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# The Failures of Japan's Nuclear Fuel Cycle Program

## 1956 – 2007

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May 2007

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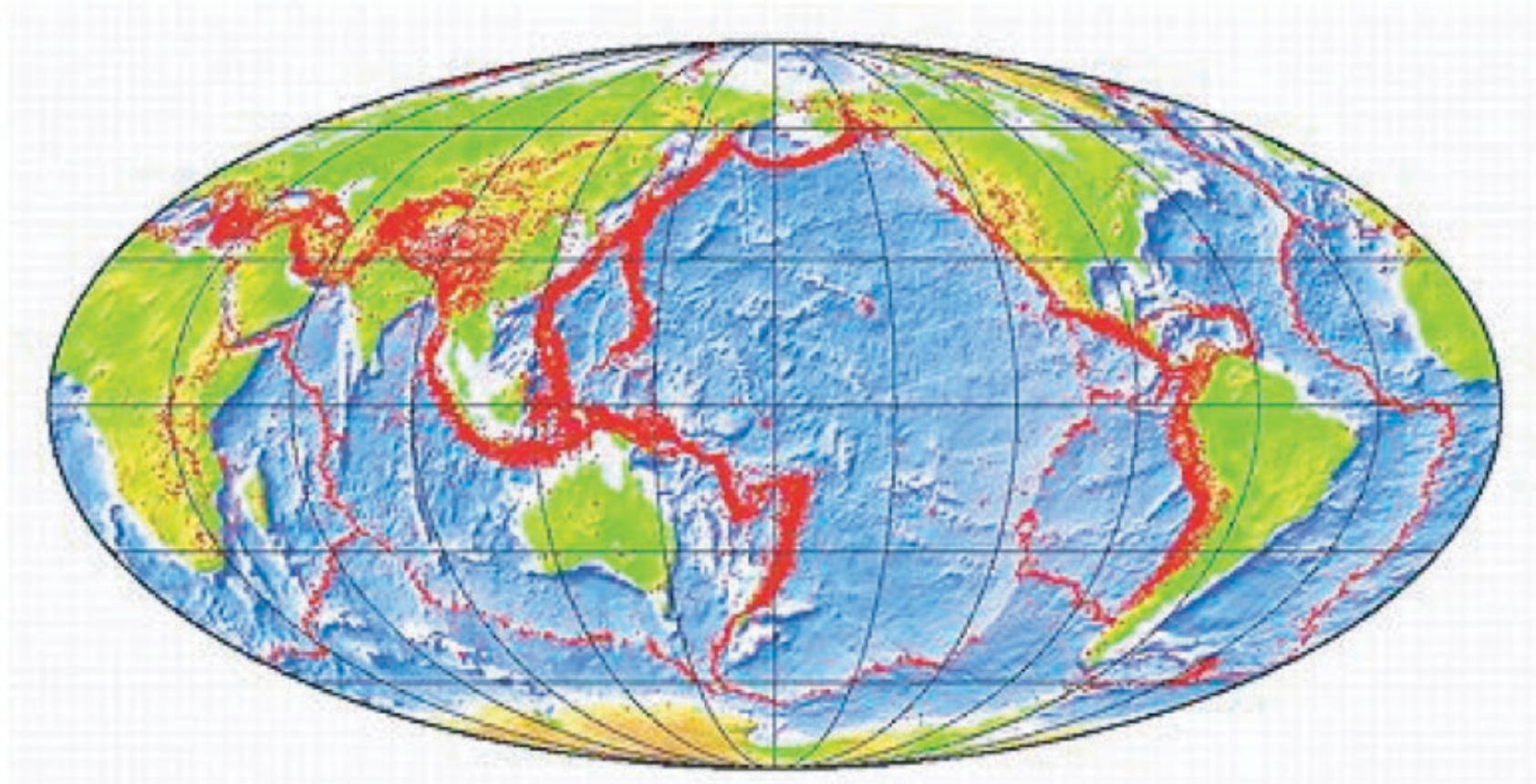
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# Japan is Earthquake Prone

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# JAPAN: Half a Century of Nuclear Fuel Cycle—A Total Failure

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Start 1956  Today 2007

## After 50 Years And US \$26\* Billion—The Result?

- ▶ **A Worse Nuclear Waste Crisis**  
Spent Nuclear Fuel Backing Up At Nuclear Power Plant Sites  
No Final Repository For High-Level Vitrified Nuclear Waste  
"Debt" (Reprocessed) Nuclear Waste Coming Back To Japan
- ▶ **Spiraling Cost Over-Runs**  
Construction of Reprocessing Plant from US\$6.9 billion (1989) to US\$20 billion (2007),  
Fast Breeder Prototype Reactor from US\$3.6 billion to US\$9 billion, Etc.
- ▶ **Not One Kilowatt Of Electricity Being Produced Today**  
Commercialization of Fast Breeder Reactor Postponed 8 Times:  
from "By Around 1970 to "By Around 2050"

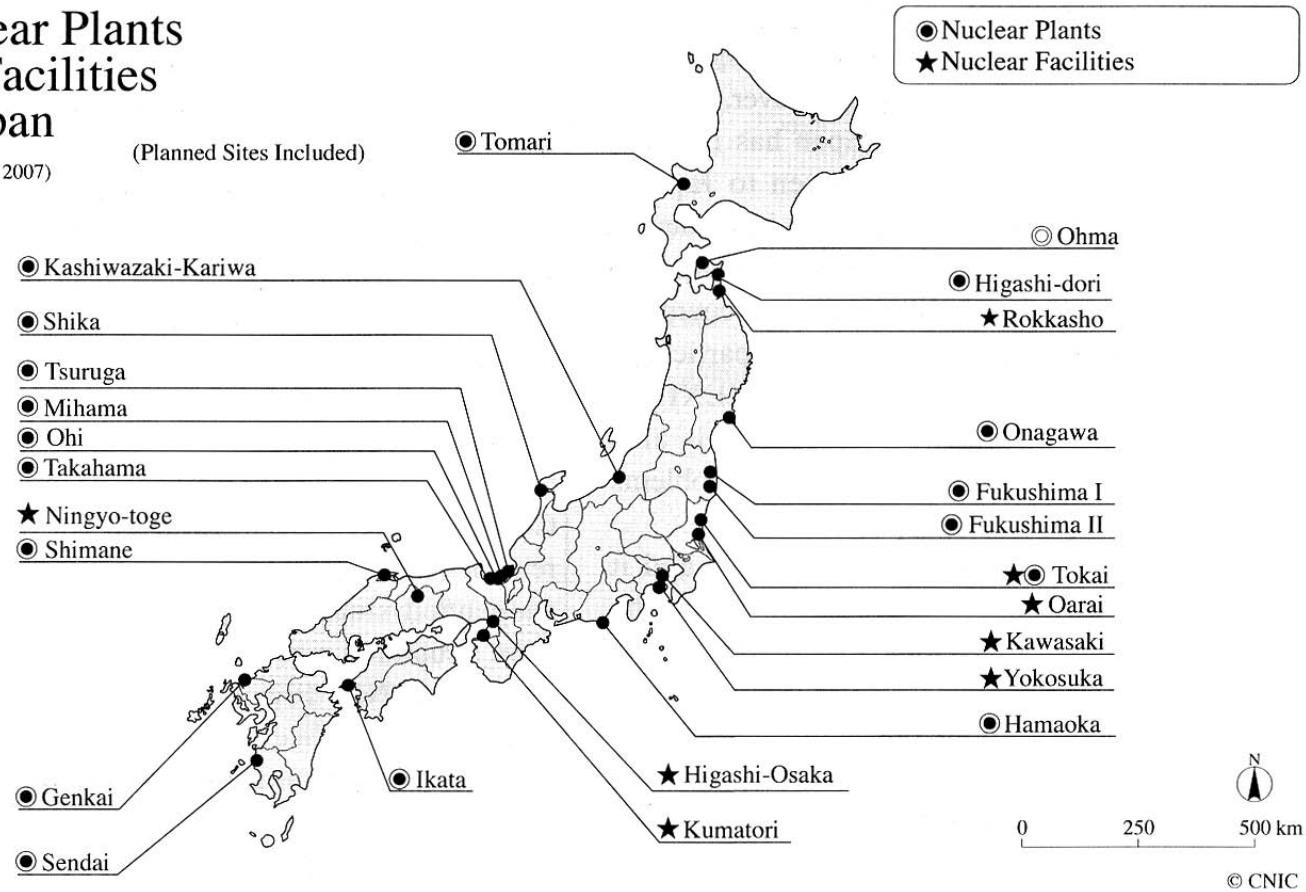
\*R&D costs only 2.8672 trillion yen (conversion: 110 yen to the dollar)

# Electricity Supplied by Nuclear Power

- ▶ 55 commercial nuclear power plants supply 31% of electricity. The Nuclear Fuel Cycle supplies 0%.

## Nuclear Plants and Facilities in Japan

(as of Jan. 2007)

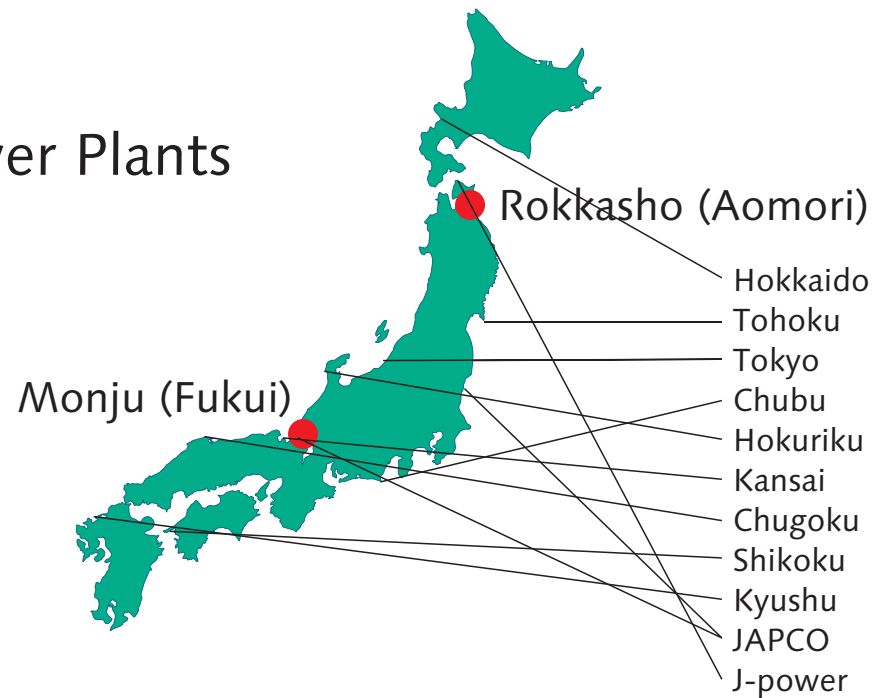


# What is Japan's Nuclear Fuel Cycle Program?

- ▶ **Fast Breeder Reactor Program**  
Monju prototype reactor  
Breeder to become commercial "by around 2050"

- ▶ **Reprocessing**  
Rokkasho Reprocessing Plant  
Commercial operation: November 2007

- ▶ **MOX Fuel Use  
in Commercial Nuclear Power Plants**  
First power plant to use MOX fuel in 2008



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## Japan's Nuclear Waste Crisis — The Toilet is Backed Up [1]

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- ▶ More than 11,000 tons of spent nuclear fuel is in pools on site at nuclear power plants.
- ▶ Every year, about 1000 tons spent nuclear fuel is generated by nuclear power plants in Japan.
- ▶ The Rokkasho reprocessing plant pools' capacity is limited.  
(Maximum capacity 3000 tons. Currently 2108 tons in pools.)
- ▶ Rokkasho reprocessing capacity: 800 tons of spent nuclear fuel a year.
- ▶ There is only one spent fuel interim storage site planned.  
(2010 start-up planned. Capacity 5000 tons. For Tokyo Electric and JAPCO only.)
- ▶ Aomori governor says it is premature to discuss storage in Aomori for intermediate level nuclear waste to be returned from Europe.

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## Japan's Nuclear Waste Crisis – The Toilet is Backed Up [2]

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- ▶ Aomori Prefecture insists it is a “nuclear fuel cycle” center, not a nuclear dump. Rokkasho reprocessing plant is to operate on condition the prefecture does not become a final repository for vitrified high level nuclear waste.
- ▶ Full-time operation of Rokkasho is scheduled to begin November 2007.
- ▶ Aomori has agreed to store vitrified high level waste for 30-50 years, but there is strong concern about storing this waste when there is no guarantee it can be shipped off to a final repository.

**At present there are zero potential sites for a final nuclear waste repository.**

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## At Present There Are Zero Potential Sites for a Final Nuclear Waste Repository

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The latest rejection: April 22, 2007

The townspeople of Toyochō on Shikoku Island elected a new mayor in a landslide vote (1821 to 761 votes).

The election was held in order to scrap plans volunteering to be a site for a document study for a final nuclear waste repository. Voter turnout: 89.26%. As usual, women played a key role.





## Japan's Final Repository Plan — A Pie in the Sky

Japan's final nuclear waste geological repository plan is based on the massive use of plutonium fuel.

Amount of plutonium put into reactors as fuel to date: 5 tons approximate.

Fugen	1.4 tons approx.
Joyo	1.3 tons approx.
Monju	1 ton approx.
Tsuruga Unit 1	4kg
Mihama Unit 1	40kg
Total:	3.8 tons PuF
<b>TOTAL PLUTONIUM:</b>	<b>5 tons approx.</b>



Final repository plan based on use of approximately 400 tons of plutonium.

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# Fast Breeder Reactor Program is a White Elephant

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- ▶ Fast Breeder Reactor Commercialization Delayed 8 Times.  
Original date "by around 1970"  
Current date "by around 2050"  
80 year delay!

The Fast Breeder Reactor Program began in 1956.

#### Year of Plan Date for Commercialization

1961	By around 1970
1967	No date
1973	1985~95
1978	1995-2005
1982	During the 2010's
1987	During the 2020's
1994	Around 2030
2000	No date
2005	By around 2050



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# Japan's Fast Reactor Program is a Fast BREEDER Program Not a Burner Program

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Monju Prototype Fast Breeder Reactor (280MWe)  
Tsuruga City, Fukui Prefecture

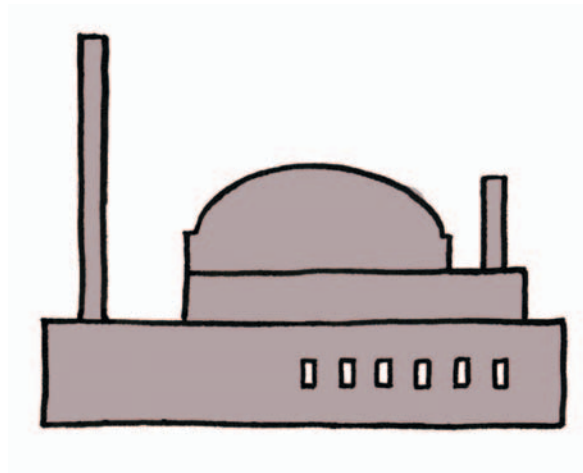
The plutonium the fast-breeder reactor breeds is “weapons-grade” plutonium. Two weeks of operating Monju at full capacity will produce enough plutonium to make one high-quality nuclear weapon.

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# Japan's Fast Breeder Program

## How Much Electricity has it Produced?

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**102,325 MWh (at Monju in 1995)**

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## Status of Monju—Japan's Prototype Fast Breeder Reactor

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- ▶ Shut down since December 8, 1995 sodium leak and fire accident.
- ▶ Modification to be completed early summer 2007.
- ▶ Equipment to undergo inspection/testing in 2007-2008.
- ▶ Restart scheduled for May 2008.
- ▶ One-third of Fukui residents have signed a petition demanding that Monju be shut down permanently.

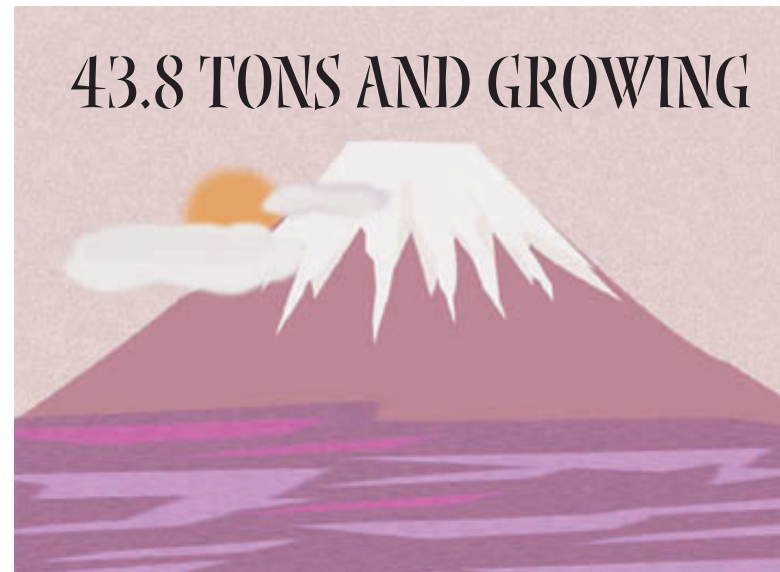


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# Japan's Nuclear Fuel Cycle — A Mountain of Plutonium

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Japan's nuclear fuel cycle program has created a plutonium stockpile of 43.8 tons.\*

37,852kg in Europe to be returned to Japan and 5,923kg in Japan.

**Rokkasho reprocessing will generate more stockpile.**

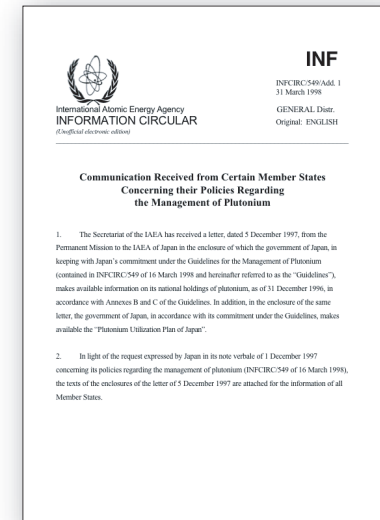
If operated as scheduled, Rokkasho will stockpile tens of tons more plutonium over the next 5 years (2012).

\*Japan Atomic Energy Commission. Amount at end 2005.



# Surplus Plutonium—Japan Reneges on Commitment to the IAEA

- ▶ Japanese government commitment to the IAEA:  
“The nuclear fuel cycle is promoted based on the principle that plutonium beyond the amount required to implement the program is not to be held, i.e. the principle of no surplus plutonium.”



IAEA Information Circular (March 31, 1998) attaching Japanese government's letter to IAEA dated December 5, 1997.

Federation of Electric Power Companies of Japan (23 February 2007)

Translation into English: CNIC

Utilization Plan for Plutonium Recovered at Rokkasho Reprocessing Plant (Fiscal Year 2007)							
Owner	quantity to be reprocessed *1	quantity held *2			purpose (to be used as fuel for Light Water Reactors) *3		
		projected quantity of Pu held at end FY06 *5 (tons Puf) *6	projected quantity of Pu to be recovered in FY07 *7 (tons Puf) *6	projected quantity of Pu held at end FY07 *8 (tons Puf) *6	reactor(s) to utilize recovered Pu	projected quantity to be used annually *9 (tons Puf/year) *6	time planned to start using Pu *10, and approximate time required to use Pu *11
Hokkaido	-	0.0	0.1	0.1	Tomari N.P.P.	0.2	In or after FY2012 about 0.5 years equivalent
Tohoku	8	0.0	0.1	0.1	Onagawa N.P.P.	0.2	In or after FY2012 about 0.4 years equivalent
Tokyo	184	0.3	0.8	1.0	On the basis of attempting to recover the trust of local residents, plan to utilize 3 to 4 reactors belonging to TEPCO.	0.6-1.6	In or after FY2012 about 0.6 to 1.1 years equivalent
Chubu	34	0.1	0.2	0.2	Hamaoka N.P.P. reactor 4	0.4	In or after FY2012 about 0.5 years equivalent
Hokuriku	-	0.0	0.0	0.0	Shika N.P.P.		In or after FY2012 about 0.1 years equivalent
Kansai	125	0.2	0.5	0.6	Takahama N.P.P. reactors 3 & 4, plus 1 or 2 reactors at Ohi N.P.P.	1.1-1.4	In or after FY2012 about 0.4 to 0.6 years equivalent
Chugoku	20	0.0	0.1	0.1	Shimane N.P.P. reactor 2	0.2	In or after FY2012 about 0.6 years equivalent
Shikoku	-	0.0	0.1	0.2	Ikata N.P.P. reactor 3	0.4	In or after FY2012 about 0.4 years equivalent
Kyushu	20	0.1	0.3	0.4	Genkai N.P.P. reactor 3	0.4	In or after FY2012 about 1.0 years equivalent
JAPCO	-	0.0	0.1	0.2	Tsuruga N.P.P. reactor 2, Tokai 2 N.P.P.	0.5	In or after FY2012 about 0.4 years equivalent
<b>sub total</b>	<b>392</b>	<b>0.7</b>	<b>2.2</b>	<b>2.9</b>		<b>4.4-5.4</b>	
J-power		Will be transferred from other utilities *12			Ohma N.P.P.	1.1	
<b>Grand Total</b>	<b>392</b>	<b>0.7</b>	<b>2.2</b>	<b>2.9</b>		<b>5.5-6.5</b>	

More details will be added as the pluthermal program proceeds and the MOX fuel fabrication plant comes on line.

\*1. The 'quantity of Spent Nuclear Fuel planned to be reprocessed' is in accordance with the reprocessing plan put together by Japan Nuclear Fuel Limited.

\*2. Listed under the 'quantity of Pu held' are the quantity of plutonium that is projected to be held by each company at the end of FY2006, the quantity projected to be recovered at the Rokkasho reprocessing plant in FY2007, and the total of these two quantities, which is the quantity projected to be held at the end of FY2007. The recovered plutonium will be allocated to each electric power company in proportion to the amount of fissile plutonium contained in the spent nuclear fuel they sent to the Rokkasho Reprocessing Plant. Consequently, plutonium may be allocated to some companies whose plutonium was not actually reprocessed in that year. However, when all spent fuel has been reprocessed, the amount of plutonium allocated to each company will correspond to the amount of fissile plutonium contained in the spent fuel that they sent for reprocessing.

\*3. Besides the amount to be used in LWRs, some plutonium will be transferred to JAEA to be used in their research projects. The amount to be transferred from each power company to JAEA will be announced when it is decided.

\*4. Figures are rounded, so totals do not add up in some places.

\*5. Because actual allocation to each electric power company will take place after active tests are completed, the 'projected quantity of Pu held at end FY06' shown here is an estimate of each company's portion of the projected quantity of plutonium to be recovered and stored from the spent fuel reprocessed at the Rokkasho reprocessing plant in FY2006. The estimate reflects the change made in the 'Variation Report for the Reprocessing Plant Construction Plan' announced by Japan Nuclear Fuel Ltd on 31 January 2007. The quantity to be reprocessed in FY2006 was altered from 238 tons U to 140 tons U. Hence the estimate here differs from the projected allocation for FY2006 (1.4 tons Puf) shown in the 'Utilization Plan for Plutonium Recovered at Rokkasho Reprocessing Plant (Fiscal Years 2005-2006)' published by the Federation of Electric Power Companies on 3 April 2006.

\*6. The 'amount of plutonium to be allocated' is shown in terms of fissile plutonium. The amount allocated to each company is rounded to the first decimal place, so in some cases a value of 0.0 is shown.

\*7. Because the allocation to each electric power company will not be completed in FY2007, the 'projected quantity of Pu to be recovered in FY07' shown here is an estimate of each company's portion of the projected quantity of plutonium to be recovered and stored from the spent fuel reprocessed at the Rokkasho reprocessing plant in FY2007.

\*8. 'Projected quantity of Pu held at end FY07' equals 'projected quantity of Pu held at end FY06' plus 'projected quantity of Pu to be recovered in FY07'. Figures are rounded to the first decimal place, so the totals do not add up in places.

\*9. The 'projected amount to be used annually' shows the amount of plutonium contained in MOX fuel to be loaded according to the plans provided by each electric power company, adjusted to a yearly basis. In some cases the amount of plutonium to be used includes plutonium recovered overseas.

\*10. The 'time planned to start using Pu' is after 2012, when the planned MOX fuel fabrication plant, located next to the Rokkasho Reprocessing Plant, is planned to start operating. Until the MOX plant commences operations, recovered plutonium will be managed and stored at the Rokkasho reprocessing plant in the form of uranium-plutonium mixed oxide powder.

\*11. The 'approximate time required to use Pu' is calculated by dividing the 'projected quantity of plutonium held at end FY07' by the 'projected quantity to be used annually'. (Note that because some plutonium is to be transferred to J-Power and JAEA, and because in some cases 'the quantity to be used' includes plutonium stored overseas, the actual time taken might not match the span shown here.)

\*12. The amount to be transferred from other power companies to J-Power will be announced after it has been decided.



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# Japan's Mox Fuel Use Program—So Far a Failure

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- ▶ Japan's MOX fuel program is supposed to consume surplus plutonium.
- ▶ So far the MOX fuel program has consumed zero plutonium.  
(44 kilograms consumed experimentally)
- ▶ The program was originally scheduled to begin in 1997.
- ▶ Present start up schedule is 2008.
- ▶ Current goal (2007): Use of MOX fuel in 16-18 commercial reactors by 2010.

# Public Concern About the Rokkasho Facility [1]

- ▶ *Aomori residents had fought a bitter battle against siting of the Rokkasho Nuclear Fuel Cycle Facility.*

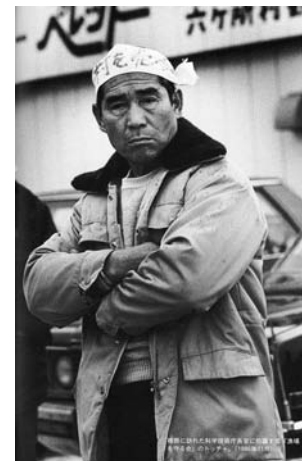
**86.1% of Aomori residents are anxious about the Rokkasho Nuclear Fuel Cycle Facility\***

Yes: 81.6%

No: 17.6%

Other: 0.8%

\*Data from survey undertaken by Aomori Prefecture (2004).

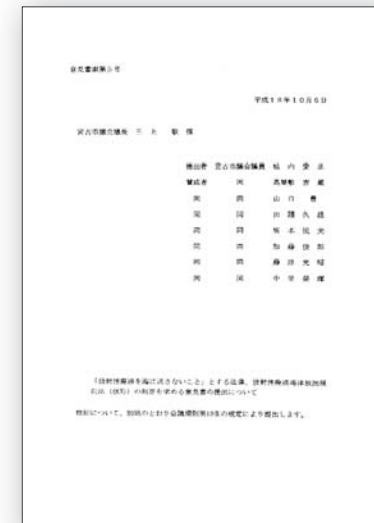


Local protest in the 1980s

# Public Concern About the Rokkasho Facility [2]

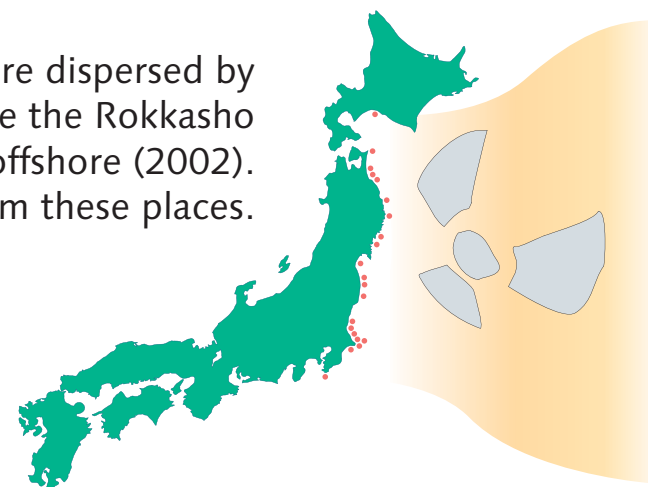
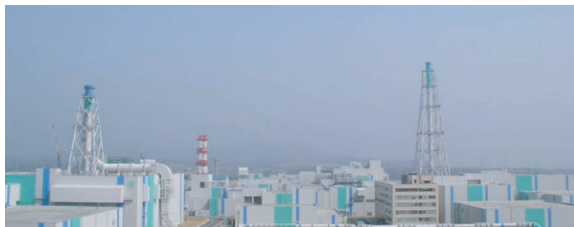
- ▶ 7 Municipalities in Iwate Prefecture Petition the National Government for a Law to Prohibit Radioactive Releases into the Marine Environment from Rokkasho (October 2006)
- ▶ Some major supermarkets in the central Japan area have stated they will not purchase Aomori or Iwate products even if contamination from Rokkasho is found to be minor.

(Questionnaire conducted by Consumers' Union of Japan, etc. 2006)



Iwate Municipalities' Petition

10,000 post cards were dispersed by citizens from above the Rokkasho reprocessing pipe located 3km offshore (2002). Postcards were recovered from these places.





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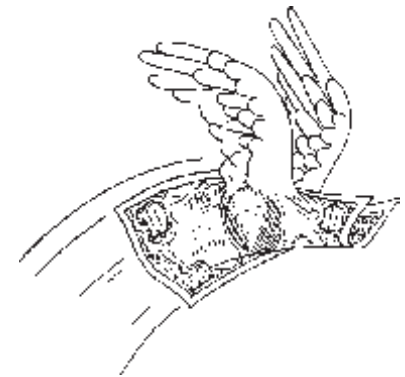
# Rokkasho Reprocessing Costs

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- ▶ Rokkasho reprocessing plant construction costs skyrocketed from 0.76 trillion yen (US\$6.9 billion) in 1989 to more than 2.3 trillion yen (US\$20 billion) in 2007.
- ▶ Operation of Rokkasho (40 years) is estimated at 12 trillion yen (US\$110 billion).
- ▶ Operation of second reprocessing plant (40 years) is estimated at 12 trillion yen (US\$110 billion). Design detail of plant to be deliberated from 2010.

## **Reprocessing Costs Grossly Under-Estimated**

- ▶ Assumption is operation at 100% capacity
- ▶ Estimates made before design of plant decided





# The Nuclear Fuel Cycle Program Gives "Nuclear" A Bad Name

3 of the 4 large accidents at nuclear facilities in Japan over the past 12 years occurred because of the nuclear fuel cycle program.

- Nuclear Fuel Cycle ▶ **JCO Criticality Accident at Tokaimura** — Making fuel for Joyo, Japan's experimental fast breeder reactor. More than 300,000 residents living near the plant were ordered to stay indoors.  
[September 30, 1999]
- Nuclear Fuel Cycle ▶ **Tokaimura Reprocessing Plant Fire And Explosion Accident** — The plant separated plutonium for Monju and Joyo fuel.  
[March 1997]
- Nuclear Fuel Cycle ▶ **Prototype Fast Breeder Reactor Monju's Sodium Leak And Fire Accident**  
[December 1995]
- ▶ **Mihama Unit 3 Nuclear Power Plant Secondary System Pipe Rupture Accident**  
[August 2004]



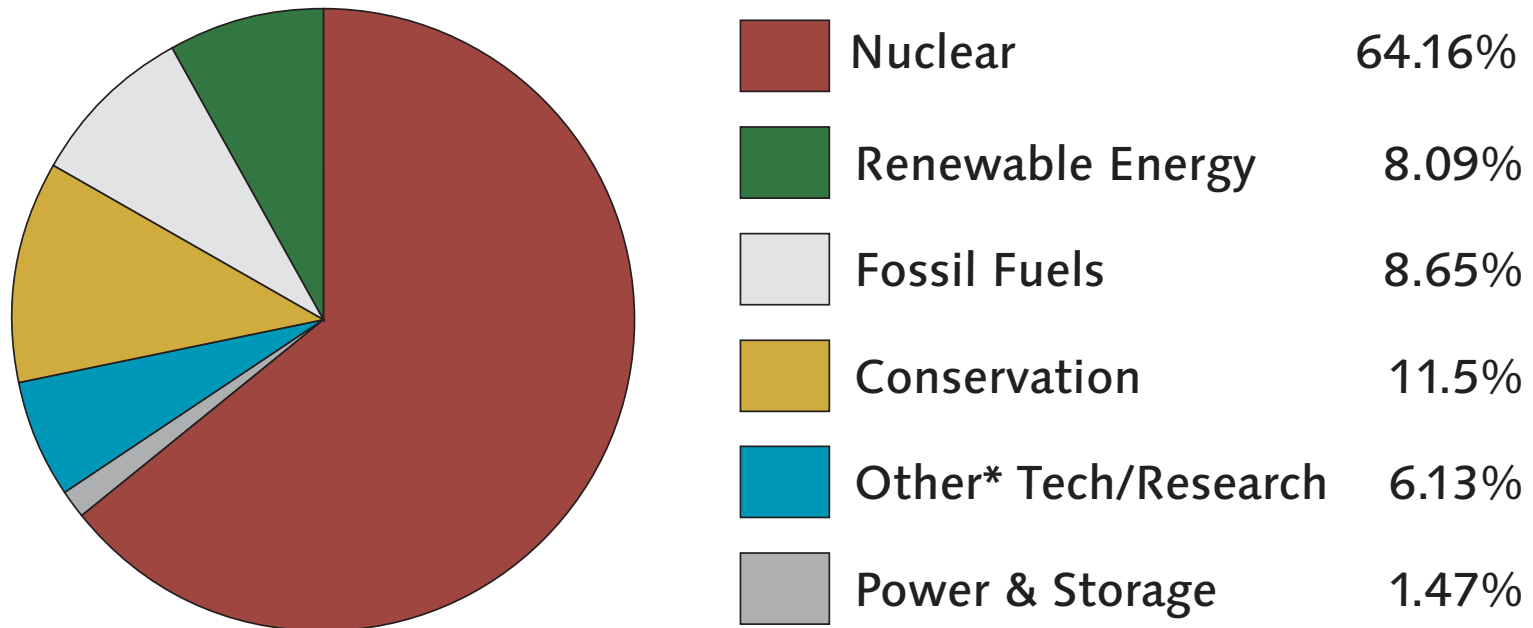
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# Fuel Cycle Program Drains Money For Renewable Energy

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- ▶ A quarter of the Japanese government's R&D for energy goes to the nuclear fuel cycle program.



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# The Result of 50 Years of Nuclear Fuel Cycle Development in Japan

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- ▶ A Nuclear Waste Crisis
- ▶ Nuclear Accidents
- ▶ Plutonium Stockpile: Over 43 tons
- ▶ Spiraling cost over-runs
- ▶ Electricity being produced: NIL
- ▶ An Outdated National Energy Program

**This is the Legacy We Leave to  
the Next Generation of Japanese**

**Don't Make the Same Mistake !**