

JAPAN'S SPENT FUEL AND PLUTONIUM MANAGEMENT CHALLENGES

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CONTENTS

1. Introduction
2. Spent fuel management
3. Plutonium balance
4. Conclusion

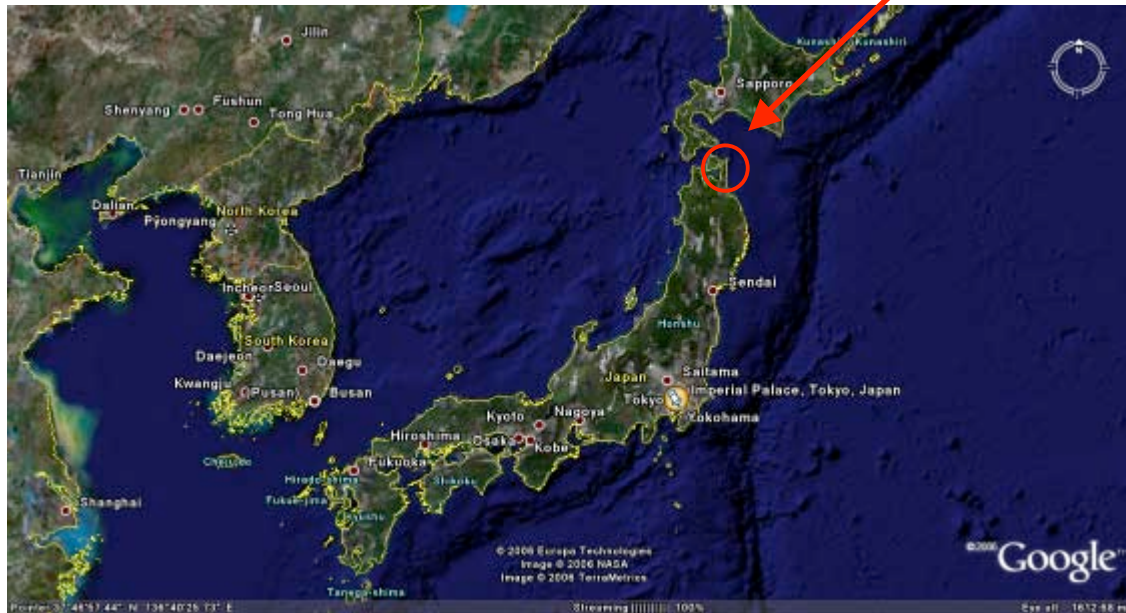
1. Introduction

Japan's Plutonium Policy: Current Status

- At the end of 2005, Japan had 37.8t of separated plutonium in Europe, recovered under contracts with BNFL and COGEMA and about 5.9t from its domestic Tokai reprocessing pilot plant.
- On March 31, 2006, the JNFL Rokkasho reprocessing plant by started active testing. If this plant operates at nominal capacity, about 8t of plutonium will be recovered annually.
- Japanese utilities plan to recycle all plutonium, into existing Light Water Reactors (LWRs), but no single reactor has been loaded with MOX fuel as of May 2007.
- Therefore, it is likely that more plutonium will be accumulated once the Rokkasho plant starts operating.

Rokkasho Reprocessing Plant

- Owner : JNFL
- 800 tonnes heavy metal per year (tHM/yr) capacity
- 3,000tHM of spent fuel storage capacity.
- Active testing started March.31, 2006.
- Plutonium separated and MOX powder was produced in November, 2006
- Commercial operation: early 2008



Reactor on-site pools are filling up

Table 1. Amount of Spent Fuel at Each Site (As of end of March 2004)

Owing power companies	Plant name	No. of reactors [tU]	1 Full core each [tU]	Annual discharge [tU]	Amount of spent fuel [tU]	Effective storage capacity ⁱ [tU]	Year when storage capacity is filled up ⁱⁱ [year]
Hokkaido	Tomari (P)	2	100	30	290	420	2008
Tohoku	Onagawa (B)	3	260	60	280	790	2012
Tokyo	Fukushima I(B)	6	580	150	1,360	2,100	2009
	Fukushima II (B)	4	520	140	1,250	1,360	2005
	Kashiwazaki-Kariwa (B)	7	960	250	1,840	2,630	2007
Chubu	Hamaoka (B)	4	420	110	820	1,090	2006
Hokuriku	Sika(B)	1	60	20	70	160	2008
Kansai	Mihama (P)	3	160	50	360	620	2009
	Takahama (P)	4	290	100	940	1,100	2005
	Ohi(P)	4	360	120	1,030	1,900	2011
Chugoku	Shimane (B)	2	170	40	330	600	2011
Shikoku	Ikata (P)	3	170	60	450	930	2012
Kyusyu	Genkai (P)	4	270	100	660	1,060	2008
	Sendai (P)	2	140	50	630	900	2009
JAPC	Tsuruga (P)	2	140	40	520	870	2013
	Tokai-II(B)	1	130	30	300	420	2008
Total		52	4,730	1,350	11,110	16,940	---

ⁱ Effective storage capacity = Storage Capacity - (1 Full core + Annual discharge).

ⁱⁱ Year when storage capacity is filled up for NPP site = year of march 2004+(Effective storage capacity - Amount of spent fuel)/Annual discharge.

(P): PWR, (B): BWR

Three types of spent fuel storage capacity

At-reactor storage

Storage capacity: 16,940 tHM/16 sites

On-site dry cask storage is not allowed by local governments (Fukushima-1 was allowed one time).



Rokkasho reprocessing plant

Storage capacity: 3,000 tHM

(Received 1,776 tHM as of April 2006)

Construction cost: \$18 billion



Mutsu Interim storage site

Dry storage

Capacity : 3,000 tHM (2,000 tHM will be added later)

Operation: 2010 (Status : Planned)

Construction cost: \$0.8 billion (including dry casks)



Cost Estimates of Rokkasho Project (40-year life time cost)

Category	Items	\$ billion
Reprocessing	Rokkasho (800tx 40 yrs) Decommissioning (\$13 billion)	91.6
HLW storage & transportation	From Europe (including HLW swapped for LLW equivalent)	8.8
HLW disposal	Only vitrified waste	21.3
TRU disposal	Both From Europe and From Rokkasho	6.8
MOX fuel fabrication		9.9
Total		138.5

Report of Study Group on Cost Estimate for Nuclear Fuel Cycle (METI, 2004)

Cost Comparison of Fuel Cycle Options by Japan Atomic Energy Commission (Yen/kwh, 2004)

	Scenario1 (Current Policy)	Scenario 2 (Stop reprocessing after Rokkasho)	Scenario 3 (Cancel Rokkasho, Direct disposal)	Scenario 4 (Interim storage then decide)
Power Gen. Cost	5.2	5.0~5.1	4.5~4.7	4.7~4.8
Cost due to Policy Change*	-	-	0.9~1.5	0.9~1.5
Total Cost	5.2	5.0~5.1	5.4~6.2	5.6~6.3

*Assumes that all nuclear power plants would be shut down due to shortage of spent fuel storage capacity and have to be replaced with fossil-fueled power plants.

Comparison of projected cumulative spent fuel discharges with currently planned storage capacity

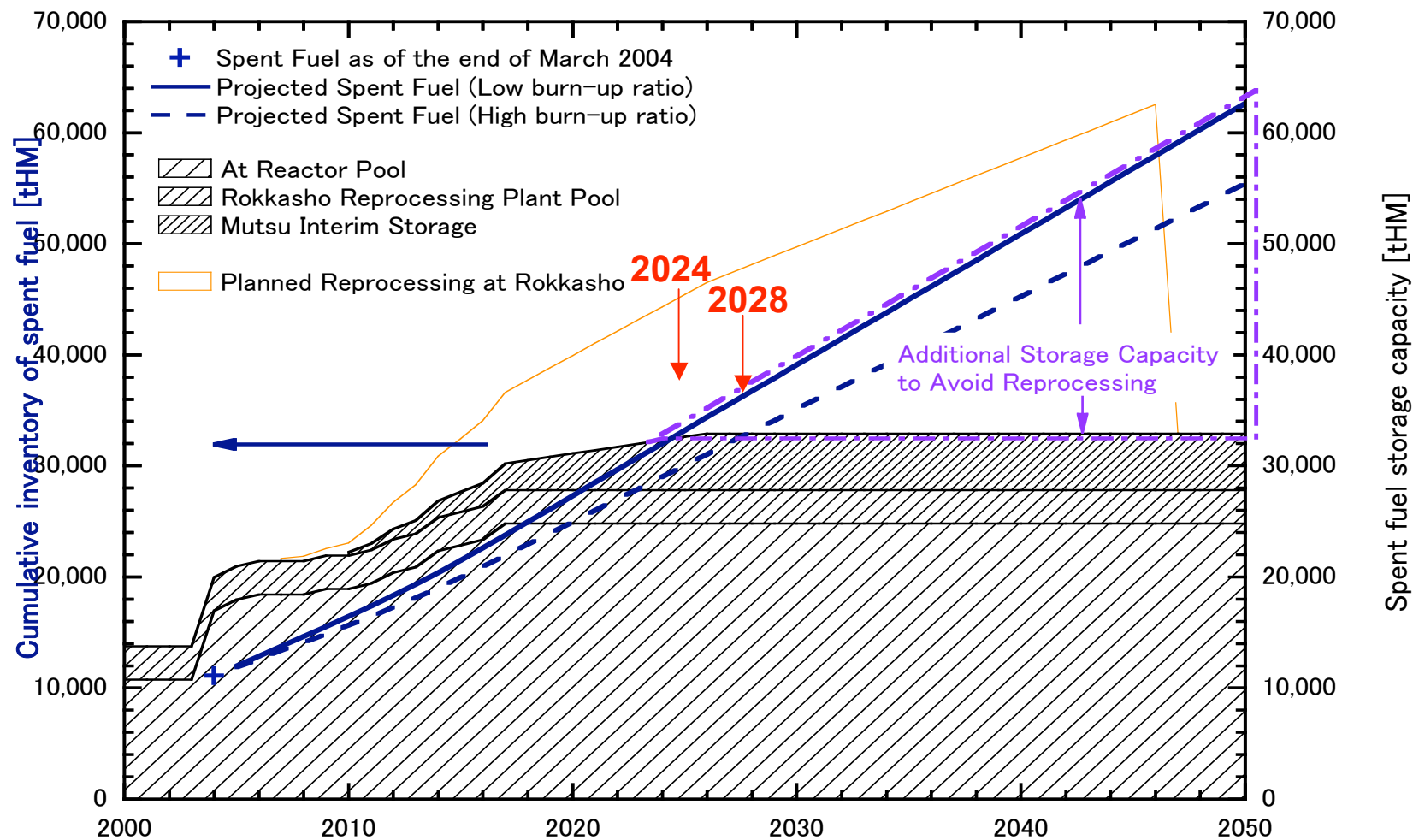


Figure 1. Cumulative inventory and management of spent fuel in the future

Spent fuel storage Inflexibilities

- Although total spent fuel storage capacity is large enough to store spent fuel up to mid-2020s, inflexibilities of spent fuel storage management make situation more complex:
 - No transfer of spent fuel between utilities is allowed.
 - Storage pool at Rokkasho plant (3,000tU) is divided into three sections; 1,000tU of PWR spent fuel, 1,000tU of BWR spent fuel and 1,000tU for either type of spent fuel.
 - Mutsu interim storage facility (5,000 tU) owned by only two utilities; TEPCO (4000 tons), and JAPCO (1,000tU).
- As a result, some utilities with PWRs may face shortage of spent fuel storage as early as 2014.
- Local mayors and governor of Aomori demand that the recycling program continue in order to guarantee that spent fuel will be removed from the site within 50 years.

3. Plutonium balance

Current stockpile

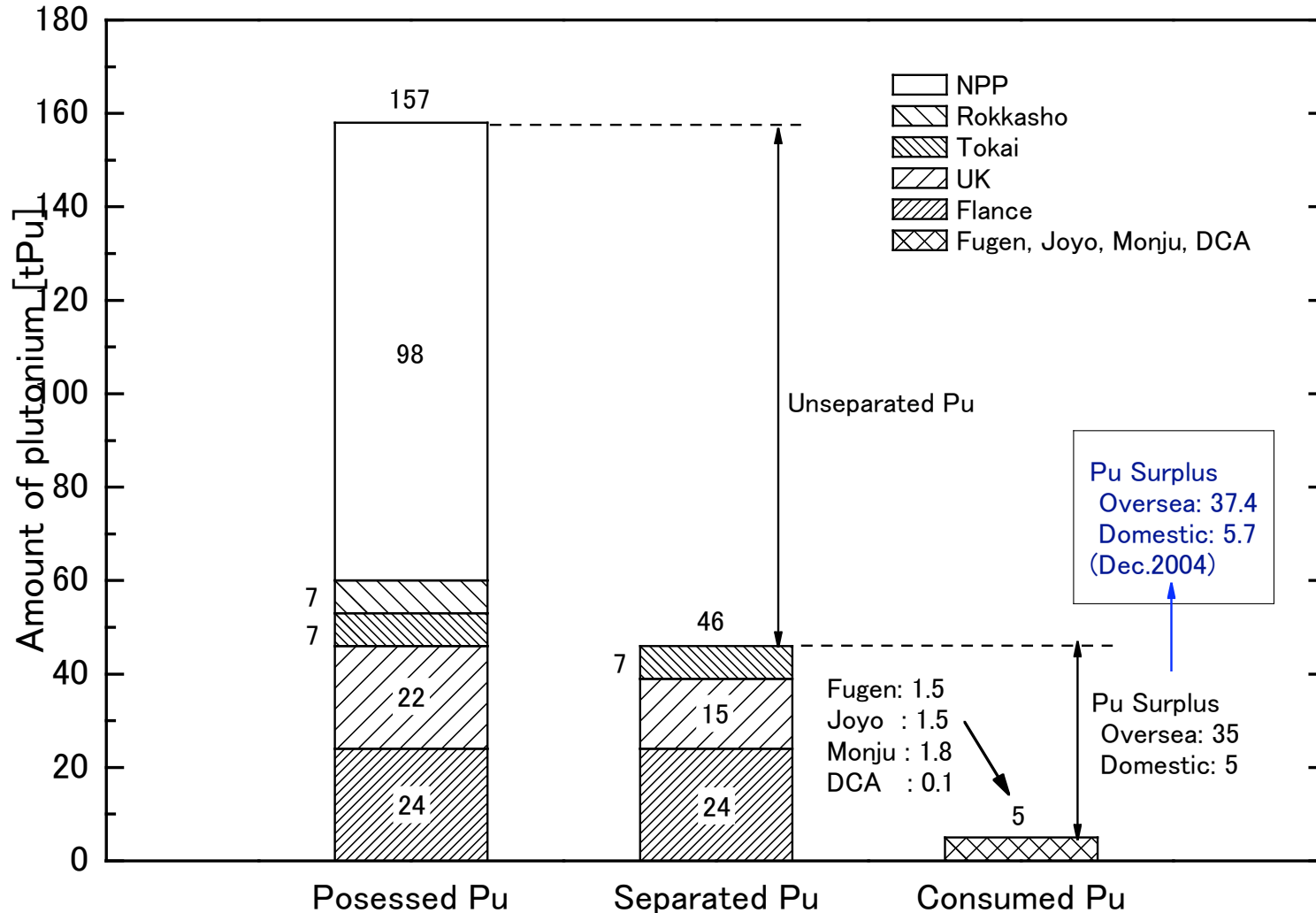


Figure 3. Management of plutonium (As of March 2004)

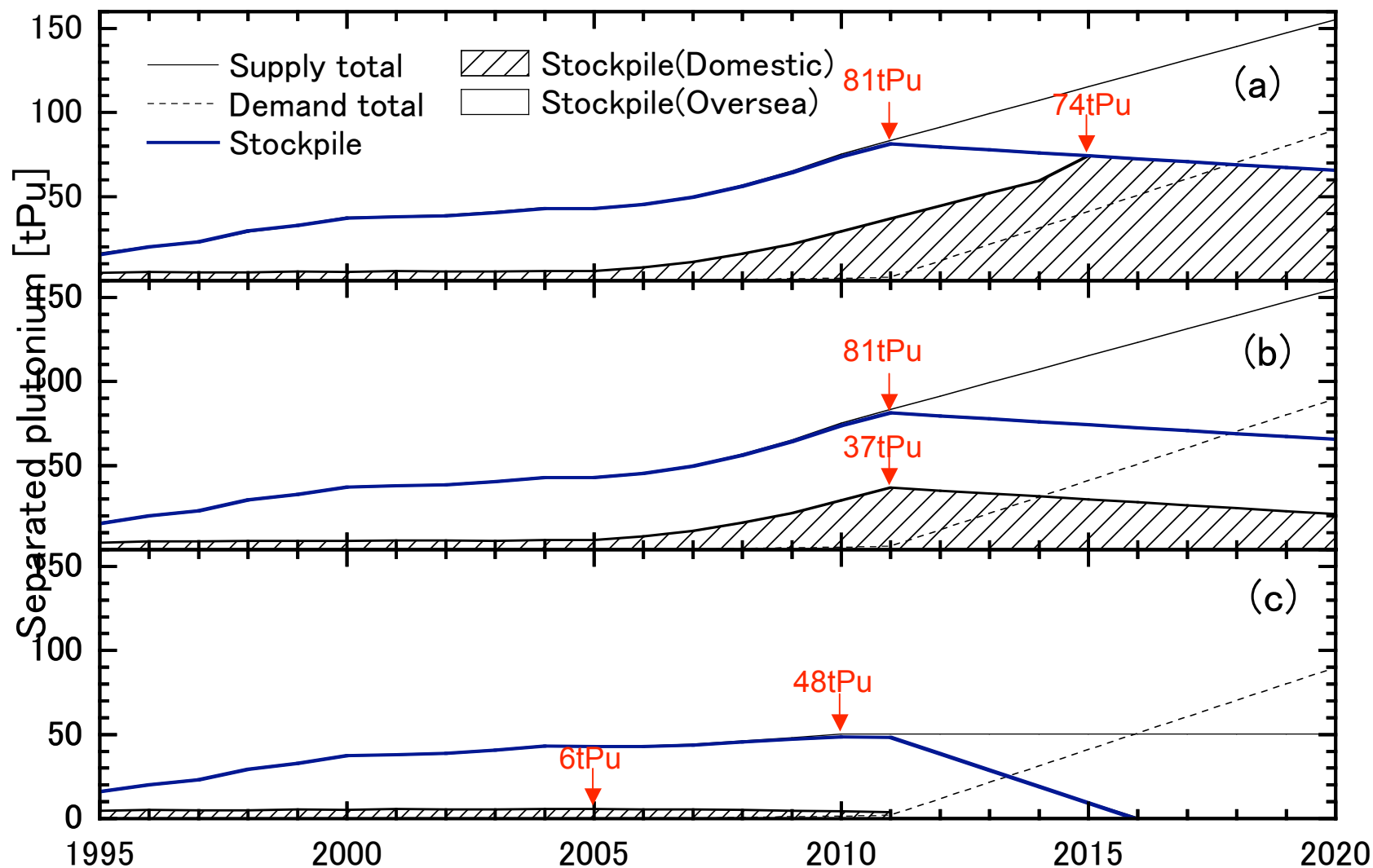


Figure 4. Future plutonium stockpile until 2020

Assumption

(a) Oversea Pu used first (b) Overseas Pu not recycled before 2020 (c) Operation of Rokkasho postponed

After 2005 : Demand MOX fuel: From 2012, 9.3 tPu/year/plants x18 plants

Monju: re-start from 2010, 0.47tPU/year

Supply Rokkasho reprocessing plant: start from 2006

(2 -6tPu/year from 2006-2009, 8tPu/year from 2010)

Progress of MOX fuel program

as of May 2007

Electric company		Start	Local Gov't Consent	Licensing Application	License Approved	Note
Hokkaido	Tomari	2010				
Tohoku	Onagawa	2010				
Tokyo	Fukushima I-3	?	(OK)	?	OK	Local consent cancelled
	Kasiwazaki-kariwa-3	?	(OK)	?	OK	Same as above
Chubu	Hamaoka-4	2010	OK			No local consent system
Hokuriku	Shika	2010				
Kansai	Takahama-3	?	OK	OK	OK	Plan suspended
	Takahama-4	?	OK	OK	OK	Plan suspended
Chugoku	Shimane-2	2010				Negotiation underway with local government
Shikoku	Ikata-3	2010	OK	OK		
Kyusyu	Genkai-3	2010	OK	OK	OK	
JAPC	Tsuruga-2	2008				Under negotiation
	Tokai-2	2010				negotiation 12
J-Power	Oma	2010				

Conclusions (1)

- Sufficient spent-fuel storage capacity in Japan up to year 2025 (low burn-up case) or 2028 (high burn-up case). There is therefore no need for reprocessing until the mid 2020s.
- But, due to inflexibilities in spent fuel management arrangements, storage pools owned by some utilities with PWRs would be filled up by 2014.

Conclusions (2)

- Reprocessing could be postponed for another decade by sharing surplus storage capacity among utilities.
 - ex. Mutsu storage capacity owned by JAPCO could be shared with other PWR-operating utilities that have less storage capacity
- Due to delays of its plutonium-usage programs, Japan has accumulated a large stockpile of separated plutonium. If the Rokkasho plant starts its full scale operation in 2007, Japan's plutonium stockpile will likely to grow from 44 tons in 2005 to more than 70 tons by 2020.

Conclusions (3)

- Deferring operation of the Rokkasho plant until the plutonium stockpile has been worked down to the minimum required level would be the best.
- This would also minimize international concern about Japan's plutonium stockpile.
- We recommend postponement of full scale operation of Rokkasho for about a decade,
 - Technically and politically feasible even under the current spent fuel storage management planning.
 - Gives Japan sufficient time to re-consider its plutonium and spent fuel management policy.