A Proposal on Nuclear Disarmament and Non-Proliferation Policy from Japan
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Nuclear Fuel Cycle in East Asia

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Conclusions (tentative)

- According to the official plan, total nuclear capacity in E. Asia could reach to ~280GWe.
- We compare total cost of four options ("all national" "regional center" "international purchase" and "Stockpile") .
- For both "enrichment" and "reprocessing", we found:
  - "all national" case is most expensive
  - "international purchase" is least expensive
  - "regional center" is more likely to be expensive than "international purchase", but could be as economical as "international purchase" if nuclear power grow as officially planned.
  - "Stockpile" option is more expensive than "International purchase" for LEU, but "dry cask storage" is least expensive of all options for spent fuel management.

Nuclear Fuel Cycle in East Asia (1)

--Enrichment Program--

- Only Japan has commercial plant (1,050 tSWU/y)
  - China has two plants for dual-purpose (1,500tSWU/y)
  - Japan is planning to expand its capacity to 1,500 tSWU/y
  - Currently, no additional plant is being planned
- It is likely that enrichment demand will still largely be met by international market

Nuclear Fuel Cycle in East Asia (2)

--Reprocessing and Spent Fuel Management--

- Only Japan has a commercial reprocessing plant at Rokkasho (800 tHM/y, under construction)
- China is planning to build a plant (800 tHM/y) from 2025 by AREVA
- No commercial reprocessing plant is being planned, but pressure to reprocess spent fuel is likely to increase
- Under the bi-lateral agreement with the US, only Japan is allowed to reprocess (not allowed for ROK and Taiwan(Chinese Taipei))

Nuclear Fuel Cycle in East Asia (3)
--R&D programs--

- Only Japan has full fuel cycle R&D facilities
  - Japan developed its own fast reactor and enrichment R&D facilities, but imported French reprocessing technology
  - Japan has a small pyro-processing program, transferred from the US, but its main hot-experiments are done in Europe
- ROK has built a small pyro-processing pilot plant, but needs prior consent from the US to conduct hot-experiments using spent fuel

Material Balance in East Asia up to 2030

East Asia: Japan, ROK, China, and Taiwan

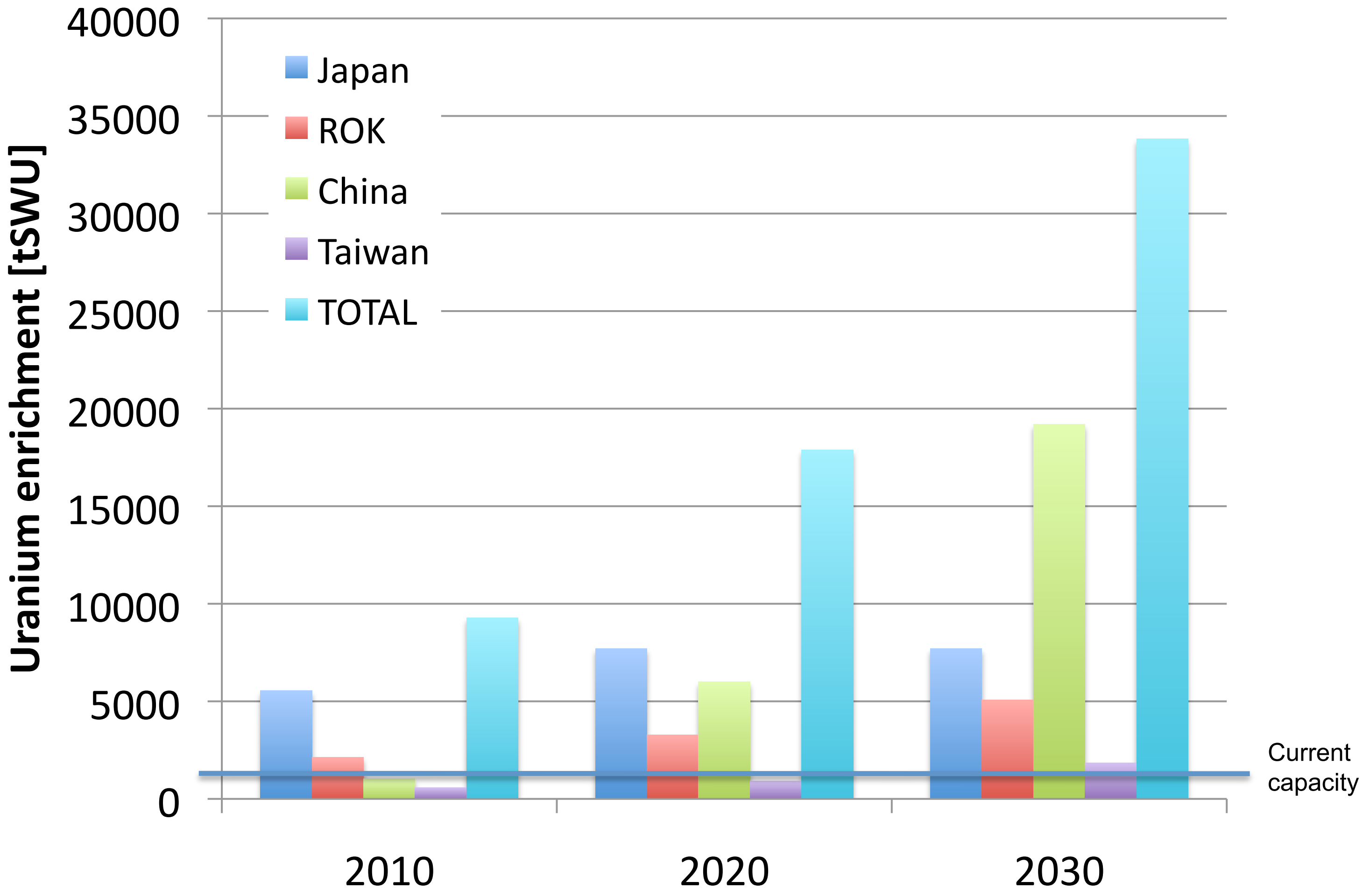
Nuclear capacity (GWe)	2010	2020	2030
Japan	46.2	64.2	64.2
ROK	17.7	27.3	42.3
China	8.6	50.0	160.0
Taiwan	4.9	7.6	15.4

$$Fresh\ Fuel\,[MTHM, UO_2] = \frac{10^3 \times Nuclear\ capacity[GWe] \times Load\ \ factor[\%] \times 365[d]}{Thermal\ efficiency[\%] \times Burn\ up\ ratio[MWd/tHM]}$$

Characteristics of nuclear reactor and fuel cycle

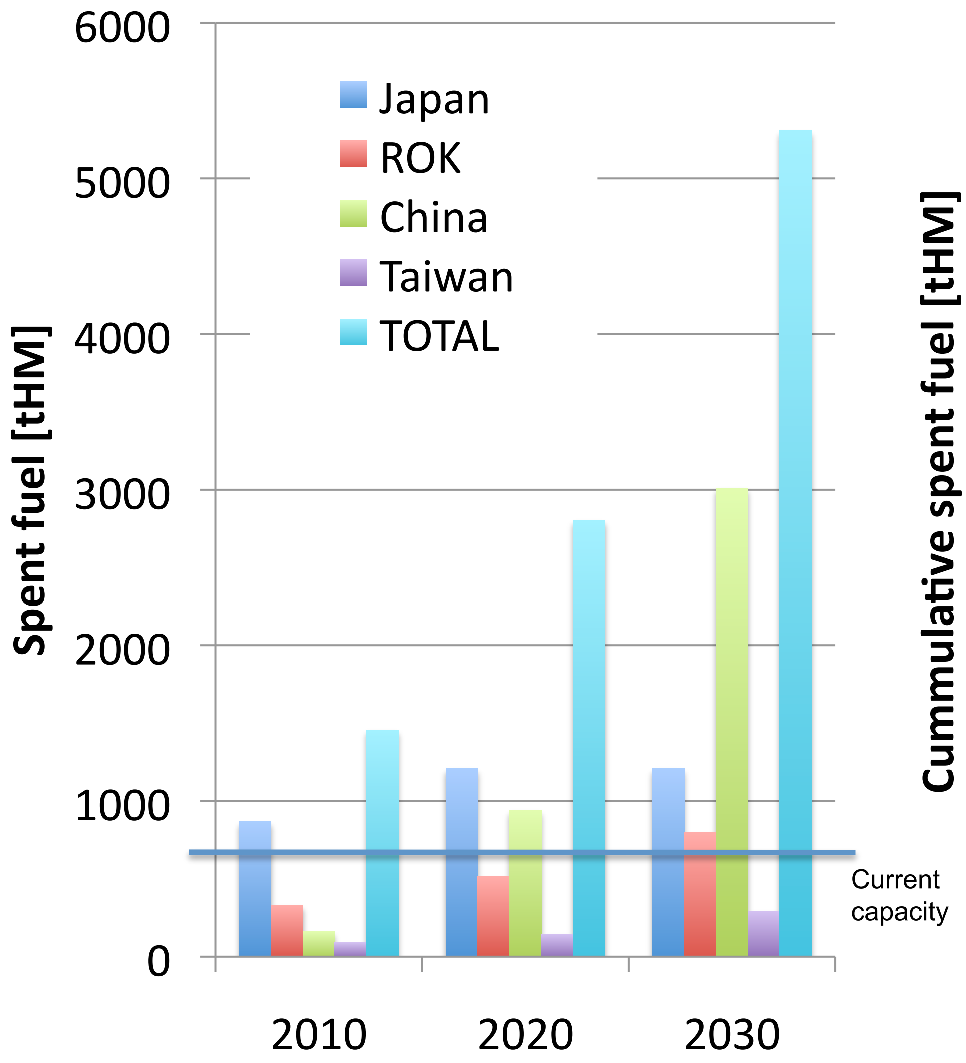
Load factor	0.9
Thermal efficiency	0.349
Specific power (kW/kgHM)	40
Burnup (MWd/tHM)	50,000
Enrichment (%)	4.5
Tail assay (%)	0.3
Fuel Fabrication loss (%)	0.5
Conversion loss (UF_6 to UO_2) (%)	0.5
Conversion loss (U_3O_8 to UF_6) (%)	0.5

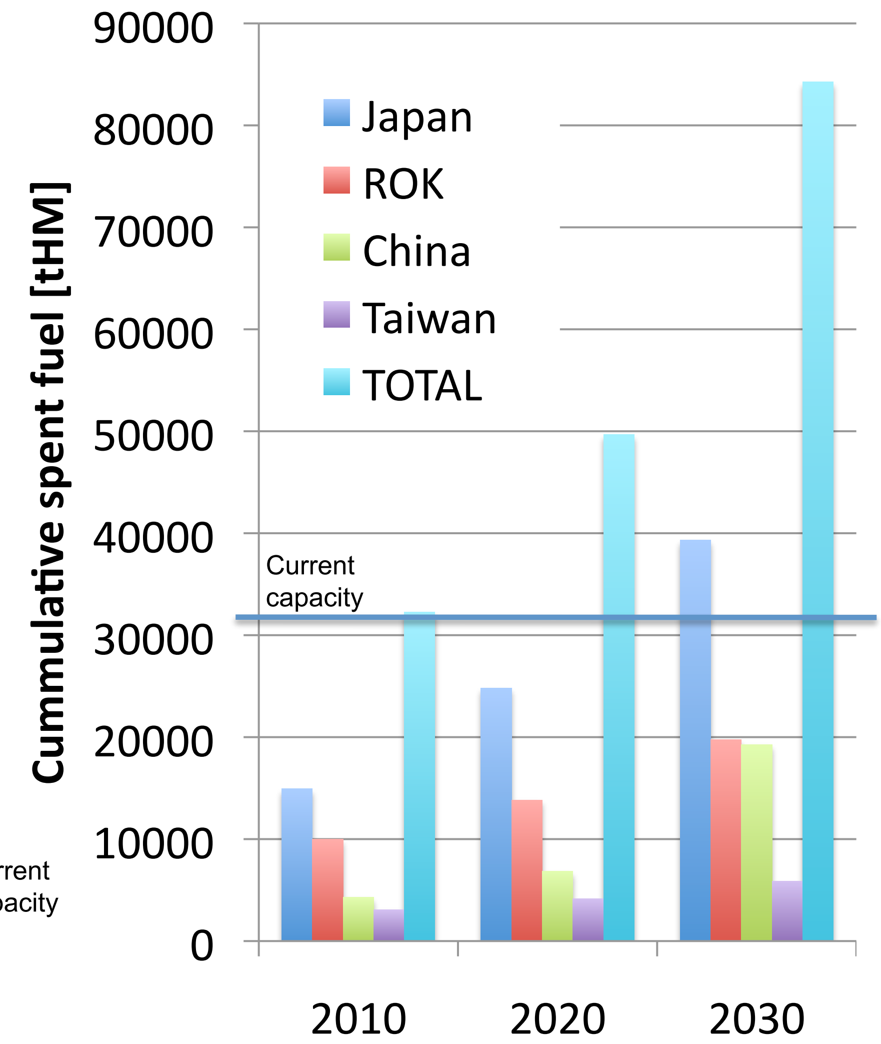
Enrichment Uranium demand up to 2030



34,000 tSWU is needed until 2030.
Currently, only Japan has a plant (1,050tSWU).

Spent nuclear fuel arising up to 2030





5,300tHM of spent fuel will be arising until 2030.
Now, only Japan has reprocessing plant (800tHM).
<u>50 tPu/y will be separated in 2030</u> if all spent fuel is reprocessed.

<u>800 tPu will be accumulated</u> until 2030 if all pent fuel is reprocessed.(without any recycling)

Cost comparison of nuclear fuel cycle

- **Frontend**
  - **Case 1: Domestic plant by each country**
  - **Case 2: Regional center**
  - **Case 3: Purchase**
  - **Case 4: Stockpile by each country**
- **Backend**
  - **Case 1:Reprocessing by each country**
  - **Case 2:Regional reprocessing center**
  - **Case 3:Reprocessing contract**
  - **Case 4:Storage by each country**

Unit cost	**Case 1** Domestic plant	**Case 2** Regional center	**Case 3** Purchase	**Case 4** 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)	**300**	**< 100 ?**	100	**100 (+3 year)**	100
Conversion (USD/kgU)	10	10	10	10	10
Fresh fuel fabrication (USD/kgU)	240	240	240	240	**240 (+3 year)**

	Case 1 Domestic plant	**Case 2** Regional center	**Case 3** Contract	**Case 4** Dry storage
Reprocessing (USD/kgHM)	**3000**	**<1000 ?**	**1000**	0
Spent fuel dry storage (USD/kgHM)	0	0	0	**300**

Cost comparison of nuclear fuel cycle (as of 2030)