Nuclear Renaissance Needs Advanced Nuclear Fuel Cycles

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Used Fuel Management

Nuclear Renaissance Needs Advanced Fuel Cycles

- Nuclear renaissance means many new reactors providing electricity, hydrogen, desalinization, and more
- Fuel supply (recycle)
  - Fuel cost; fuel assurance
  - Advanced reprocessing, enrichment, fuel fabrication
- Waste management
  - Volume and toxicity reduction
  - Separation of waste materials having different disposal requirement
  - Need advanced reactors (fast spectra reactors)
- Non-proliferation
  - Keep reprocessing and enrichment in the “club”

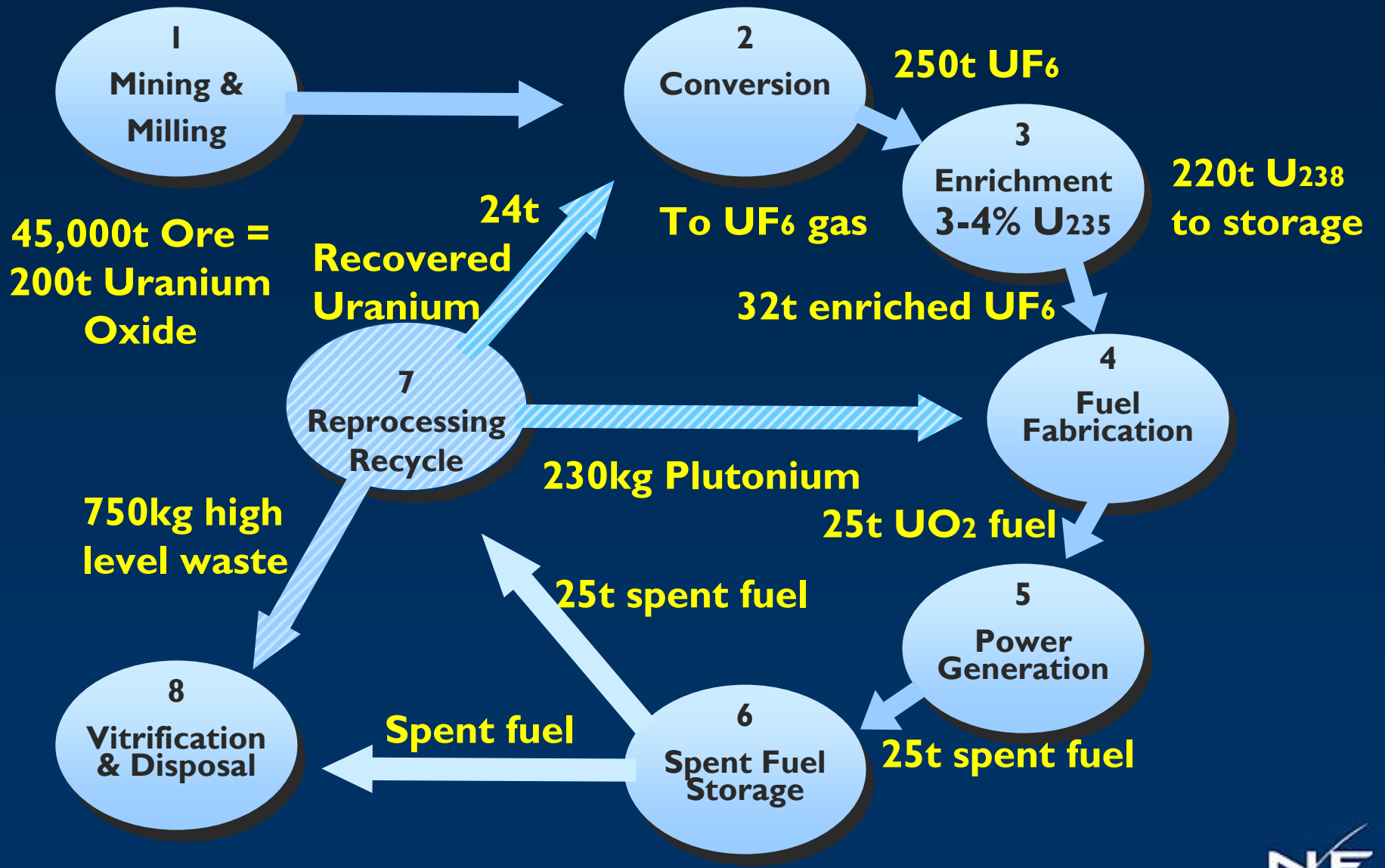
HLW Options and Possibilities*

Nuclear Futures		Existing License Completion	Extended License Completion	Continuing Level Energy Generation	Continuing Market Share Generation	Growing Market Share Generation
Cumulative spent fuel in 2100 (MTiHM)		90,000	120,000	250,000	600,000	1,500,000
		Existing Reactors Only <-----		-----> Existing and New Reactors		
Fuel Management Approach		**Number of Repositories Needed (at 70,000 MT each)**				
----> No Recycle	Direct Disposal (current policy)	2	2	4	9	22
	Direct Disposal with Expanded Repository Capacity	1	1	2	5	13
Recycle <----	Limited Thermal Recycle with Expanded Repository Capacity	1	1	1	3	7
	Repeated Combined Thermal and Fast Recycle	(requires new reactors)		1	1	1

*AFCI-2005

Nuclear Fuel Cycle

7 Not In U.S.

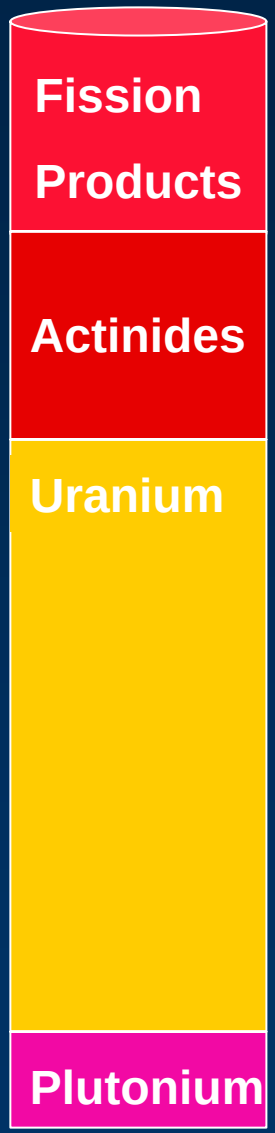


What is Reprocessing

- Only separation of the constituent isotopes that make up used nuclear fuel
  - Uranium 94.5% (mostly U-238)
  - Plutonium 1.15%
  - Waste (fission products) 4.55%
- Recycle of fuel materials
- Technology
  - PUREX (WWII) (not proliferation resistant)
  - UREX+
  - Pyroreprocessing and others

} Requires R&D

Used Fuel Separations Today



Short lived (heat)

Long lived

4.55%

Long lived

Drive repository design

94.5% U-238 (fertile) mostly
U-235 very little

1.15% Pu-239 fissionable

Always needs disposal: as HLW unless separated, then LLW, but need R&D

If separated still needs disposal. Could be transmuted with future technology

Dispose as LLW

Use with Pu as MOX

Re-enrich

Save for use in breeder reactors(50y)

Recycle as MOX

Status of Current Reprocessing

- 33 nations have nuclear programs
- 12 nations use reprocessing
  - France, UK, Russia, Japan (near-term)
- Reprocessing was the original US plan
  - 6 month old used fuel
- Proliferation concerns
- Cost of fuel considerations
- Government policies
- Reprocessing as currently practiced does not help waste disposal

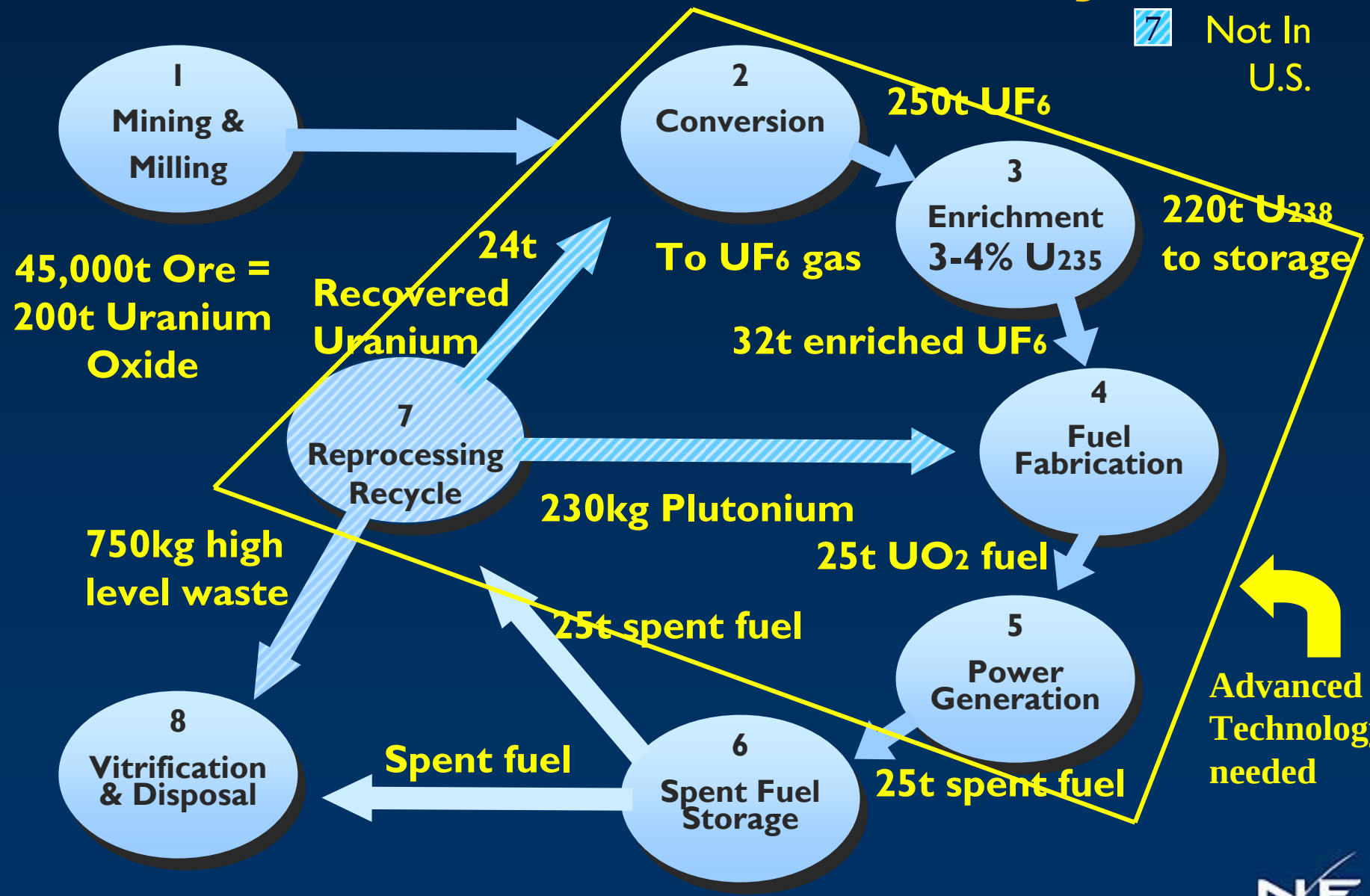
Cost of Current Reprocessing

- Variety of estimates
- Cost of nuclear fuel
  - Fresh fuel v. reprocessed fuel
  - Cost of reprocessed fuel above fresh fuel must be accounted for as higher fuel costs or for other purposes
    - Waste disposal
    - National policies (federal budget)
- Break-even cost estimates vary
  - 2x to 8x current cost based on historical data
  - More than break-even needed

Advanced Fuel Cycle Challenges

- Recycled Uranium and MOX
  - Requires re-enrichment facilities
  - Fuel fabrication facility for uranium and MOX
  - Modifications to reactors to use mox
  - MOX fuel will also require new regulatory basis
- Actinides
  - Requires fabrication facilities
  - Advance Burner (fast) Reactors to consume
  - Requires new regulatory basis
- Fission Products
  - Cs-137 and Sr-90 held for decay (50 years)
  - I-129 and Tc-99 Transmuted
- Advanced technology developed needed for all

Advanced Nuclear Fuel Cycle



Future of Advanced Fuel Cycles

- Technology must be proliferation resistant
- Fuel supply
  - Rising uranium cost
  - Future demand – more reactors; hydrogen
- Waste management
  - Develop technologies in parallel with current practices and phase in when available on production scale
- Non-proliferation
  - Could be used to prevent other countries
- Sustained government support needed

Global Nuclear Energy Partnership (GNEP)

Administration's proposal for the advancement of the use of nuclear energy around the world while addressing the concerns with proliferation and waste disposal.

- Reactors and nuclear technology for any country interested in the nuclear option
- Proliferation
  - Country commits not to develop or build enrichment or reprocessing facilities
  - Once through fuel cycle or used fuel is returned to US or other participating partner for reprocessing and return as re-enriched uranium or mox fuel

Global Nuclear Energy Partnership (GNEP)

- Waste
  - Recycling through Advanced Burner Reactors
  - Only fission products and some minor actinides go to repository
- Regardless of fuel cycle, some thing will have to go somewhere.

Impact on Waste Disposal

- Timing
  - No near term benefits
    - Lack of technology
    - Lack of regulatory basis
  - Long term benefits
    - More valuable to recent used fuel then old used fuel
    - Only of value if complete infrastructure is developed
- Expectations 30 to 50 years
- Yucca Mountain still needed

Summary

- Advanced Fuel Cycles needed to sustain nuclear renaissance
- GNEP will provided needed technology development
- Current used fuel programs must continue
- Yucca Mountain still needed