# JAPAN'S NUCLEAR ENERGY POLICY

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# Policy Goals



- Maintain proper infrastructure for the promotion of safe, secure, safeguarded and sustainable utilization of nuclear energy and make the share of nuclear in electricity generation greater than 40 % in 2030.
- Reprocess used-fuel from LWRs with the domestically available capability, utilize fissile material thus recovered in LWRs for the time-being, and dispose the vitrified high-level radioactive waste from the reprocessing process into a deep geologic repository.
- Promote nuclear energy research and development (R&D) efforts, including those for commercializing fast breeder reactor and its fuel cycle technology that can attain better fuel utilization and waste minimization before 2050.
- Promote international cooperation and trade for assuring safe, secure, safeguarded and sustainable utilization of nuclear energy in every part of the world, with a view to contributing to the improvement of the welfare of humankind.

# Nuclear Power Generation: Current Status



- As Tomari-3 started operation in last December, 10 electric power companies are currently operating 54 LWRs (49 GWe) that supply about 30% of electricity.
- Tsuruga-1 started operation beyond 40 years in April this year and Mihama-1 will do so in December.
- The nuclear power contributes to the reduction of the 300 Mt $CO_2$ emission annually as well as to the increase in Japan's energy self-supply ratio from 4 % to 16 %, as it can be categorized as an indigenous energy source.
- 2 units (Ohma, Shimane-3) are under construction, 3 applications to construction permit (Tsuruga-3&4, Higashidori-1) are in the final stage of regulatory review. On the other hand, 3 units ( Tokai, Hamaoka-1&2) are in the decommissioning phase.

# Nuclear Power Generation: Current Issues



- It is specified in the basic energy plan decided by the Cabinet this June that the share of nuclear in power generation is expected to be 49% in 2030 as a part of actions for combating global warming: In order to attain this goal, we are required to;
  - Improve the capacity factor of operating plants, 85% by 2020 and 90% by 2030 through strong quality management and the adoption of the new maintenance rule that makes it possible to program the schedule of legal inspection and thus continuously operate for more than 14 months before a planned shutdown for maintenance.
  - Promote ageing management of long-life plants with a view to continuing their operation beyond 40 years:
  - Promote the replacement of aged plants with new plants and the addition of new plants: EPCs are expected to construct 9 units by 2020 and 14 units by 2030:
  - Pursue the public understanding of the validity of such regulatory innovation as well as the importance of nuclear energy for both assuring energy security and combating global warming.

# Average Capacity Factors (%)

| FY | BWR | PWR | Total | OUTAGE> 3 Month: *italic: due to earthquake* |
|---|---|---|---|---|
| 2005 | 65.2 | 81.5 | 71.9 | *On1-3, H1&2*, 2F3, M3 |
| 2006 | 63.9 | 79.2 | 69.9 | *On1-3, H1&2*, 1F1, H5, S2, M3, G2 |
| 2007 | 49.7 | 77.8 | 60.7 | *K1-7, H1&2*, S1&2, On3, 1F1, Ts2, M2, Tk2, Tk3 |
| 2008 | 51.1 | 73.7 | 60.0 | *K1-7*, S1, 1F1, H5, Ts2, To1, To2, M2, Tk3, Tk4, O3 |
| 2009 | 55.5 | 78.0 | 65.7 | *K1-7*, S2, 1F3, H4, *H5*, On2, Ts2, To2, O1, O2 |

- K1,6&7 are now in operation. K5 is ready for restart.
- 1% increase in the capacity factor corresponds to the reduction of 3Mt-$CO_2$ or 0.2% of Japan's total $CO_2$ emissions.

# Nuclear Power Generation : Results of Pubic Opinion Survey



| | 2005 | 2009 |
|---|---|---|
| **Promotion or phase out** | | |
| Positively promote | 8.0% | 9.7% |
| Cautiously promote | 47.1% | 49.8% |
| Maintain status quo | 20.2% | 18.3% |
| **Feel easy or feel uneasy** | | |
| Feel easy | 4.4% | 6.1% |
| Feel easy on balance | 20.4% | 35.7% |
| Feel uneasy on balance | 48.1% | 43.4% |
| Feel uneasy | 17.8% | 10.5% |

- The reason why feel uneasy:
  - Accident is probable.
  - Accident has occurred.
  - Japan is a country with frequent earthquakes.

# Front-End of Fuel cycle



- Secure uranium
  - Concluding long-term supply contracts with various suppliers in diverse areas
  - Participating in mining projects
- Secure conversion and enrichment services
  - Concluding long-term contract with major suppliers
  - Assuring domestic enrichment capacity up to 1,500 ton SWU by introducing the next generation centrifuge machine in 10 years.
- Secure fuel fabrication services
  - EPCs are enjoying competition among domestic and foreign fabricators.

# Back –End of Fuel Cycle



- Used Fuel Management
  - 40,000 tons to be generated during 2009 - 2046:
    - ✓ 16,000 tons will be reprocessed in RRP after reprocessing 15,500 tons already stored:
    - ✓ 24,000 tons will be stored at spent fuel storage facilities at reactor or interim storage facilities away-from-reactor for the time being and will be reprocessed at the second commercial reprocessing plant in the future.
- Key activities are to;
  - Assure MOX fuel fabrication capability;
  - Start the operation of RRP;
  - Assure spent fuel storage capability (At-Reactor and Away-From-Reactor facilities)
  - Promote the construction of high-level radioactive waste disposal facility.

# Use of MOX Fuel



- 7 LWRs (including Ohma ABWR of which core can load MOX fuel fully) were licensed to load MOX fuel: Genkai-3, Ikata-3 and Fukushima1-3 have started operation, loading MOX fuel.
- 2 LWRs are under regulatory review on this matter.
- Rokkasho MOX fuel fabrication plant (JMOX) is to start operation in 2015.
- JAEA restarted the operation of Monju in May 2010.
- Spent MOX fuel discharged from LWRs shall be stored until fast breeder reactors will be introduced: plutonium recovered from this fuel will be fed to FBRs.

# Rokkasho Reprocessing Plant



- The completion of commissioning test has been delayed due to a series of trouble in establishing operational procedure of the joule-heating ceramic glass-melter in the high-level waste vitrification line.
- AEC is recommending the JNFL to go steadily, overcoming the difficulties that come from the insufficient understanding of the effect on its operation of insolvable electricity conducting impurity of which density increases in accordance with the increase in the burn up of fuel processed.
- The JNFL recently announced that the revised completion date is October 2010, based on the analysis of the result of a series of mock-up test and other measurements and studies with a view to establishing  the operating procedure of the melter.

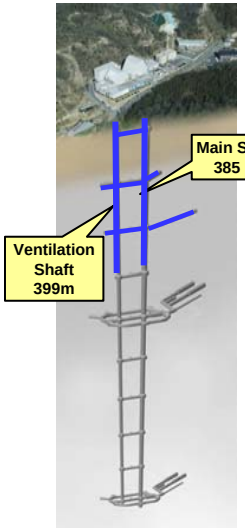
# High-Level Radioactive Waste Disposal

R&D activity is promoted by the IAEA with a view to developing technical basis for the disposal project by NUMO and for safety regulations.

**ACTIVITIES:**

- R&D for engineering technology and safety assessment methods
- Development of integrated methods for characterizing the deep geological environment
- Development of technical knowledge basis

Tono Geoscience Center



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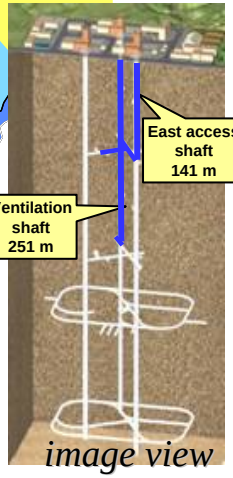
## Mizunami URL

- Crystalline rock
- Fresh water

View of the Construction Site




Horonobe Underground Research Center



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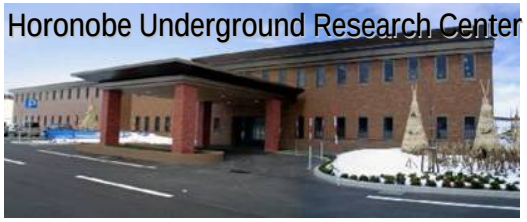
## Horonobe URL

- Sedimentary rock
- Saline water


View of the construction site




Tokai R&D Center

- Disposal technology
- Safety assessment method, etc.


# Siting of a HLW Disposal Facility



- In 2004, the NUMO, an organization authorized to promote the disposal activity, started to invite mayors of municipalities to apply for site suitability investigation.
- However, so far no mayor has successfully applied: in one case a mayor who applied was defeated in the election due to rally with such an appeal as “Can you and your posterity live with 40,000 highly radioactive canisters each of which has radioactivity equivalent to 30 Atomic Bombs dropped on Hiroshima-city”.
- The Government as well as the NUMO has started to strengthen public information activities on the safety and the importance of the disposal facility at both national and municipal levels, taking into consideration lessons learned from this case.

# Innovative Nuclear Technology Development Roadmap

## (1) Short and Medium-term R&D

2000 2010 2020 2030 2040 2050

**Effective use of Existing Facilities**

▼initial plants 40 years progress

▼initial plants 60 years progress

・Seismic design back check
・Ageing Management
・Higher availability factors

**Nuclear Fuel Cycle technology**

・Uranium enrichment ・Radioactive waste treatment
・Spend Fuels Reprocessing ・Decommissioning

**●2030s;**
**Start disposal of High Level Radioactive Waste**

## (2) Medium-term R&D

**Next generation light-water reactor**

・For replacing aged domestic plants
・Fro global standard of G III+++

・Safety、Economy 、Reliability

**Small and Medium Sized Reactor**

Improve economy through integration & modularization and lowering of maintenance costs

Development to the overseas market

## (3) Medium-term R&D on nuclear hydrogen production technology

**Innovative nuclear hydrogen production system technology**

HTTR
(O-arai,Ibaraki)
'98 initial criticality

・Performance evaluation through development of pilot plant using industry materials

CO2-free hydrogen production、economic、large-scale stable

HTTR: High Temperature Engineering Test Reactor

## (4) Long-term R&D

**Fast Breeder Reactor and Its Fuel Cycle Technology**

"Joyo" Test Reactor
(O-arai, Ibaraki)
'77 initial criticality、
Now operating

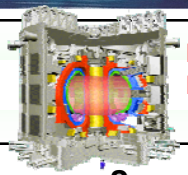
**"Monju" Prototype Reactor**
(Tsuruga, Fukui)
'94 initial criticality
Now in preparation of restart

**Demonstration Reactor**

**Commercial Reactor**

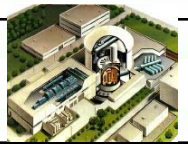
**Fusion reactor technology**

**Broader Approach (BA)**



**International Thermonuclear Experimental Reactor (ITER)**

Prototype Reactor



## (5) Generic R&D : Innovation in nuclear science & engineering

**Nuclear safety・nonproliferation technology**

**Basic nuclear science and technology**

**Development of innovative material for energy technology innovation**

# FR Cycle Development Program in JAPAN

2005 | 2010 | 2015 (JFY)

**Feasibility Study**
(JFY 1999-2005)
Identify The Most Promising Candidate Concept

C&R

Review & Basic Policy by MEXT &AEC

**Fast Reactor Cycle Technology Development Project (FaCT)**

Decision of Innovative Tech. (2010)

**R&D of Innovative Technologies**

**Experimental FR "Joyo"**

**R&D at Prototype FR "Monju "**

**Conceptual Design of Commercial & Demonstration FR Cycle Facilities**

**R&D at "Monju "**
- ◆ Demonstrating its Reliability as a Operation Power Plant
- ◆ Establish Sodium Handling Tech.

**2015**
Establishment of Innovative Technologies with Conceptual Design

Basic Design & Construction

**2025**
Operation Start of Demonstration FR & its Fuel Cycle Facility

Validation of Economy & Reliability

**2050**
Commercial Introduction of FR Cycle Facilities

◆Cooperation with related Organization ◆International Cooperation（GNEP, GEN-IV, INPRO etc.）

# International Cooperation and Trade: Objectives and Actions



**Objective 1**: Shape international environment for safe, secure, safeguarded and sustainable nuclear energy use in the world

- The activities of the IAEA, NEA, IFNEC for nurturing and maintaining international regime for such nuclear energy use:
- Facilitate the capacity building and human resource development in new comer countries:

**Objective 2**: Promote mutually beneficial bi- and multilateral cooperative activities with a view to effective and efficient execution of nuclear energy R&D activities:

- GIF, ITER, INPRO, Japan-France cooperation etc,

**Objective 3**: Shape environment for Japanese nuclear firms to be able to export nuclear materials, manufactured products and information:

- Conclude nuclear agreement:
- Establish one-stop interface for emerging countries to be able to consult on the contents of trade with team-Japan.

# Oversea Business of Japanese Nuclear Industry



- Japanese nuclear industry has completed many NPP construction projects in Japan on time and on budget, in cooperation with electric utilities, supplying high quality systems and components.
- The industry has also supplied high-quality components of LWRs like SG to the global market.
- Now AEC suggests the industry to pursue also, in cooperation with electric utilities, the construction of NPPs in foreign countries, sharing with foreign operators the organizational culture to value quality, a sense of security, cleanliness of workplaces and visualization that has been cultivated in Japan.
- The AEC has also proposed Government to arrange measures to reduce the financial risk accompanied with oversea business and pursue the inclusion of nuclear energy in the flexibility mechanisms of the Post-Kyoto Regime.

Backup Slide

# Lessons Learned From the Seismic Event of Kashiwazaki-Kariwa NPP



- Need for using “a **fault model”** in which not only the source characteristics (number of asperities, their sizes and locations on the fault ) but also the propagation characteristics of crust geological structure (such as folding structure) and the site characteristics (such as low velocity sediment layers in the free base stratum under the plant) are considered.
- Need for reviewing the appropriateness of aseismic design of non-safety grade systems, structures and components from the viewpoint of business continuity risk.

# A Global Vision of Fuel Cycle Services in the Future



- The operation of 1000 -1500 GWe nuclear power generating capacity in 2050 is a moderate prediction from the viewpoint of controlling the risk of global warming, though it will be necessary for realizing this size of nuclear capacity in 2050 to maintain safe, reliable and economical operation of nuclear power plants and add continuously more than 20 units in a year.
- Global community with 1,500 GWe LWRs will need 10 enrichment centers each of which capacity is 18,000 t SWU/y and 10 reprocessing centers each of which capacity is 3,200 t/y.
- The assurances of these services beyond national boundaries by these 10 + 10 centers may make it unnecessary for “consumer” countries to argue for indigenous enrichment and reprocessing programs, though they should dispose the used-fuel or the high-level waste sent back from the reprocessing center with MOX fuel as an obligation of every country that enjoy the nuclear power.