

***Managing spent fuel in the United States:  
The illogic of reprocessing***

(report on [www.fissilematerials.org](http://www.fissilematerials.org))

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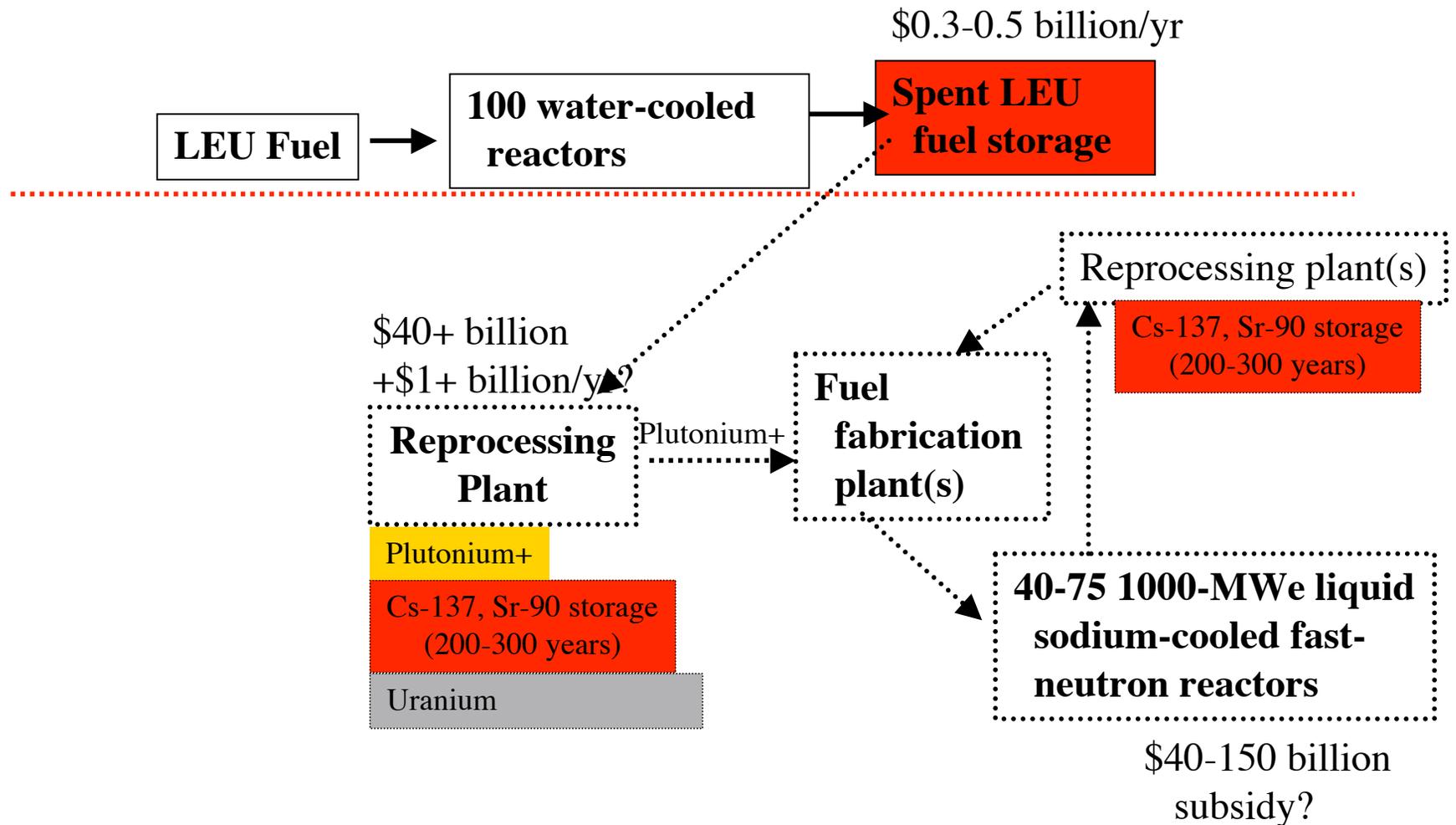
Fuel Cycle Information Exchange, hosted by the U.S. Nuclear Regulatory  
Commission Office of Nuclear Material Safety and Safeguards, NRC headquarters,  
Two White Flint North Auditorium, June 17, 2008, 1:00-1:30 PM

**U.S. nuclear utilities want Department of Energy (DOE) to start removing spent fuel from reactor sites and are suing to recover their extra costs for storage since 1998 (\$0.3-0.5 billion/year)**



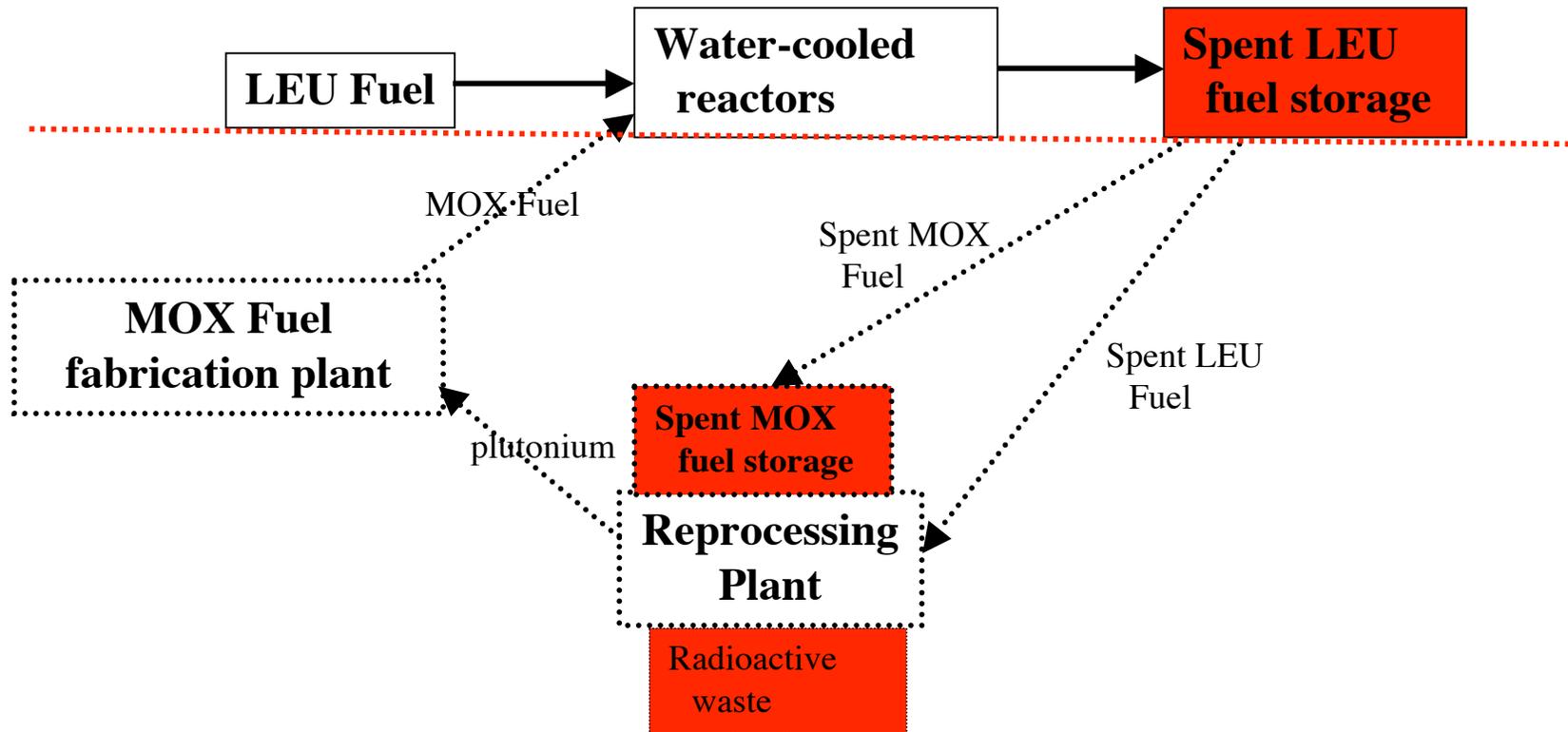
Spent fuel from Maine Yankee reactor, which is now shutdown.

**2006: DOE proposed a program to subsidize construction of a reprocessing plant and fast-neutron reactors to fission transuranics (mostly plutonium)**  
 Until the fast-neutron reactors were built, the reprocessing plant would become a centralized interim storage site for reprocessed spent fuel.



**DOE now proposes that, until fast-neutron-reactors are built, the U.S. separate & recycle plutonium once in “mixed oxide” (MOX or plutonium-uranium) fuel and store the spent fuel at the reprocessing plant -- as in France.**

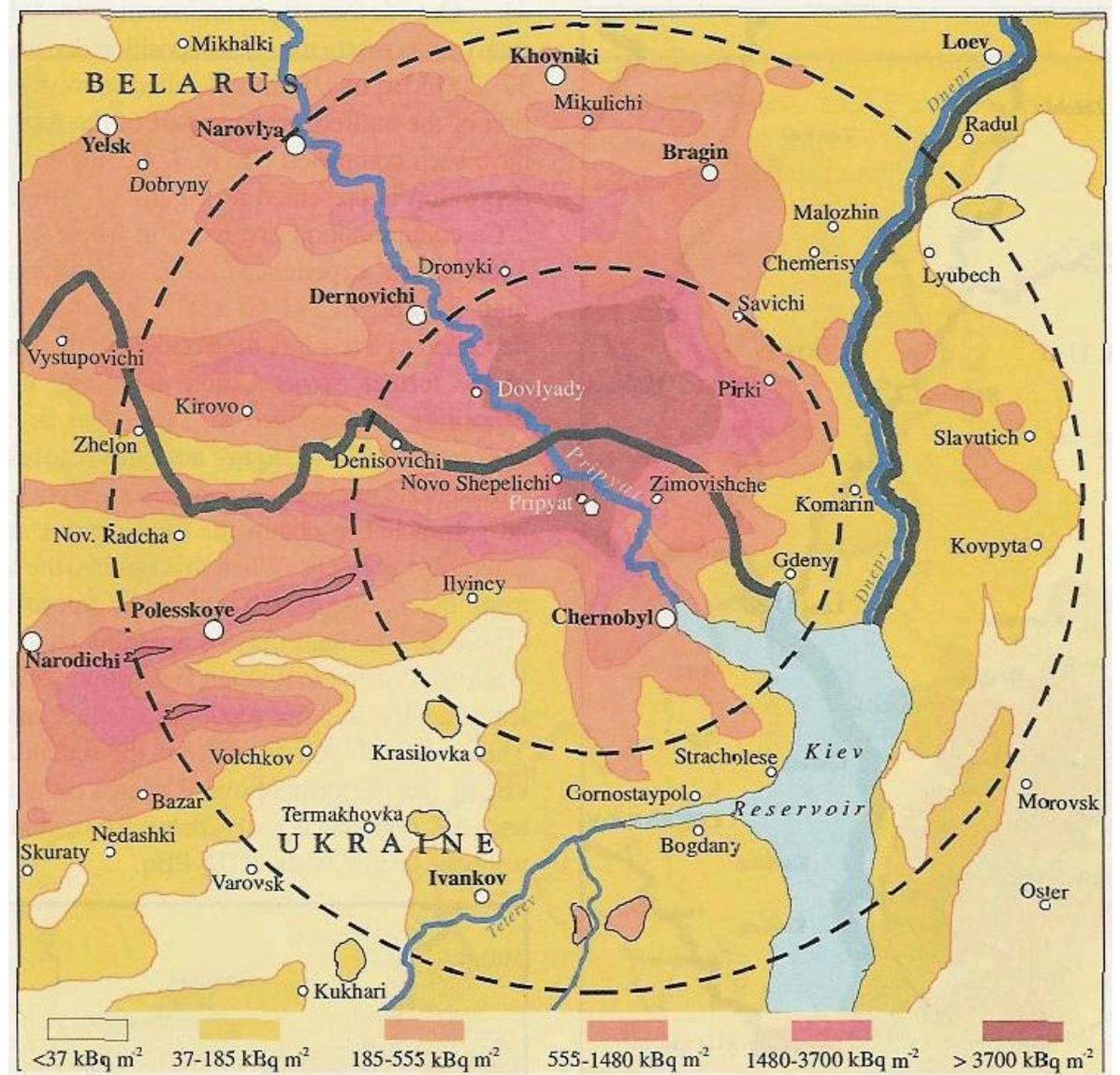
This would provide centralized interim storage of spent MOX fuel and high-level waste *but no waste disposal benefit* (DOE agrees).



# Primary Safety Issue: Liquid high-level waste

A 2500-ton/year reprocessing plant would separate *each* year twice as much high-level waste as the Savannah River reprocessing plants did in their entire lifetimes.

*Each two days*, it would separate out the amount of 30-year-half-life cesium-137 that caused the long-term evacuation of an area of more than 1000 square miles around Chernobyl.



Surface ground deposition of cesium-137 in the immediate vicinity of the Chernobyl nuclear power plant. The distances of 30 km and 60 km from the nuclear power plant are indicated.

## Why reprocessing costs so much more than storage

*La Hague reprocessing plant:* One square mile complex.  
\$20+ billion capital cost and \$1 billion/year operational cost vs  
\$0.3-0.5 B/year for dry-cask spent-fuel storage



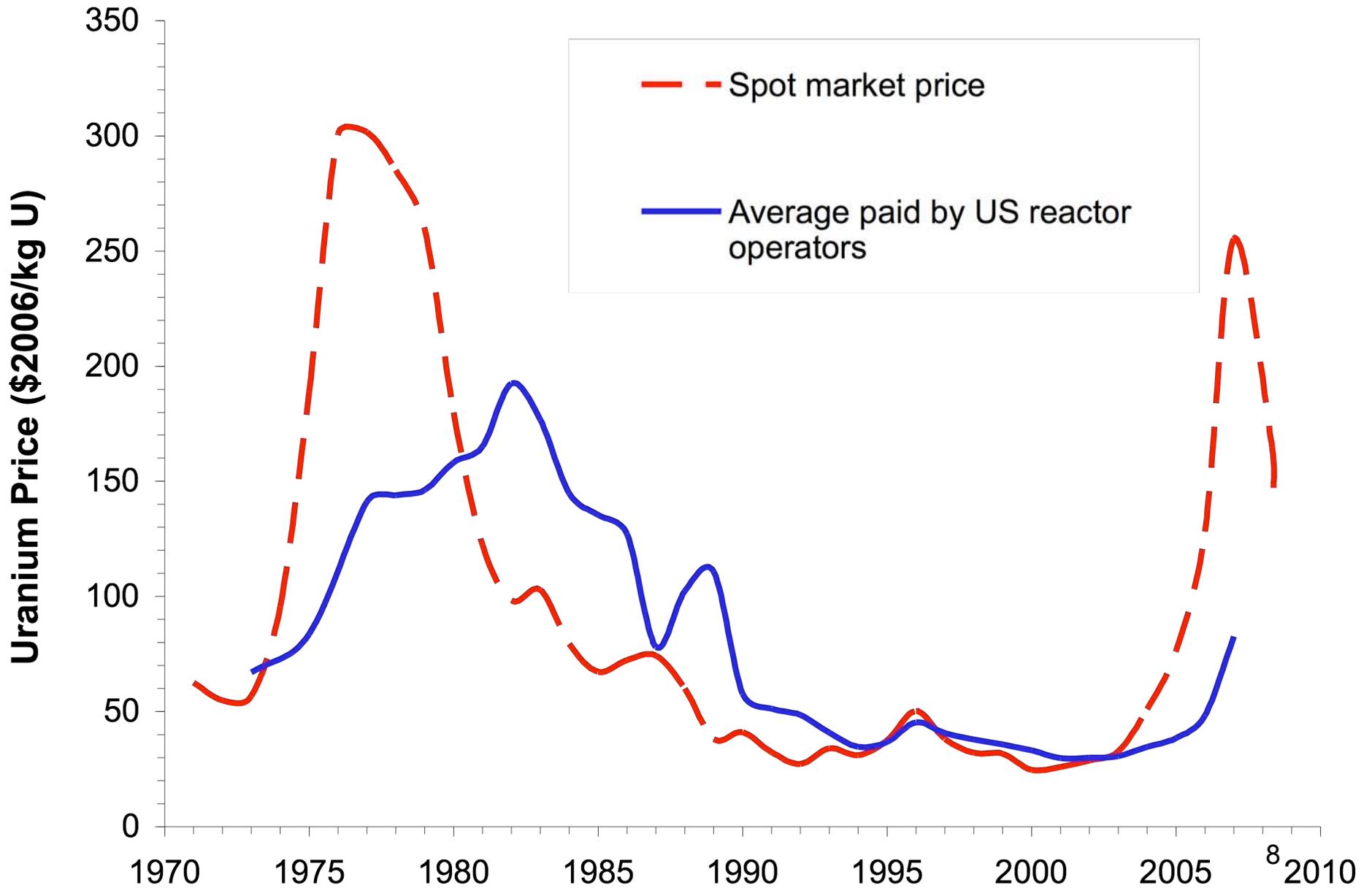
## **Exchanging LEU spent fuel into MOX spent fuel doubles the estimated cost of spent-fuel disposal in France**

*[Report to the Prime Minister [of France]: Economic Forecast Study of the Nuclear Power Option, (2000)]*

France's electric utility, *Electricité de France*, has refused to renew its reprocessing contract with *AREVA* unless the price comes down.

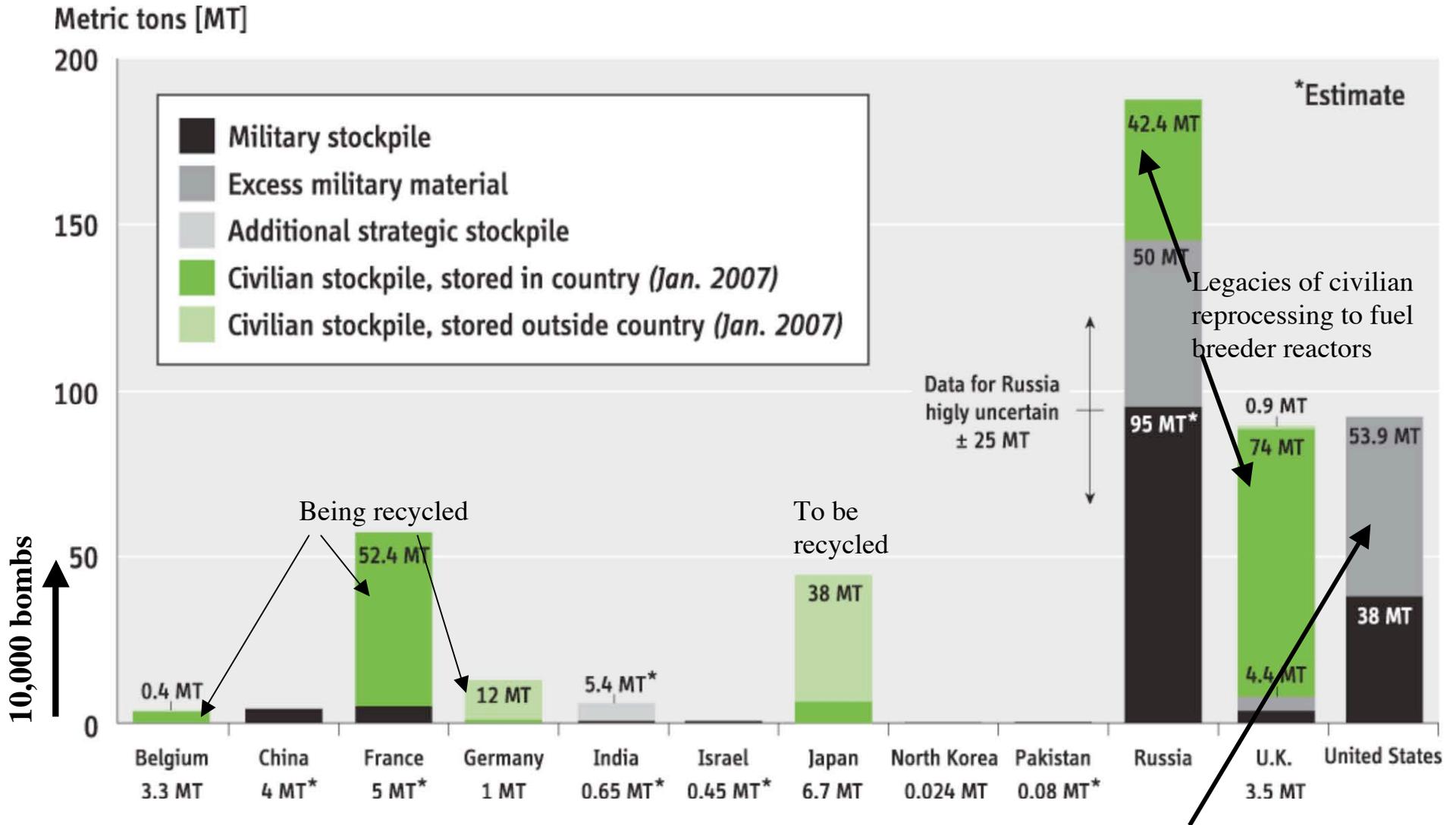
Even with the plants paid for, *AREVA* says that it can't bring the price down.

← Breakeven in France about \$400/kgU



# Challenge is to reduce stocks -- not separate more!

(Global stocks of separated plutonium, metric tons, end 2006, *Global Fissile Material Report, 2007*, updated)



**U.S. excess plutonium will cost >\$10 B to dispose**

**Separated plutonium can be carried away easily.  
Spent fuel is self-protecting for more than a century.**

### Separated plutonium



2.5 kg Pu in light-weight container. Can be processed in a glove box. 3-4 cans enough for Nagasaki-type bomb.

(Mayak Reprocessing Plant, 2004)

### PWR Spent fuel assembly (500 kg and 3.5 m long)

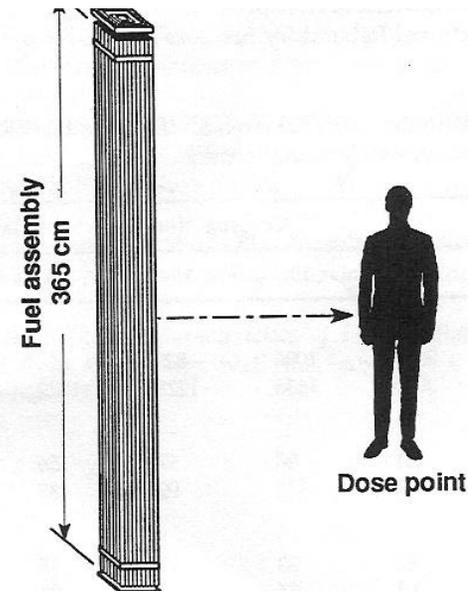
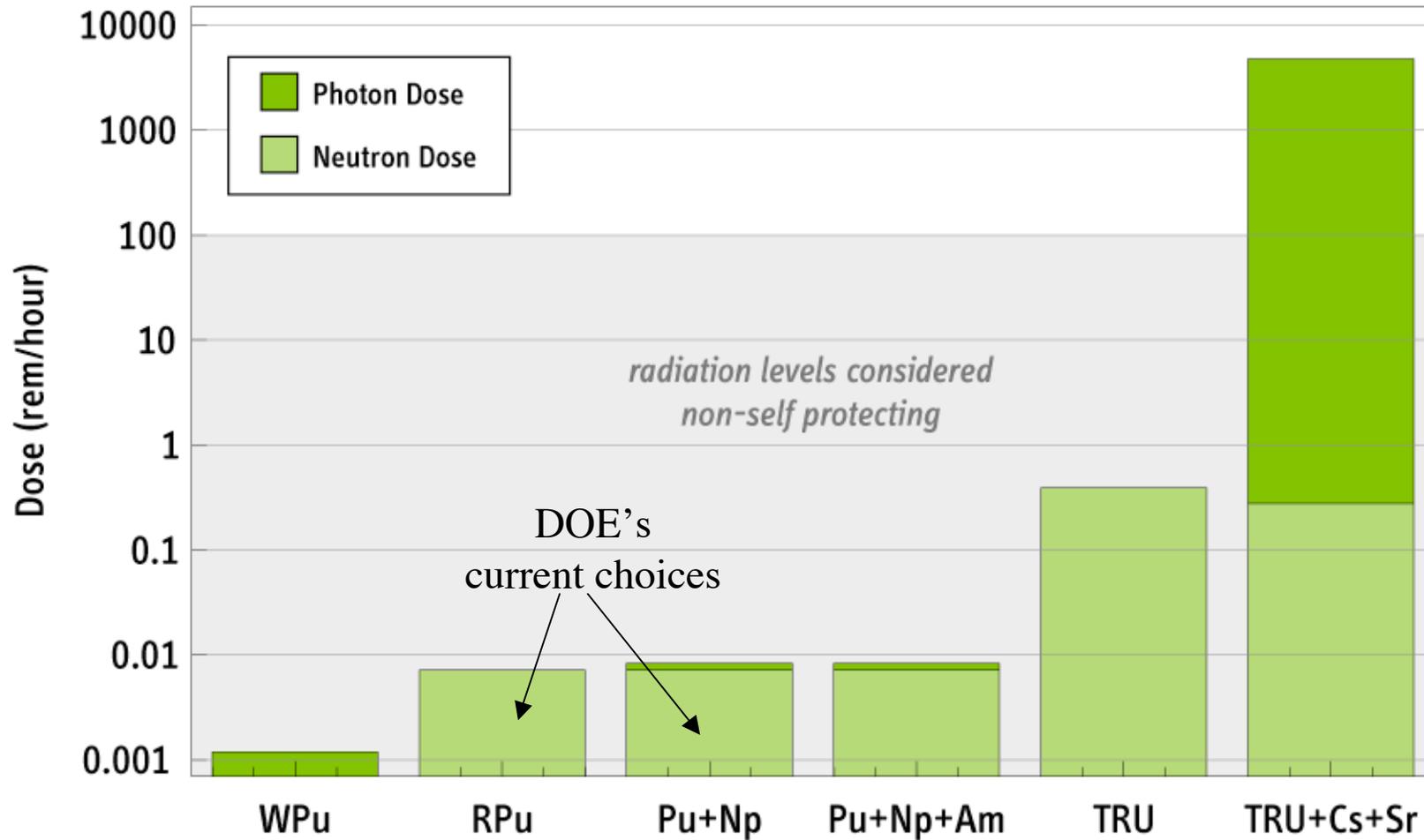


figure 1. Dose rate from a PWR fuel assembly.

5 kg Pu. Fuel assembly lethal in 20 minutes at 1 meter 50 years after discharge.  
20-ton container to transport & reprocessing behind thick walls to recover plutonium

# “Proliferation resistant” mixes of transuranics not much more self protecting than separated plutonium

(Dose rate from 4.4 kg of transuranics through a canister)



## **Reprocessing and proliferation**

Before 1974, the U.S. transferred reprocessing technology to other countries.

In 1974, one of these countries, India, used the first plutonium it separated for a “peaceful nuclear explosion.”

France & Germany were about to sell reprocessing plants to Brazil, South Korea and Pakistan

All these countries intended to use the technology for weapon programs.

## **U.S. nonproliferation policy on reprocessing**

After 1974, U.S. policy became:

***“We don’t reprocess. You don’t need to either.”***

***No additional non-weapon states have launched “civilian” reprocessing in the past 30 years and several have stopped.***

Bush Administration has proposed new GNEP policy:

***“The weapon states and Japan will do it for you.”***

Negative reactions about a “two-class world.”

Parts of Administration are putting their enthusiasm for reprocessing ahead of nonproliferation including encouraging South Korea to reprocess in violation of the 1992 Korean Peninsula Denuclearization agreement.

**Merchant Reprocessing has failed in any case.  
Customer countries with one third of global nuclear  
capacity have not renewed their contracts.  
U.K. -- a supplier country -- is also quitting**

<b>Customer Country</b>	<b>Nuclear Generating Capacity end 2006 (Gigawatts )</b>	<b>Country Supplying the Reprocessing Service</b>
Armenia	0.4	Russia
Belgium	5.8	France
Bulgaria	1.9	Russia
Czech Republic	3.5	Russia
Finland	2.7	Russia
Germany	20.3	France and UK
Hungary	1.7	Russia
Japan (reprocesses at home)	47.8	France and UK
Slovakia	2.0	Russia
Spain	7.5	France and UK
Sweden	9.1	France and UK
Switzerland	3.2	France and UK
<u>Ukraine</u>	<u>13.1</u>	Russia
<b>Total</b>	<b>119.0</b>	

*Spent fuel will have to be removed from reactor sites eventually. But no reason to panic.*



- Only 5% of U.S. spent fuel is *not* at sites with operating reactors.
- At an operating nuclear power plant, consequences of accidents and attacks on dry-cask-stored fuel would be orders of magnitude less than from attacks on reactors or storage pools.
- All U.S. nuclear power plant sites can accommodate spent fuel from 60 years of operation.

# Summary

## Reprocessing:

- Exchanges interim, on-site storage of self-protecting spent-fuel for interim stockpiling of separated plutonium that is easily carried.
- Costs much more than on-site storage.
- More dangerous than on-site storage.
- Provides cover for countries to develop nuclear-weapon options.

# ***October, 2007: National Academy of Sciences Review does not understand DOE's hurry***

([http://books.nap.edu/catalog.php?record\\_id=11998](http://books.nap.edu/catalog.php?record_id=11998), Summary, pp. 8-9)

"All committee members agree that the GNEP program should not go forward and should be replaced by a less aggressive research program"

"DOE claims that the GNEP is being implemented to save the United States nearly a decade in time and a substantial amount of money. In view of the technical challenges involved, the committee believes that the opposite will likely be true.

"...none of the cycles proposed, including UREX+ and the sodium fast reactor, is at a stage of reliability and understanding that would justify commercial-scale construction at this time."

## Growing Skepticism in Congress

- **“aggressive program proposed by the Department is at best premature.”**
- **“Embarking on a costly process leading to major new construction projects is unwise, particularly where there is no urgency.”**
- **“before the Department can expect the Committee to support funding for a major new initiative, the Department must provide a complete and credible estimate of the life-cycle costs.”**

*--House Appropriations Committee Report on House FY08 Energy and Water Development Appropriations Bill: (Report 110-185, 11 June 2007, pp. 66-68*

***“no funds are provided for facility construction for technology demonstration or commercialization.”***

*--Congressional Statement Accompanying Omnibus Appropriations Bill, December 2007*