

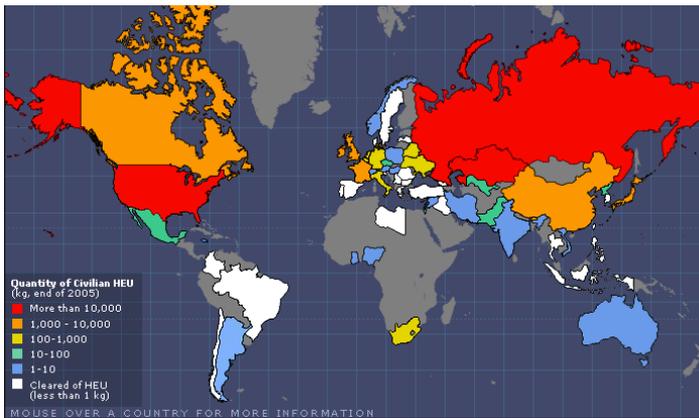
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# HEU management in East Asia

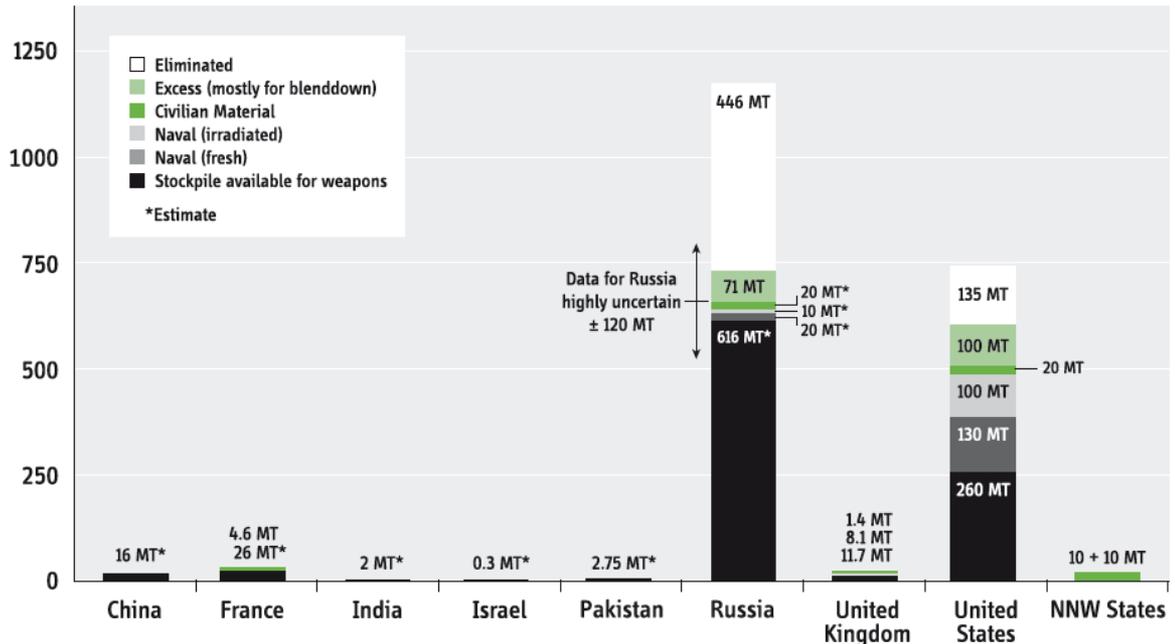
Tadahiro KATSUTA  
Meiji University  
Tokyo, JAPAN

# Outline

- HEU stockpile in East Asia (Japan, China, ROK, DPRK, and Taiwan) is relatively low compared to that of in US and Russia.
- However, this region has a complicated situation concerning nuclear peaceful use and weapon use.
  - 1) Nuclear power plant installed capacity
    - Japan: 3rd, ROK: 6th , China: 11th in the world (as of 2010)
  - 2) Two nuclear weapon states
    - China, DPRK



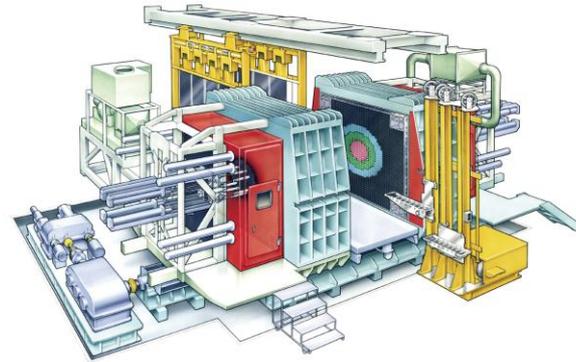
Metric tons [MT]



- In this presentation, current situation of HEU management will be reviewed.
- In addition, the possibility of Multilateral Enrichment Center in East Asia will be introduced.

# Japan

- Current HEU stockpile: 1,200 – 1,400 kg
- The US shipped a total of 2,054 kg of HEU to Japan primarily in the 1960s and 1970s. Japan has 14 reactors that use or have used HEU as of 2001.
  - According to the Nuclear Threat Initiative (NTI), between May 1996 and May 2010, Japan shipped back to the US 656 kg of HEU.
- The most complicated HEU is the Fast Critical Assembly (FCA), which is designed to test the criticality of fast-neutron-reactor cores. It holds significant amounts of HEU.
- The FCA has about 200 kg of weapon-grade uranium as well as plutonium and 20% enriched uranium, according to the US report.



- Fast Neutron Source Reactor, YAYOI of the University of Tokyo was closed at the end of March, 2011.
  - Main reason was economics caused by aging.



# Japan's Unstable Nuclear Management

- Laser enrichment plan for commercial use
  - According to the New York Times (Aug. 20th, 2011), a joint venture business of GE and Hitachi is planning to construct a commercial laser enrichment facility.
  - Since this technology doesn't require a large facility, it may be difficult to detect secret developments by the rouge states or terrorist groups that acquire the technology.
- Japan, IAEA discussing large amount of unaccounted-for nuke materials
  - September 2011 Japan has started backstage talks with the IAEA on the discovery of unaccounted-for or unreported enriched uranium and plutonium in large quantities of nuclear waste disposed of by Japanese facilities, hoping to ward off international criticism with an early report to the IAEA.
  - In a follow-up investigation, the government found some 2.8 kg of HEU solidified with cement and a total of 636 g of plutonium at the JAEA's Nuclear Science Research Institute.
  - Some 4 tons of LEU at a private nuclear fuel company were among them.



Nuclear material, presumed to be uranium powder and such, that was in the possession of Chugoku Electric Power Co.

- According to the NTI Nuclear Materials Security Index, Japan's overall score was 68, and was 23rd in ranking among the 32 countries. The score is the lowest among the Group of Seven (G7).

# DPRK

- Current HEU stockpile: 42 kg
- In 2010, DPRK revealed an advanced uranium enrichment program that it claimed as civilian but that could have allowed it to produce HEU for weapons.
- The existence of this program had been suspected since at least 2002.
- According to the Institute for Science and International Security (ISIS), several buildings located at the Fuel Fabrication Facility were constructed or renovated soon after the April 2009 departure of IAEA monitors. North Korea began renovating the building that now contains the gas centrifuge plant at some point after this April 2009 departure.

An overview of the Fuel Fabrication Facility at the Yongbyon nuclear site showing the location of various construction and renovation activities that occurred after April 2009.

<http://isis-online.org/isis-reports/detail/additional-construction-activity-at-yongbyon-nuclear-site/>



# ROK

- Current HEU stockpile: 0-1 kg
- The US shipped 28 kg of HEU to South Korea from 1974 through 1978. The material was for use in the TRIGA Mark-III and the TRIGA Mark II research reactors.
- Laser enrichment experiment in 2000
  - According to the IAEA, ROK conducted a laser enrichment experiment without declaring it to IAEA and produced 0.2 g of about 80% HEU.
- Nuclear Security Summit in Seoul
  - According to the news from ROK (Jan. 18, 2012), participation countries agreed that they will declare that they will not use HEU in the Leaders Declaration of Nuclear Security Summit in Seoul.



# China and Taiwan

- **China**

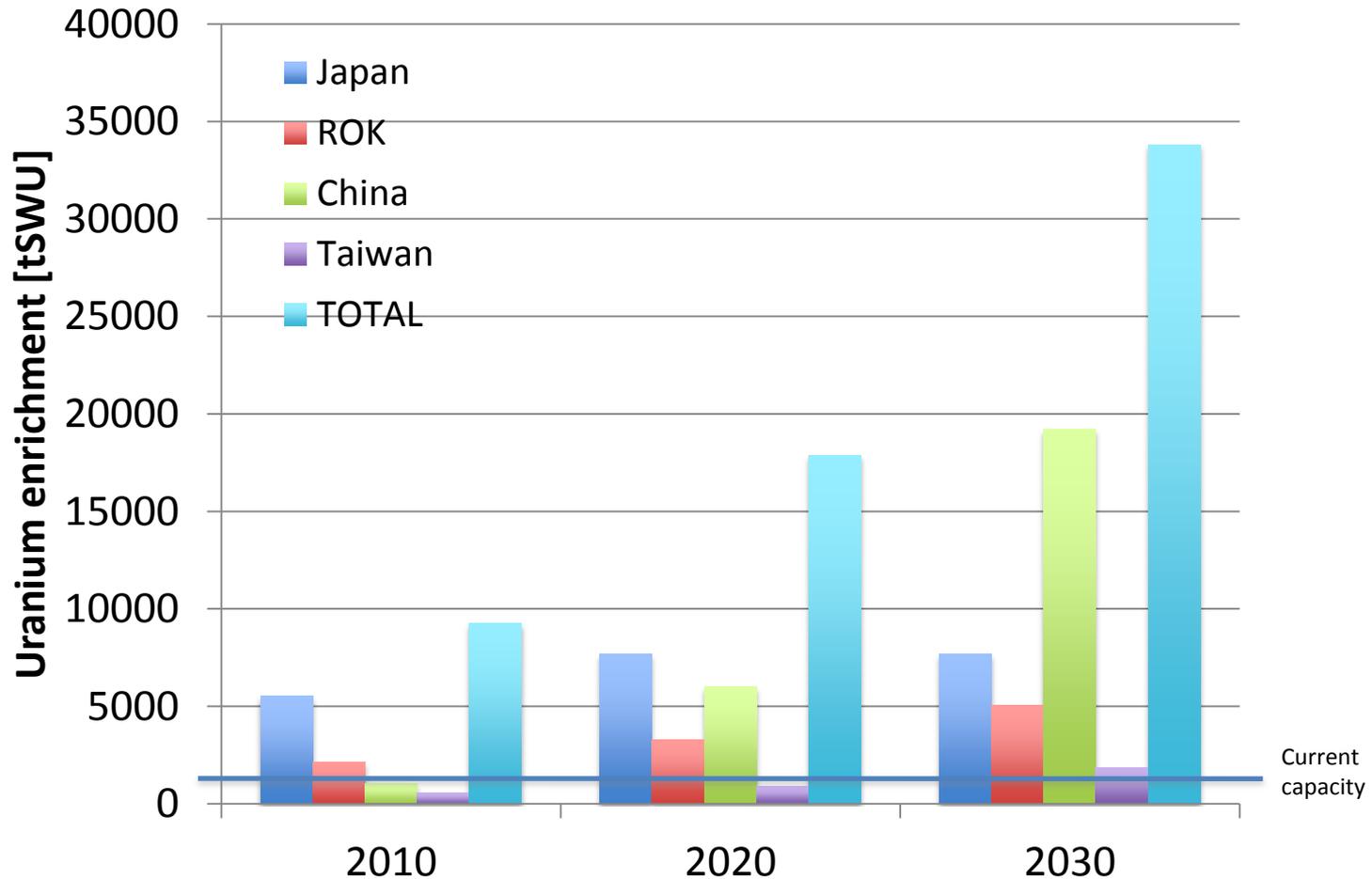
- Current HEU stockpile: 1,000kg
- According to the IPFM, it is estimated that China has a stockpile of military  $16 \pm 4$  tons of HEU, and that an additional 4 tons of HEU may have been consumed in nuclear-weapon tests and in research reactor fuel.
- China produced its HEU at the Lanzhou gaseous diffusion enrichment plant from 1964 to 1980, and at the Heping plant from 1975 to 1987.
- China does not release any information on its stockpile of HEU and has not declared any of its HEU as civilian.

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- **Taiwan**

- The US shipped 10kg of HEU to Taiwan from 1967 to 1973. The material was for use in the Thor TRIGA research reactor.

# Enrichment Uranium demand up to 2030



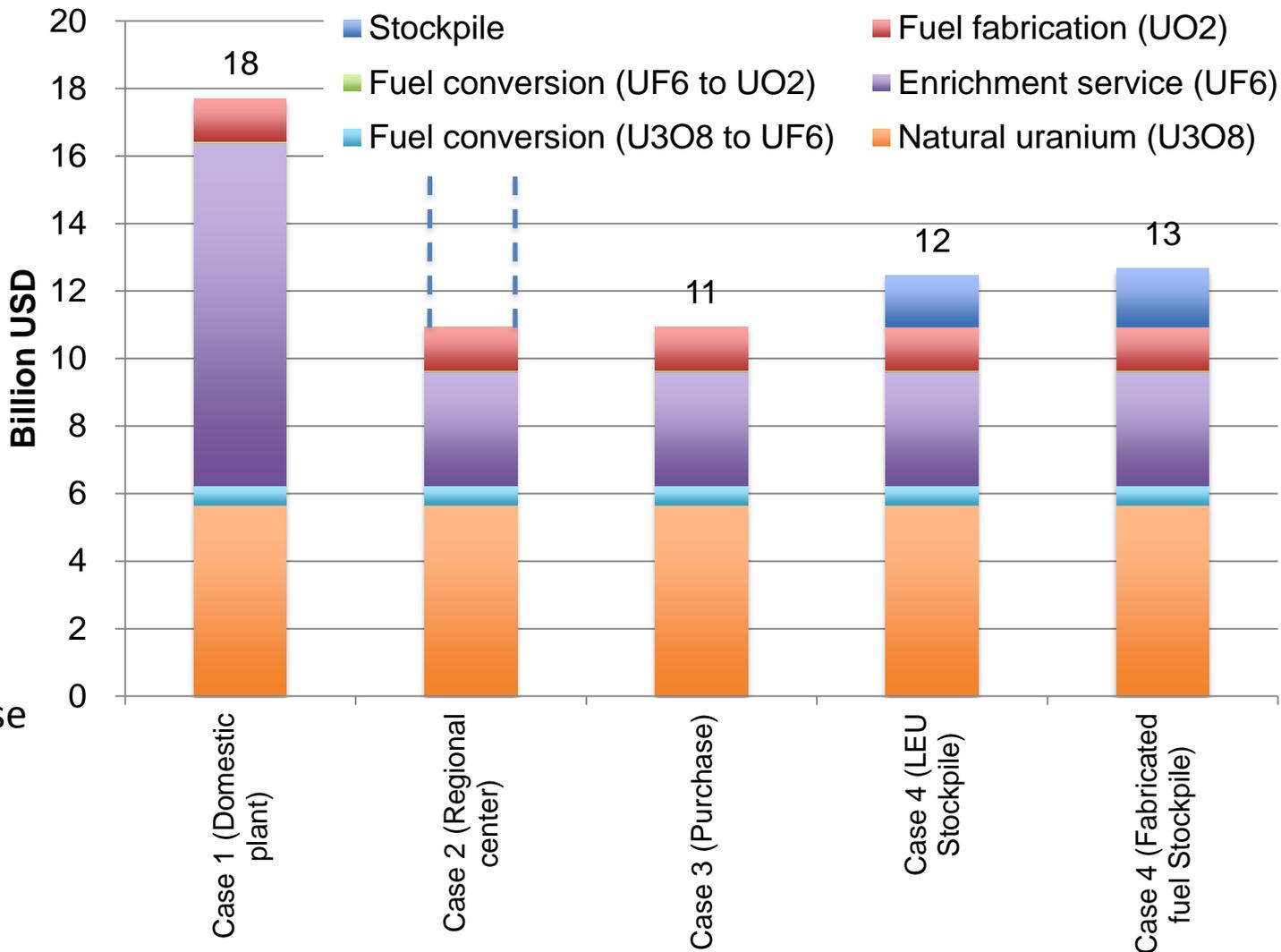
34,000 tSWU is needed until 2030.

# Cost comparison of regional uranium center

- Assumption
  - Case 1: Each country uses their domestic uranium enrichment facility
  - Case 2: Countries use a uranium enrichment center in the region
  - Case 3: Each country purchases LEU from outside the region
  - Case 4: Each country stores uranium (LEU or fabricated fuel)

Unit cost	Case 1	Case 2	Case 3	Case 4	
	Domestic plant	Regional center	Purchase	Stockpile: LEU	Stockpile: Fabricated fuel
Natural uranium (USD/kgU)	100	100	100	100	100
Conversion (USD/kgU)	10	10	10	10	10
Enrichment service (USD/kgSWU)	<b>300</b>	<b>&lt; 100 ?</b>	100	<b>100 (+3 year)</b>	100
Conversion (USD/kgU)	10	10	10	10	10
Fresh fuel fabrication (USD/kgU)	240	240	240	240	<b>240 (+3 year)</b>

# Result (as of 2030)



Total front end cost for domestic plant case is estimated to be about 60% more expensive than purchase case.

Regional case is estimated to be more expensive than purchase case but could be as economical as purchase case if total nuclear capacity grow as officially planned.

Three year stockpile option (for LEU or fabricated fuel) is almost as expensive as regional case.

# Conclusion (1/2)

- In Japan, there is a trend of research facilities owned by universities being decommissioned because of the increase in economic burden.
- There is extremely little information on the HEU usage in nuclear-weapon states such as China and DPRK.
- With an aggressive nuclear power generation use program, will to establish nuclear fuel cycle is strong in several countries.
- Multilateral Uranium Center in East Asia
  - Economically speaking, there will be a big LEU demand in the future in this region. Multilateral uranium enrichment center may compete in comparison with suppliers outside the region.
  - However, it will be difficult to get an agreement to make the center because of political and social problems.

## Conclusion (2/2)

- Future political situation is unclear.
  - In Japan, the opinion that “nuclear power generation is important as one of the nuclear deterrence strategies” has begun to appear openly while there is an atmosphere of “de-nuclear power generation” triggered by Fukushima accident.
  - On January 11, 2012 the Korean government released a report that North Korea might go ahead and conduct its third nuclear test and discharge long-distance ballistic missiles by the end of this year.
- Continued efforts for not only aggressive HEU reduction but also LEU management is necessary in East Asia.