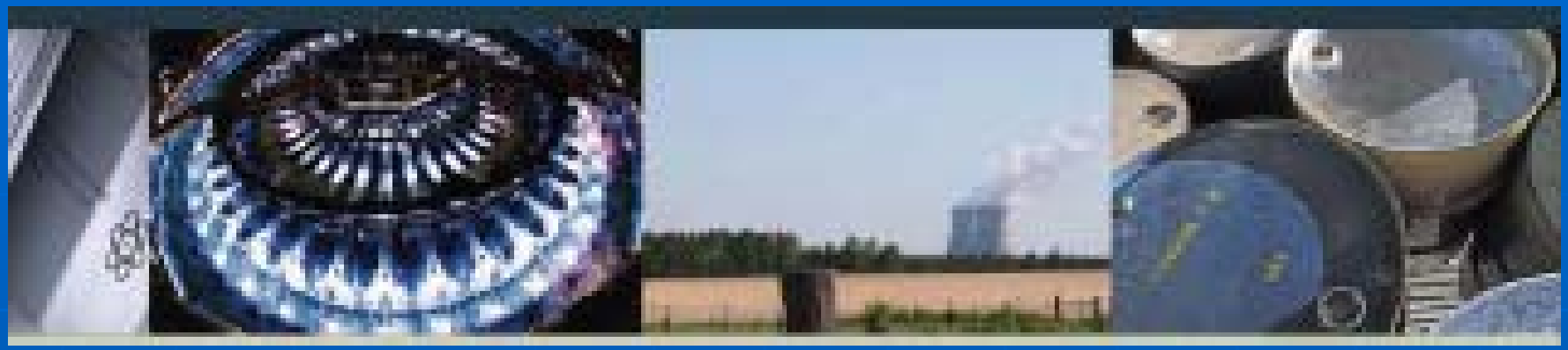

High-Level Radioactive Waste and and the *Nuclear Energy Renaissance*

By
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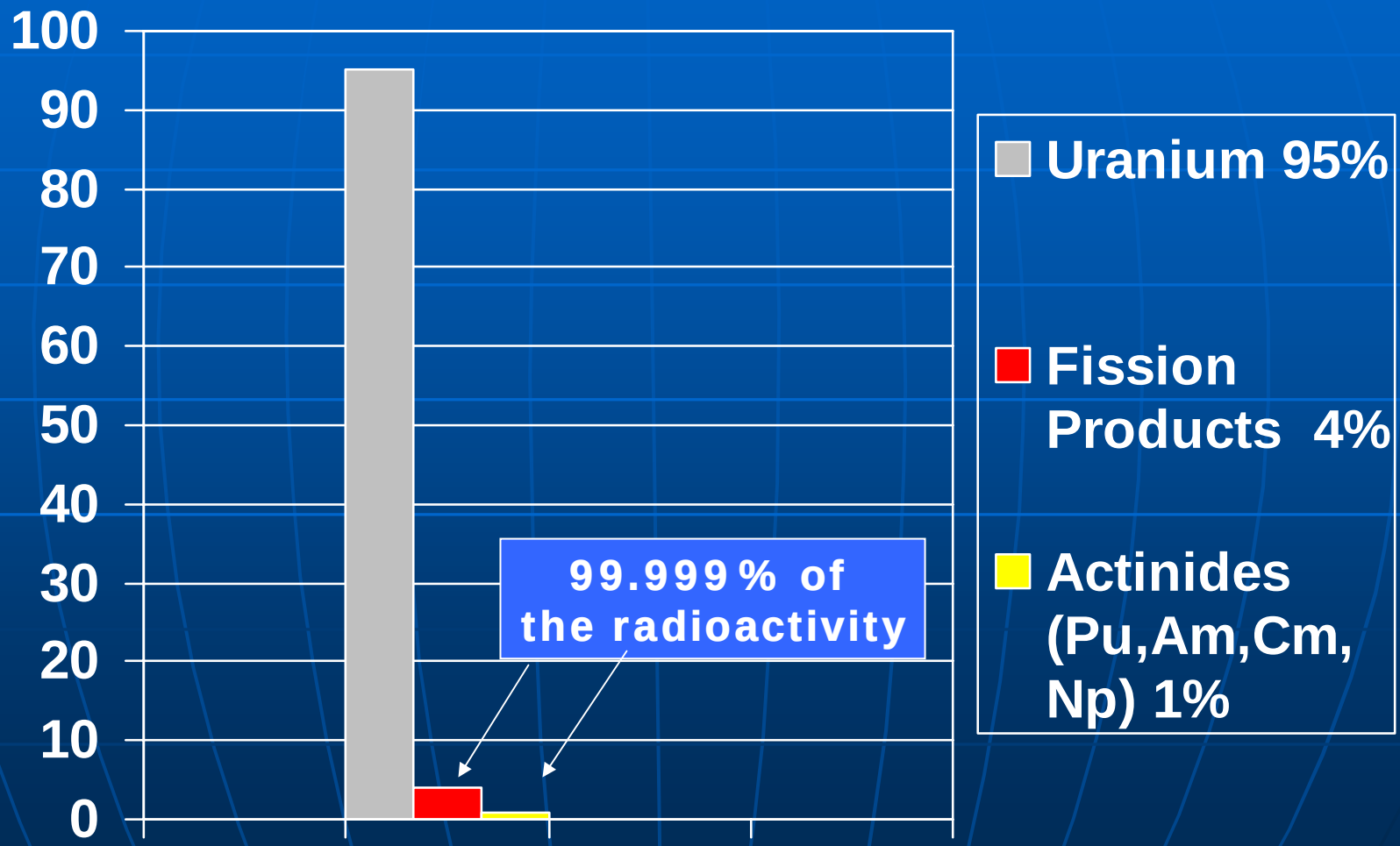
Institute for Policy Studies
November 7, 2008

Conference
on
'The nuclear energy revival: regional perspectives and governance challenges'
Centre for International Governance Innovation
Waterloo, Ontario, Canada

Challenges

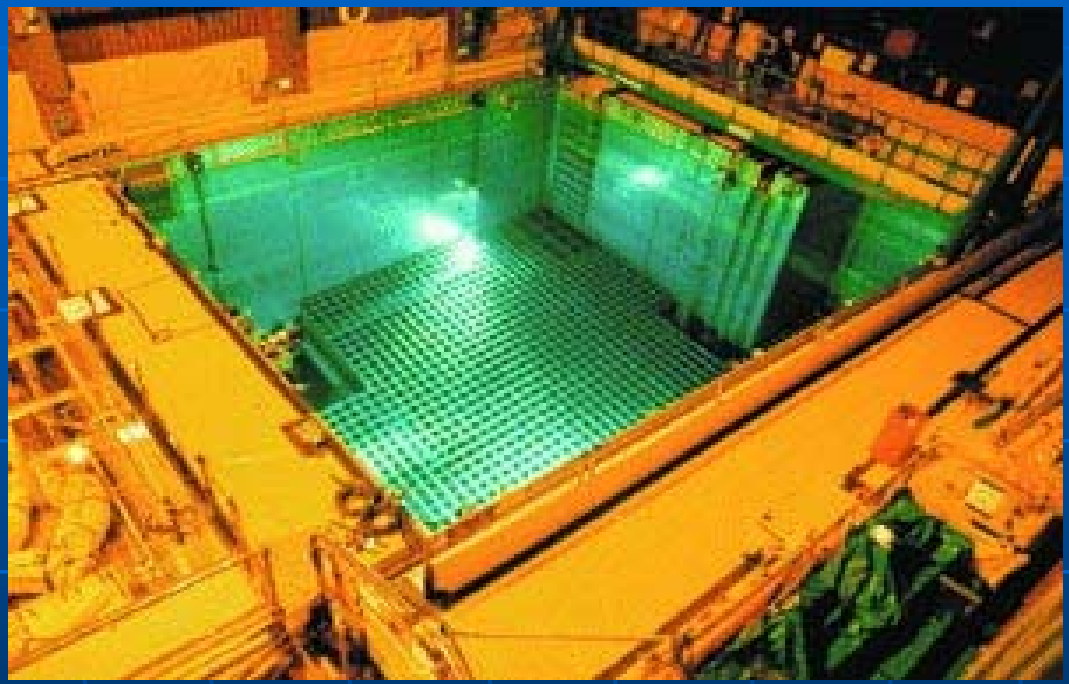
- Safe and Secure Storage
- Safe Disposal
- Proliferation Risks
- Costs
- Engineering and construction
- Geological disposal

Composition of Spent Fuel by Weight



Source: DOE/EIS 0250

What About Spent Fuel?



An almost full spent-fuel storage pool

Dry Casks

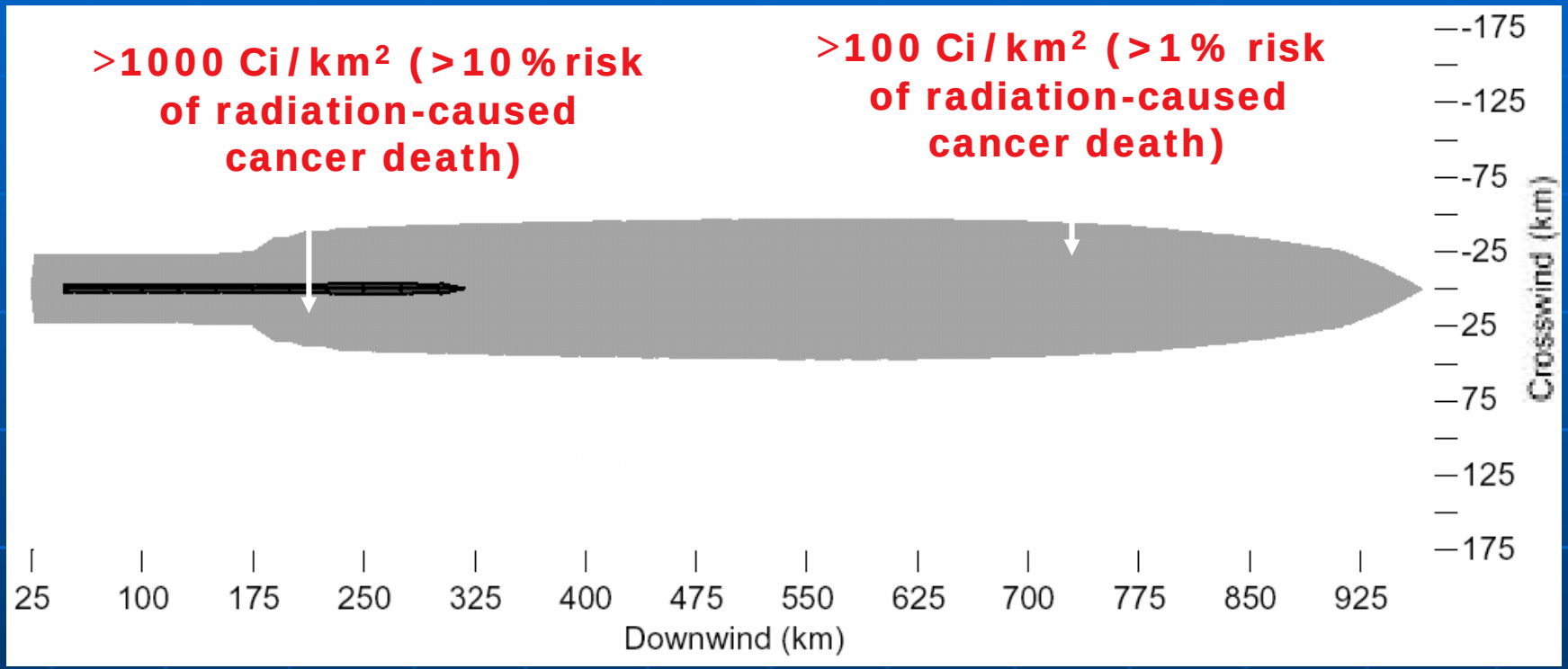
Risks of Densely Compacted Spent Fuel Pools

"it is not prudent to dismiss nuclear plants, including spent fuel storage facilities as undesirable targets for terrorists…

"under some conditions, a terrorist attack that partially or completely drained a spent fuel pool could lead to a propagating zirconium cladding fire and release large quantities of radioactive materials to the environment."

National Research Council, Committee on the Safety and Security of Commercial Spent Nuclear Fuel Storage(2005)

MACCS2 Code Prediction for hot pool fire that released 35 MCi of cesium-137 into a 10-mph steady wind



Area: 27,000 sq. miles (Maryland + New Jersey + Massachusetts)
Losses would be hundreds of billions of dollars.:

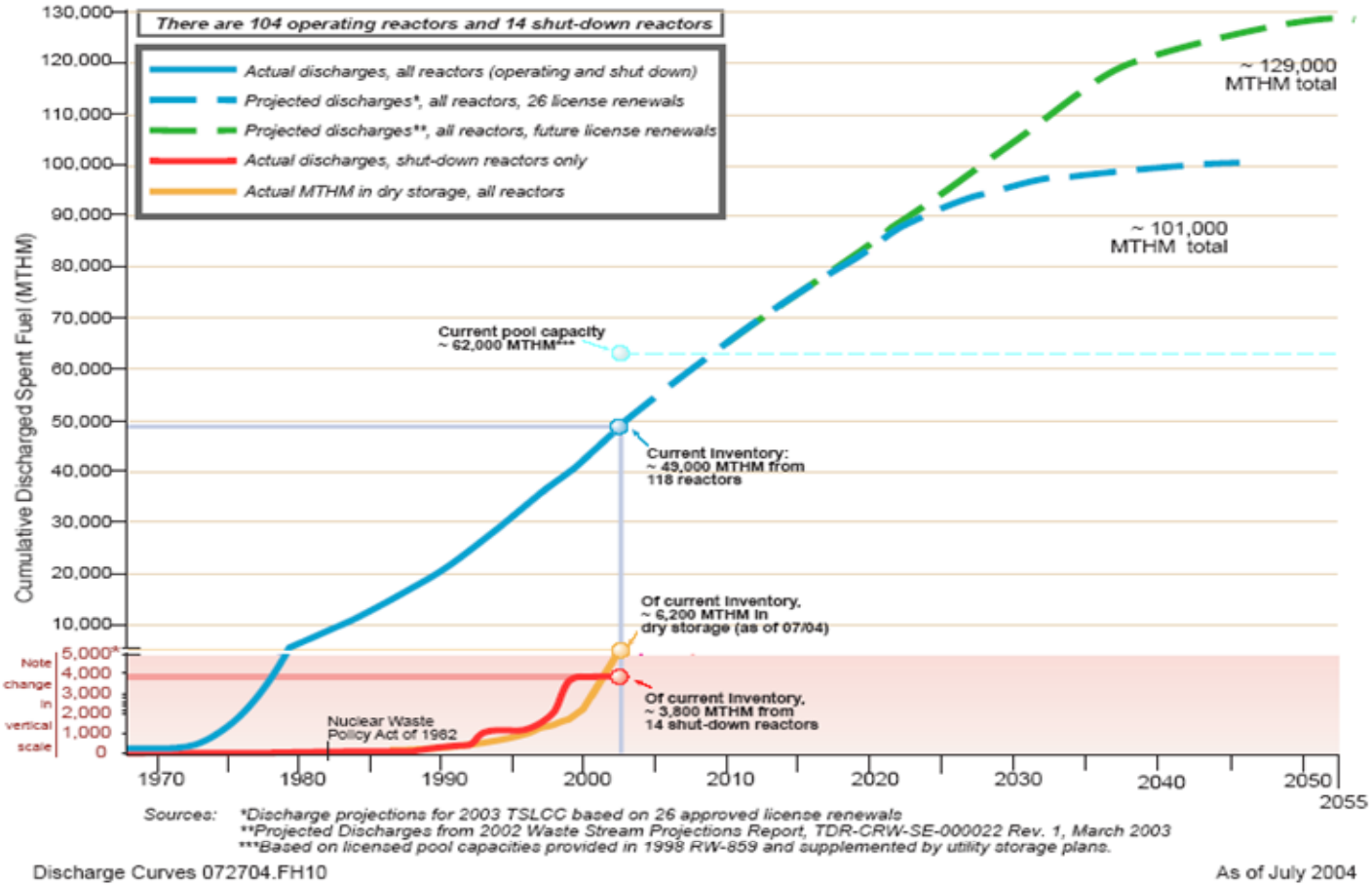
Source: ***Science and Global Security, 11:1–51, 2003***

Nuclear Waste Disposal

Proposed Yucca Mountain Project in Nevada

The schedule for the proposed Yucca Mountain disposal site in Nevada has slipped almost more than two decades past the original opening date of January 1998.

Historical and Projected Commercial Spent Nuclear Fuel Discharges



The Global Nuclear Energy Partnership

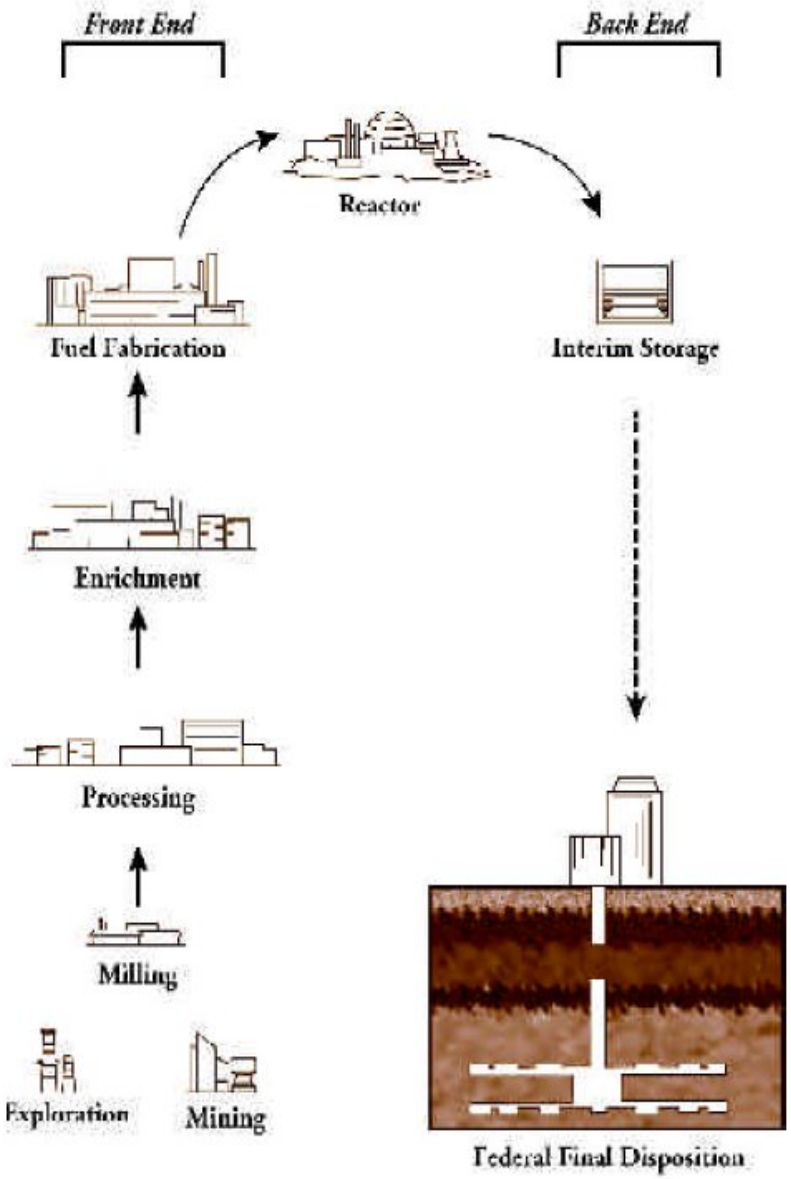
- **Sell reactors to developing nations**

- **Take back reactor spent fuel to U.S.**

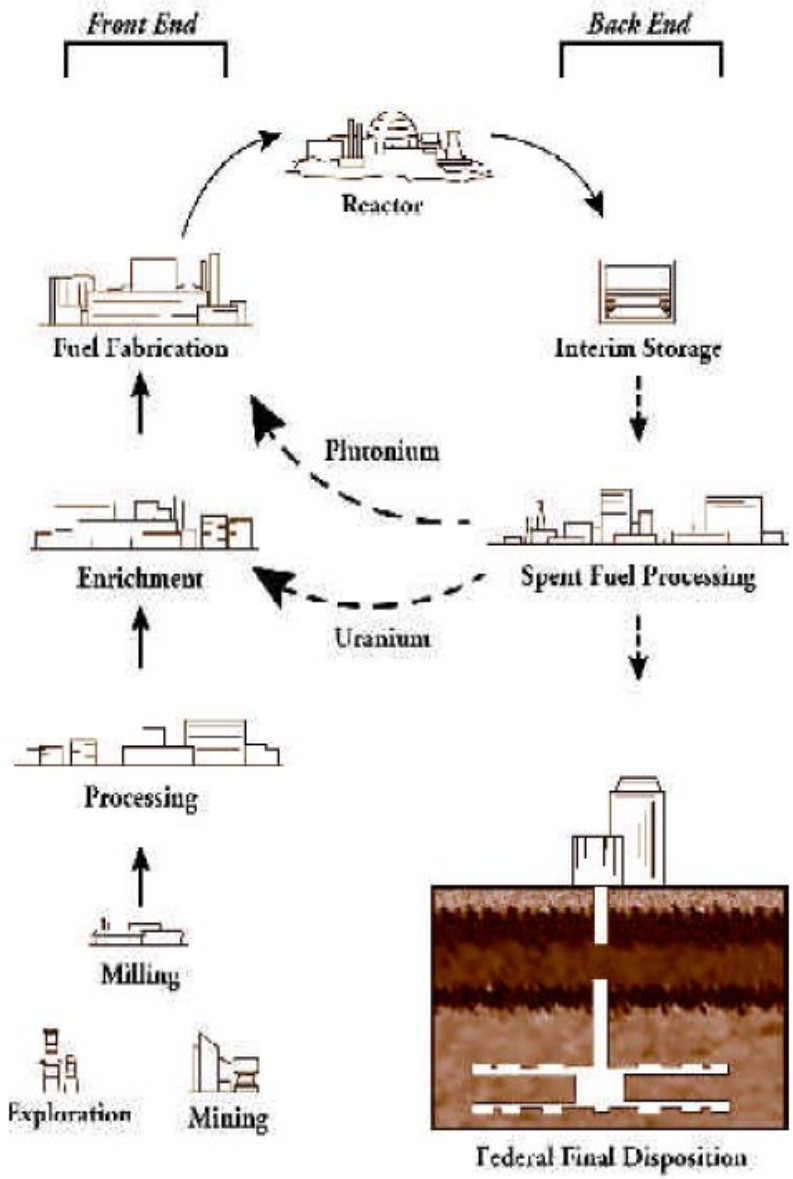
- **Reprocess foreign and U.S. spent fuel at a single site.**

- **Reduce disposal of high-level wastes and “burn up” plutonium**

Once-Through Fuel-Cycle For Natural Uranium Reactors



Closed Fuel-Cycle Full Recycle of Plutonium and Uranium



"Once Through" and "Closed" Nuclear Fuel Cycle Policies

- **1950's to 1977** -The U.S. Government (AEC), advocates a "closed" nuclear fuel cycle.

- **1974**- India detonates nuclear explosion with plutonium obtained from "peaceful" atomic energy.

- **1977**- President Carter bans reprocessing in the U.S. Intact spent fuel rods were to be sent directly to a repository – a "once through" nuclear fuel cycle.

- **1981** - President Reagan lifts ban on reprocessing, but the "closed" fuel cycle collapses in the U.S.

- **1992**- President Bush ceases weapons reprocessing and opposes reprocessing of U.S. spent fuel.

- **1993**- President Clinton issues policy statement discouraging the use of plutonium as a fuel.

GNEP FUEL CYCLE AND Waste Streams

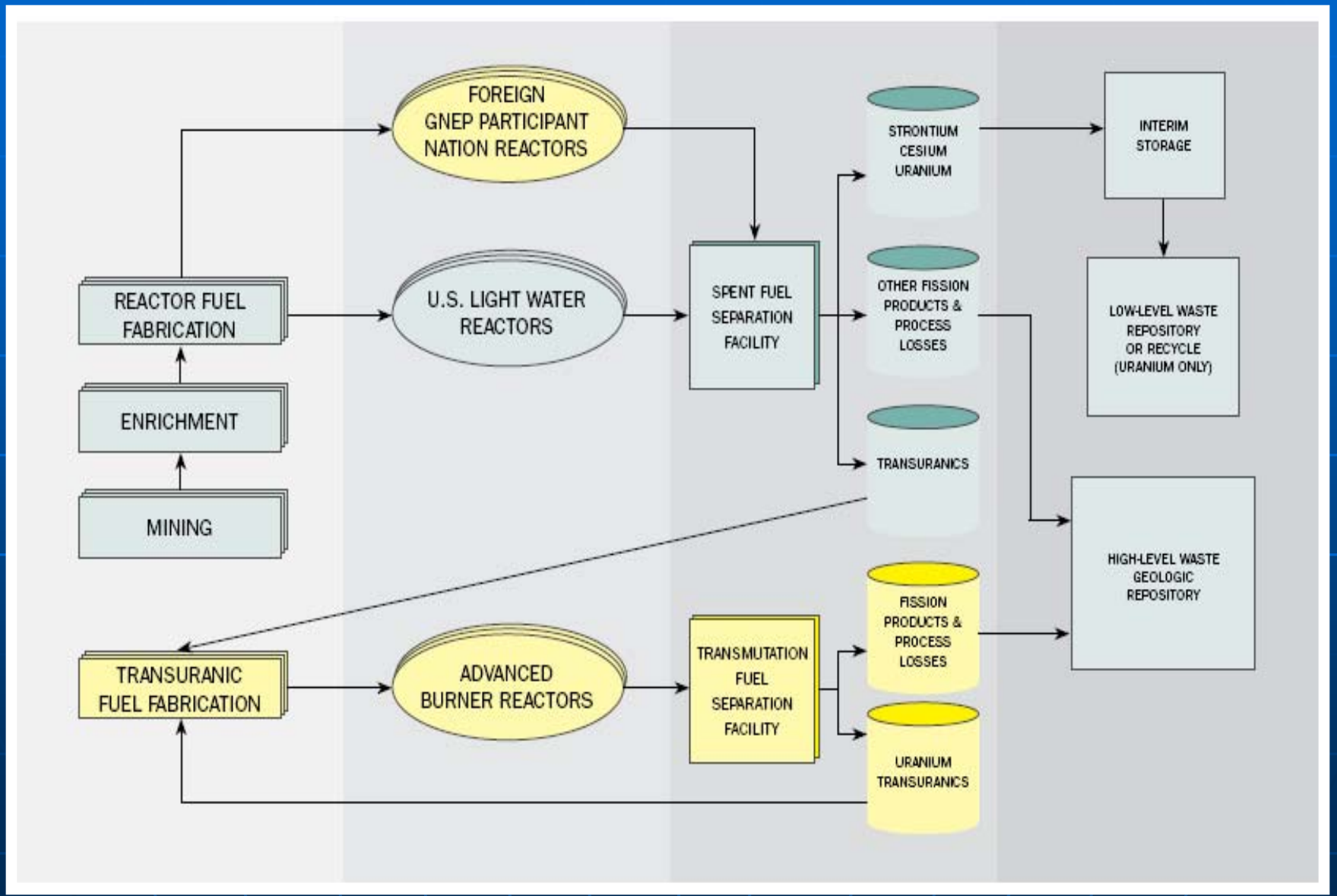
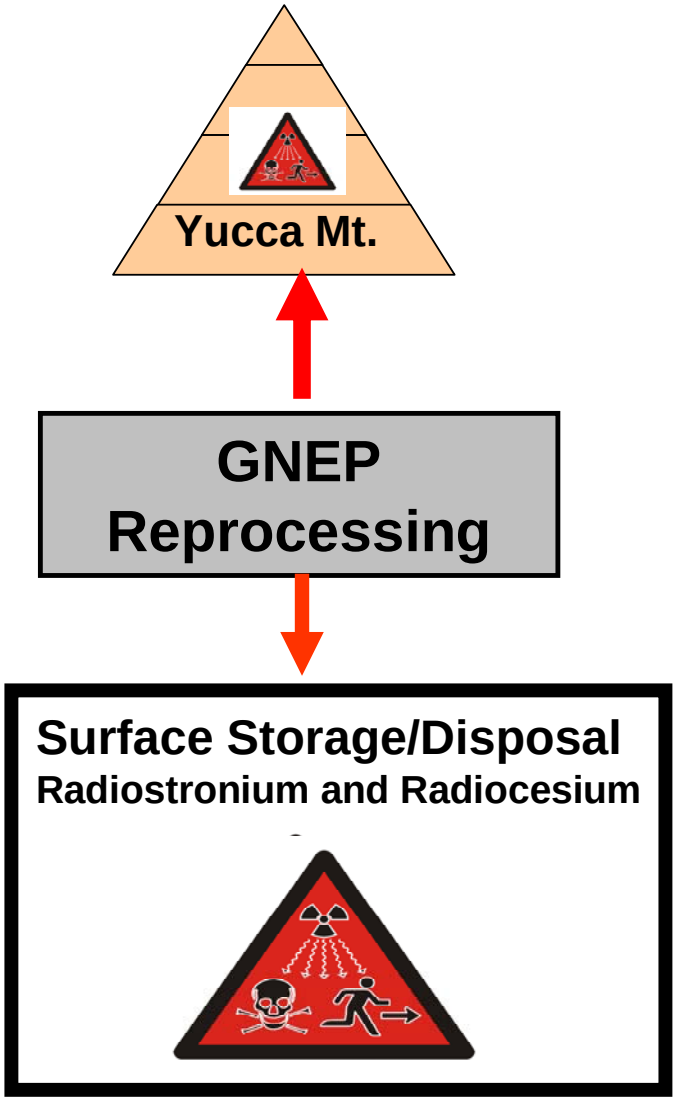


Figure 1

GNEP Disposal Plan Leaves Hottest Waste on the Surface



Strontium-90 and Cesium-137

-- Dangerous for hundreds of years

-- Over two thirds of the radioactivity

-- Main Source of Heat in spent fuel

Cesium-135

half-life= 2.3 million years and dominates human doses in about 600 years.

Source: Galinsky (2006)

GNEP Technological Hurdles

Lack of proliferation resistant barriers

Testing of the UREX+ technology is at one-one millionth of commercial size.

Lack of credible waste plan

Capture, storage and disposal of radioactive gas discharges (i.e. Krypton-85, and Iodine-129)

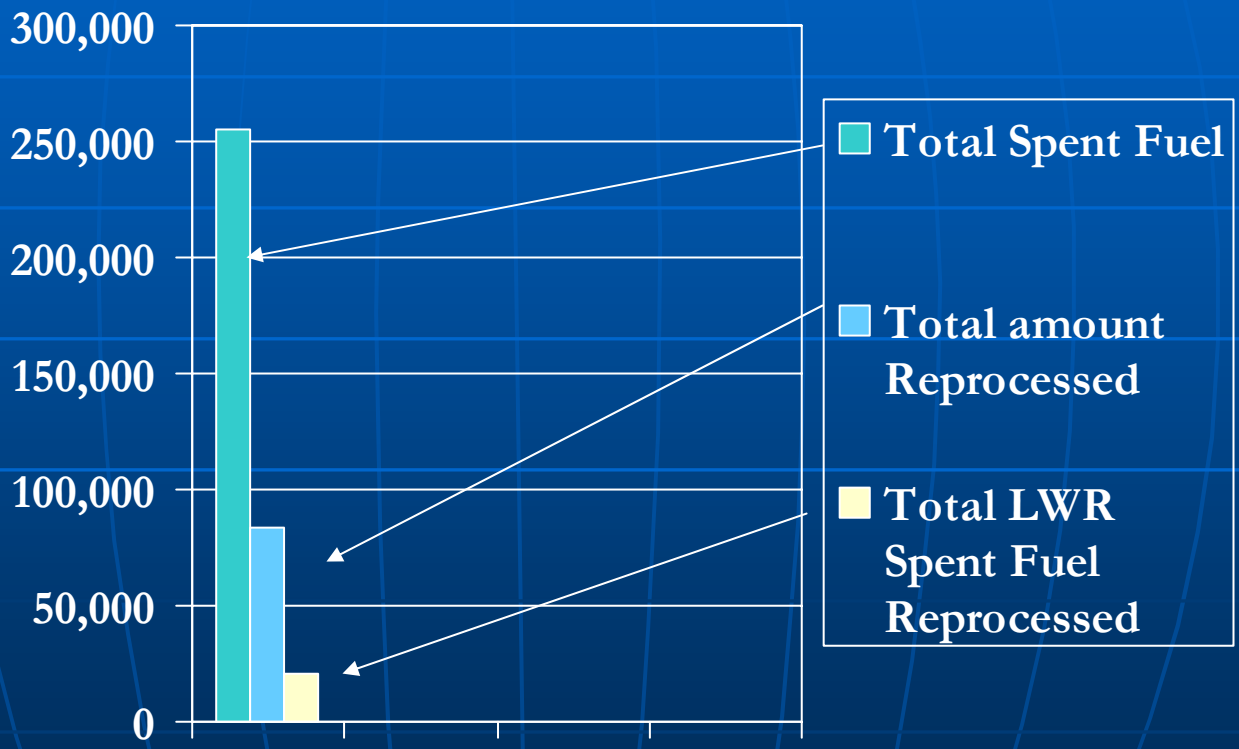
Actinide fuel fabrication and performance

Operating Reprocessing Plants

- France – La Hague – 1,700 MT/yr
- Japan– Tokai – 30-40 MT/yr (800 MT/r planned)
- Russia – Mayak (RT1)–120-150 MT/yr
- UK -- Thorp – 800-900 MT/yr
- India – 100 MT/yr

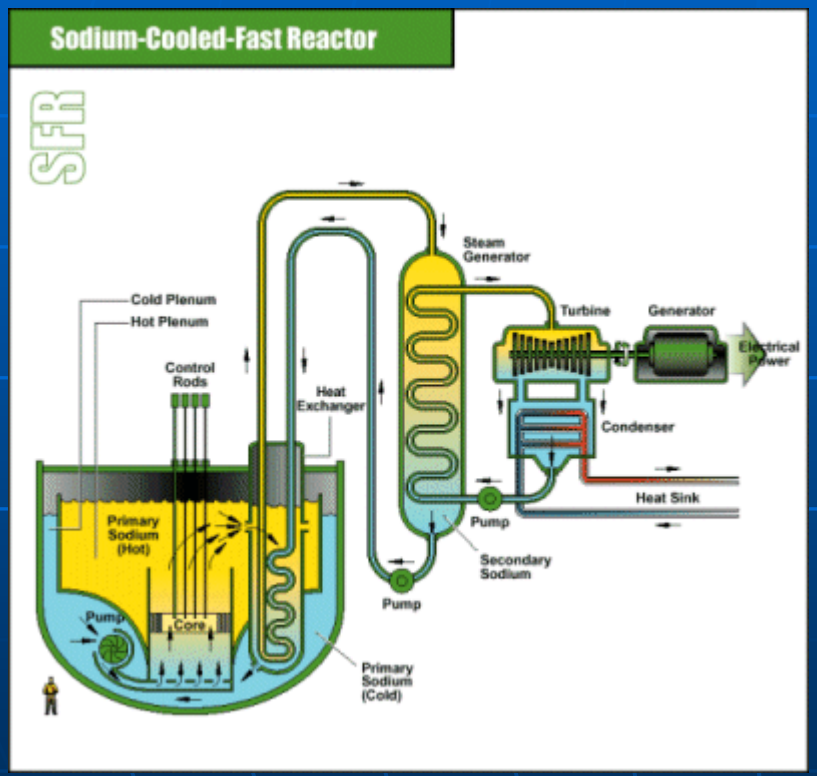
Source: IAEA TECDOC 1529 February 2007.

Reprocessing and Spent Fuel World Wide 2003



Source: IAEA TECDOC 1529 February 2007.

What about “Fast” Reactors?



- The “closed” nuclear cycle was based on the assumption that global uranium supplies would be depleted by 2000.

- Over the past 50 years, at least 15 “fast” reactors have been closed due to costs and accidents in the U.S., France, Germany, England, and Japan.

- Russia has the only operating fast reactor, but it has experienced 15 sodium fires in 23 years.

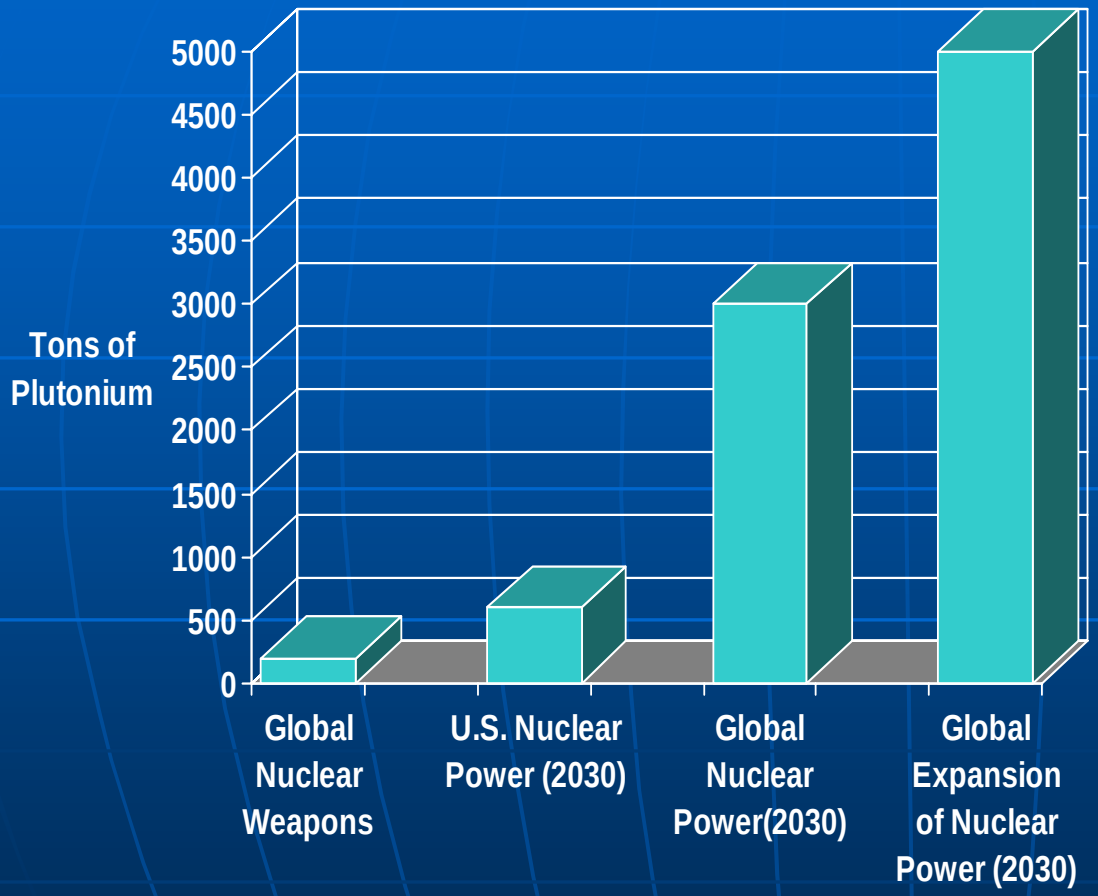
What About MOX?

The net average of plutonium that is "burned up" in MOX fuel is ~20% per reactor load.

MOX spent fuel is not being reprocessed in France.

According to the French government in 2000, the use of plutonium in existing reactors doubles the cost of disposal.

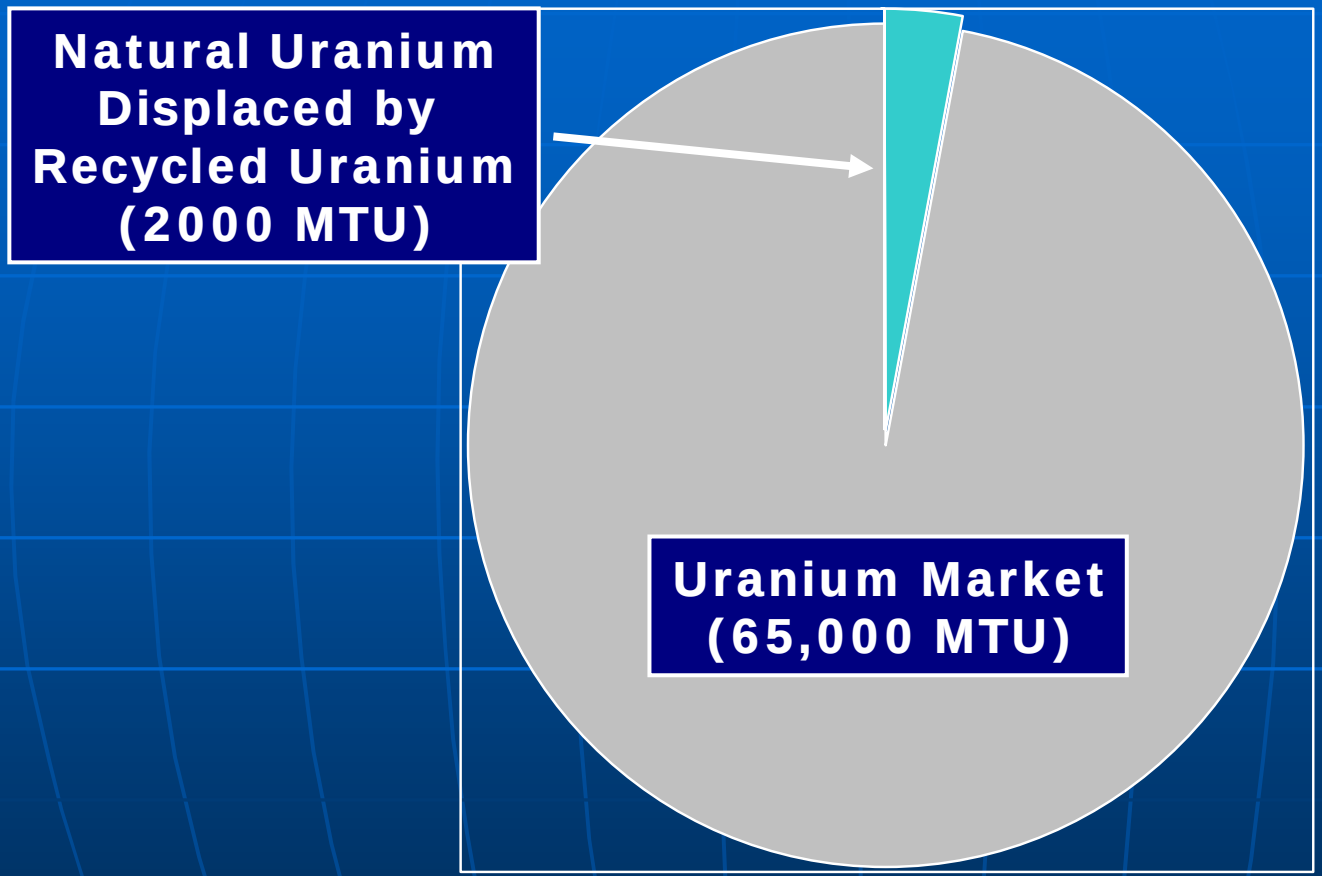
Plutonium Stocks and the Unfulfilled Promise of "Fast Reactors"



- About 370 metric tons of plutonium have been extracted from power reactor spent fuel over the past several decades.

- About 250 tons of sits at reprocessing plants around the world – equivalent to the amount in some 30,000 nuclear weapons in global arsenals.

Global Uranium Recycling 2007



" Reprocessed uranium currently plays a very minor role in satisfying World uranium requirements for power reactors." Source: IAEA TECDOC 1529 February 2007.

COSTS

- In 1996, a panel of the National Academy of Sciences (NAS) concluded that that reprocessing and transmutation would cost as much as $700 billion (2008 dollars) and take 150 years.
- In 2007 the Academy tossed cold water on the Bush administration's nuclear recycling effort by concluding that "there is no economic justification for going forward with this program at anything approaching a commercial scale."

CONCLUSION

- **The United States should re-establish its policy of discouraging reprocessing to stem proliferation risks.**

- **Spent fuel can be safely stored in dry-hardened storage modes for 100 years at less expense than the "closed" fuel cycle.**

- **The practice of densely compacted spent fuel pools in the U.S. should be phased out.**

- **<u>The parameters defining growth of nuclear energy should include credible disposal of high-level radioactive wastes.</u>**