Utilization and development of nuclear energy in Japan

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KNS 40th Anniversary Meeting, Jeju, May 21, 2009

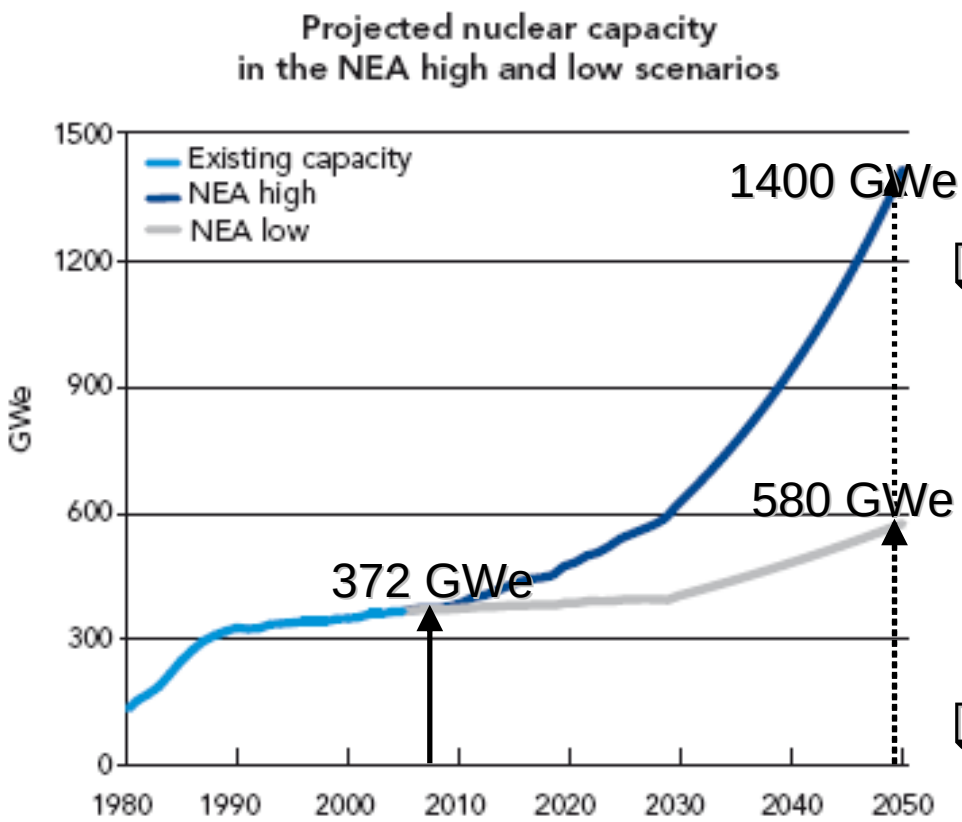
New Look at Nuclear Power

Growing Consensus

- A Key Means to Concurrently Secure Stable Supply of Energy and Cope with Global Warming
- Making a Major Contribution to Reducing Greenhouse Gas Emission
- A Currently Available Commercial Technology to Mitigate Climate Change
- The Role of Nuclear Power (G8 Summit 2008 in Toyako, Hokkaido)
  - ➡ In Reducing CO_2 Emissions
  - ➡ In Responding to Individual Countries' Increasing Energy Security Needs

New Look at Nuclear Power

Global Nuclear Capacity



Nuclear Energy Outlook 2008 (NEA)

- By 2050, global nuclear capacity is projected to increase by a factor of between 1.5 and 3.8.
- Under the high scenario, the nuclear share of global electricity production would rise from 16% today to 22% in 2050.
- These projections are in broad agreement with those from other organizations.

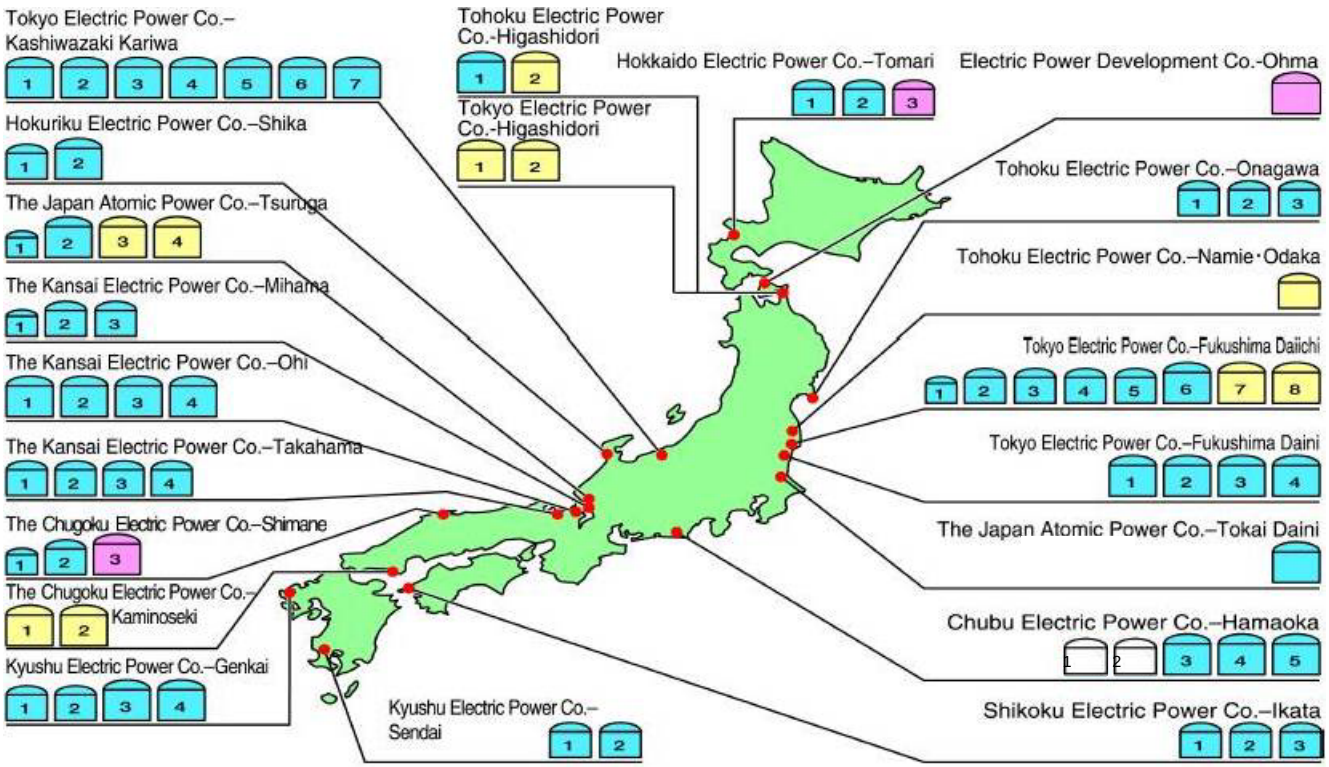
New Look at Nuclear Power

Necessity of Nuclear Energy in JAPAN

- Nuclear Energy at the Center for the Progress of Coping with Global Warming
- Extensive Utilization of Nuclear Energy for the 50% Reduction in CO_2 Emissions by 2050
- "The Road Map for Technology Innovation in Environmental Energy (2008)"
  - ➡ Use of LWR (Short and Mid-Term Plan, to 2030)
  - ➡ Development of Next Generation LWR and FBR Cycle Technology (Mid and Long-Term Plan, after 2030)

Nuclear Power in JAPAN

Commercial NPPs (As of February, 2009)



	No.	Power (MWe)
Operating	**53**	**4808.7**
Under Construction	**3**	**366.8**
Preparing for Construction	**10**	**1356.2**
Total	**66**	**6531.7**

- ❑ 53 NPPs
  - ➡ 30 BWRs
  - ➡ 23 PWRs
- ❑ 48 GWe
  - ➡ 1/3 of Total Electricity
  - ➡ 12% of Primary Energy
- ❑ After 2030
  - ➡ More than 30 ~ 40% of Total Electricity

Nuclear Power Utilization in Japan

- Over 50 LWR plants; BWR and PWR
- 9 utilities (TEPCO, Kansai, Chubu etc) by region and JAPC and J-Power(EPDC)
- First LWR demo (JPDR, 12MWe BWR) in 1959
- First commercial plant (GCR) in 1965, LWR in 1970
- 3 LWR vendors; Toshiba, Hitachi/GE and Mitsubishi(MHI)
- 3 nuclear fuel manufacturers; GNF,Mitsubishi,NFI
- Commercial nuclear fuel cycle program by JNFL (enrichment, spent fuel reprocessing and low level radioactive waste disposal) in Rokkasho
- Only for peaceful use, no nuclear weapon by law

Safety grades demonstrated well at the KK earthquake

TEPCO Kashiwazaki-Kariha NPP, 7 BWR, total 8.21GWe

Reference: http://www.tepco.co.jp/nu/kk-np/intro/outline/images/b_kk_l.jpg

Tomari Unit No.3 (Hokkaido EPC) : PWR,912MW

Construction start: Nov. 2003.11

Commercial operation: 2009.12(planned)

Units No. 1, 2 and 3 (from left)

http://www.hepco.co.jp/corporate/ir/ir_lib/pdf/annual2008.pdf

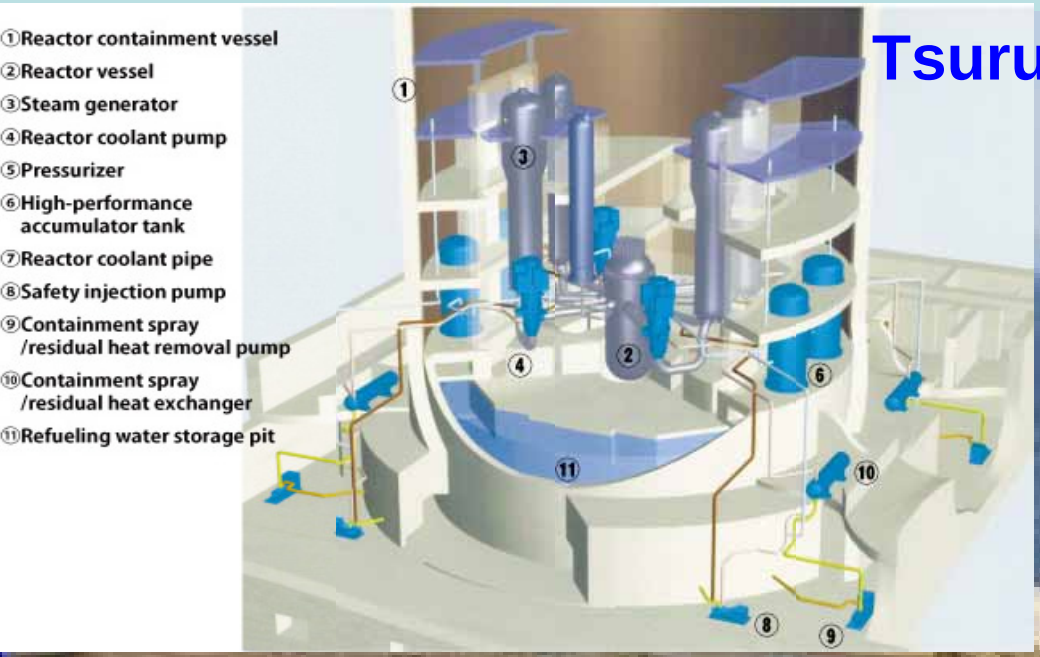
Shimane No.3 (Chugoku EPC) : ABWR,1373MW

construction start: Dec. 2005

commercial operation: Dec. 2011(planned)

http://www.energia.co.jp/e/report/ar_08.pdf

Japan Atomic Power Company: APWR



Tsuruga units 3 and 4; 1530MWx2

- **Approval for start of the preparation work, June 29, 2004**
- **Groundwork underway (July 2, 2004~)**
- **Scheduled first criticality: 2016 (unit 3), 2017 (unit 4)**

http://www.japc.co.jp/english/index.html
http://www.mhi.co.jp/en/

Full MOX ABWR at Ohma (J-Power)

(Rendering of Ohma Nuclear Power Plant)

ABWR (Full MOX core),

loaded with mixed-oxide (MOX) fuels of up to 100% of the core.

The figure is from the website of J power, Japan (http://www.jpower.co.jp/english/news_release/news/news081111.pdf)

Globalization of Japanese manufacturers

- Toshiba-Westinghouse(WH)

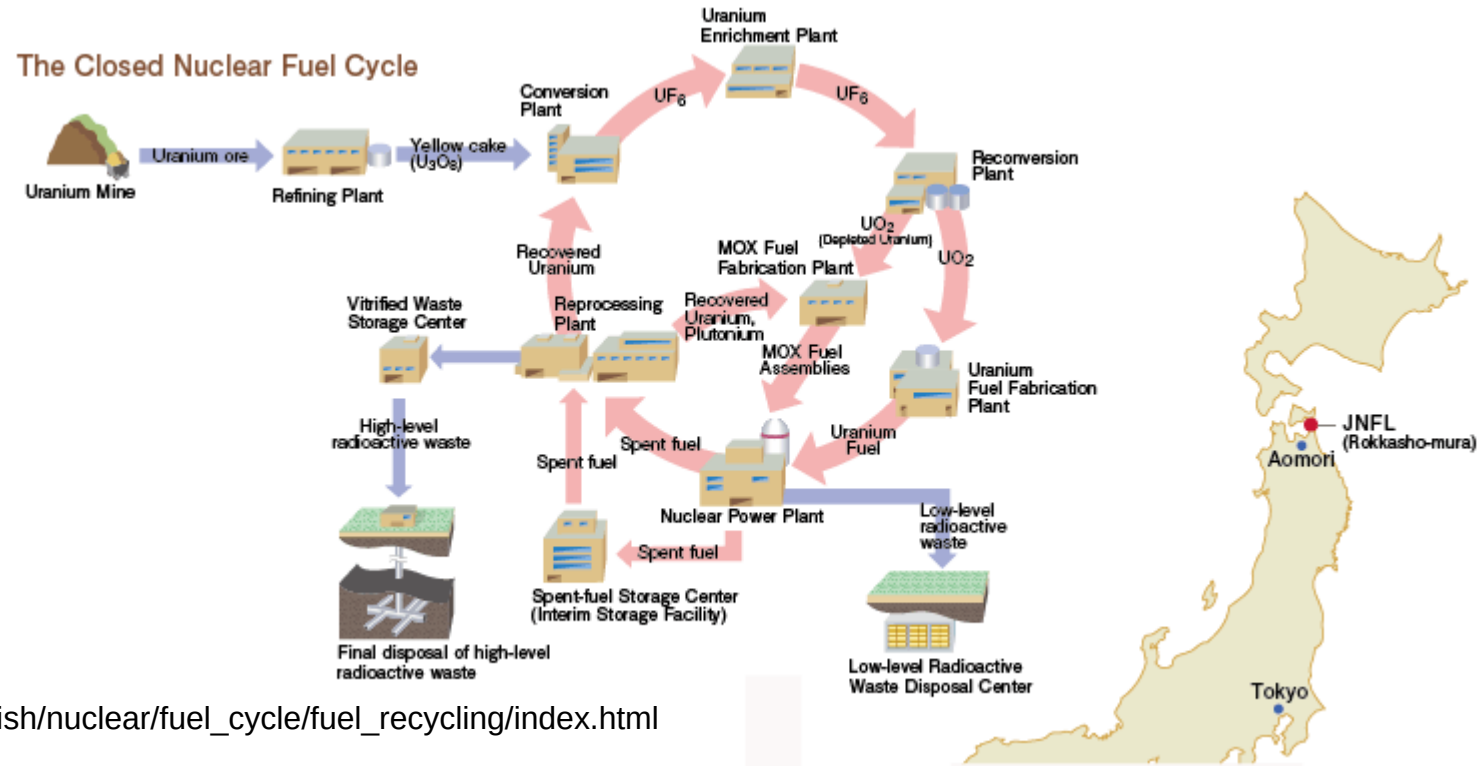
  ABWR, AP1000
- Hitachi-General Electric (GE)

  ABWR, Full MOX ABWR, ESBWR
- Mitsubishi Heavy Industries(MHI)--AREVA

  (Mid-size PWR, Fast Reactor, HTGR)

Japan's Nuclear Fuel Cycle

- A closed nuclear fuel cycle policy:
  - adds to long-term energy security
  - conserves uranium resource
  - reduces the amount of high-level radioactive waste



http://www.fepc.or.jp/english/nuclear/fuel_cycle/fuel_recycling/index.html

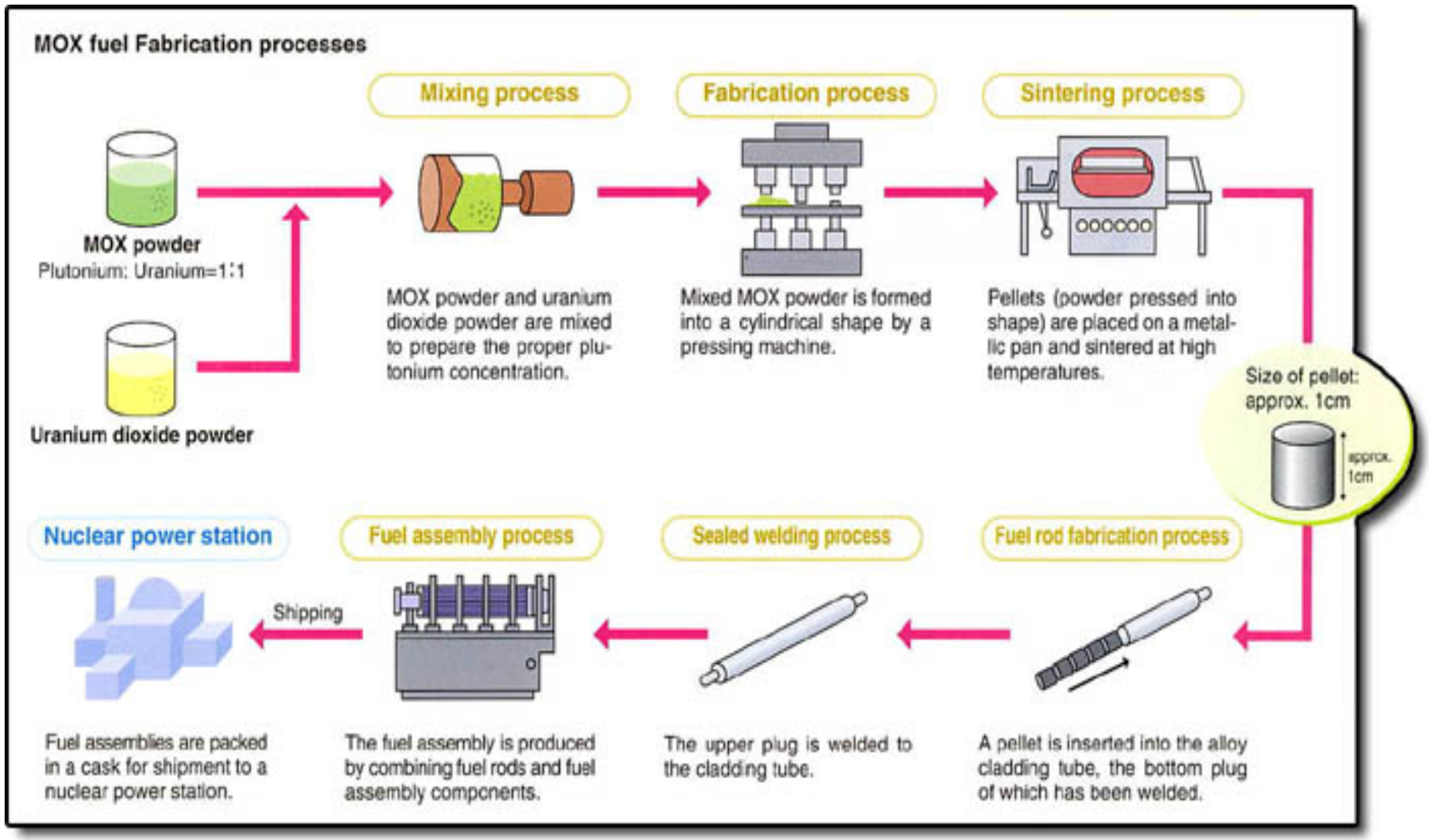
JNFL Rokkasho Reprocessing Plant

- Testing since Nov. 1999
- Site area 3,800,000m^2
- Max. reprocessing capability 800tU
- Max. storage capacity 3,000tU

JNFL Rokkasho LLW Repository

- Site area 3,600,000m^2
- In service:(Unit1, 40,000m^3)1992-,
  (Unit2, 40,000m^3)1999-
- Max. future repository capacity
  600,000m^3

JNFL: a MOX fuel fabrication plant



http://www.jnfl.co.jp/english/mox.html

Nuclear R&D in Japan

Japan Atomic Energy Agency (JAERI and JNC merged in 2006)

- Fast breeder reactor program; Experimental fast reactor JOYO, Prototype FBR MONJU
- High temperature gas cooled reactor; experimental reactor HTTR(30MWt) for high temperature application and hydrogen production
- Nuclear fusion program; JT-60, participate in ITER and broader approach
- Accelerators; J-Park etc

“Joyo” (Experimental Fast Reactor), JAEA

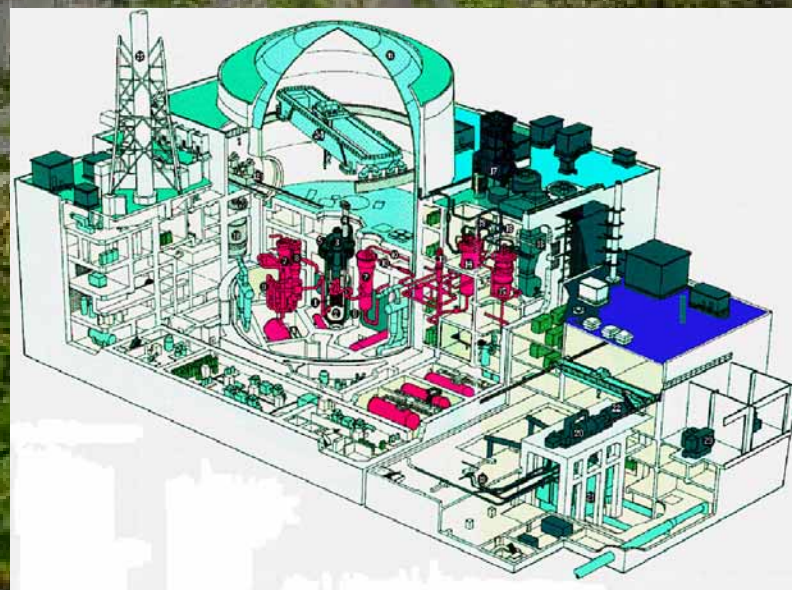
- MK-I: “The Fast Breeder Reactor”, 75MWt (1977-1981)
- MK-II: “Irradiation Reactor”, 100MWt (1982-2003)
- MK-III: “Upgraded Irradiation Reactor”, 140MWt (2003-)

Oharai, Ibaraki

http://www.jaea.go.jp/04/o-arai/joyo/indexes.htm

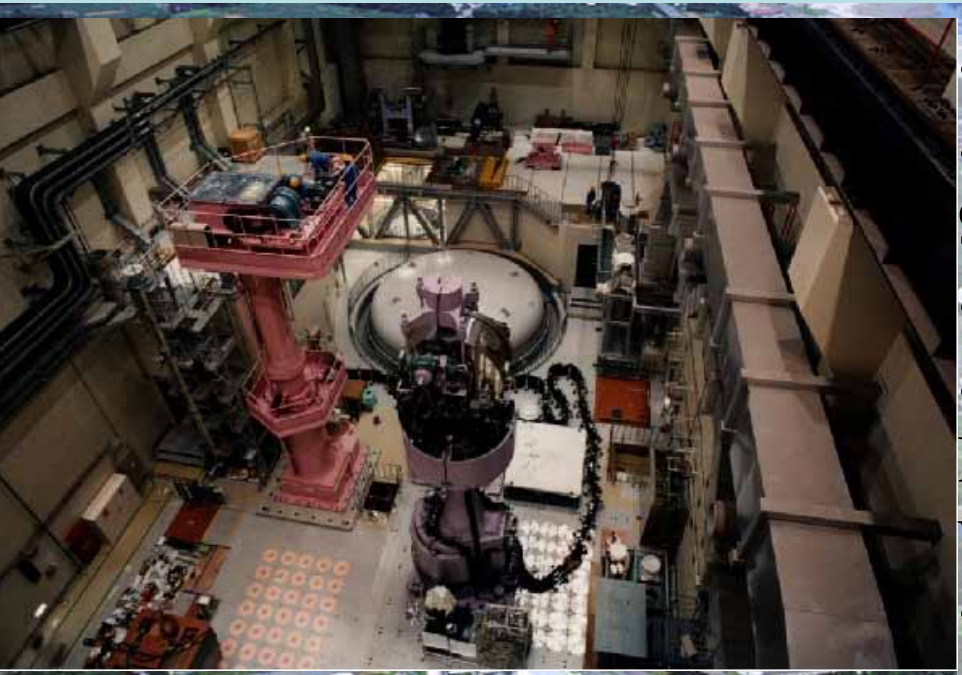
LMFBR “Monju” (Prototype Reactor), JAEA

- Coolant: Liquid Na
- Thermal / electric output: 714MW / 280MW
- First criticality: April, 1994
- Stopped since 8th Dec. 1995 (Na leakage from the secondary loop.

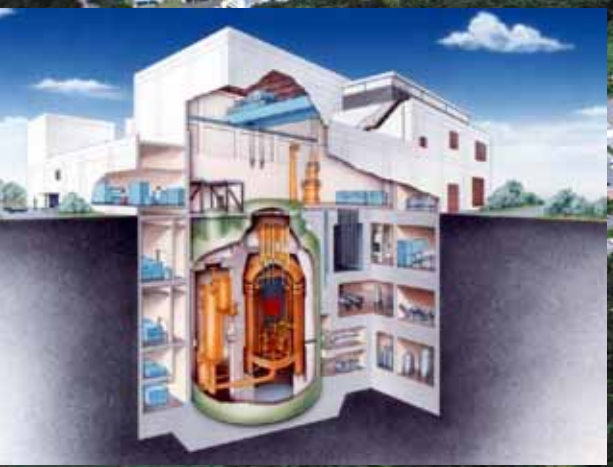


http://www.jaea.go.jp/04/turuga/index.html

High Temperature Engineering Test Reactor (HTTR), JAEA



- Thermal output: 30MW
- Coolant: He gas (4MPa, 395/850-950℃)
- 10th Nov. 1998: First Criticality
- 21st Aug. 2003: Succeeded hydrogen production from water with thermo-chemical I-S process.
- 19th April 2004: achieved 950℃ operation



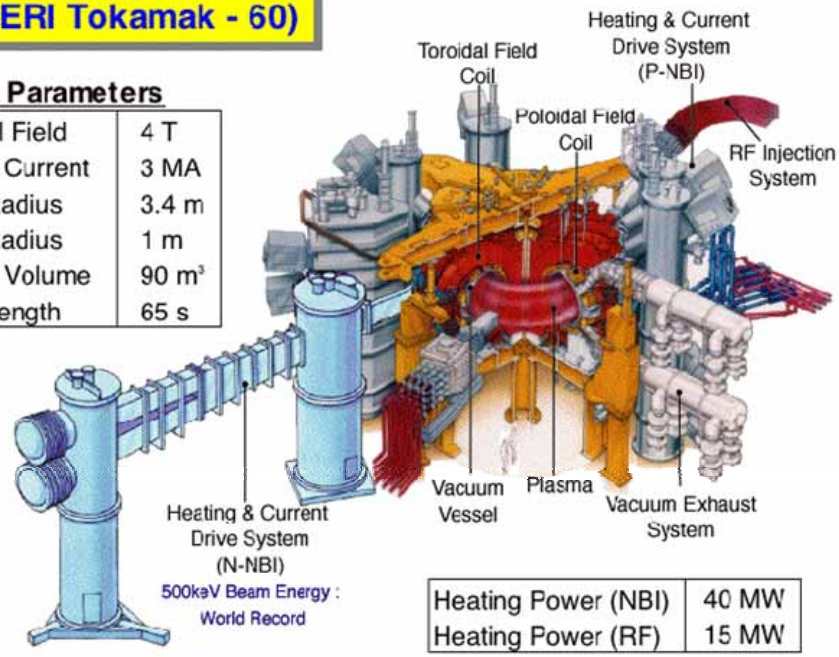
http://httr.jaea.go.jp/eng/index_top_eng.html

JT-60:Plasma Fusion Device, JAEA

JT-60 (JAERI Tokamak - 60)

Main Parameters

Toroidal Field	4 T
Plasma Current	3 MA
Major Radius	3.4 m
Minor Radius	1 m
Plasma Volume	90 m³
Pulse Length	65 s

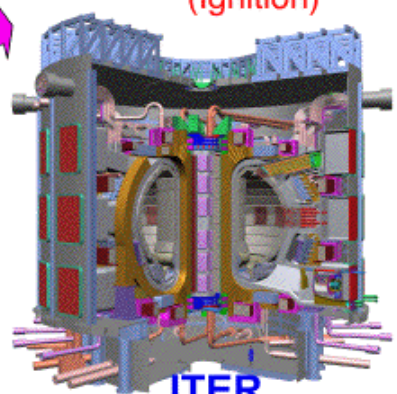


Heating Power (NBI)	40 MW
Heating Power (RF)	15 MW

- 1985-1989: Hydrogen experiment
- 1991~ : Deuterium experiment

Break-even Plasma → Burning Plasma (Ignition) → Generation of Electrical Power for Steady-State

JT-60

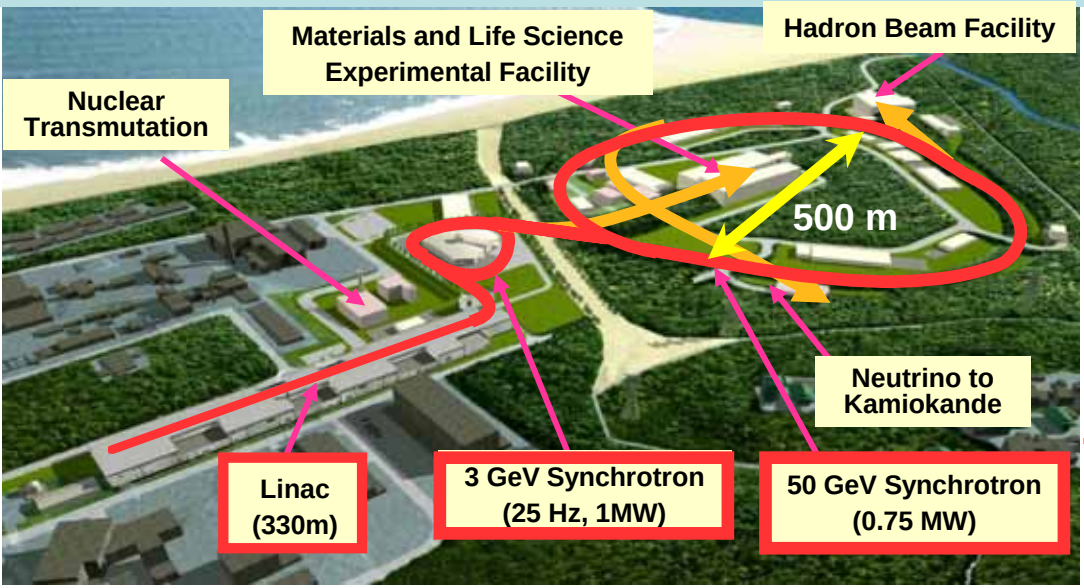


ITER

DEMO

http://www-jt60.naka.jaea.go.jp/english/index-e.html

J-PARC: Japan Proton Accelerator Research Complex, JAEA



J-PARC consists of following accelerators:

- 400-MeV normal-conducting Linac
- 600-MeV superconducting Linac
- 3-GeV synchrotron ring
- 50-GeV synchrotron ring

- June, 2007: Completion of civil construction of the Hadron Hall
- October 31, 2007: Successful beam acceleration at the 3-GeV synchrotron
- May 30, 2008: First neutron production at J-PARC Materials & Life Science Experimental Facility (MLF).
- December 23, 2008: Successful beam acceleration up to 30 GeV at the 50-GeV Synchrotron (MR)
- The next step for the MR is the extraction to the hadron experimental hall (January 2009) and to the neutrino beam line (April 2009)

http://j-parc.jp/index-e.html

Congratulations
KNS 40th anniversary

KNS 창립 40주년을 진심으로 축하드리며,
KNS와 AESJ 두 학회의 협력과 발전을 기원합니다.
감사합니다.