Politics and Japan's Rokkasho Reprocessing Plant

September 2014

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Three years after the Fukushima accident, Japan continues to struggle with decisions on how to move forward with nuclear energy. No one is sure how many nuclear power plants will restart (Japan operated 55 before the March 2011 earthquake that closed them all pending safety checks), but the Japanese government has largely proceeded with its previous plans for a closed nuclear fuel cycle. This means that Japan plans to separate plutonium from its spent reactor fuel with no clear path for its use. This article sketches the political underpinnings of Japan's fuel cycle policy that contribute to this "business as usual" approach.

With the election of the pro-nuclear Abe government in 2013, the cogs of the nuclear bureaucratic machine began to turn, leaking out bits of fuel cycle policy slowly. In April 2014, the Ministry of Economy, Trade and Industry (METI) stated in the 4th Strategic Energy Plan of Japan that the Monju Fast Breeder Reactor (FBR) would continue as a research center that would focus on waste reduction. On July 11, 2014, METI announced that it would target three issues: the decommissioning of reactors, deregulation of electric power markets, and the handling of spent fuel.[1]

The Rokkasho Reprocessing Plant (RRP) plays a central role in closing the nuclear fuel cycle for Japan -- that is, separating plutonium and uranium in spent fuel from highly radioactive fission products so that the plutonium and uranium can be used in nuclear fuel again. Japan is one of a handful of countries that reprocesses for commercial nuclear power; some countries reprocess irradiated nuclear material for weapons purposes. Japan will not fully close the fuel cycle until it commercializes reactors that breed plutonium; until then, it will simply recycle its plutonium once in mixed oxide (mixed plutonium and uranium in oxide form) fuel in conventional light water reactors.

Whatever the ultimate goal of reprocessing, Japan, along with all other countries operating commercial nuclear power plants, has not yet managed to open a permanent waste repository. Often referred to as a "mansion without a toilet,"[2] Japan has about 17,000 tU (metric tons of uranium)[3] of spent fuel and no permanent disposal site.[4] METI expects that some spent

[1] *Nihon Keizai Shimbun.* "METI announced three target issues. "July 11, 2014. http://www.nikkei.com/article/DGXNASDF11H0B_R10C14A7PP8000/

[2] *Fukui Shimbun.* "Nuclear waste." July 11, 2014. http://www.fukuishimbun.co.jp/localnews/editorial/52126.html

[3] tU refers to the initial weight of uranium in a fuel assembly before irradiation and is used to calculate the amounts of spent fuel. This is the unit most commonly referred to in official estimates of Japanese spent fuel.

[4] Technical Subcommittee on Nuclear Power, Nuclear Fuel Cycle, etc. "Nuclear fuel cycle." (核燃料サイクルの諸量・経済性評価について) June 11, 2012. http://www.aec.go.jp/jicst/NC/tyoki/hatukaku/keisan/kaku_cycle.pdf

Figure II: Rokkasho Reprocessing Plant

Figure II Source: Wikimedia, http://upload.wikimedia.org/wikipedia/commons/1/12/Rokkasho_2.JPG

fuel pools will reach their maximum capacity in three years,[5] and about 2951 tU of this spent fuel is also stored in Rokkasho.[6] How will the Japanese government solve its spent fuel problem, and by extension, determine the future of the Rokkasho Reprocessing Plant? What are some of the political considerations of the Rokkasho Reprocessing Plant?

Rokkasho Reprocessing Plant: Origins and Future[7]

Originally, the Japanese government developed reprocessing technologies in order to extract uranium and plutonium for use in the Monju FBR to "breed" more plutonium than it consumes. In doing so, government officials hoped that this closed fuel cycle would produce a self-sufficient supply of energy. A related motivation was the (ultimately disproven) fear that uranium was scarce and would eventually run out. This perceived need for energy security was particularly acute in Japan, given its lack of domestic resources and its reliance on energy imports.[8] Currently, with all of its nuclear reactors mothballed, Japan imports 90% of its total energy resources from abroad. However, because of a series of troubles at the Monju FBR, the government instead pushed for the so-called Pluthermal program in which MOX fuel is utilized in light water reactors (LWRs) instead of the Monju FBR.

In order to develop Japan's fuel cycle, the Japan Atomic Energy Agency (JAEA) has operated a reprocessing plant in Tokai Village of Ibaraki Prefecture, which accepted its first load of spent

[5] *Nihon Keizai Shimbun.* "METI announced spent fuel pool. "February 20, 2014. http://www.nikkei.com/article/DGXNASFS20026_Q4A220C1EE8000/

[6] Aomori Prefecture. "Report of Spent fuel in Rokkasho Reprocessing Plant."(再処理工場、高レベル放射性廃棄物貯蔵管理センター、低レベル放射性廃棄物埋設センター、ウラン濃縮工場、東通原子力発電所に関する報告について) June 30, 2014. http://www.aomori-genshiryoku.com/entry/file/teikihoukoku140630.pdf

[7] JNFL. "The present situation and future prospects of Rokkasho Reprocessing Plant." February 21, 2012. http://www.aec.go.jp/jicst/NC/tyoki/sakutei/siryo/sakutei4/siryo2-2.pdf

[8] METI. "The 4th Strategic Energy Plan of Japan." April, 2014. http://www.enecho.meti.go.jp/category/others/basic_plan/pdf/140411.pdf. (pp.8).

fuel in 1977. This reprocessing plant was commissioned in 1981. However, the capacity of Tokai Reprocessing Plant was 210 tU of spent fuel per year, and most of Japanese spent fuels were sent to France and Britain for reprocessing. In March 1997, an explosion occurred at the facility and operation did not resume until 2000. Following the Tokai Reprocessing Plant, Japan Nuclear Fuel Ltd. (JNFL) established Japan's first commercial nuclear fuel reprocessing plant in Rokkasho Village of Aomori Prefecture. The construction of the Rokkasho Reprocessing Plant (RRP) started in 1993 and began active testing in March 2006. The maximum processing capacity of the RRP is 800 tU of spent fuel per year, which would produce 4 tons of separated plutonium.[9] With all its nuclear power plants operating, however, Japan would be producing 1000 tons of spent fuel per year. Rokkasho was never meant to be the end of the reprocessing story, but rather the beginning.

Critics of the Rokkasho program point to schedule delays, tremendous cost increases, and technical problems. Rokkasho was expected to be operational on October, 2013 yet it still has not opened.[10] RRP's cost of construction has increased threefold since its application for a business license (See Table I in the Appendix). JNFL stated that these increased costs were due to labor costs, and the cost of implementing aircraft crash protections and earthquake resistance measures.[11] Before the Fukushima accident, JNFL's completion had been delayed more than 20 times, in part due to troubles at the fusion furnace, where high-level radioactive waste is vitrified into glass.[12] On June 19, 2014, the new Nuclear Regulatory Authority (NRA) stated that JNFL's application for an operating license was deficient. In particular, Shunichi Tanaka, the first chairman of the NRA, stated that JNFL had not established an appropriate risk management system for severe accidents. Also, he stated that JNFL failed to conduct the proper severe accident measures and that JNFL provided insufficient answers to NRA questions during review meetings.[13] Thus, the NRA stated that it cannot review the application because of insufficient paperwork from JNFL. While JNFL had originally planned for RRP to begin reprocessing spent fuel by October 2014, this timeline seems increasingly unlikely because it will need to resubmit its application to the NRA.[14]

Japan's Current Spent Fuel Outlook and the Rokkasho Reprocessing Plant

There is currently about 17,000 tU of spent fuel in Japan while RRP's spent fuel capacity is 3000 tons. By mid-2014, the Rokkasho facility was already storing 12,008 spent fuel rods (about 2,951 tU of spent nuclear fuel)[15] Table II shows the storage situation of each nuclear power plant as of March 31, 2014. The data indicates

[9] JNFL. "The present situation of Rokkasho Reprocessing Plant." March 26, 2013. http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2013/siryo11/siryo2-1.pdf

[10] JNFL. "Current situation of Rokkasho Reprocessing Plant." March 26, 2013. http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2013/siryo11/siryo2-1.pdf

[11] JNFL. "Q & A." http://www.jnfl.co.jp/goiken/answer.html

[12] *Yomiuri Shimbun.* "RRP completion has been delayed. "February 11, 2014. http://www.yomiuri.co.jp/local/fukui/feature/CO005797/20140210-OYT8T01751.html

[13] *Kahoku Shimpo.* "JNFL cannot operate by October 2014 Rokkasho Reprocessing Plant." May 18th, 2014. http://www.kahoku.co.jp/tohokunews/201405/20140518_23016.html

[14] *Mainichi Shimbun.* "JNFL cannot operate by October 2014 Rokkasho Reprocessing Plant." June 25, 2014. http://mainichi.jp/select/news/20140620k0000m040168000c.html

[15] Aomori Prefecture. "Report of Spent fuel in Rokkasho Reprocessing Plant."(再処理工場、高レベル放射性廃棄物貯蔵管理センター、低レベル放射性廃棄物埋設センター、ウラン濃縮工場、東通原子力発電所に関する報告について) June 30, 2014. http://www.aomori-genshiryoku.com/entry/file/teikihoukoku140630.pdf

that 6 nuclear power plants are already in excess of 70% of their spent fuel storage capacity. For some of these plants, such as the Genkai, Tokai, and Kashiwazaki-Kariwa NPPs, spent fuel storage will reach its total capacity within approximately 3 more years of operation. If a nuclear power plant reaches its spent fuel storage capacity, the utilities cannot continue to operate the plant.

Table III shows the estimated amount of nuclear spent fuel. According to the Diet's Nuclear Energy Subcommittee, the total amount of spent nuclear fuel that would be generated per year is 1,080 tU as of March 31st in 2014, assuming that all reactors restart. Assuming that Rokkasho operates at full capacity (800 tU spent fuel per year), it would be able to reprocess all of the spent fuel generated by about two-thirds of the current reactor fleet. Clearly, the justification for operating RRP will depend on the number of reactor restarts. If all of the nuclear power plants restart, there will be a stronger rationale for operating RRP to be able to move spent fuel away from reactor sites.

As part of its plans for handling its spent fuel and separated plutonium, Japan has promoted the Pluthermal program, which uses MOX fuel, a mixture of uranium and plutonium reprocessed from spent uranium at LWRs. Before the Fukushima accident, Japan and utilities hoped to run 16-18 reactors on MOX fuel by FY 2015.[16] While RRP can reprocess 800 tU of spent fuel per year, this does not cover spent MOX fuel. The government had originally planned to reprocess spent MOX fuel in another reprocessing plant, but the location, place and date of construction of this second reprocessing plant is undetermined.[17] Ultimately, the Pluthermal program will not offer a permanent solution to Japan's spent fuel problems and Japan will need to find a final disposal site for storing its waste and spent fuel.

According to METI's most recent plans, RRP would produce approximately 4 tons Plutonium per year.[18] Before the Fukushima accident, METI planned to consume 5.5-6.5 tons Plutonium annually. This number included the Ohma Reactor (which would have consumed 1.1 tons Plutonium in MOX fuel) and Fukushima No 3 and No 4 Reactor (which would have consumed 0.9-1.6 tons Plutonium in MOX Fuel), both of which are unlikely to restart after the Fukushima accident. Thus, without operation of these reactors and no replacement for their plutonium consumption, the operation of RRP would lead to a growth in separated plutonium.[19]

Aomori Prefecture, Rokkasho Village, and JNFL all agreed to a memorandum regarding RRP on July 29, 1998. According to the memorandum, Aomori Prefecture, Rokkasho Village, and JNFL will hold consultations and promptly implement all necessary and appropriate measures if there are difficulties with reprocessing, including the possibility of JNFL shipping back the spent fuel stored in Rokkasho.[20] Furthermore, in 2012, the Rokkasho Village assembly adopted the opinion

[16] The Federation of Electric Power Companies of Japan. "The present of Pluthermal." http://www.fepc.or.jp/nuclear/cycle/pluthermal/genjou/

[17] *Fukui Shimbun.* "Spent Mox fuel." October 8, 2014. http://www.fukuishimbun.co.jp/localnews/nuclearpowertworings/24115.html

[18] JNFL. "The present situation of Rokkasho Reprocessing Plant." March 26, 2013. http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2013/siryo11/siryo2-1.pdf

[19] Table IV Source: Resources and Energy Agency. http://www.cas.go.jp/jp/seisaku/genshiryoku_kaigi/dai3/siryou1.pdf

[20] Aomori Prefecture. "Memorandum." http://www.pref.aomori.lg.jp/soshiki/energy/g-richi/files/siryou21.pdf

Figure II: Location of Aomori Prefecture and Rokkasho Village

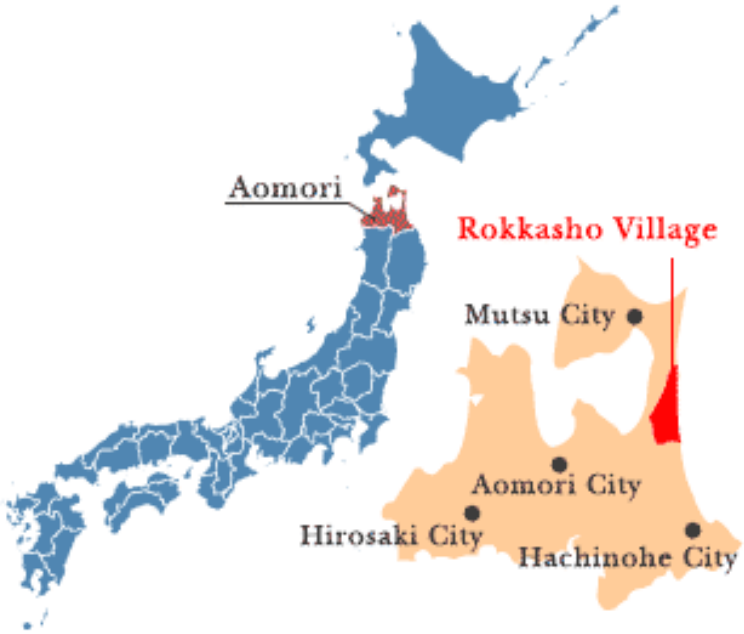

Figure I Source: Rokkasho Prefectural Museum

that Rokkasho should send all of the spent fuel stored at Rokkasho back to nuclear power plants if the government no longer supports the back-end facilities at Rokkasho.[21] If this occurs, Genkai, Tokai-2, Kashiwazaki-Kariwa, and Shimane NPPs would have to cease operations within two years because of the added spent fuel from Rokkasho.[22]

The Politics of Rokkasho Village

Rokkasho Village is located on the Pacific side of Aomori Prefecture. The total population of Rokkasho Village is 10,788, and 200 of this population work in Rokkasho for JNFL. Also, according to the JNFL, half of all JNFL employees (the total number of JNFL employees in Japan is 1250) are originally from Rokkasho Village, indicative of the local ties between Rokkasho and JNFL.

Since 1985, most of the successive mayors of Rokkasho have expressed support for RRP. In 1989, although then-candidate Hiroshi Tsuchida pledged to freeze RRP during his mayoral campaign, he reneged from his pledge and promoted RRP after becoming Mayor. On June 22, 2014, the newly elected Mamoru Toda, also the former vice Mayor, followed this trend of past mayors and argued that Rokkasho Village should promote RRP and the closed nuclear fuel cycle. Running against three other candidates who were all against RRP, Toda won and received 95% of the total votes.

[21] Rokkasho Village assembly. "Opinion brief." http://www.rokkasho.jp/index.cfm/11,491,32,134,html

[22] Technical Subcommittee on Nuclear Power, Nuclear Fuel Cycle, etc. "The risk of nuclear spent fuel." http://www.aec.go.jp/jicst/NC/tyoki/hatukaku/siryo/siryo15/siryo1-5.pdf

The Rokkasho Village assembly supported Toda as well. In Rokkasho Village, there are three choices for party affiliation: Kizuna, Yuseikai, and no party. According to the *Mainichi Shimbun*, all three categories supported Toda. If a Rokkasho Village party supports a candidate who ends up losing the election, the villagers who supported the party would not win a bid for a public works project in Rokkasho Village. Thus, all parties chose to support RRP and not debate its merits, rather than risk losing their bid for a public works project.[23] Thus, RRP was not a central issue in Rokkasho Mayoral Race.

On June 24th, 2014, Mamoru Toda stated that he would not agree to the Nuclear Safety Agreement[24] with JNFL until the NRA finishes its emergency management response plan. The Nuclear Safety Agreement is required for full-scale operation of nuclear power plant. The main points in the agreement are the monitoring of radiation, emergency procedures, the right to make on-site inspections, and notification of new construction or expansion.[25] If the Governor of Aomori Prefecture and the Mayor of Rokkasho Village conclude an agreement, it means an acceptance of full-scale operation of nuclear power facilities. Thus, the Nuclear Safety Agreement is the primary means to preventing an accident at RRP. After the Fukushima accident, the NRA expanded the Nuclear Emergency Response zone (UPZ) of nuclear power plant from 10km to 30km and now reviews the disaster prevention guidelines. However, the review of RRP has been postponed.[2627] Nonetheless, Rokkasho Village has remained united on its stance regarding the operation of RRP since 1989. Even now, the majority of Rokkasho Village and Aomori Prefecture where RRP is located agree that they should promote RRP for the local economy.

Support in the Diet[28]

Prime Minister Shinzo Abe and his Liberal Democratic Party (LDP) have promoted nuclear energy in Japan and pledged to restart nuclear reactors under the world's highest level of safety standards. Most LDP members have not declared their stance on RRP. However, several LDP Diet members and lawmakers (Taro Kono[29], Masatoshi Akimoto, Masahiko Shibayama [former Senior Vice-Minister for Internal Affairs and Communications], Masanobu Ogura, Shunsuke Takei, Keiko Nagaoka, and Gaku Hasegawa) have stated that

[23] *Mainichi Shimbun."*Rokkasho village election." June 25, 2014. http://senkyo.mainichi.jp/news/20140625ddlk02010072000c.html

[24] The Federation of Electric Power Companies of Japan. "Nuclear safety Agreement." http://www.fepc.or.jp/library/words/genshiryoku/seido/seido/1225456_4579.html

[25] The Federation of Electric Power Companies of Japan. "Nuclear safety Agreement." http://www.fepc.or.jp/nuclear/chiiki/nuclear/kakunenryouzei/

[26] *Kahoku Shimpo.* "New mayor doesn't enter into Safety agreement until guideline." July 8, 2014. http://www.kahoku.co.jp/tohokunews/201407/20140708_21018.html

[27] *Toonipposha.* "New mayor doesn't enter into Safety agreement until guideline." June 25, 2014. http://headlines.yahoo.co.jp/hl?a=20140625-25100832-webtoo-l02

[28] See *Asahi Shimbun.* "LDP member visit Monju." January 21, 2014, http://www.asahi.com/articles/ASG1N4J6BG1NUTFK00J.html.

[29] Taro Kono Official blog. http://www.taro.org/2012/06/post-1214.php. Also see, *Tokyo newspaper.* "No nuke in the LDP." October 14, 2014. http://www.tokyo-np.co.jp/article/feature/nucerror/list/CK20131014021000004.html

government should halt RRP plans and reconsider its plans for the nuclear fuel cycle. The policy of the DPJ in 2012 was to continue the closed fuel cycle and reprocessing, even though it also aimed for nuclear phase-out by the 2030s.

The support for these candidates is tenuous. Among them, Keiko Nagaoka's constituency is Ibaraki Prefecture which has the Tokai 2 Nuclear Power Plant. In the election of House of Representatives in 2012, Nagaoka failed to gain the single-seat district but was elected in the proportional representation system. While Nagaoka could not get enough support from Ibaraki 4th district, she could still be sent to the Diet because of the party won in the proportional representation block. At the time, Kishiro Nakamura (former Construction Minister and Director General of the Science and Technology Agency) won in Ibaraki 4th district and stated that the nuclear power plant should restart if it clears the new standards.

National Funding System: Kofu-kin and Tax Revenue

During the economic growth period in the 1960s, when the demand for electricity in Japan had increased more than 10% per year, the rapid development of an electric power supply was an imminent challenge for the Japanese government.[30] Responding to growing energy demands, the Japanese government passed legislation known as the "Three Power Source Development Laws" for promoting electric supply development in 1974. Under the Three Power Source Development Laws, regions that accepted nuclear, water, and/or thermal electric power plants are eligible for Kofu-kin, which is a government subsidy for regional infrastructure, such as roads, bridges, and meeting halls, but is not for nuclear power plants. However, the amount of Kofu-kin provided is heavily tied to the development nuclear power plants. In the case of a nuclear plant with a maximum output of 1350MW the local government could receive up to 121.5 billion yen of Kofu-kin in total, over the span of 45 years.[31] Kofu-kin is disbursed from a special account which consists of tax revenues from electric payments by households and firms. In essence, this Kofu-kin system has worked to deliver "pork" to municipalities in which nuclear power is located.

Municipalities can also earn huge direct revenues from utilities through fixed asset taxes imposed on nuclear power plants. In the case of a nuclear plant with a maximum output of 1200MW constructed in 2010 at the cost of 440 billion yen, a municipality can earn about 6.2billion yen in the first year of operation. However, due to the depreciating taxation system, the fixed asset tax revenues decrease by half in five years (3 billion yen) and to a quarter in ten years (1.5 billion yen).[32] On average, this national funding (Kofu-kin and tax revenues) makes up more than 15% of total revenues for municipalities nuclear are located.[33] Furthermore, the conditions for spending this tax revenue was not as limited as the Kofu-kin under the Three Power Development Laws, which this tax revenue particularly attractive to municipalities. The

[30] Koike, Takuji. "Fiscal and Economic Problems of Local Governments Owning Nuclear Power Plants."（「原発立地自治体の財政・経済問題」） National Diet Library of Japan. Jan. 29, 2013.pp.1 http://dl.ndl.go.jp/view/download/digidepo_6019846_po_0767.pdf?contentNo=1

[31] Koike, pp.4

[32] Koike, pp.5

[33] Koike, pp.6

depreciation of fixed asset tax may very well underlie the fact that many municipalities have introduced additional nuclear power plants and the locations of nuclear power plants are biased to specific regions. Eventually, municipalities' discretion over Kofu-kin was expanded to include other types of public services such as welfare.[34]

In addition to a tax on fixed assets, Shutsuryoku-wari is a nuclear fuel tax system. The Nuclear fuel tax is normally determined by the amount of the value of nuclear fuel rods loaded into operating reactors. But under recent changes in Shutsuryoku-wari since the Fukushima accident, municipalities can impose a tax on idled reactors for secure tax revenue by basing the tax on a reactor's heat output, rather than the previous metric of the fuel rods' value. The rate of tax varies by municipality. Aomori Prefecture has adopted Shutsuryoku-wari since 2012. In addition to it, Aomori Prefecture has imposed 2.3 times the nuclear fuel material handling tax since April in 2014. Tax revenue is 37 billion yen every year. Aomori Prefecture stated that the reason for the cost increase was the cost for safety preparation.[35]

Fiscal situation of Rokkasho

Total Kofu-kin for Rokkasho Village from 1981-2011 was 426 billion yen. Kofu-kin for Rokkasho was 32 billion yen in Aomori Prefecture in FY 2013.[36] Table V shows the Kofu-kin that goes toward infrastructures expenses in Rokkasho Village. In addition, Rokkasho village income per capita was 11.7 million yen in FY 2011, which is the top village income in Aomori prefecture.[37]

Conclusion

The Rokkasho reprocessing facility, now under construction for a quarter of a century, has been a significant source of jobs and revenue for the municipal government and certainly has its entrenched support among the local population. RRP also comes with a lot of political baggage. While there may be some decaying support for Japan's fuel cycle plans in the Diet, debate over the decision to operate RRP has fallen by the wayside in the wake of Japan's consternation over reactor restarts. As such, the Japanese Government used "flexibility" to describe its nuclear fuel cycle policy in the 4th Strategic Energy Plan of Japan, which appears to avoid declaring a coherent policy on the issue.

Nonetheless, there are several concerns with alternative paths forward for RRP. Continued operation of RRP would likely increase the supply of separated plutonium, particularly with an undermined Pluthermal

[34] Koike, pp.2

[35] *Asahi Shimbun.* "Nuclear fuel tax." March 26, 2014. http://www.asahi.com/articles/ASG373WMBG37UTIL00Q.html

[36] *Kahoku Shimpo.* "Three Power Source Development Laws". June 10, 2014. http://www.kahoku.co.jp/tohokunews/201406/20140610_21015.html

[37] Calculated as (business income + municipal income + individual income)/population.
Aomori Prefecture. "Income of municipal inhabitant." FY 2011.
http://www6.pref.aomori.lg.jp/tokei/data/0000003207/00000003207_1_6.pdf

program. If RRP no longer operates, there is also the question of where the spent fuel stored at RRP would go and which prefectures might accept interim storage for nuclear spent fuel. Adequate political and economic incentives for both Rokkasho and an interim storage would need to be established. However, whether or not Japan chooses to operate RRP, Japan will need to establish a final disposal site for its spent fuel. Clearly, the answers to all of these questions will depend on the number of reactor restarts, which also remains in limbo.

While the new Mayor of Rokkasho Village and Governor of Aomori Prefecture stated that they would not agree to the Nuclear Safety Agreement with JNFL until the NRA finishes its emergency management response, the primary concern for these parties is safety. If the NRA gives its permission to operate RRP, Rokkasho Village and Aomori Prefecture will agree to the Nuclear Safety Agreement with JNFL since they have relied on nuclear money for their infrastructure. More attention should be paid to nuclear security concerns, given that operation of RRP will increase stockpiles of separated plutonium that can be stolen and used by terrorists.

In any scenario, solutions for RRP require government leadership. The 4th Strategic Energy Plan of Japan in 2014 states that government will take the initiative to find final disposal site and enhance promotion of the nuclear fuel cycle. Thus, the nuclear fuel cycle is a national policy and the government should have the responsibility for RRP and determining the future of the nuclear fuel cycle in Japan. We learned from the Fukushima accident that the government should enhance its communication efforts for establishing trust with Japanese citizens. If there is a concrete reason why the government wants to operate RRP, the government should explain how it plans to manage its plutonium stockpiles and why operation of RRP would be better than the alternatives.

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Appendix: Tables

Table I. Costs of the Rokkasho Reprocessing Plant

Year	Total cost of construction (trillion yen)	Notes
1989	0.76 (Original cost)	As of application for reprocessing activity
1996	1.88	As of application for change of business plan
1999	2.14	As of change of construction plan
2004	2.19	As of change of construction plan
2005	2.19	As of change of construction plan

Table 1 Source: Japan Nuclear Fuel Ltd. http://www.aec.go.jp/jicst/NC/tyoki/sakutei/siryo/sakutei4/siryo2-2.pdf

Table II. Stockpile of Spent Nuclear Fuel as of March 31st, 2014

Utility	Plant	1 replacement (every 16 months) (tU)	Stockpile (tU)	Percentage of Storage Utilization (%)
Hokkaido	Tomari	50	400	39
Tohoku	Onagawa	60	420	53
	Higashidori	30	100	23
TEPCO	Fukushima-1	-	1,960	86
	Fukushima-2	-	1,120	82
	Kashiwazaki-Kariwa	230	2,370	81
Chubu	Hamaoka	100	1,140	66
Hokuriku	Shika	50	150	22
Kansai	Mihama	50	390	58
	Takahama	100	1,160	67
	Ohi	110	1,420	70
Chugoku	Shimane	40	390	65
Shikoku	Ikata	50	610	63
Kyushu	Genkai	90	870	78
	Sendai	50	890	67
JAPC	Tsuruga	40	580	67
	Tokai-2	30	370	84
Total		1,080	14,330	69

Table II Source: Nuclear Energy Subcommittee. See www.meti.go.jp/committee/sougouenergy/denkijigyou/genshiryoku/pdf/001_s01_00.pdf

Table III: Spent Nuclear Fuel Predictions

- Total nuclear spent fuel (tU)/year: 1,080.
  - 1/3 restart: 1080/3=360
  - 2/3 restart : 980/3*2=720

Condition of restart	Spent fuel (tU)/year	Untreated Nuclear spent fuel (tU)/year
1/3 restart	About 360	About -440
2/3 restart	About 720	About -80
All restart	About 1080	About 280
Condition of restart	Spent fuel (tU)/year	Untreated Nuclear spent fuel (tU)/year
1/3 restart	About 360	About -440
2/3 restart	About 720	About -80
All restart	About 1080	About 280

Table III Source: Nuclear Energy Subcommittee. http://www.meti.go.jp/committee/sougouenergy/denkijigyou/genshiryoku/pdf/001_s01_00.pdf. *Untreated Nuclear spent fuel is calculated by the author*.

Table IV: Pluthermal (MOX Fuel) Plutonium Consumption Plans in 2010

Utility	Plant	Plutonium tons/year
Hokkaido	Tomari3	0.2
Tohoku	Onagawa3	0.2
TEPCO	3-4 Reactors of Fukushima and Kashiwazaki-Kariwa	0.9-1.6
Chubu	Hamaoka4	0.4
Hokuriku	Shika1	0.1
Kansai	Takahama3 and Takahama4 1-2 Reactors of Ohi	1.1-1.4
Chugoku	Shimane2	0.2
Shikoku	Ikata3	0.4
Kyushu	Genkai3	0.4
JAPC	Tsuruga2 and Tokai2	0.5
JNFL	Ohma	1.1
Sum		5.5-6.5

Table IV Source: Resources and Energy Agency. http://www.cas.go.jp/jp/seisaku/genshiryoku_kaigi/dai3/siryou1.pdf

Table V: Rokkasho Village Kofu-kin (yearly average exchange rate in 2012: 1yen = $0.012)

Project (1981 -2012)	Project cost (yen)	Portion Kofu-kin (yen)
Road construction	3,613,430,342	3,426,565,000
Park improvement project	1,388,519,509	1,342,933,000
Water project	4,515,677,000	4,342,394,000
Communication facilities	2,507,104,372	2,468,235,000
Sports facilities	595,082,900	560,658,000
Environmental facilities	1,015,394,000	1,004,892,000
Education facilities	8,527,679,898	8,122,333,000
Medical facilities	2,567,617,204	2,522,048,000
Social welfare facilities	3,425,584,294	3,346,300,000
Fire equipment	267,300,000	266,270,000
National conservation facilities	125,531,000	122,000,000
Industrial development (agriculture, forestry, and fisheries)	4,805,724,000	4,229,015,000
Industrial development (tourism)	363,952,981	357,956,000
Industrial development (Commerce and industry)	715,470,000	685,914,000
Event business	112,766,326	84,399,346
Public information investigation business	49,811,360	49,200,000
Regional activation business	6,266,406,643	5,575,708,000
Agriculture, forestry and fisheries industry promotion support project	512,264,275	511,697,000
Firm location support project	120,000,000	120,000,000
Local promotion program planning business	37,977,738	37,000,000
The atomic energy location benefit addition	5,742,487,163	5,700,909,700
Measures grants (cycle) such as public information security	571,527,715	560,919,555
Measures grants (Higashidori) such as public information security	130,682,960	126,425,000
Total	47,977,991,680	45,563,771,601

Table V Source: Rokkasho Village http://www.rokkasho.jp/index.cfm/7,886,17,html.