described that the basic policy of Japan is to promote a nuclear fuel cycle “from the viewpoint of effective utilization of resources and reduction of the volume and harmfulness of high-level radioactive waste.” [6]

Second, Japan has a longstanding history of cooperation among all parties in the promotion of recycling and solving the issue of spent fuel management, which is regarded as a significant mid to long-term topic of concern. Over time, the central government has formulated national policy and developed fundamental technology, while industry has constructed and operated recycling facilities. The local government of Aomori, a prefecture in the northern part of Japan's main island of Honshu, has accepted these facilities and the interim storage of spent fuel and nuclear wastes as a result of reprocessing. In the *Strategic Energy Plan*, it is described that the Japanese government will steadily promote reprocessing and plutonium use “while taking into consideration the past history and seeking the understanding of the relevant municipalities,” and that “problems related to the nuclear fuel cycle cannot be solved in a short period but require a mid to long-term approach.” [6]

The Fukushima nuclear accident certainly brought to light a significant problem of spent fuel management that nuclear reactors stopped and the plutonium consumption plan became unclear. However, does it lead directly to the idea that Japan stops its recycling policy?

When considering the history of Japan, it is more realistic and natural for Japan to make best efforts to solve these new problems and continue its recycling policy.

Because only a few years have passed since Japan established its post-Fukushima nuclear accident policy in 2014, it should be carefully watched and monitored.

2. ***Japan should explore other options regarding spent fuel management so that it can change its policy if necessary in the future.*** Some U.S. experts point out that one of the reasons why Japan doesn't discontinue its recycling policy is because of the complicated relationship between the central and local governments.

If the Japanese government stops its recycling, all of the spent fuel and nuclear wastes that have accumulated must be moved out of Aomori prefecture because the continuation of recycling policy is the condition for all of cooperation of Aomori prefecture. But who is ready (and willing) to accept the spent fuel and nuclear waste buildup? The Japanese government has no realistic answer. The U.S. experts point out that this situation makes it difficult for the Japanese government to stop its recycling policy. Another U.S. expert insists that just to be able to continue its present policy is one of the reasons why the Japanese government doesn't stop its recycling policy.

These opinions reveal a negative aspect of Japan's policy. Because Japan concentrated solely on the promotion of a recycling policy for so long, it appears to have no other realistic policy options about spent fuel management now.

Looking towards the future, Japan should improve this problem. And some activities have been beginning after Fukushima nuclear accident.

In the *Strategic Energy Plan*, it is described that the Japanese government will "secure reversibility and retrievability so that the future generation will be able to select the best disposal method when a better solution will be found in the future," and that it is "necessary to expand the capacity for storing the spent fuels and is urgently important to broaden the range of choices for managing the spent fuels while ensuring safety," and "it will make flexibility of policies and response, and contribute to medium-term energy security." [6]

After the Fukushima nuclear accident, Japan began R&D on the spent fuel direct disposal method and began to strengthen its efforts for facilitating the construction and utilization of new interim storage facilities and dry cask storage facilities. [7] [8]

These activities are examples of how Japan is exploring additional options should a policy change occur in the future. Japan should promote such innovation and advancement in the field of nuclear energy.

3. ***Japan should continue to intensify its efforts for the peaceful use of nuclear energy.***

Moreover, in order to promote its recycling policy, Japan needs to overcome nuclear proliferation and security risks related to reprocessing. Japan has already taken several positive steps in the direction of peaceful nuclear energy use, such as its aggressive acceptance of IAEA safeguards over the years. Japan must continue these activities.

Yet the Fukushima nuclear accident highlights a new problem about recycling and Japan must take accountability to solve this problem. This will be discussed in the coming sections.

What can (and should) Japan do based on the opinion that Japan should balance its production and consumption of plutonium?

Japan should develop a new mechanism to take the appropriate balance of plutonium production and consumption before RRP starts to operate. Most of the U.S. experts who emphasize proliferation and security risks caused by recycling are concerned about the possibility that Japan will produce more plutonium at RRP than it can consume in nuclear reactors.

RRP is planned to begin operations during the first period of the Japanese fiscal year 2018 (between April and September of 2018). [4] From there, it will gradually pump up its operations and, when it reaches full scale, approximately 4.5 tons of Puf can be produced per year. Yet because the process of restarting nuclear reactors has been delayed and the restart times are difficult to foresee, the expected amount of plutonium consumption is also unclear. In order to restart nuclear reactors, approval of the NRA and the consent of local governments are necessary. This strict process stems from anxiety about nuclear reactor safety after the Fukushima nuclear accident. A report estimates the probable amount of plutonium consumption as of 2023 and it insists that it is impossible for Japan to consume 4.5 tons of Puf per year under current evaluations. [9] This leads to the need for an adjustment of the throughput of RRP in order to balance the amount of plutonium emitted.

However, because RRP is a commercial plant operated by a private company, operations should be carried out on a business basis. Adjusting the throughput can lead to a fall in profits, so it is not necessarily easy to adjust the throughput of RRP in today's systems; this creates a tricky dynamic between nonproliferation and business.

In order to resolve this difficult situation, the Japanese government working together with industry should consider building a new mechanism to satisfy both nonproliferation concerns and commercial objectives, while also fulfilling the issue of plutonium balance. Although it is described in the *Strategic Energy Plan* of 2014 that the Japanese government will “conduct an appropriate management and utilization of plutonium while paying due consideration to an appropriate balance between separation and utilization of plutonium,” a more concrete and transparent mechanism must be determined. [6]

This mechanism can be achieved through various approaches, including the establishment of an organization, regulation standards, a budget, and so on. This mechanism may be enforced by the Japanese government, industry, or a combination of the two. In order to increase the credibility and transparency of this mechanism, the Japanese government must commit to it regardless of where it's made.

In addition, this mechanism should be grounded on the idea that the production amount should be determined based on the estimated amount of consumption, while also taking into account the mechanism should be realistic and flexible enough to truly work. Although the amount of plutonium produced can be adjusted technically by changing the operation level of RRP, the estimated amount of consumption is more difficult to quantify because of the complicated and unforeseeable process of reactors' restarts. So, the amount of production can only be determined based on the consumption amount estimated at a certain level of accuracy. Although the criteria of “a certain level of accuracy” are difficult to establish, a significant benchmark may be securing the approval of the NRA and the consent of local governments about restarting reactors that are planning to use MOX fuel.

Moreover, even though the amount of consumption is approximated carefully, the estimated amount does not always match with how much plutonium is actually consumed. There is a time lag between the timings of estimation and consumption because some processes, such as MOX fuel fabrication, are necessary. During this time lag, the plutonium consumption plan of each reactor can be changed based on varying circumstances encountered during operations. For example, there may be a case when a reactor stops because of an unplanned shutdown and it can't consume as much plutonium as it planned to consume. To solve this issue, it is important

not to aim to take the plutonium balance every year tightly but take it in a certain time period. In the case above, the plutonium production amount of next some years should be adjusted to take the appropriate balance at the end of the time period. It is not a simple and easy task to take the plutonium balance. Japan should consider a new mechanism that is realistic and flexible enough to work.

What can (and should) Japan do based on the opinion that Japan should decrease its overall amount of plutonium as much as it can?

If Japan doesn't currently have a serious need or plan to use its own plutonium that is stored in the United Kingdom and France, taking its ownership to both countries is a possible good idea. Japan should begin discussions with both countries in regards to the feasibility of this idea.

In 2014, on the occasion of the third Nuclear Security Summit in The Hague, Netherlands, Prime Minister Abe and President Obama pledged to remove and dispose of all of the plutonium and highly-enriched uranium from Fast Critical Assembly, a testing facility in Japan. These nuclear materials are set to be securely transferred to the United States and then fully converted into less sensitive forms. [10] These efforts to decrease nuclear material of both countries are highly evaluated.

Japan has a large quantity of plutonium stockpiled not only in Japan, but also in the United Kingdom and France. By learning from the achievement at the third Nuclear Security Summit, it seems to be effective for Japan to take ownership of Japan's plutonium to both countries if Japan doesn't have strong needs or plans to use it today. Japan should start to discuss this idea with both countries.

One of the biggest concerns about Japan's current plutonium storage situation is the anxiety over the excess of plutonium that can't be consumed or disposed of. However, this same anxiety exists in the United Kingdom and France as well because the plutonium management plans of both countries are not clear or uncertain. [11] When considering solely the Japanese situation, this idea of taking ownership of excess plutonium to the UK and France definitely alleviates these concerns, yet it may increase European unease when considering the whole world.

Of course, because taking ownership of plutonium diminishes the risk caused by transportation of plutonium from Europe to Japan, this idea should remain on the table. So I believe that Japan should try to carry out this idea, but that it should recognize that other countries have similar issues, and that any decision by any country can have widespread impacts and consequences.

What can (and should) Japan do based on the opinion that Japan should explore all possibilities, especially about spent fuel disposal, and opinions about Japan's R&D approach towards the future?

In order to explore and maintain many policy options, Japan should promote broad R&D. As mentioned previously, when considering the policy about spent fuel management, I think Japan should explore other policy options while it continues its recycling policy. For this purpose, I believe it is important and effective to promote R&D.

In nature, R&D is an effective tool, not only because it furthers existing national policies, but also because it contributes to the building of technical standards and the exploring of the possibility of new national policies. This importance of R&D is true of not only of spent fuel management but also of other issues. Japan began to promote R&D on the direct disposal method of spent fuel after the Fukushima nuclear accident. Japan has also promoted R&D on advanced nuclear reactors and renewable energy use, in which U.S. experts have vested interests (as shown above). Japan should continue and intensify these types of R&D activities in order to explore and maintain several policy routes in the future. Moreover, in order to promote R&D effectively and economically, it is important to cooperate with other countries which have aligned problems and interests.

In addition to robust technical R&D, policy research is also vital. By considering what policy may be desirable in the future and how it can be achieved, Japan can advocate for candidates of its policy and R&D. In general, because policy research isn't as expensive compared to technical R&D, the Japanese government should fund policy research in order to gather useful ideas from professionals and experts in the field. In particular, participation and collaboration of experts internationally will be effective should Japan's policy be considered in a global context.

Conclusion

In this paper, I showed U.S. experts' opinions about Japan's nuclear energy policy, especially concerns about its recycling policy, and considered five suggestions for Japan's future.

1. Although it is not realistic for Japan to stop its recycling policy now, Japan should explore other options about spent fuel management so that it can change its policy if necessary in the future.
2. Japan should continue its efforts for the peaceful use of nuclear energy, including its plutonium management.
3. Japan should develop a new mechanism to take the appropriate balance of plutonium production and consumption before RRP starts to operate.
4. In order to decrease the amount of Japan's plutonium, taking ownership of Japan's plutonium stored in the United Kingdom and France to both countries is a possible good idea. Japan should start to discuss this idea with them.
5. In order to explore and maintain many policy options, including those about spent fuel management, Japan should promote broad R&D.

Through these kinds of activities, Japan should continue and intensify its peaceful nuclear energy use, while also promoting its accountability and transparency to the international community.

Besides, Japan should contribute to the whole world. Japan is a unique country in that it has one of the most developed nuclear energy use programs and it is the only non-nuclear weapon state that has full recycling technology capabilities and facilities, all while being the only country that has suffered from nuclear weapons at war. Because of its distinctive status, Japan's policy can affect all countries which use or will use nuclear energy. Improvement of its stored plutonium management can contribute to other countries that have the same problems and Japan's experiences and advanced technology about peaceful nuclear energy use, such as safeguards, can contribute to the development of countries emerging in the nuclear energy field.

It is important for Japan to recognize its position in the international regime and to make its best effort to improve both domestic and international peaceful nuclear energy use.

Endnotes

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