Nuclear Waste Management in Japan

～ A new strategy powered by old thinking～

27 August 2018

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Content

Background information about nuclear waste management

- Legal Framework
- Technology
- Financial framework
- Site selection process

Uncertainties/ Problems in Japan

-The direction of nuclear energy policy

-The direction of nuclear fuel cycle

-Difficulty to gain public trust

-**Conclusion**

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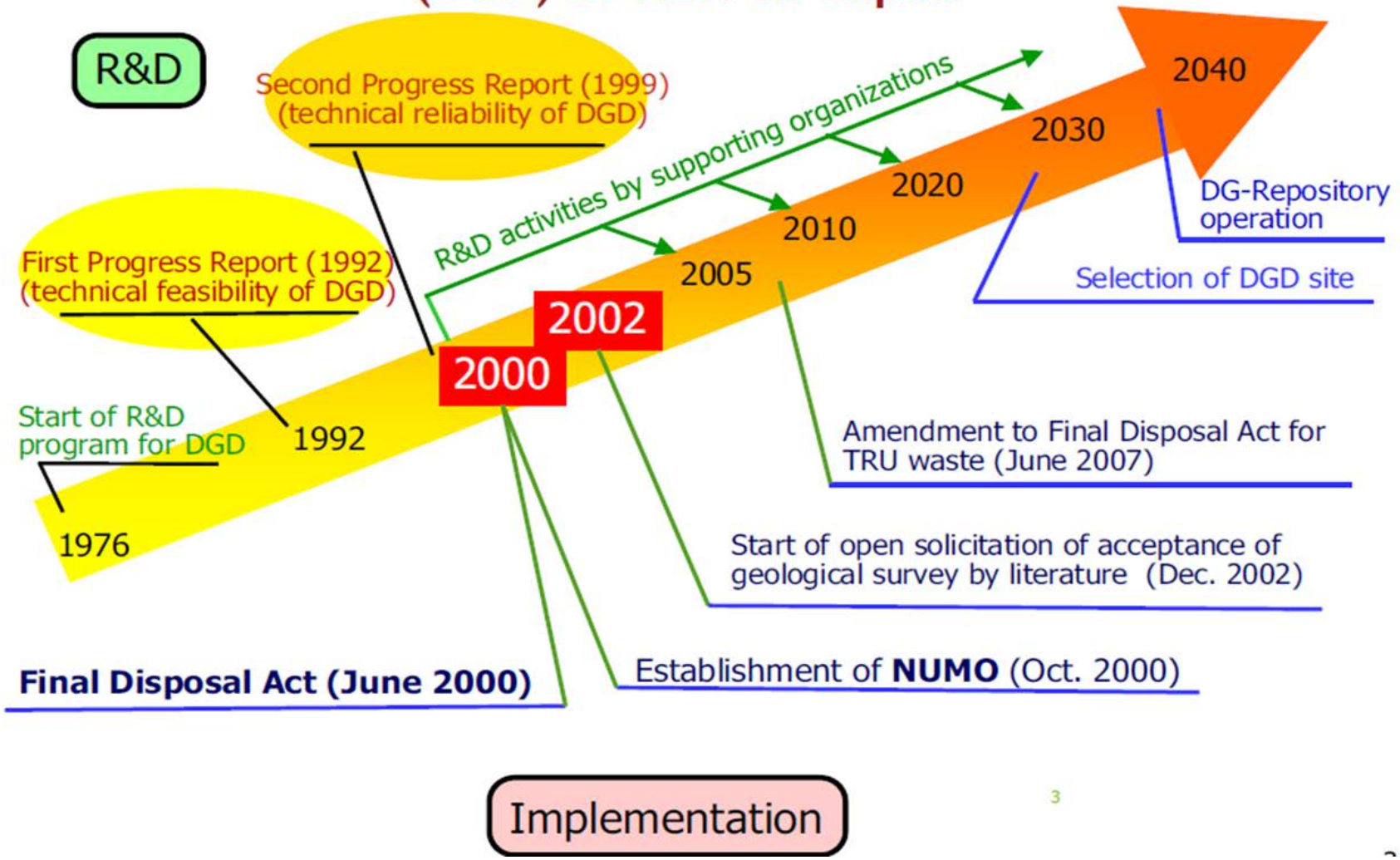
- HLW: High-Level radioactive Waste
- JAEA: Japan Atomic Energy Agency
- JNFL: Japan Nuclear Fuel Limited
- METI: Ministry of Economy, Trade and Industry
- MOX: Mixed Oxide Fuel
- NRA: Nuclear Regulatory Authority
- NUMO: Nuclear Waste Management Organization of Japan
- TRU: Transuranic Waste

Timeline of Program for Deep Geological Disposal (DGD) of HLW in Japan



Source: JAEA

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Legal framework

2000

Specified Radioactive Waste Final Disposal Act (Final Disposal Act)

2005

Framework for Nuclear Energy Policy

Final Disposal Act (2000)

- HLW -> geological disposal
- Establishment of implementing body
- Contribution-based system for the funds for final disposal
- Three steps for selecting disposal sites

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Geological disposal

- **HLW = vitrified waste**
  from the reprocessing of spent fuel
  used in the nuclear power plants

- **TRU (Trans-Uranic) waste**:
  generated by the operation and
  dismantling of reprocessing plants

⇒ deeper than 300 meters underground

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The current status of radioactive waste

25,000 tons of spent fuel

2,167 vitrified packages

2,200 vitrified packages
from Areva and Sellafield

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The Nuclear Waste Management Organization of Japan **(NUMO)**

Since October 2000 authorized by METI

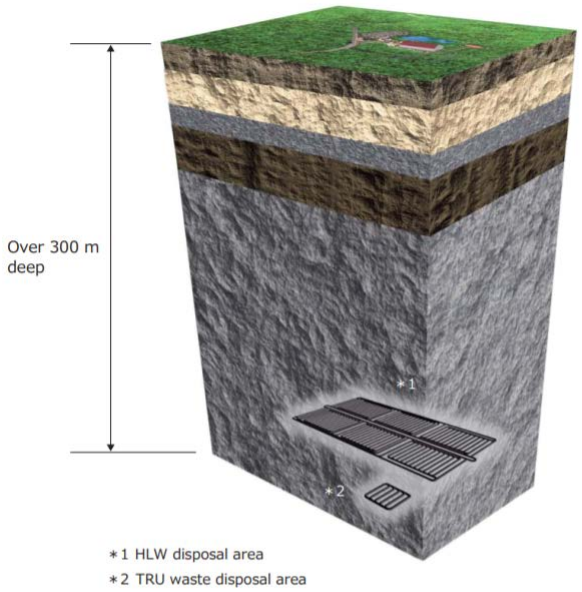
- the selection of disposal sites
- the construction and management of disposal facilities, final disposal, the sealing of disposal facilities
- their management thereafter
- disposal operations in general

Example of repository layout

Planned only one facility

Anticipated Volume:
vitrified HLW
more than 40,000 canisters

TRU waste
more than 18,000m^3



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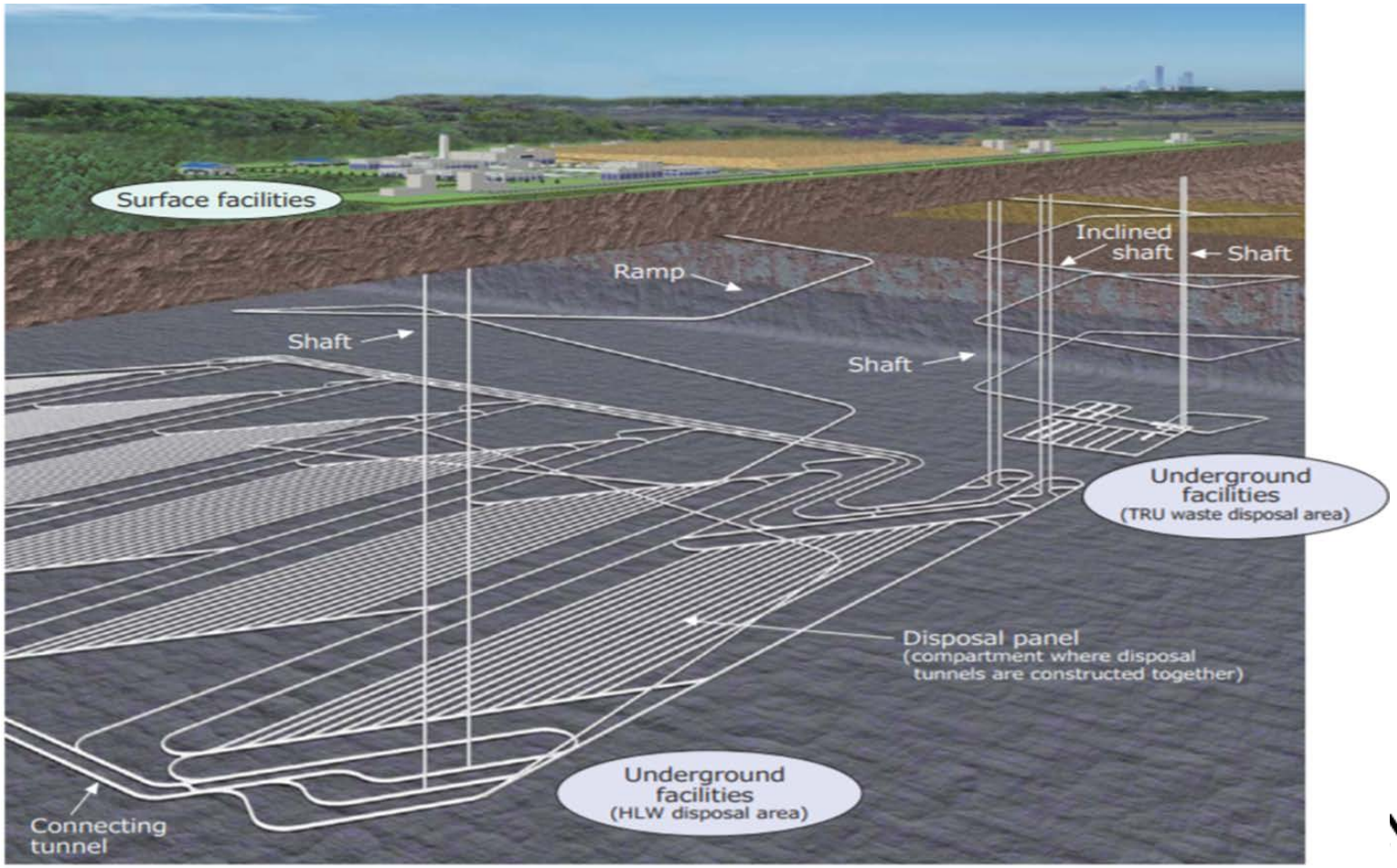
Example of repository layout

Planned only one facility



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Example of repository layout

Surface facilities:

1-2 km^2

Underground facilities :

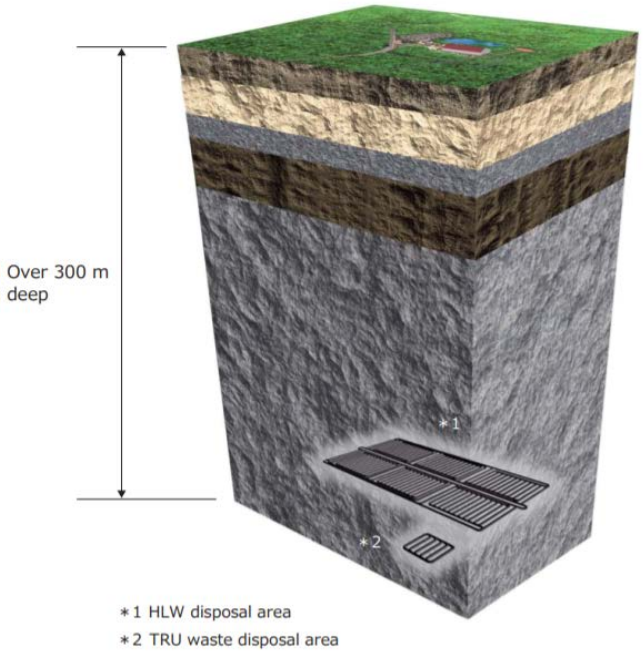
6~10 km^2

HLW disposal area:

around 3 km X 2 km

TRU waste disposal area:

around 0.5 km X 0.3 km



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Burden of final disposal costs

1. SF reprocessing costs
2. reactor decommissioning costs
3. geological disposal costs
4. development and siting costs

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The repository site selection process

three-stage process

with voluntary system by municipalities

1. The literature survey

ca. 7.5 million euro per year to both the municipal and prefectural governments of the area

2. The preliminary investigation stage

ca. 15 million euro per year to both the municipal and prefectural governments of the area

3. The detailed investigations

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Final disposal

HLW = vitrified waste
from reprocessing spent fuel

HLW/TRU⇒ geological disposal
- only one facility
- more than 300m deep
- safe for 100,000 years

NUMO: implementing body

Selection process: Three stages

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Final disposal

Legal framework ✓

Technology ✓

Financial framework ✓

Site selection process ✓

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Uncertainties

1. The direction of nuclear energy policy

2. The direction of nuclear fuel cycle

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The direction of nuclear energy policy

Nuclear power after 2030

1. Abandoning → zero flow waste

2. Continuation with a clear deadline for abandoning
   → flow waste calculable

3. Continuation without a clear deadline
   → ????????

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Uncertainties

1. The direction of nuclear energy policy

2. The direction of nuclear fuel cycle

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Commercializing fast breeder reactors

Monju

1994 Reached first critical state

1995 suffered sodium leak and fire

2016 decommissioned

Worked 250 days

Cost 0.4 million euros per day just to maintain

Ca. 8 billion euros in total

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The reprocessing plant in Rokkasho

1993 Japan Nuclear Fuel Ltd. JNFL

max. annual processing capacity of 800 tons of uranium.

Expected to be completed in 1997……

now in 2021...

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The direction of nuclear fuel cycle

× reprocessing plant
× fast breeder

Spent fuel
→reprocessing or
direct disposal (once through)?

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Final disposal

・Candidate site ×
・nuclear power ✓
・fuel cycle ✓

——>

HLW

Total amount /

disposal method ✓

・Candidate site ×
・nuclear power ? ?
・fuel cycle ? ? ?

——>

HLW

Total amount /

disposal method ???

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Uncertainties/Problems

1. The direction of nuclear energy policy
   Strategic Energy Plan 2018

2. The direction of nuclear fuel cycle
   Plutonium stockpiles

3. Difficulty to gain public trust

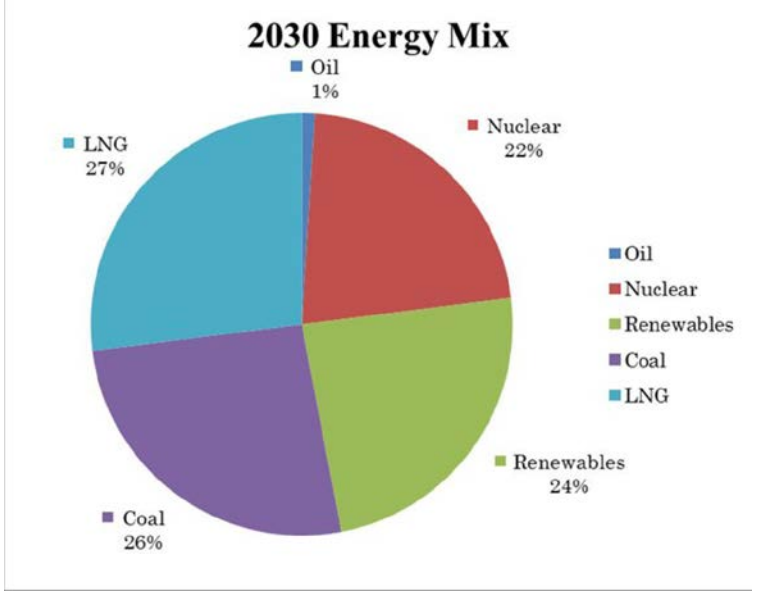
Nuclear power

prior to Fukushima:
54 nuclear reactors
288 TWh
30% of Japan's total output

Now:
32 operable power reactors
14 reactors passed a safety assessment
6 reactors are in operation

Strategic Energy Plan 2018

Nuclear energy policy



- Promoting reactor restarts
- Promoting nuclear fuel cycle

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Strategic Energy Plan 2018

Two contradictory key principles

- nuclear power generation
  as the core and baseload power source

- lowering the nation's dependence (on nuclear power) as much as possible

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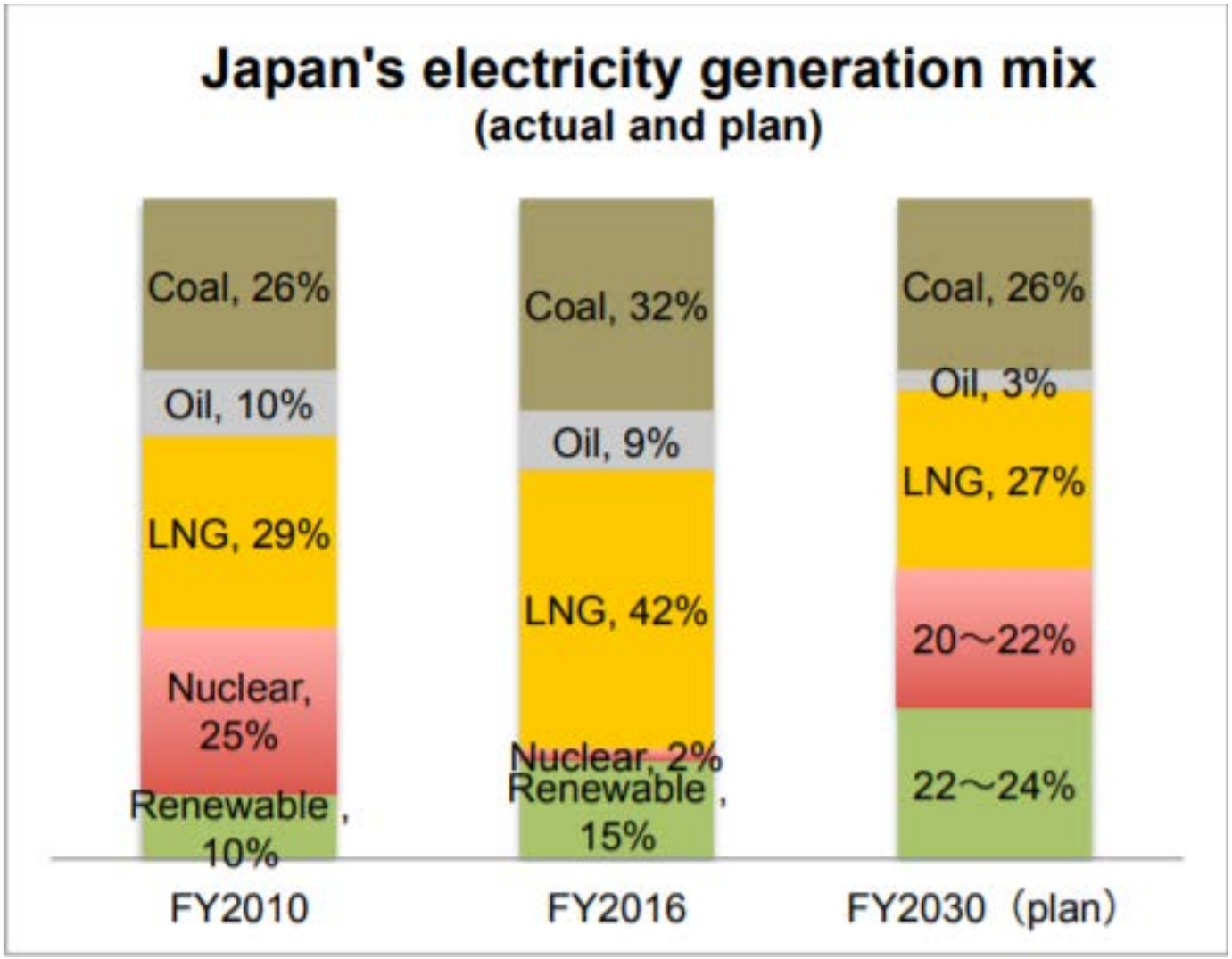
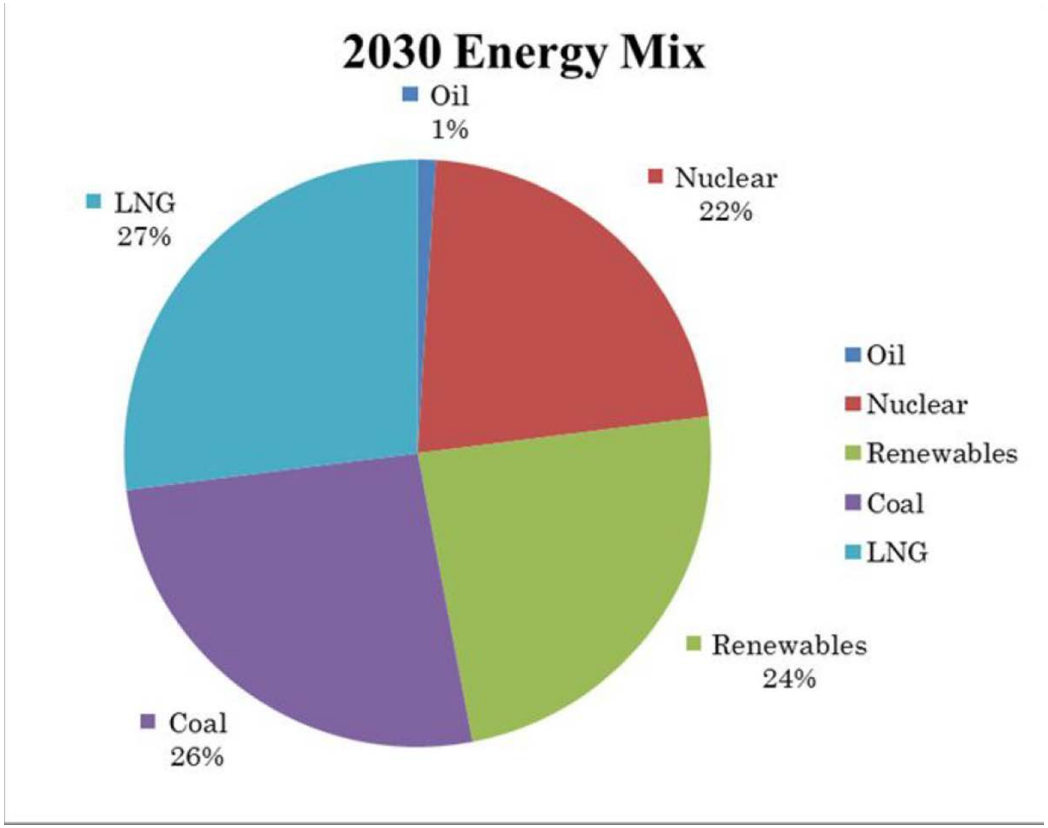

Japan's electricity generation mix
(actual and plan)
Coal, 26%
Oil, 10%
LNG, 29%
Nuclear, 25%
Renewable, 10%
FY2010
Coal, 32%
Oil, 9%
LNG, 42%
Nuclear, 2%
Renewable, 15%
FY2016
Coal, 26%
Oil, 3%
LNG, 27%
20~22%
22~24%
FY2030 (plan)

Source: METI



- Promoting reactor restarts (about 30 reactors) and extending their operational life

- construction of new nuclear reactors

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Uncertainties/Problems

1. The direction of nuclear energy policy

   Strategic Energy Plan 2018

   → contradictory and unrealistic

2. The direction of the nuclear fuel cycle

   plutonium stockpiles

3. Difficulty to gain public trust

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The Japan-U.S. Nuclear Cooperation Agreement.

In 1968 :

the Agreement for Cooperation between Japan and US for Cooperation Concerning Peaceful Uses of Nuclear Energy (extended in 1988 for thirty years)

Under this Agreement
Japan can reprocess spent nuclear fuel

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The Japan-U.S. Nuclear Cooperation Agreement.

The automatic renewal of the 1988 US-Japan peaceful nuclear cooperation agreement in July 2018

---->

the pact can be cancelled or renegotiated with six months written notice by either Japan or the United States

Foreign Minister Taro Kono:
"unstable" future of the agreement

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US demands Japan reduce its plutonium stockpiles

In Japan: 10 tons

In Britain and France: 37 tons

47 tons ≒

6,000 atomic bombs

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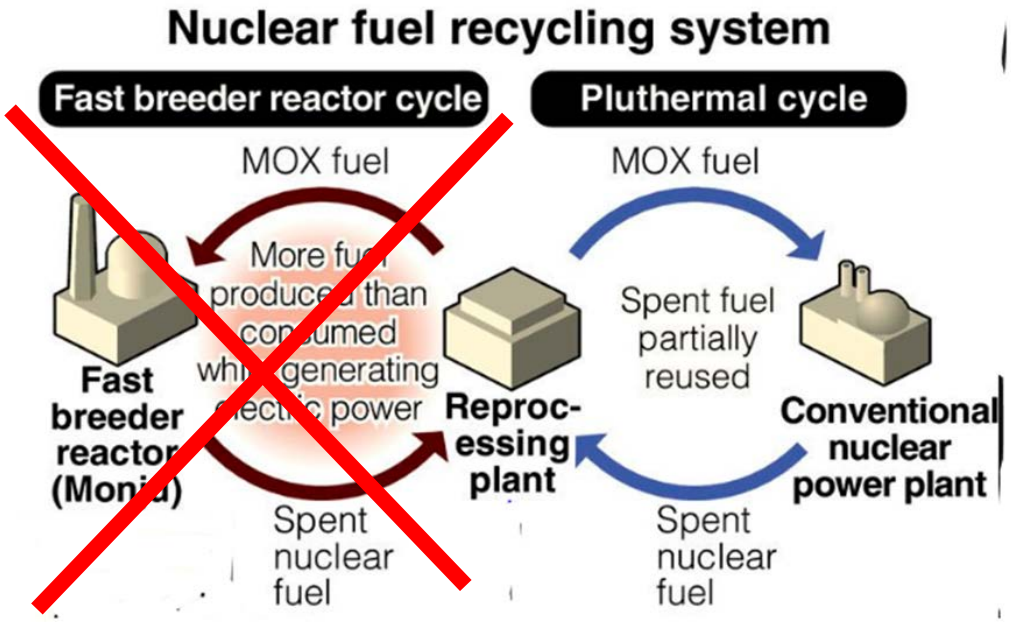
Plutonium stockpiles

Capping and reducing stockpile

No specific timeline or targets



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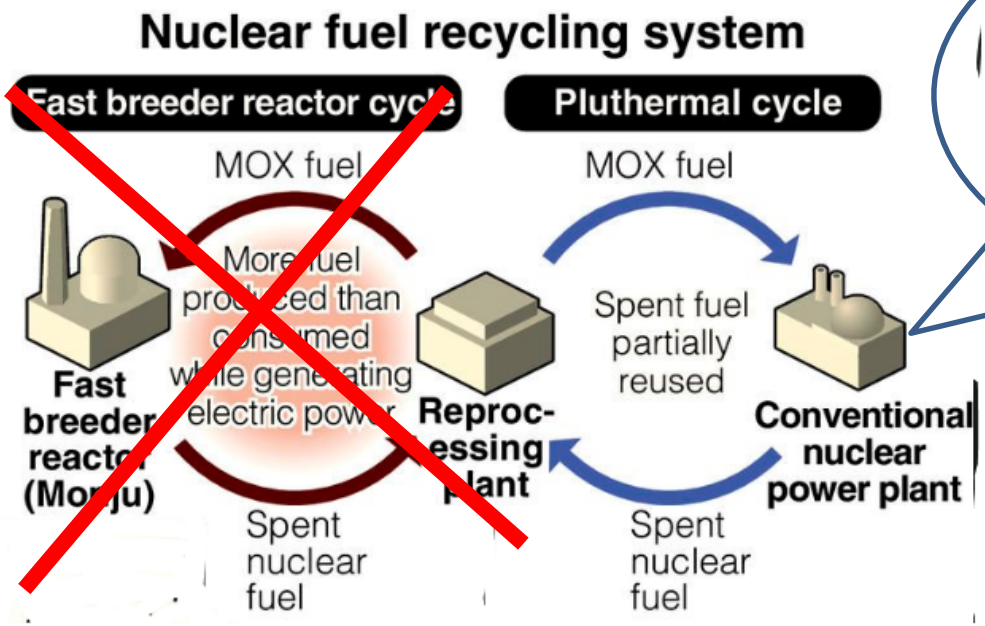
MOX（Mixed Oxide）**fuel**

＝ mixed plutonium-uranium oxide fuel

should be used

at 16 to 18 conventional reactors



now:
only 4 reactors
can use MOX fuel

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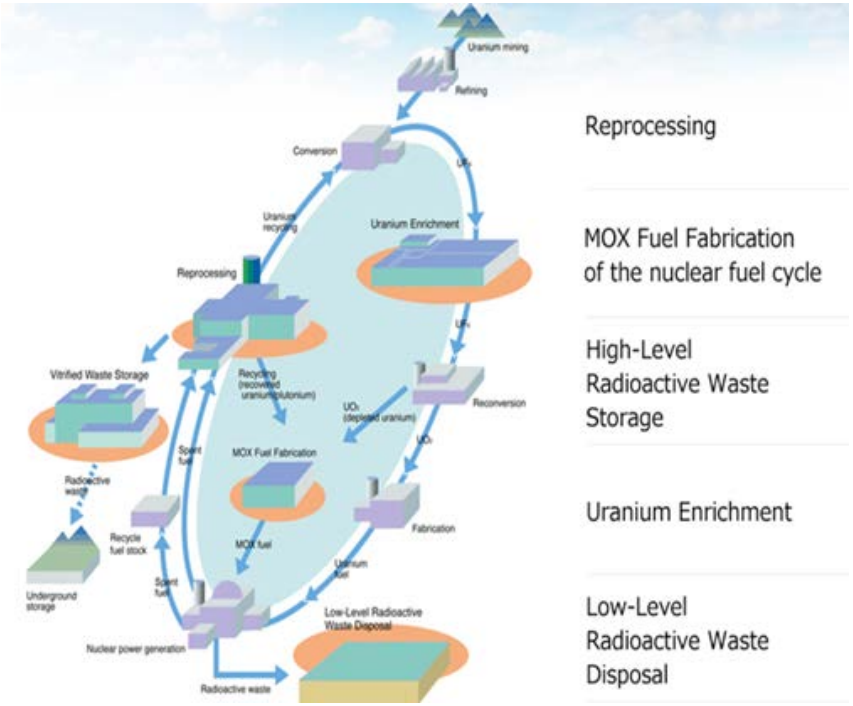
Plutonium stockpiles

Reprocessing plant in Rokkasho in operation

→ 8 tons annually



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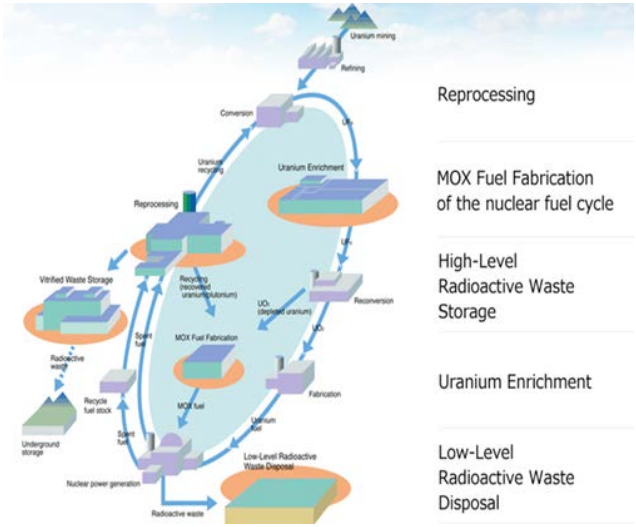
Contradiction of nuclear fuel cycle

~~Reducing of plutonium stockpiles~~

~~Promoting nuclear fuel cycle~~



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Uncertainties

The direction of nuclear energy policy

1. Promoting nuclear power
2. Reducing the dependence on nuclear power

The direction of nuclear fuel cycle

a. Promoting nuclear fuel cycle

b. Reducing of plutonium stockpiles

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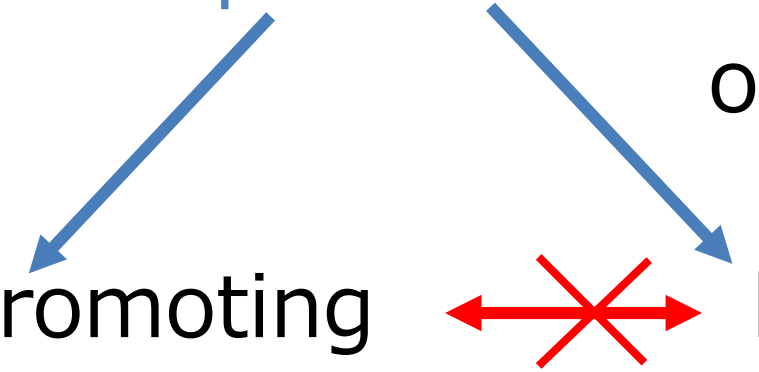
Uncertainties

1. Promoting nuclear power
   more spent fuel → needs bigger facility
   or more facilities?



a. Promoting nuclear fuel cycle
→vitrified

b. Reduction of plutonium stockpiles
→ direct disposal

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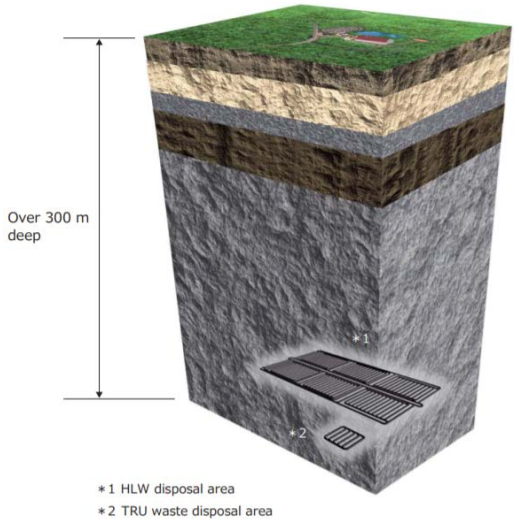
Spent fuel -> reprocessing
vitrified
for 100,000 years

Spent fuel -> direct disposal
for one million years,
needs more space



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Uncertainties/Problems

1. The direction of nuclear energy policy
2. The direction of nuclear fuel cycle
3. Difficulty to gain public trust

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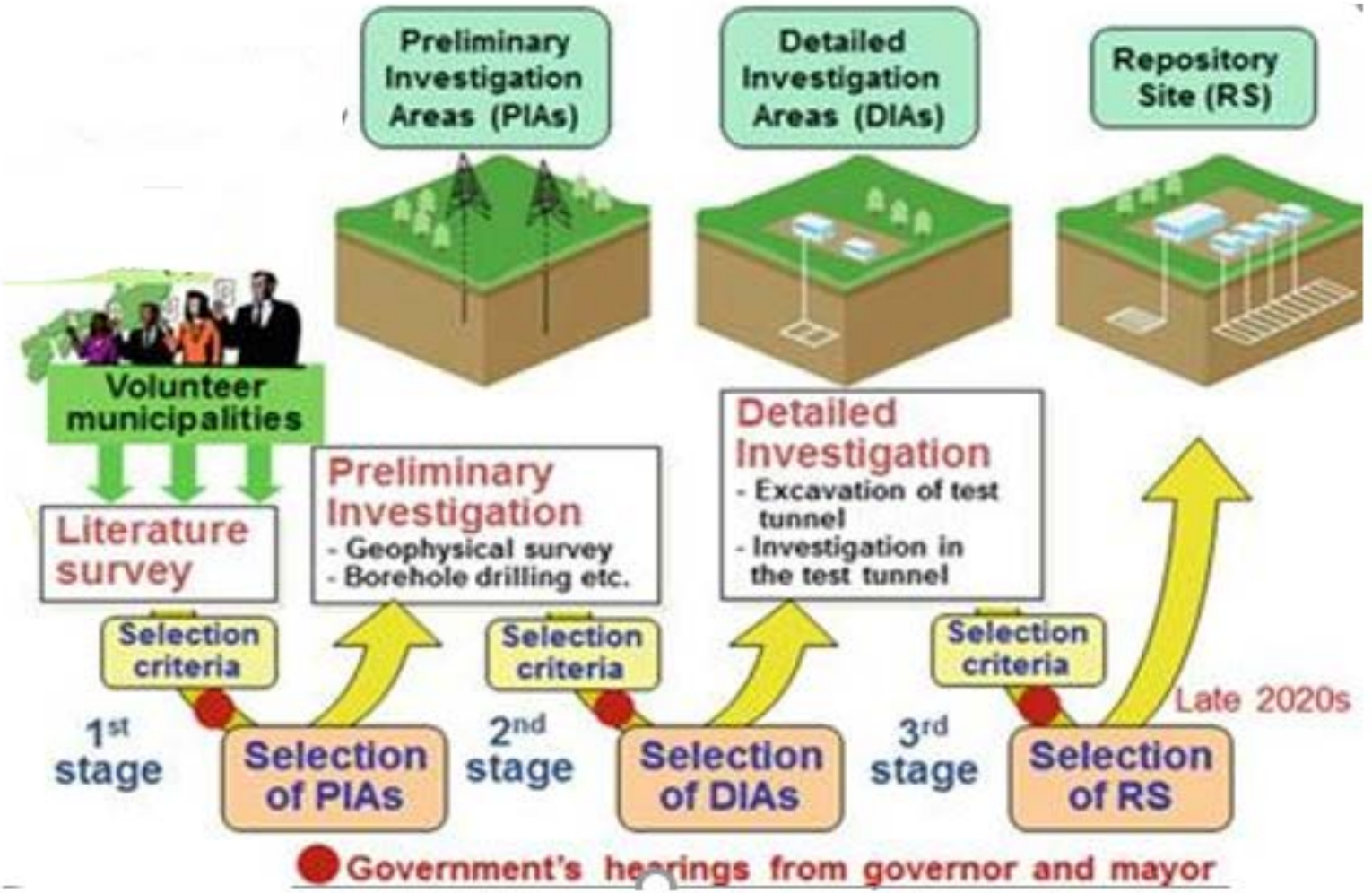

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Shift in policy on site selection methods

May 2015

revision of the government's Basic Policy

based on the Final Disposal Act

The key point: from a system of voluntary application by local governments to a ***government-led selection system***

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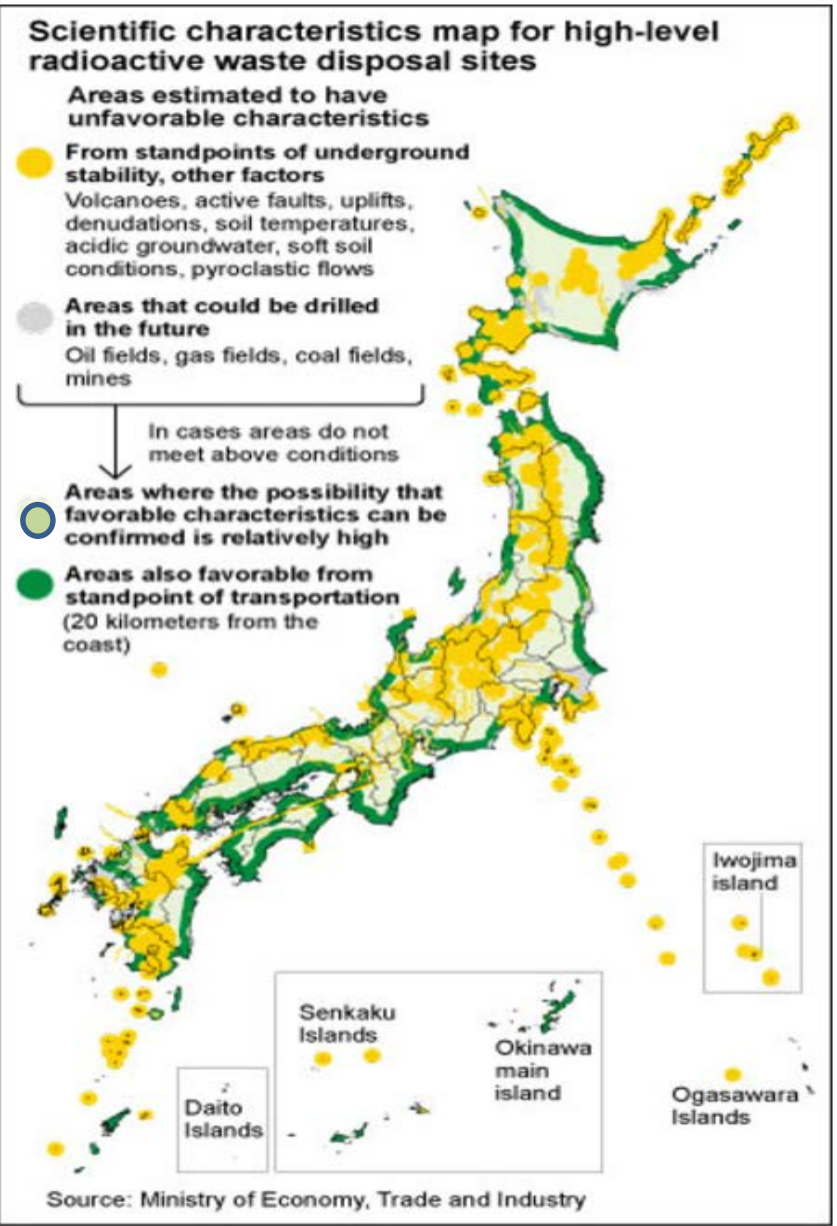
Scientific characteristics map



Nearby volcanoes or active faults

Possible drilling in the future

Relatively favorable for disposal

Most favorable for disposal

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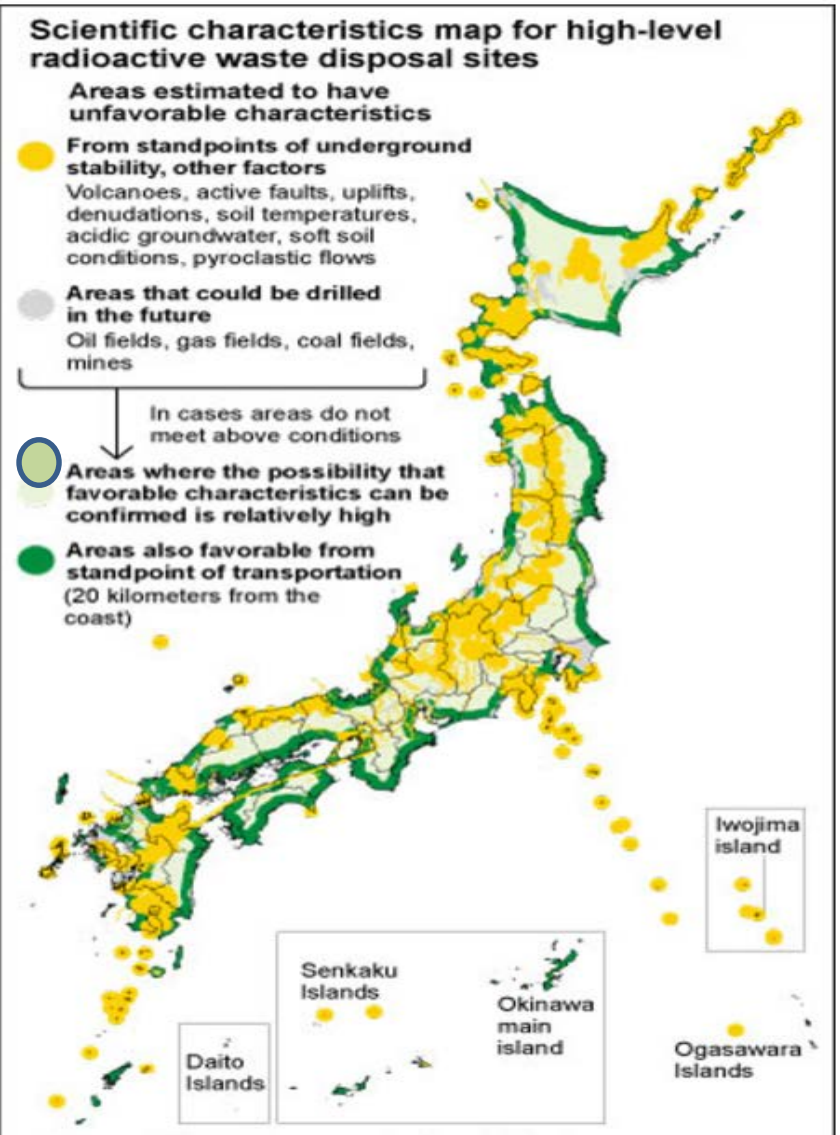
Scientific characteristics map



Relatively appropriate for disposal

Most appropriate for disposal

- 30% of the country's total land
- 900/1750 municipalities in Japan

+ = 65 %

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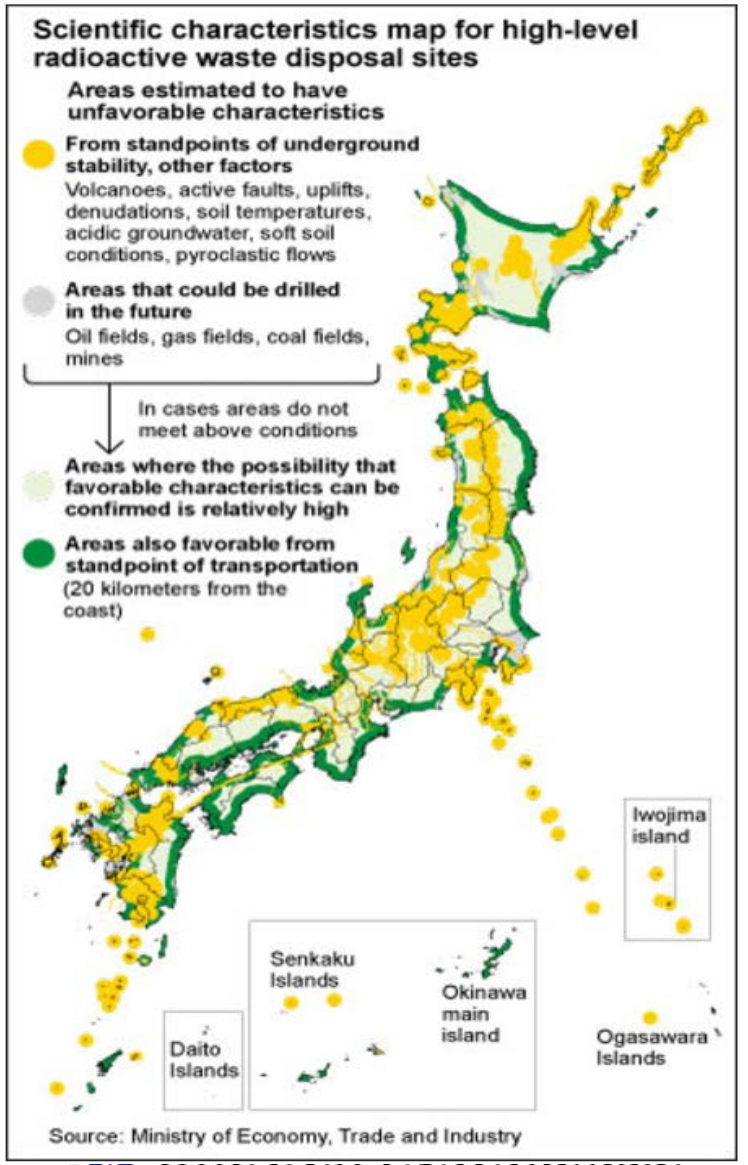
Newly added process under the new cabinet decision

Nationwide scientific screening by government (mapping)

Implementation of dialogue activities (organisation of meeting, etc.)

- Applications by municipalities
- **Proposals by the national government for multiple areas**



Students offered reward for joining govt. events on nuclear waste

39 students

10,000 yen (about 70 Euro) in cash or goods worth the same amount
in exchange for participation in the event

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The Mainichi
Japan's National Daily Since 1922

Unfinished nuclear fuel reprocessing plant faked safety records: NRA

October 11, 2017 (Mainichi Japan)

Japanese version

The firm that owns an uncompleted nuclear fuel reprocessing plant in Aomori Prefecture failed to conduct necessary checks and falsified safety check records relating to the plant, the Nuclear Regulation Authority (NRA) has reported.

【Related】After years of setbacks, Japanese unfit for nuclear energy projects

The NRA concluded on Oct. 11 that Japan Nuclear Fuel Ltd. (JNFL) has violated safety measures after it was learned that the firm failed

Uncertainties/Problems

1. The direction of nuclear energy policy
   Promoting nuclear power
2. The direction of nuclear fuel cycle
   Promoting nuclear fuel cycle
3. Difficulty to gain public trust
   - scandals and falsified info/cover-up
   - emphasize safety
     but do not mention risks

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Conclusion

Nuclear energy Policy &
Nuclear waste management
The new strategy is driven by old thinking
and facing a dilemma.

⇒

Need for a drastic review of
nuclear power/waste policy

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Thank you for your attention!

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Six Suggestions from SCJ

1. **Drastic review of policies** on disposal of high-level radioactive waste
2. Recognize **the limitation of scientific and technological capability** and secure scientific autonomy for scientific deliberation;
3. Rebuild a framework of policy on the premise of **temporary storage** of HLW and **the control of total amount** thereof;
4. Explore socially acceptable procedures such as those in which fair burden-sharing among people is ensured;
5. Pursue multi-step procedures to build consensus among the public by establishing venues for discussion among them;
6. Recognize the need for long-term tenacious efforts to solve the problems.

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Quantity of spent fuel stored at each NPP in tons (March 2014)

Electric Power Company/ NPP		Quantity of Waste Stored	Available Capacity	Remaining Available Capacity	Remaining Operation Time (years)
Hokkaido	Tomari	400	1,020	620	16.5
Tohoku	Onagawa	420	790	370	8.2
	Higashidohri	100	400	340	15.1
Tokyo	Fukushima Daiichi	1,960	2,270	n/a	n/a
	Fukushima Daini	1,120	1,360	n/a	n/a
	Kashiwazaki Kariwa	2,370	2,910	540	3.1
Chubu	Hamaoka	1,140	1,740	600	8.0
Hokuriku	Shiga	150	690	540	14.4
Kansai	Mihama	390	670	280	7.5
	Takahama	1,160	1,730	570	7.6
	Ohi	1,420	2,020	600	7.3
Chugoku	Shimane	390	600	210	7.0
Shikoku	Ikata	610	940	330	8.8
Kyushu	Genkai	870	1,070	200	3.0
	Sendai	890	1,290	400	10.7
JAPC	Tsuruga	680	860	280	9.3
	Tokai Daini	370	440	70	3.1
Amount		14,330	20,810	5,950	