Global 2005

October 10 – 13, 2005, Tsukuba, Japan

Civilian Nuclear Fuel Cycle and Nonproliferation Norms

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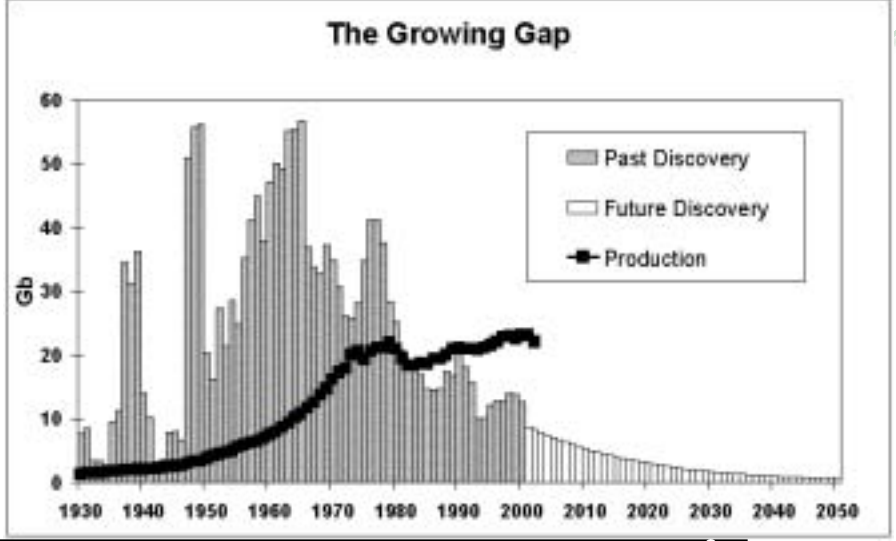
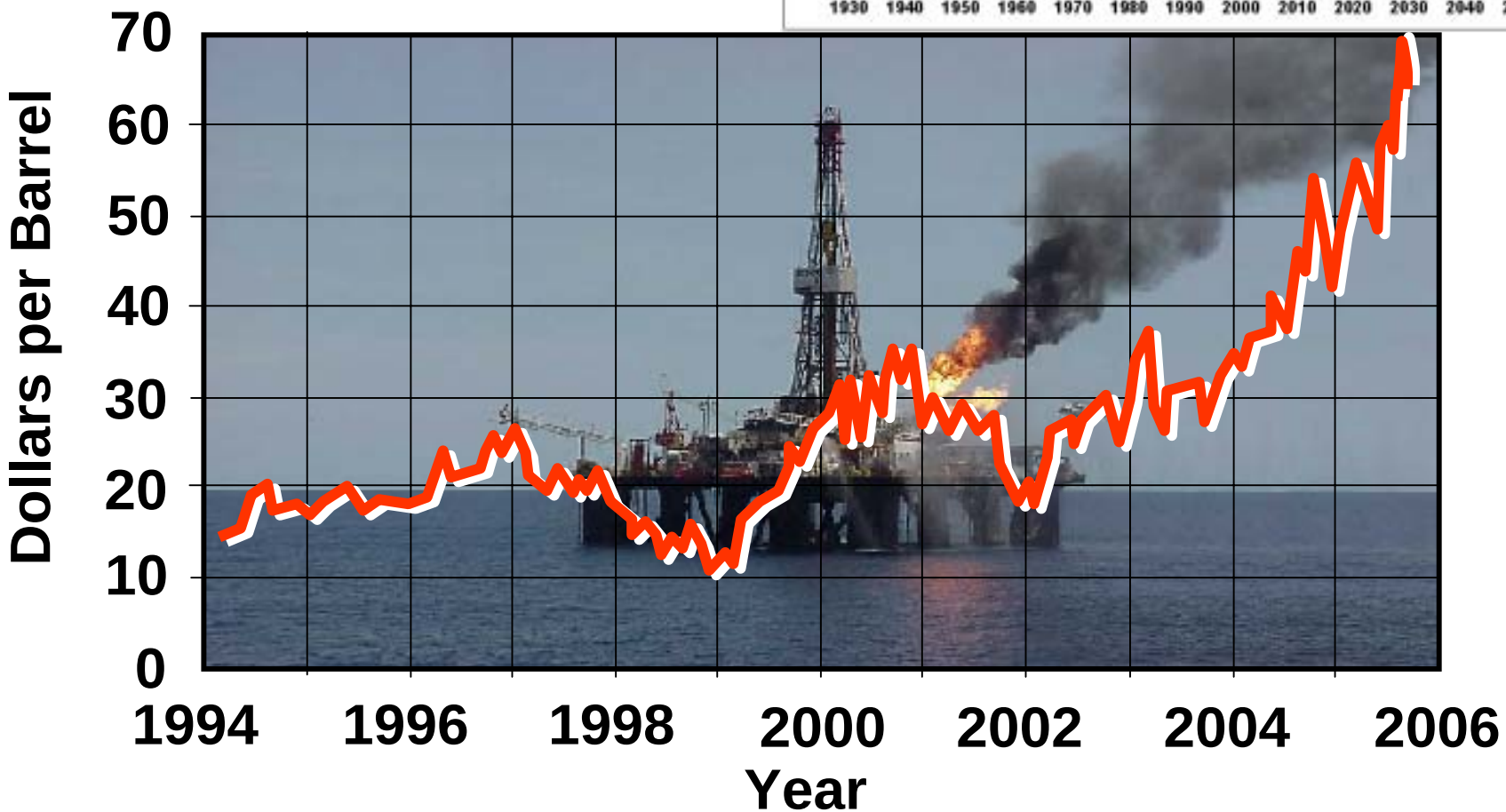
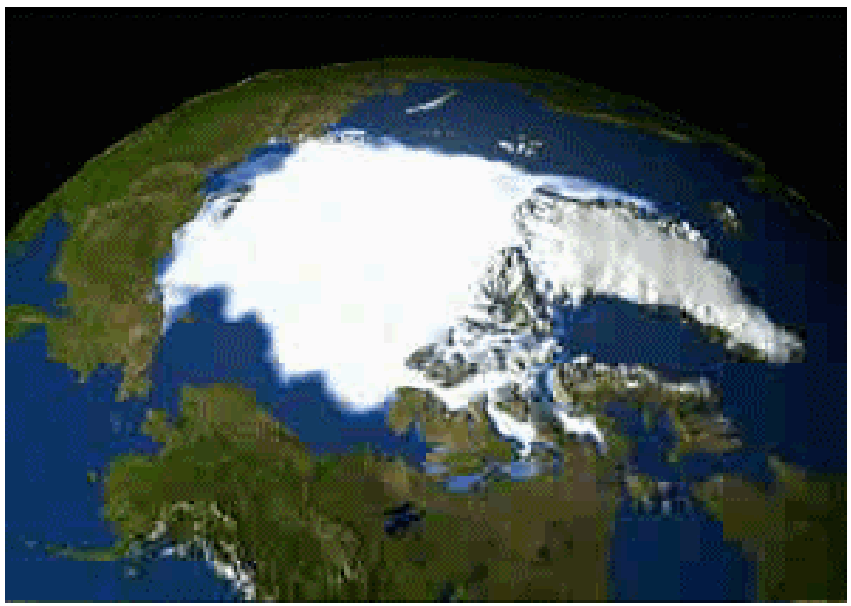
Rise of Oil Prices



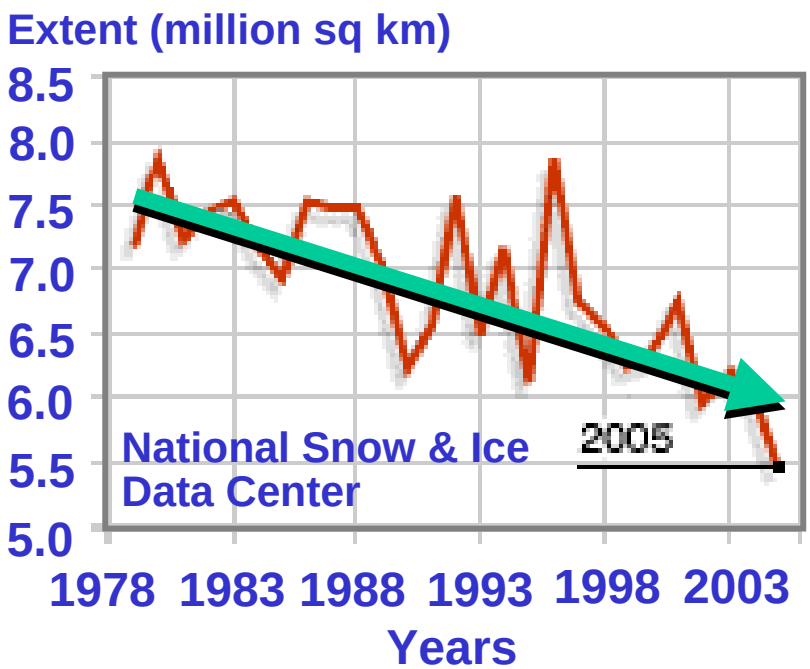


Arctic Ice Is Melting !

- **Rate of shrinkage of the area covered by ice = 8% per decade (September trend)**
- **At this rate there may be no ice at all during the summer of 2060 !**

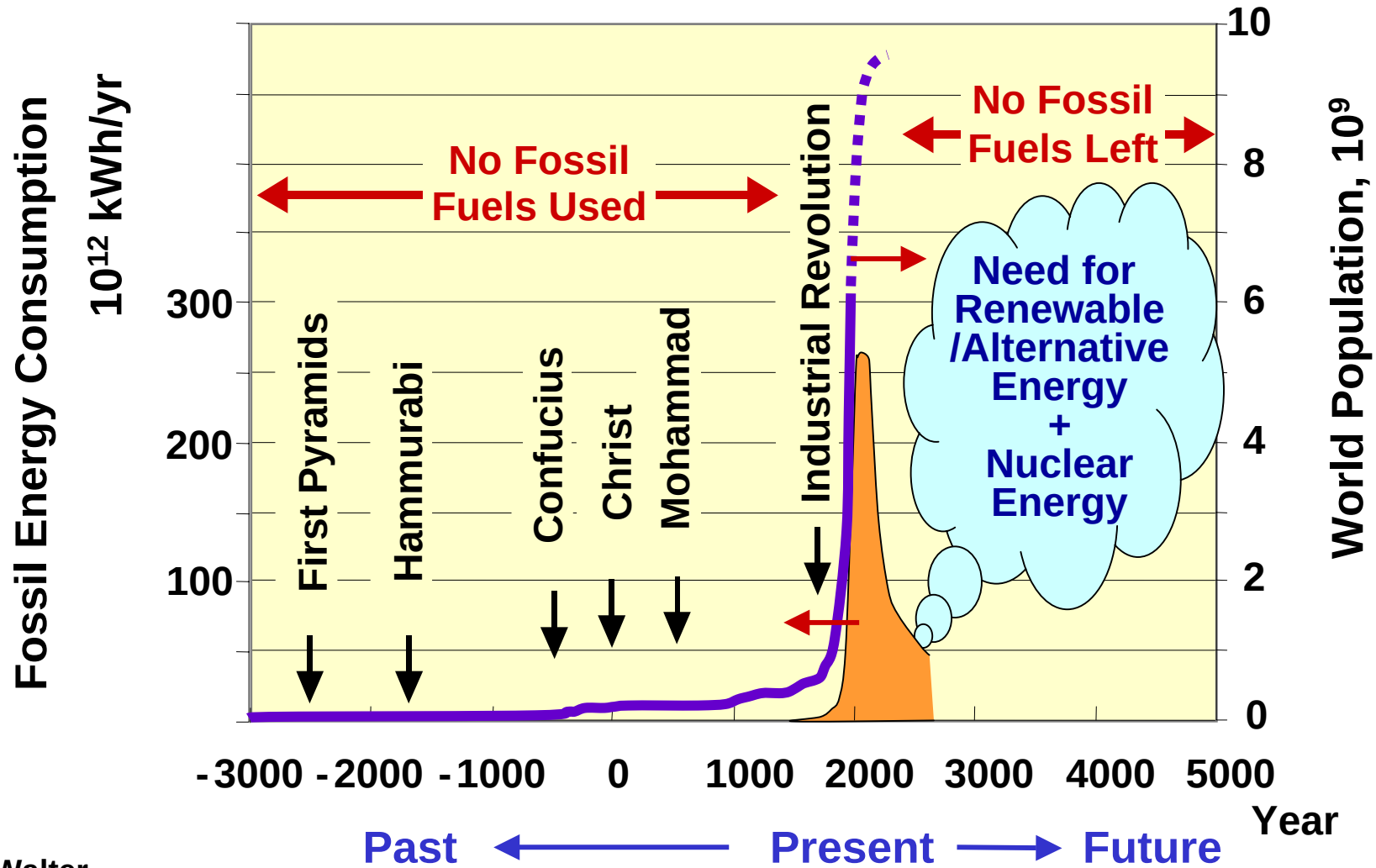


NASA



Gigantic Hurricanes and Typhoons

Sustained use of nuclear energy is indispensable for our future generations



Sustainability of nuclear energy

- **Sustainability of fuel supply**
- **Sustained availability of waste (HLW) repositories**

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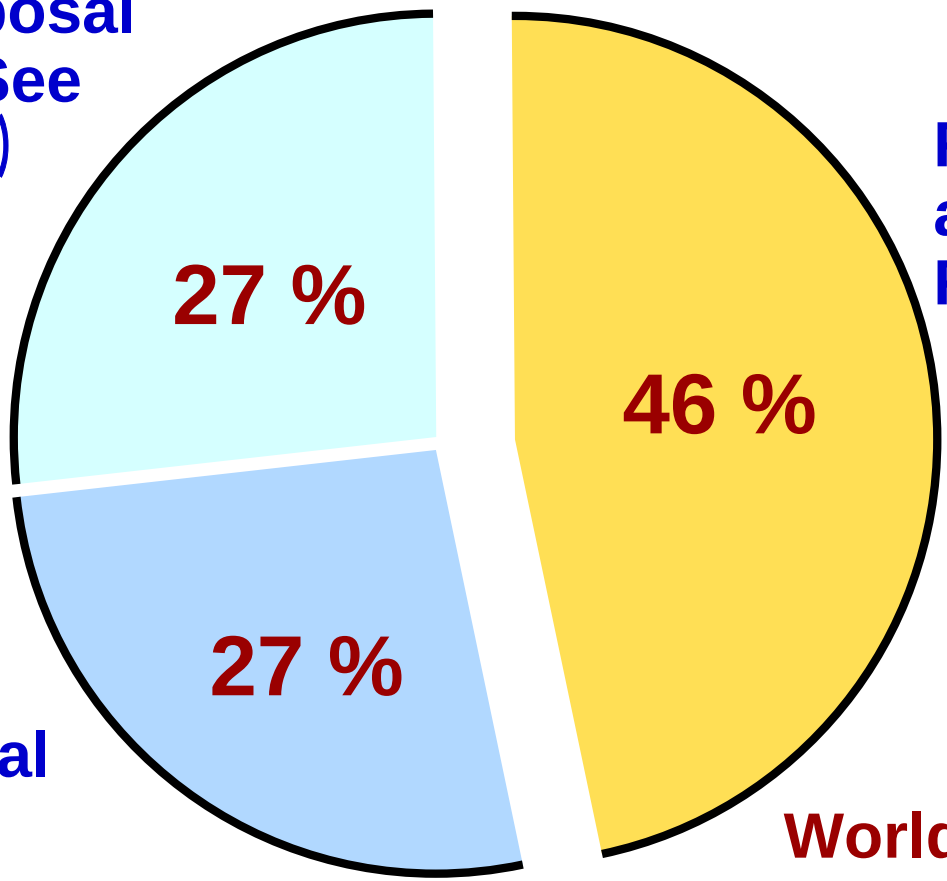
- **Economical competitiveness**
- **Safety**
- **Compatibility with nonproliferation norms**

World Installed Capacity Sorted by Fuel Cycle Policies



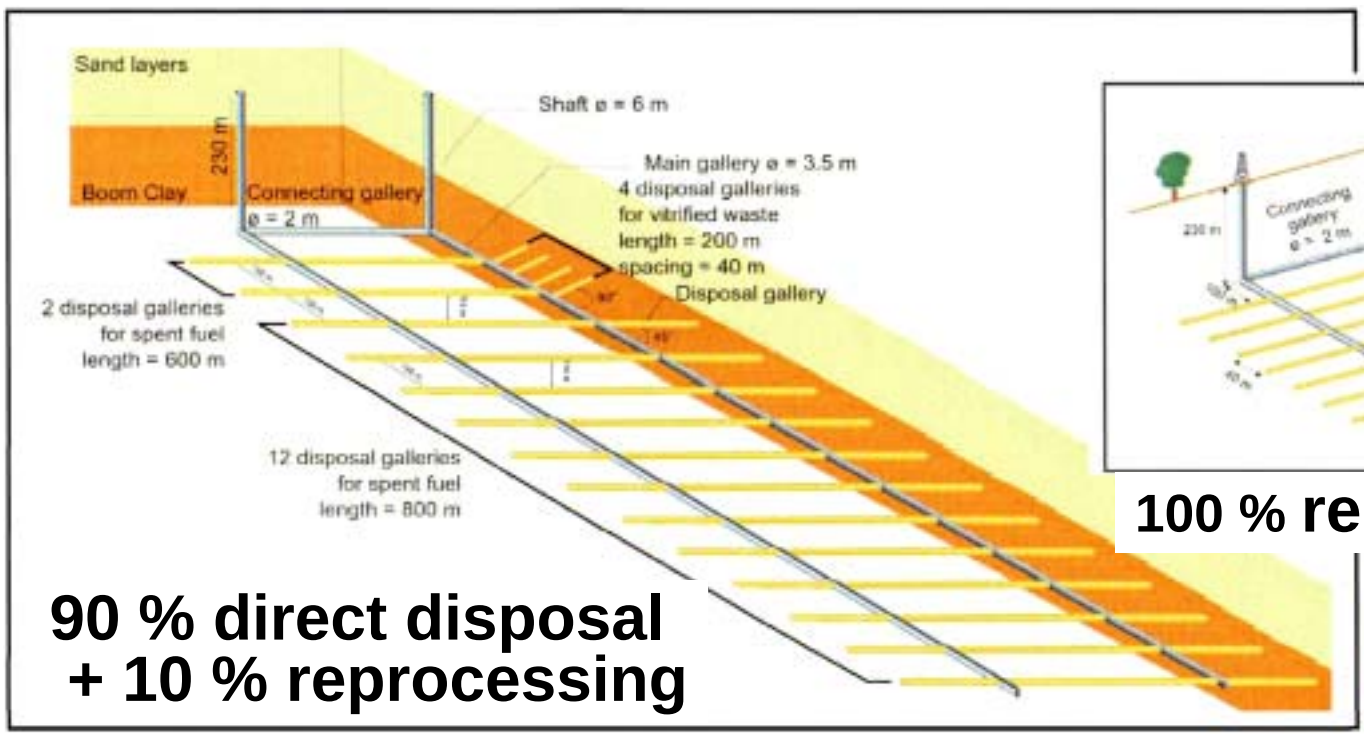
World net installed capacity = 368 GWe (as of end of 2004)

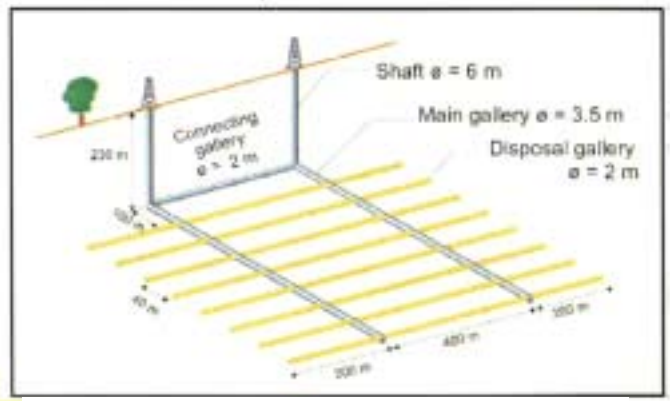
Three fundamental problems in direct disposal option

- **Extremely low uranium utilization efficiency (<1%)**
- **Need for larger HLW repository space due to larger volume and larger heat load of waste packages**
- **Formation of plutonium mines**
  - **More than 8,000 tons of Pu will be buried by 2100**
  - **100 years later, access becomes easier, and plutonium properties become more attractive for weapon use**

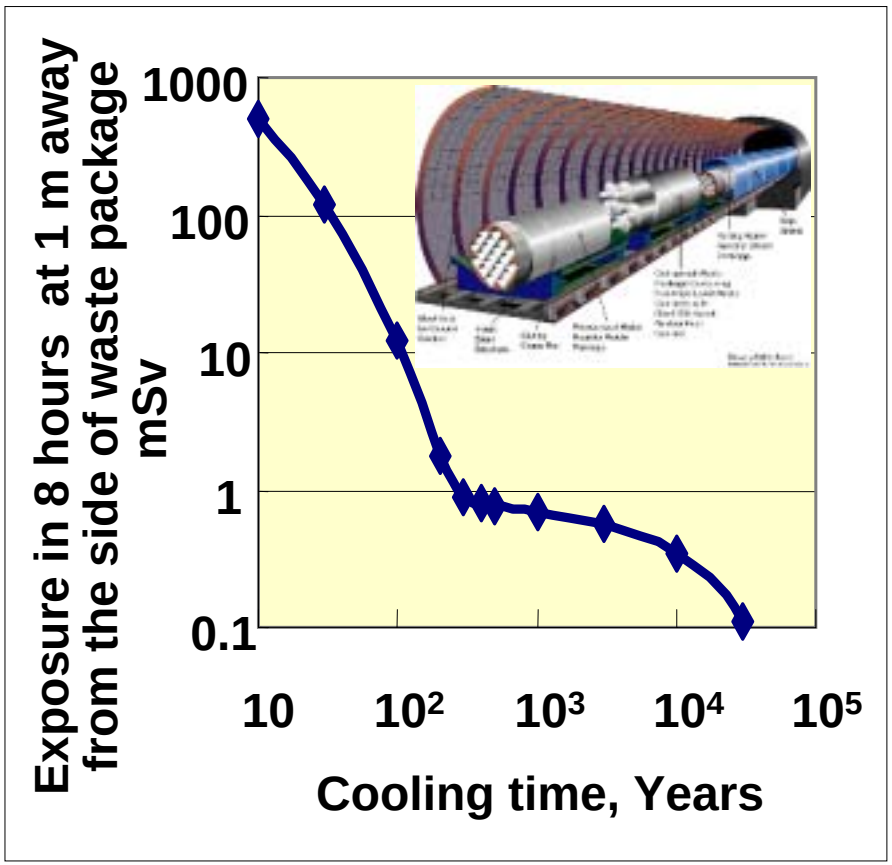
Direct Disposal vs. Vitrified HLW Disposal - Belgian Case –

- **SAFIR 2 Report (December 2001)**
- **Direct disposal requires 6 times larger space than vitrified waste disposal**

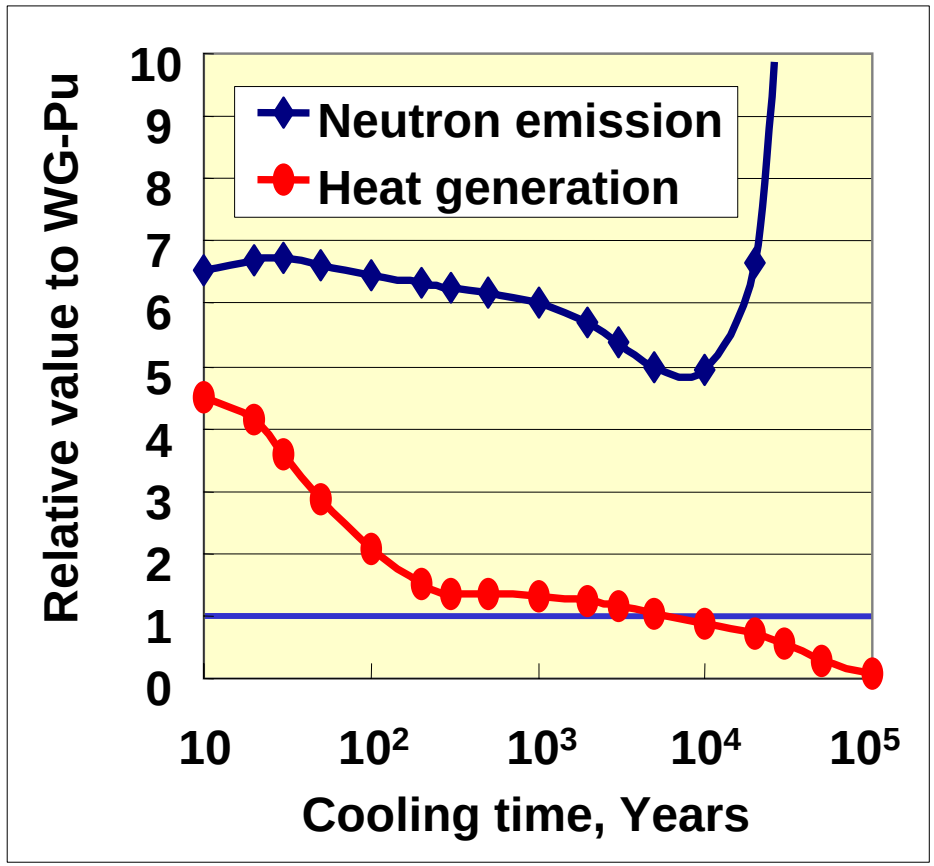




100 years later, access becomes easier and plutonium becomes more attractive in direct disposal



Radiation exposure



Plutonium properties

For countries with large-scale nuclear power program (> 20 GWe),

- **Endless reliance on once-through option would be problematic because of**
  - **Need for unrealistically large number of HLW repositories**
  - **Imposition of uncontrollable proliferation risk upon future generations**
- **Recycle option will solve these problems**
- **Needless to say, the compatibility with non-proliferation norms is prerequisite for recycle option**

For countries with relatively small-scale nuclear power program,

- **Once-through option will continue to be a reasonable choice, because:**
  - **Recycle option will not be economically justifiable due to lack of scale merit**
  - **Spent fuel discharge rate is low and space requirement for HLW repository remains modest**
- **Building a limited number of centralized regional repositories under multi-national or international control is strongly recommended in order to avoid the risk of forming too many small plutonium mines spread throughout the world**

Fuel Cycle Options for Countries with Large-scale Nuclear Power Program (>20 GWe)

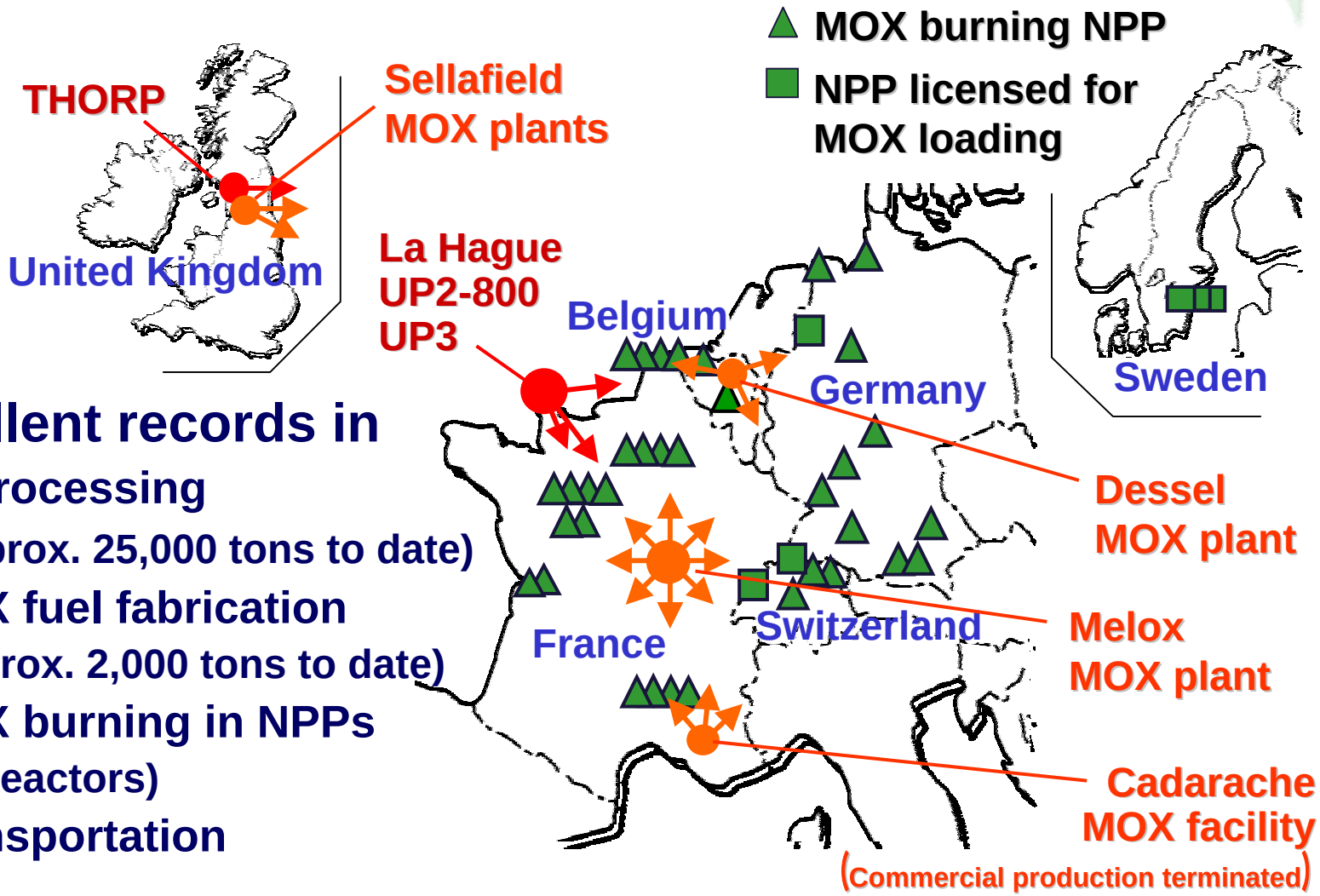
Country	Number of NPPs*	Installed Capacity (GWe) *	Current Policy	Future Options
USA	103	97.5	Direct Disposal	Proliferation-resistant closed cycle (R&D under AFCI)
France	59	63.5	Closed Cycle	Closed cycle with FBR
Japan	52	46.3	Closed Cycle	Closed cycle with FBR
Germany	19	22.4	Nuclear phase-out	-
Russia	30	21.7	Closed Cycle	Closed cycle with FBR
South Korea	19	16.8 (26.1 by 2015)	Direct Disposal	DUPIC cycle (Study on FR is also in progress)
China	9	6.6 (32- 36 by 2020)	Closed Cycle	Closed cycle with FBR
India	14	2.5 (20.9 by 2020)	Closed Cycle	Closed U/Pu cycle with FBR or thorium cycle with AHWR

* As of end of 2004

Is the compatibility between nonproliferation norms and civilian nuclear fuel cycle achievable ?

- **Yes**
- **There are examples which show that the compatibility is achievable in modern industrialized countries**
  - **Western Europe**
  - **Japan**

Reprocessing and MOX fuel utilization in Europe



Excellent records in

- Reprocessing
  (approx. 25,000 tons to date)
- MOX fuel fabrication
  (approx. 2,000 tons to date)
- MOX burning in NPPs
  (35 reactors)
- Transportation

Japan – unique case

- **Only one country with full-scope nuclear fuel cycle as NNWS under NPT**

Rokkasho
Enrichment Plant

53 LWRs (47 GWe)

Rokkasho
Reprocessing Plant

MOX Fuel Fabrication
Plant in Tokai

Prototype
FBR Monju

Tokai
Reprocessing Plant

Japan – unique case

First country with nuclear power and fuel cycle program to qualify for Integrated Safeguards

“I am pleased to note that Japan has become the first State with an advanced nuclear cycle to qualify for integrated safeguards”

Statement by IAEA DG El Baradei to 2004 IAEA General Conference (20 September 2004)

How has Japan succeeded in achieving the status of an Integrated Safeguards state ?

- Five key background elements -

(1) Obvious need of fuel cycle program

(2) Country's clear intention for renunciation of nuclear armament

(3) Transparency of national nuclear energy program

(4) Excellent record of compliance with nonproliferation norms for many decades

(5) Numerous proactive efforts

(1) Obvious need for nuclear fuel cycle program in Japan

- **Importance of long-term energy security as a highly populated, highly industrialized and yet energy-scarce island country**
- **Large-scale nuclear power program (47 GWe)**
- **Virtually no domestic uranium resource**
- **Very limited land availability for waste disposal**

(2) Country's clear intention for renunciation of nuclear armament

- **"Peaceful purposes only" policy in Atomic Energy Basic Law enacted in December 1955**
  "The research, development and utilization of atomic energy shall be limited to peaceful purposes, ……." (Article 2)
- **This policy reflects Japanese strong desire to realize the world without the fear of nuclear wars as a nation that experienced two A-bomb tragedies in Hiroshima and Nagasaki**

(3) Transparency of national nuclear energy program

- **AEC's Long-Term Program**
  Long-Term Program for Research, Development and Utilization of Nuclear Energy
  - **Open document to describe national nuclear energy policy & program**
  - **Adherence to "Peaceful purposes only" policy**
  - **Periodical revision (every 5 years)**
- **Transparency of policy making process**
  - - Open process for revising L-T Program
- **Transparency of national budgetary system**

(4) Excellent record of compliance with nonproliferation norms for many decades

- **Good record of compliance with Comprehensive Safeguards since 1977**
- **Ratification and implementation of Additional Protocol**
- **Complete adherence to bilateral agreements with US and others since 1955**
- **Incorporation of Zanger Com. and NSG requirements into export control laws**
- **Incorporation of enhanced PP requirements into domestic laws**

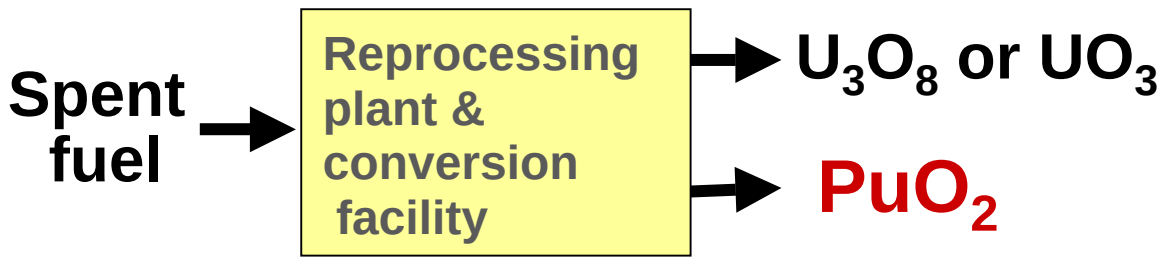
(5) Numerous proactive efforts made by Japan

- **Enhancement of proliferation resistance in reprocessing plants**
- **Active cooperation with IAEA in developing and demonstrating reliable safeguards methodologies to be applied to civilian nuclear fuel cycle: JASPAS, LASCAR, etc.**
- **Cooperation with US in the area of advanced safeguards technologies**
- **Ratification of CTBT and support to FMCT**
- **Support to Russia for disposition of excess W-Pu**

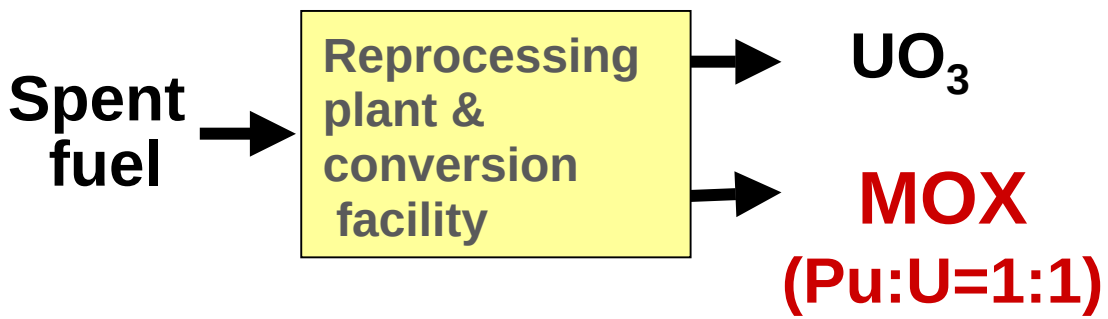
Enhanced proliferation resistance in Japanese reprocessing plants

- Example of proactive effort -

European Reprocessing Plants
- UP2-800, UP3
- THORP

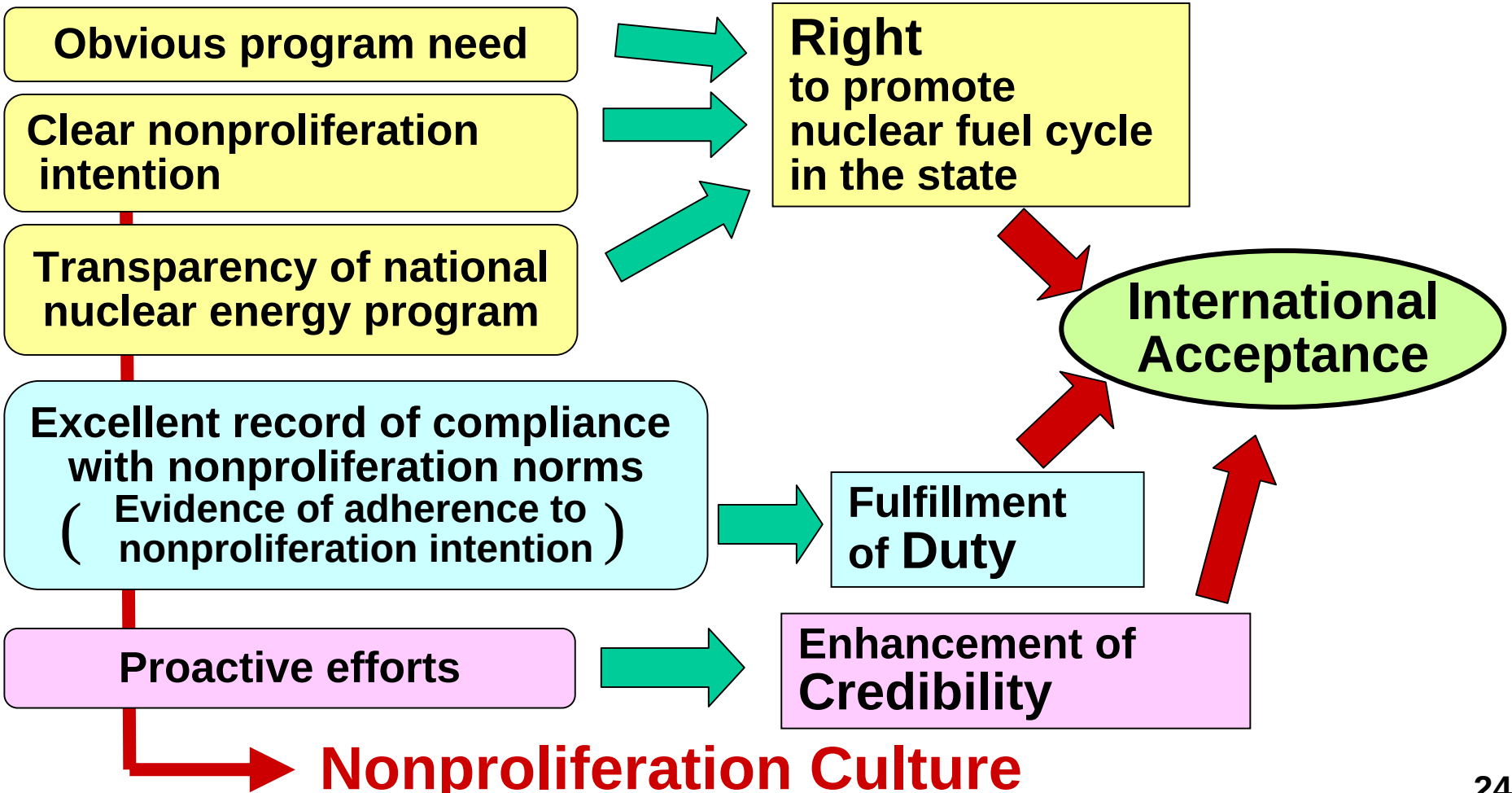


Japanese Reprocessing Plants
- Tokai RP
- Rokkasho RP



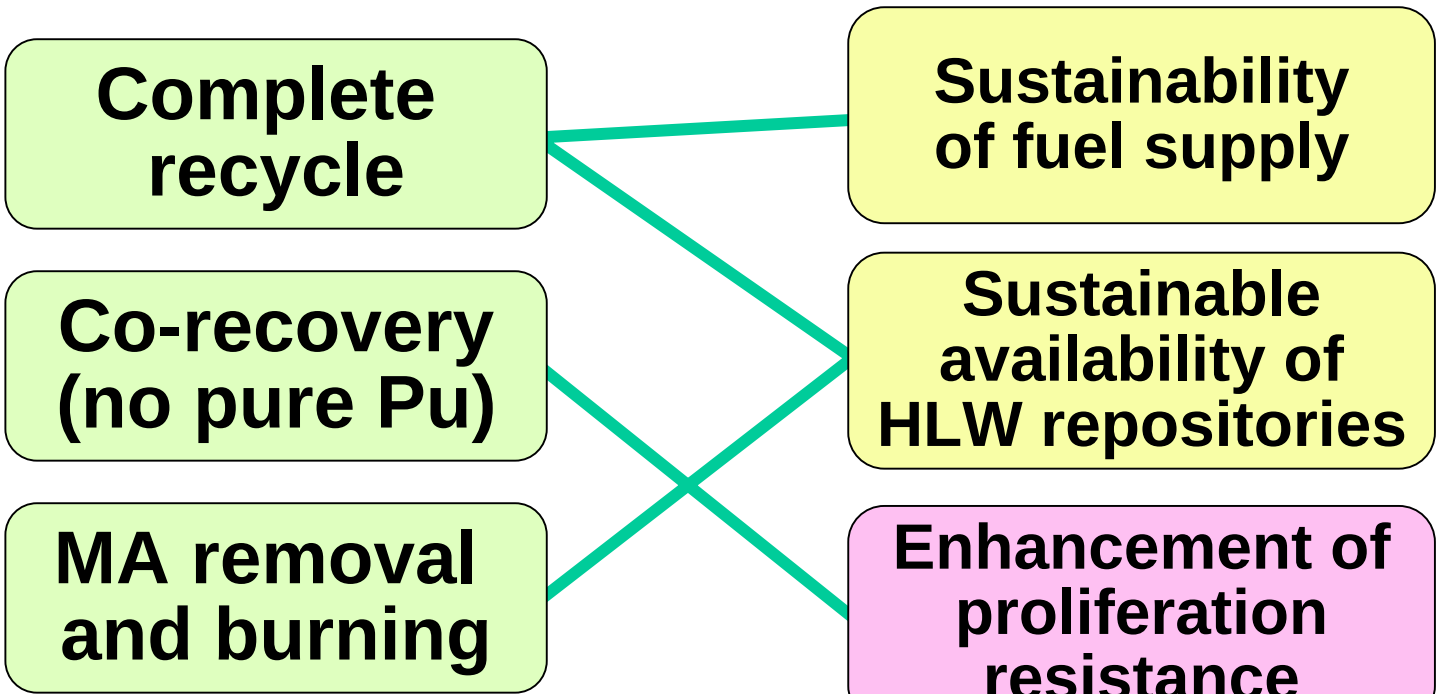
Japanese Model

- An acceptance model for civilian nuclear fuel cycle in NNWS



Key factors for future nuclear cycle

(other than safety and economy)



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Establishment of nonproliferation culture

Conclusions (1)

- **Closed nuclear fuel cycle is necessary for sustained use of nuclear energy in large scale**
- **Building centralized regional HLW repositories under multi-national or international control is recommended for use by countries with relatively small-scale nuclear power program relying on direct disposal policy**

Conclusions (2)

- **Compatibility with nonproliferation norms and civilian nuclear fuel cycle is achievable in modern industrialized counties**
- **Implementation of Integrated Safeguards in Japan is a proof of the success of original objectives of NPT regime**
- **Japanese case offers an acceptance model for civilian nuclear fuel cycle program in NNWS (Japanese model) and this model will become the basis of establishing "Nonproliferation Culture"**

Thank you for attention