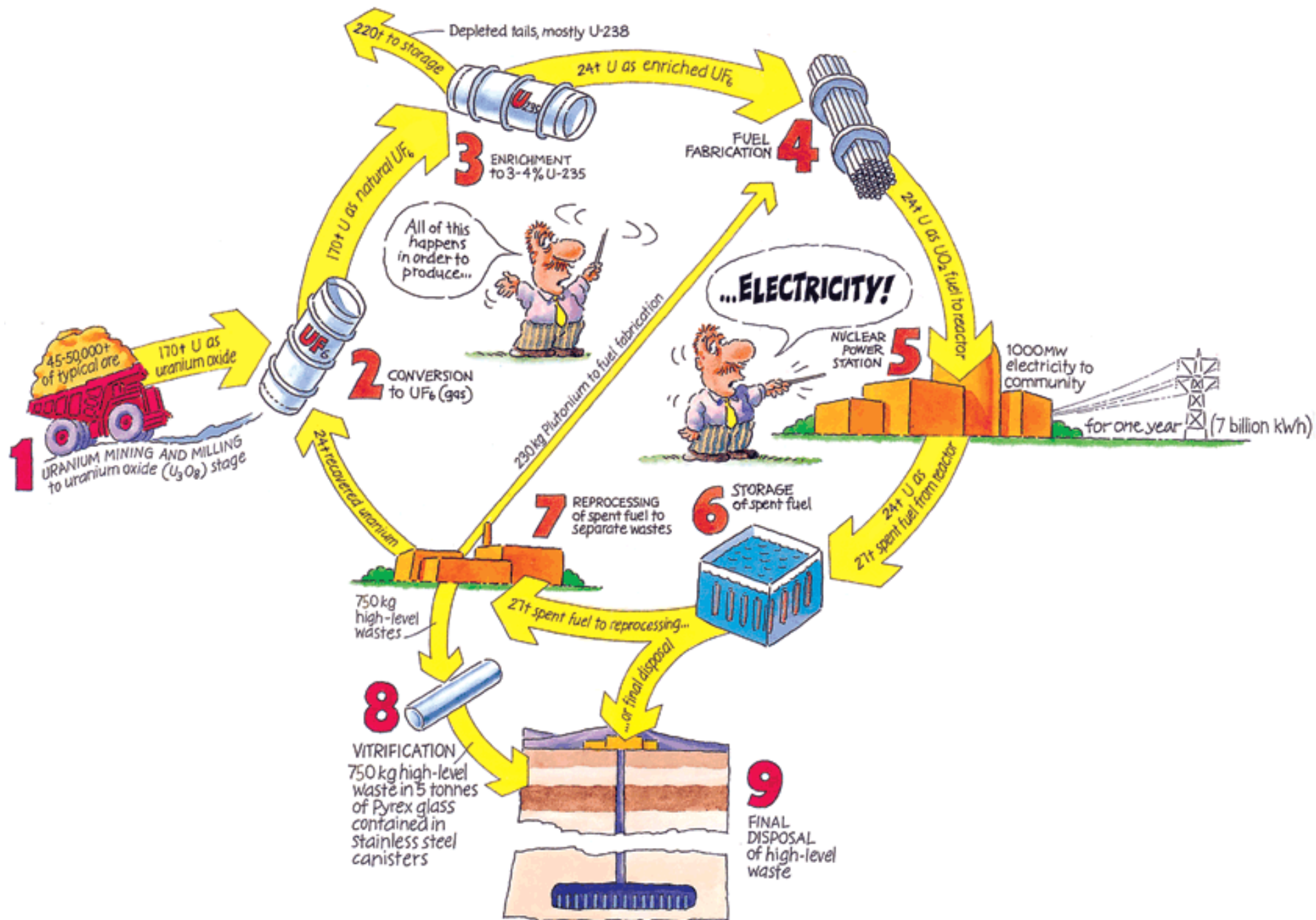


The Nuclear Fuel Cycle

Mary Lou Dunzik-Gougar, PhD

ANS Teachers' Workshop

2013

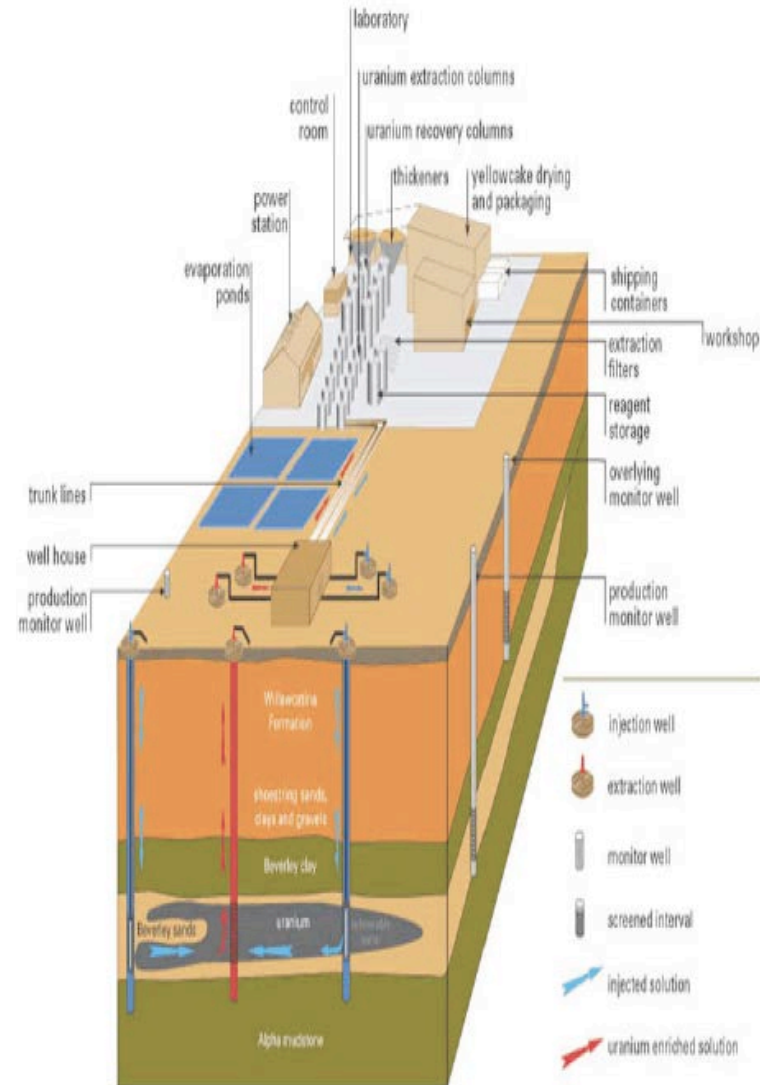


Uranium Mining

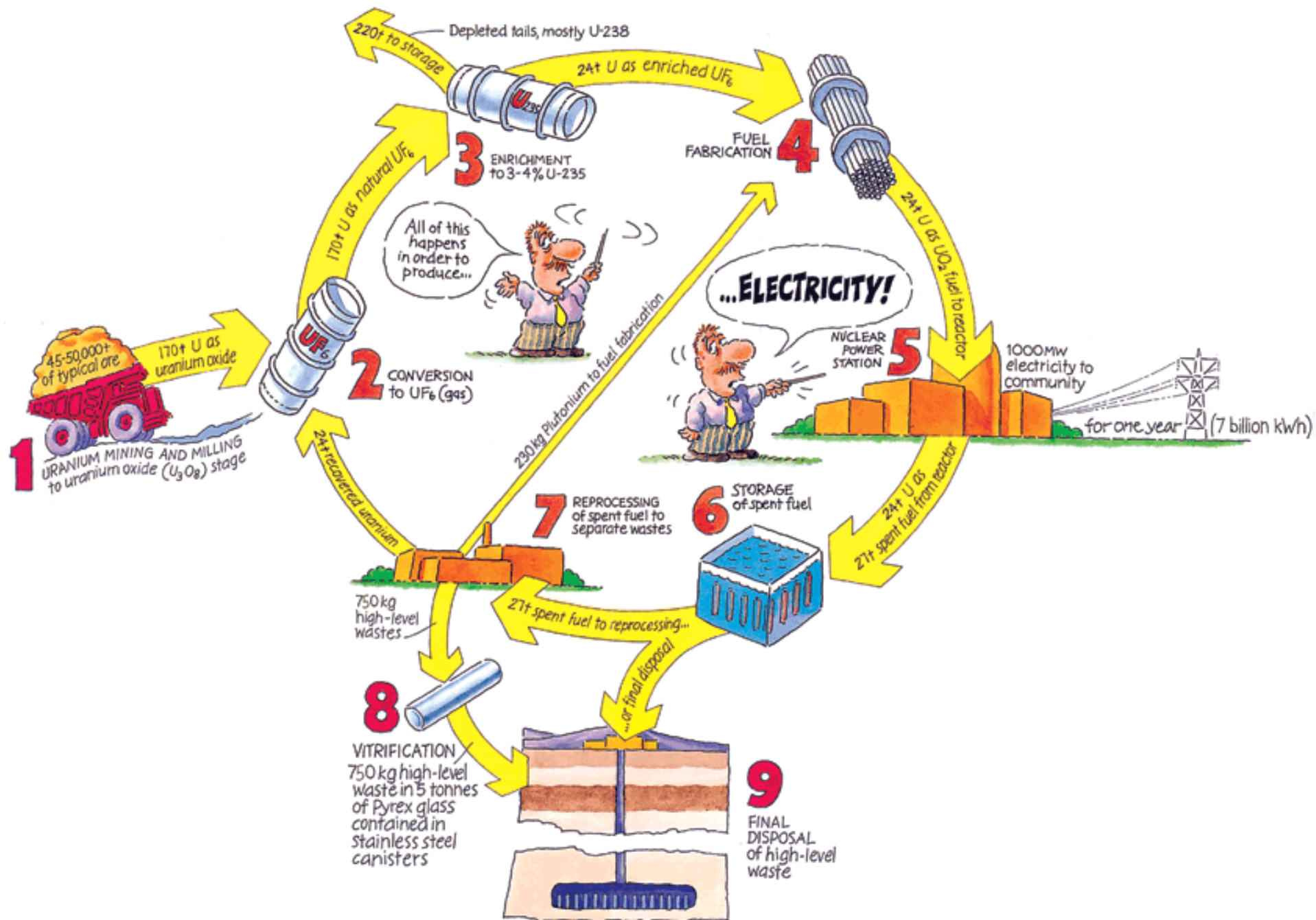
Open pit (strip) mining



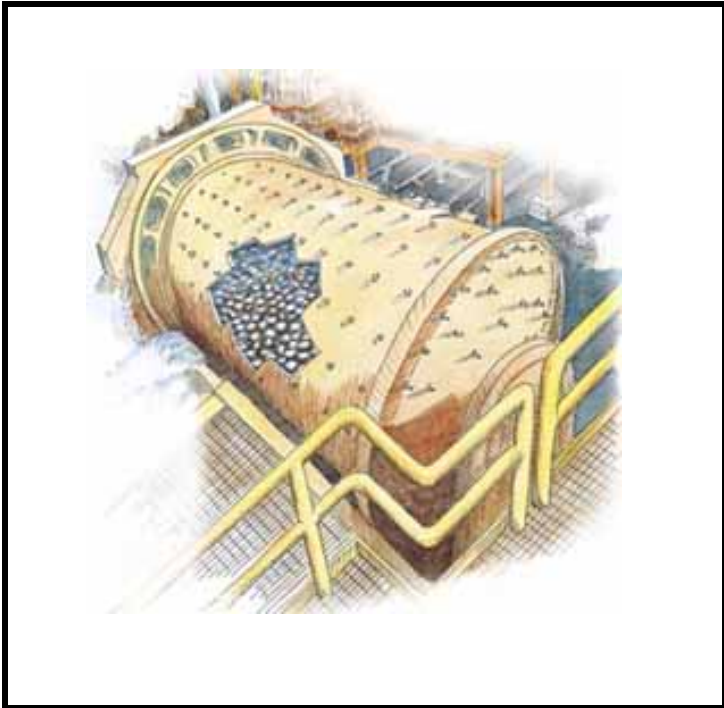
Underground mining



In situ leaching



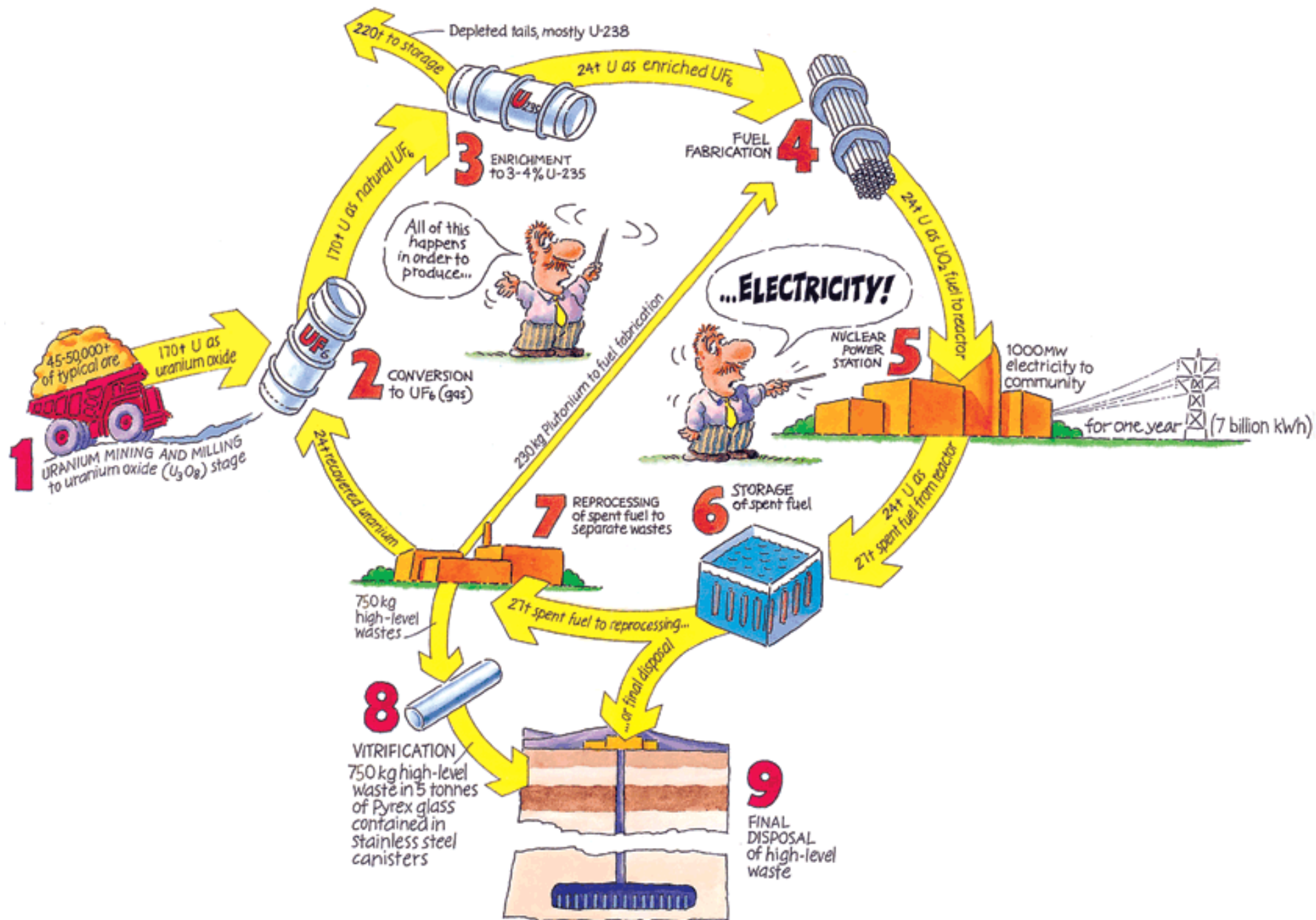
Uranium Milling



- Ore is crushed
- Uranium is separated



- U_3O_8 “yellow cake” produced

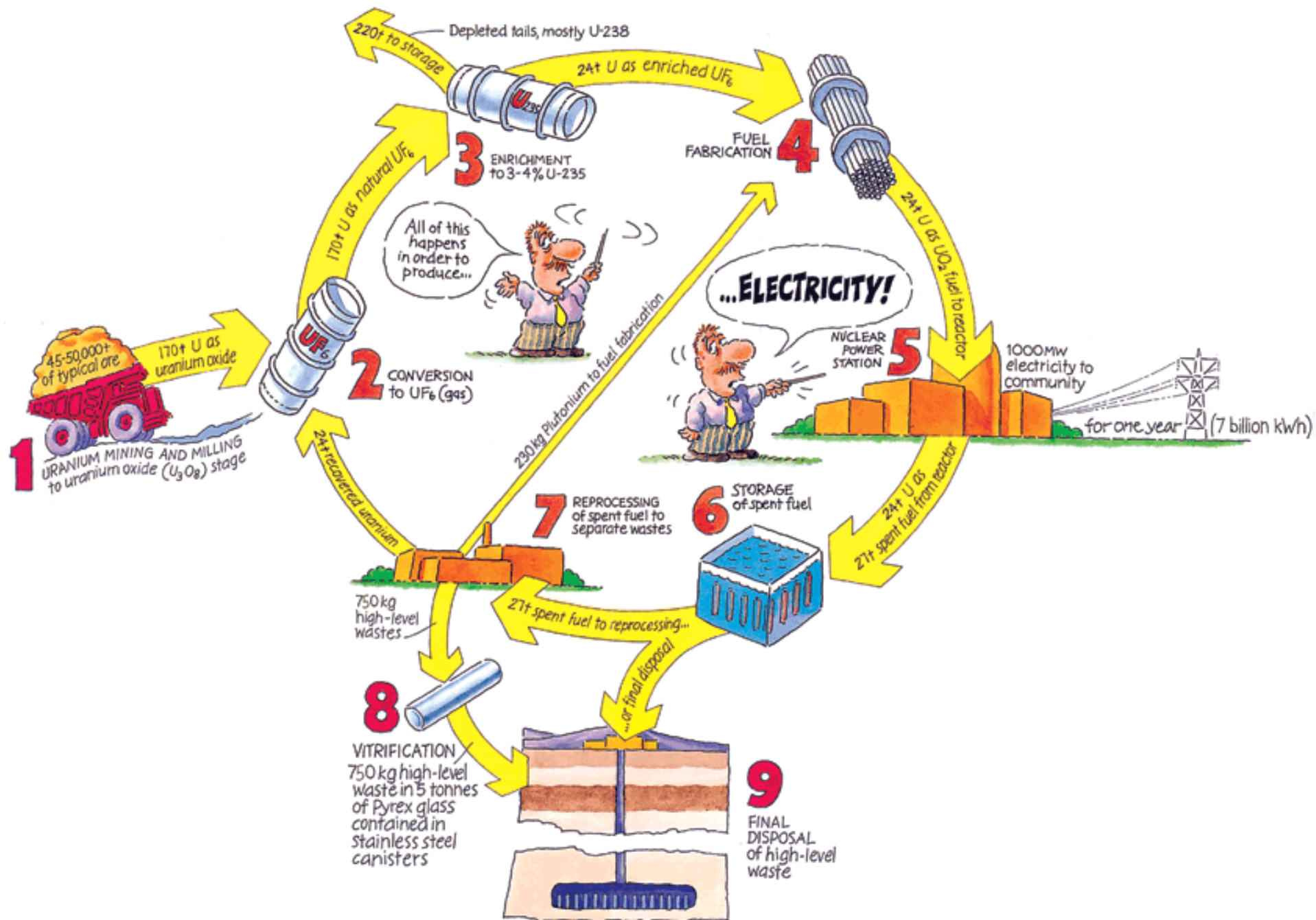


Uranium Conversion (to UF_6 gas)

- Impurities removed
- Uranium combined with fluorine
- UF_6 gas produced
 - Gaseous form facilitates enrichment

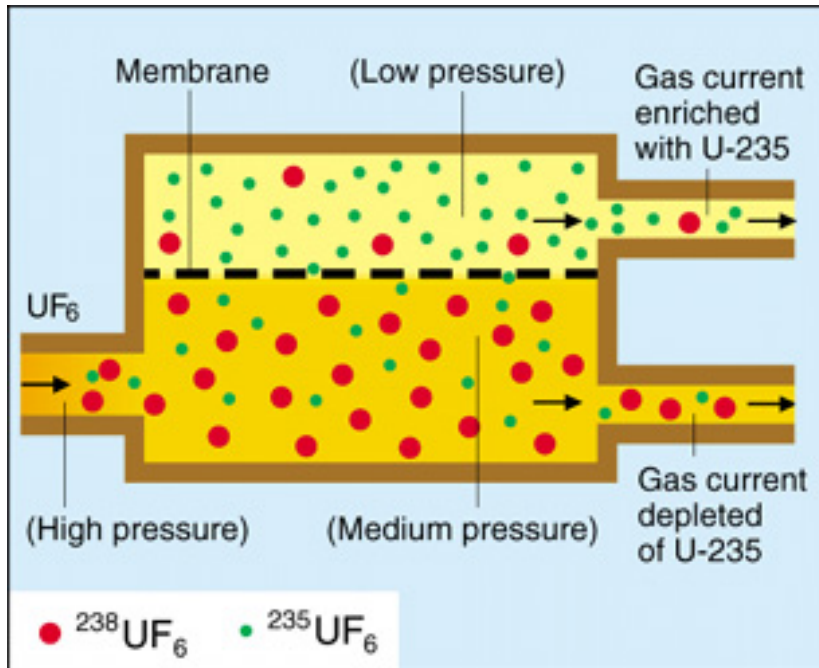


UF_6 containers

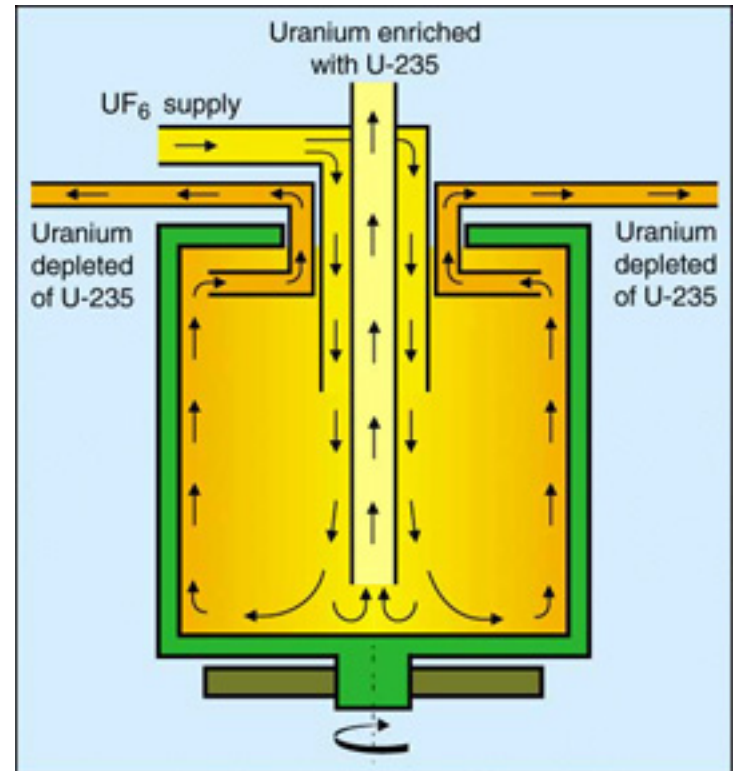


U Enrichment

- Natural U is $> 99\%$ ^{238}U and only $\sim 0.7\%$ ^{235}U
- Separation of $^{235}\text{UF}_6$ and $^{238}\text{UF}_6$ based on (very small) mass difference

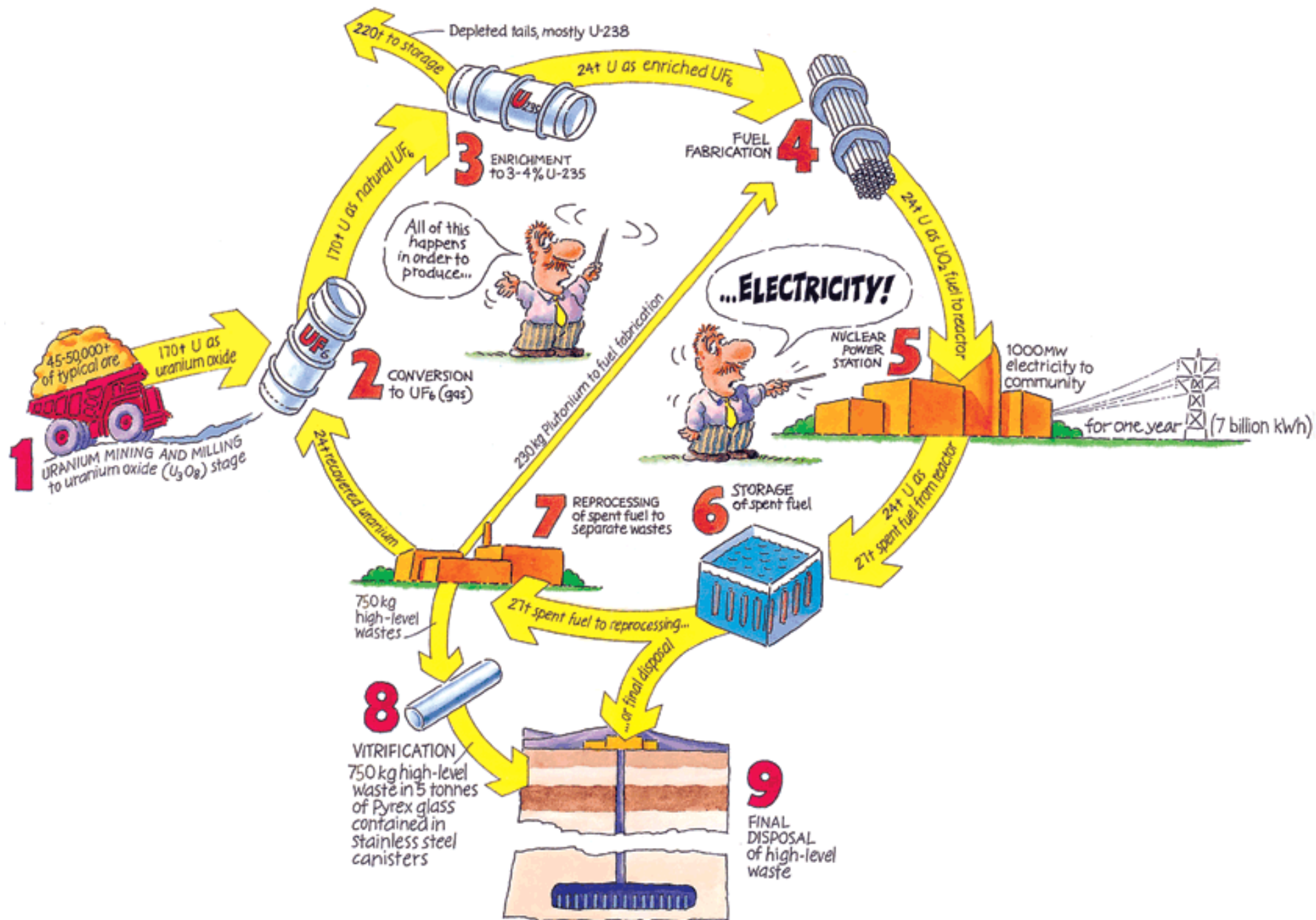


Diffusion



Centrifugation

- UF_6 enriched from 0.7% ^{235}U to $3\%-5\%$ ^{235}U

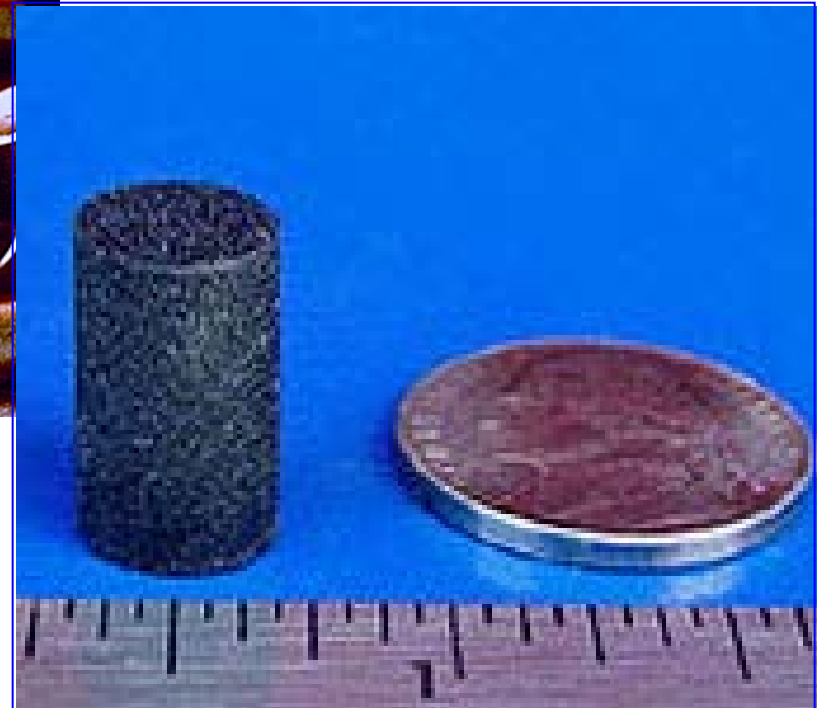


Fuel Fabrication

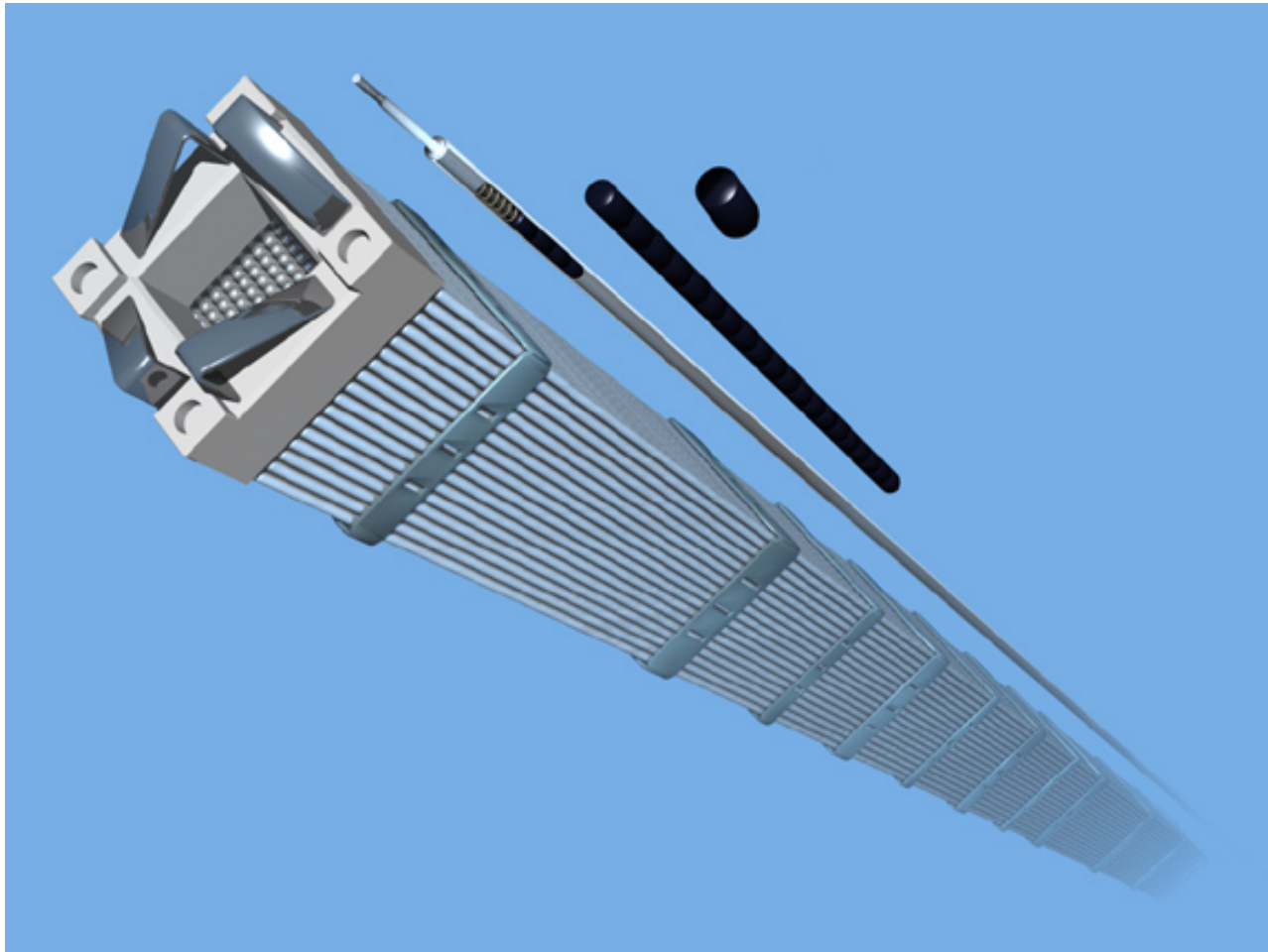
Enriched UF_6 gas converted to uranium oxide (UO_2) solid



Uranium Oxide Ceramic Fuel Pellets



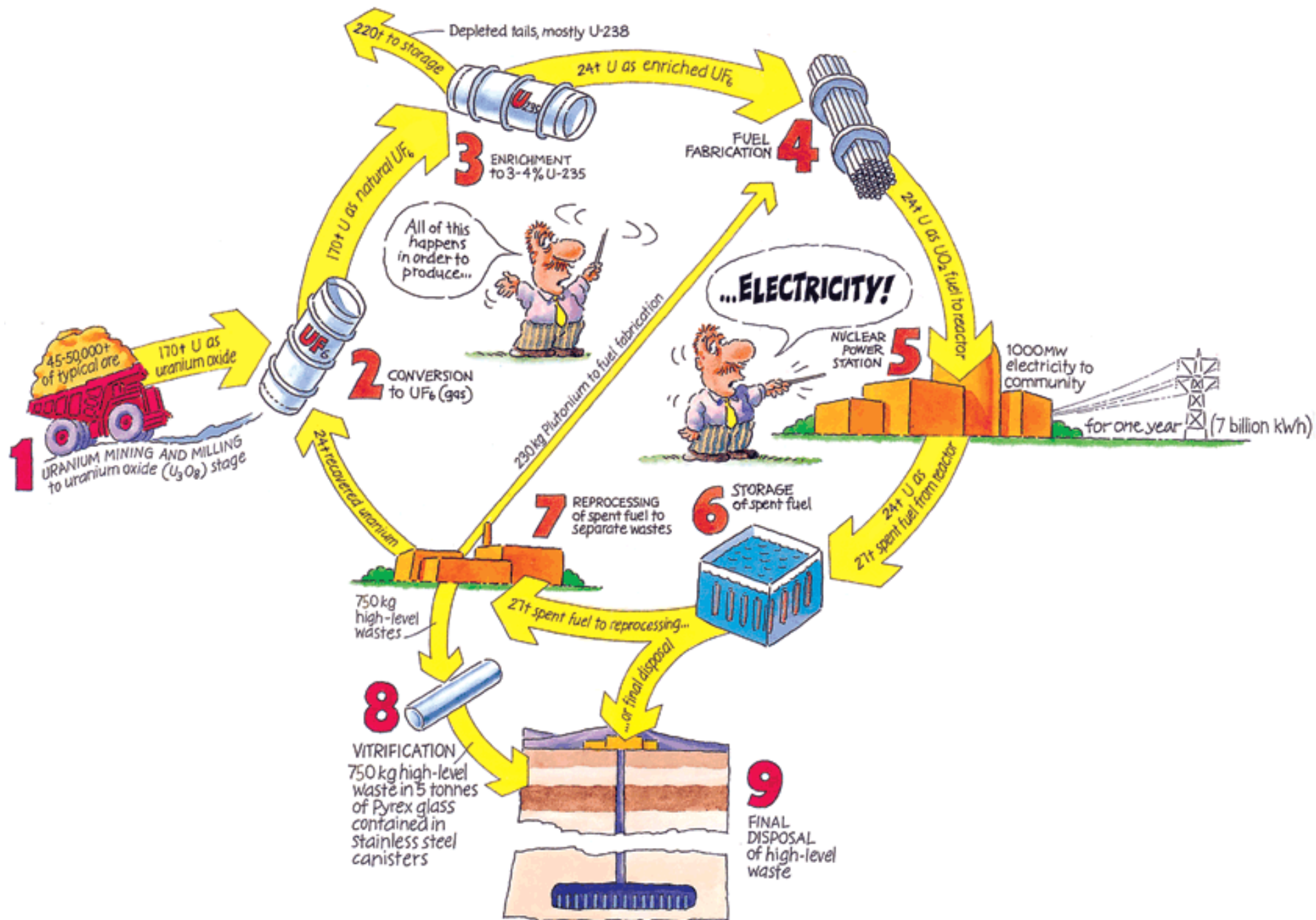
Fuel rods filled with **ceramic pellets** are grouped into **fuel assemblies**



Fuel Fabrication



A pressurized water reactor fuel assembly



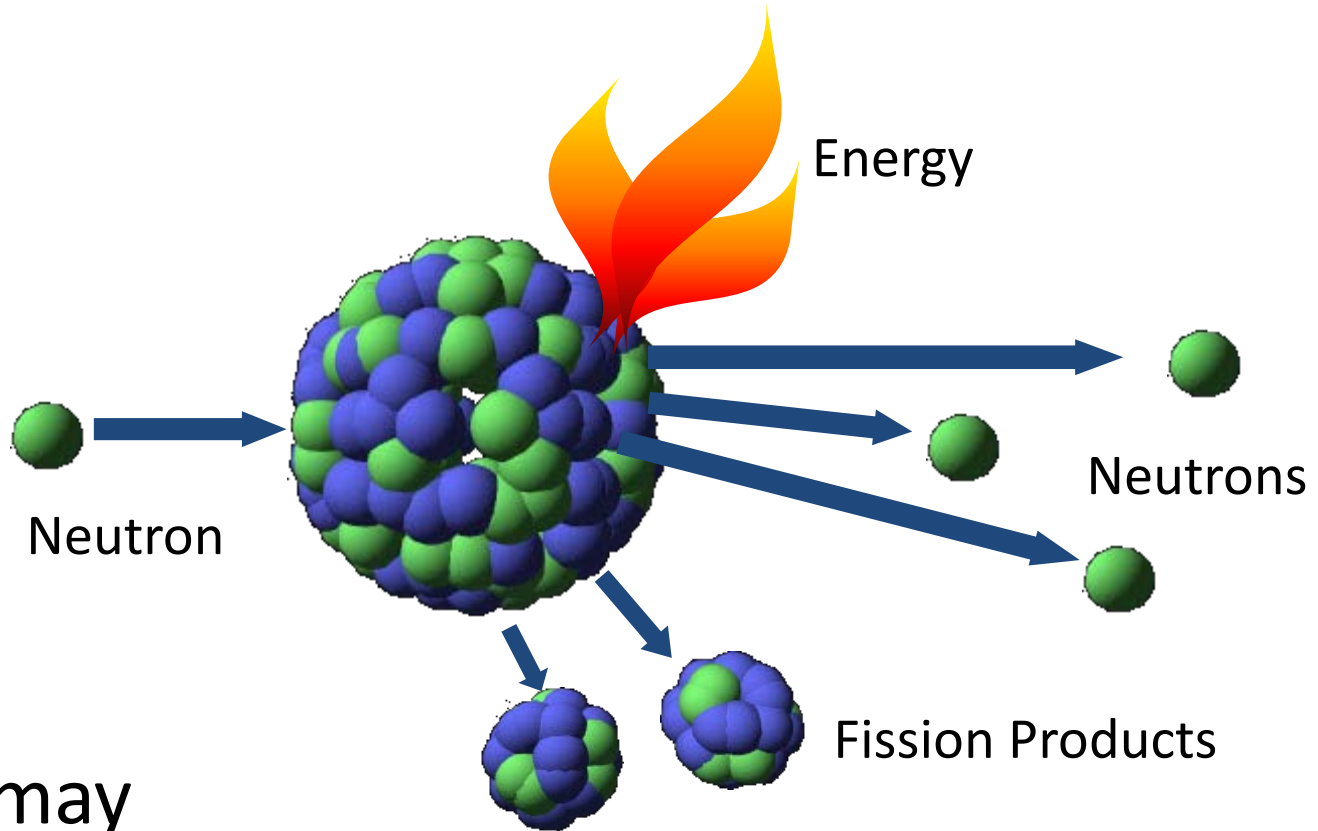
Reactors



Diablo Canyon nuclear power plant in the U.S.



In the reactor, ^{235}U fissions to produce . . .



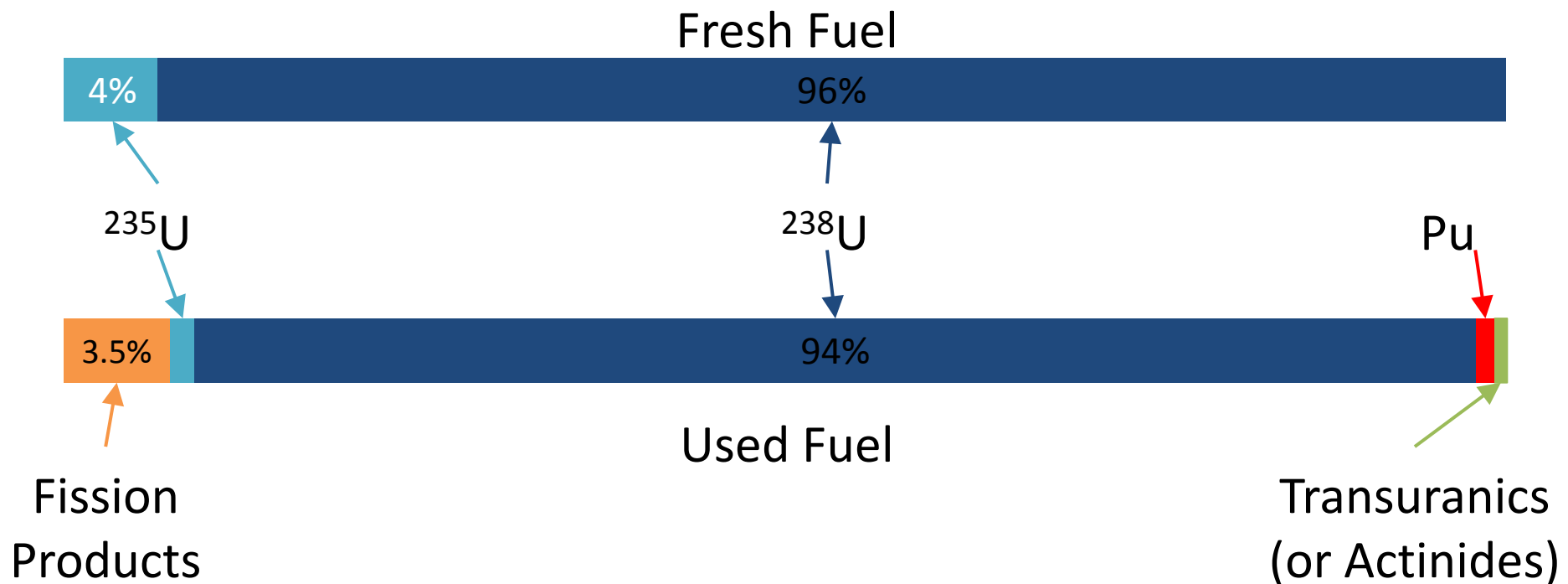
Neutrons may

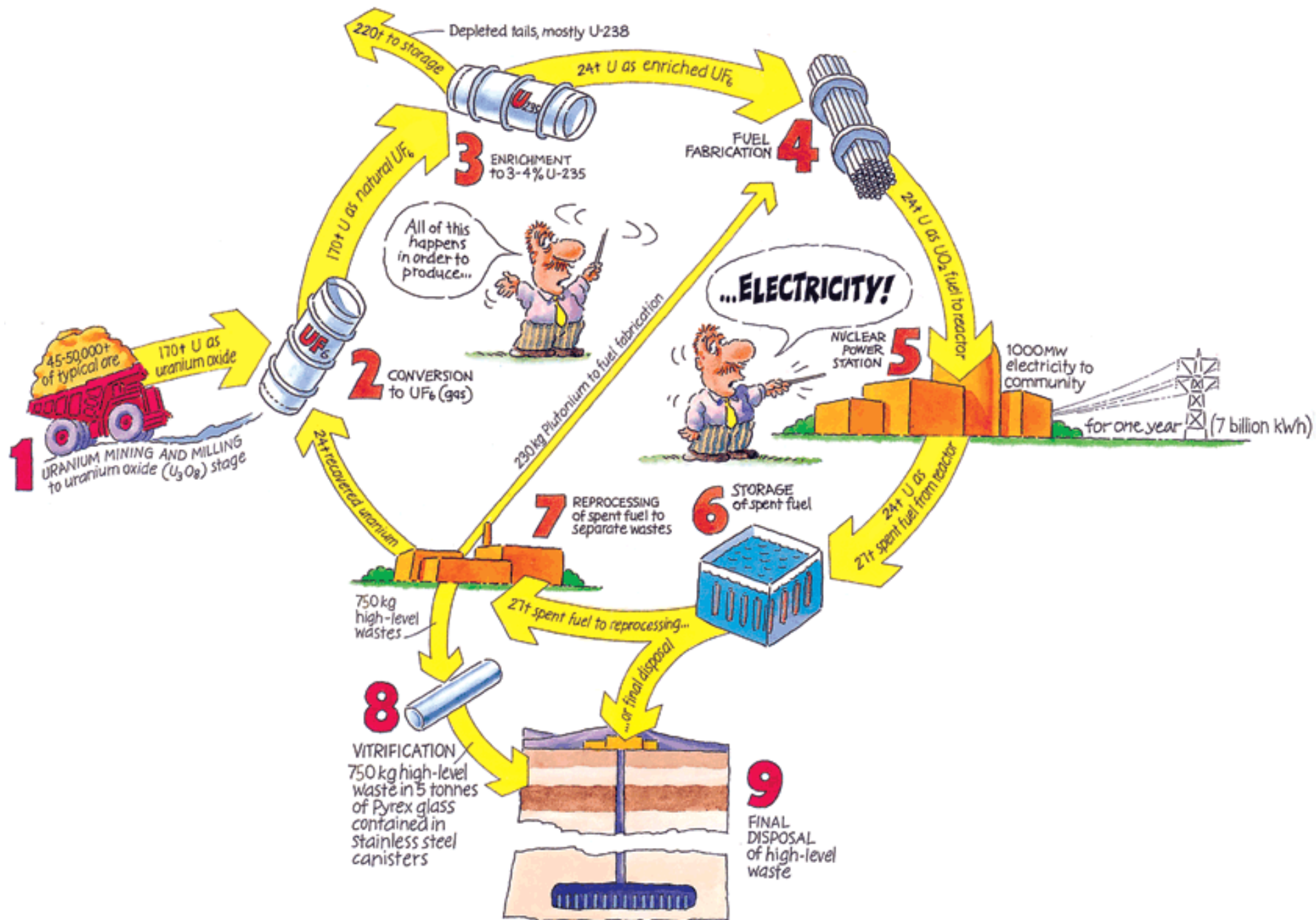
- Cause new fissions to occur
- Be absorbed to form unstable, radioactive nuclide

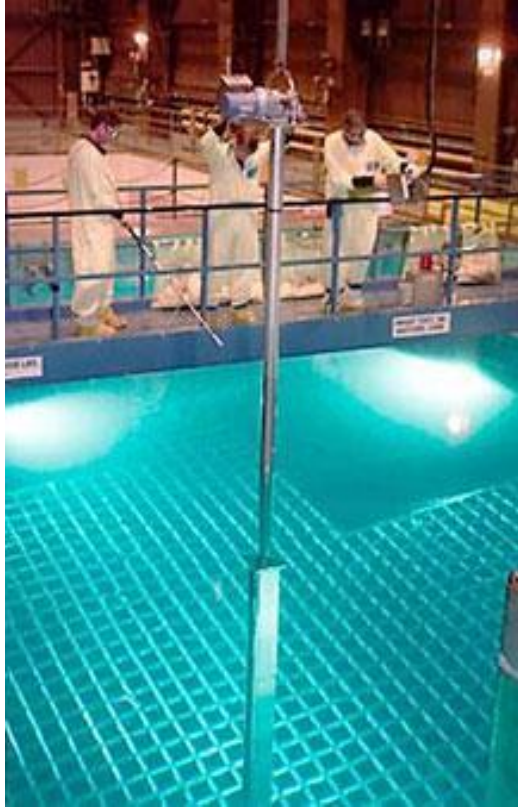


Fuel Consumption in the Reactor

- Fuel is in reactor for 4 – 6 years
- U consumed, fission products and transuranics (mostly Pu) produced

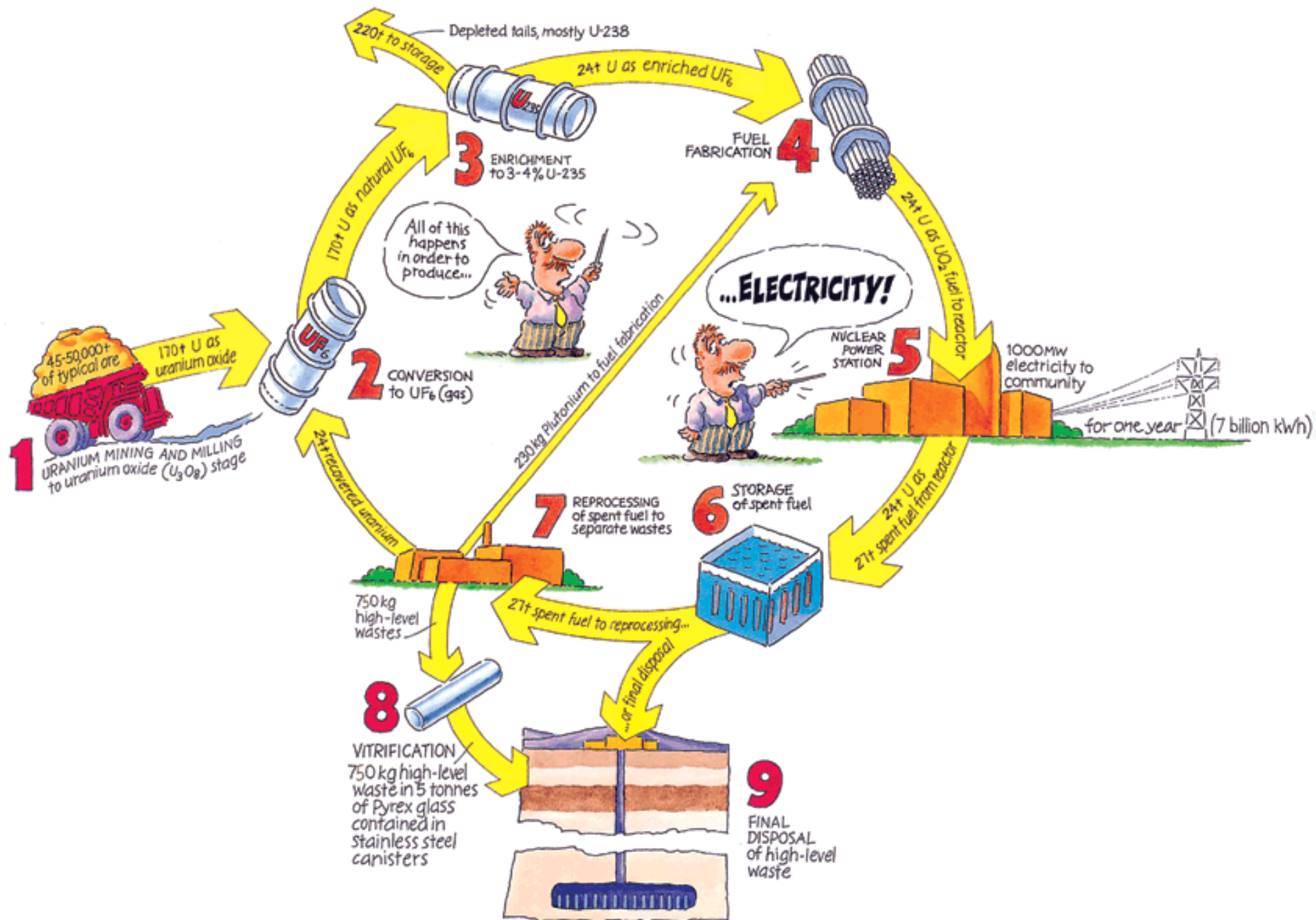




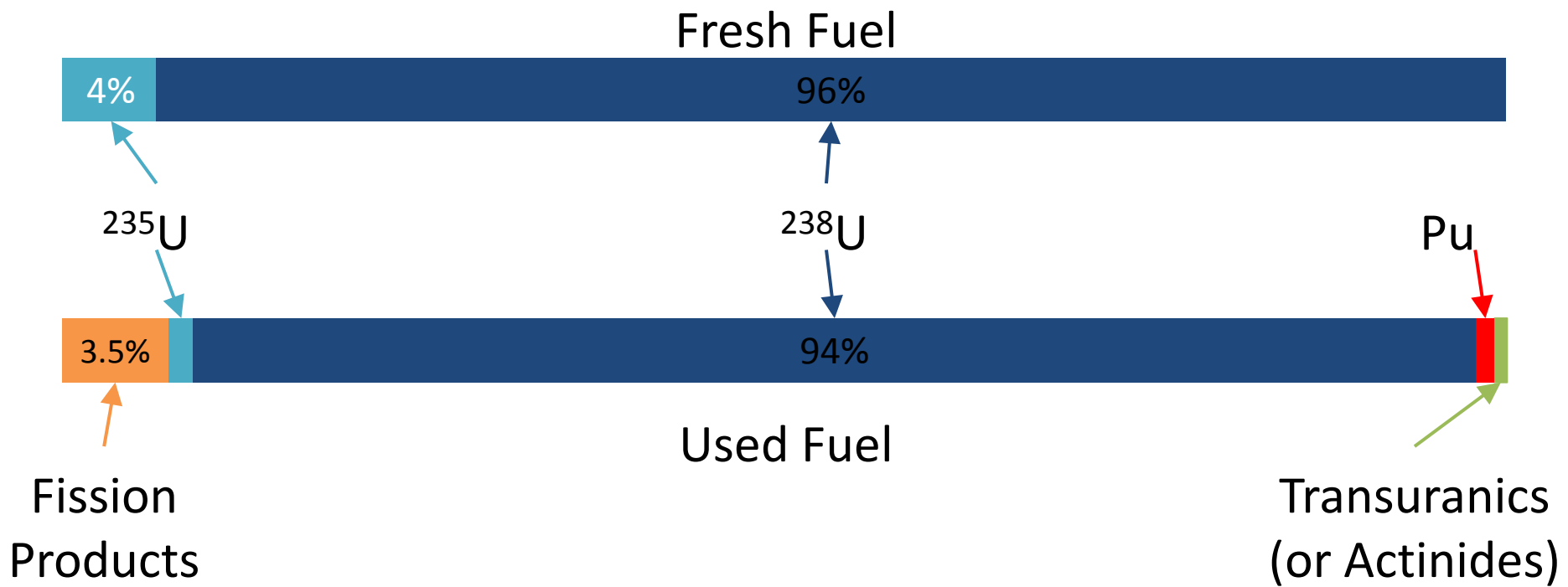


- Used fuel first stored in pool at least 5 years
 - Cooling and shielding
- Older fuel can move to dry casks
 - Air cools
 - Steel and concrete shields

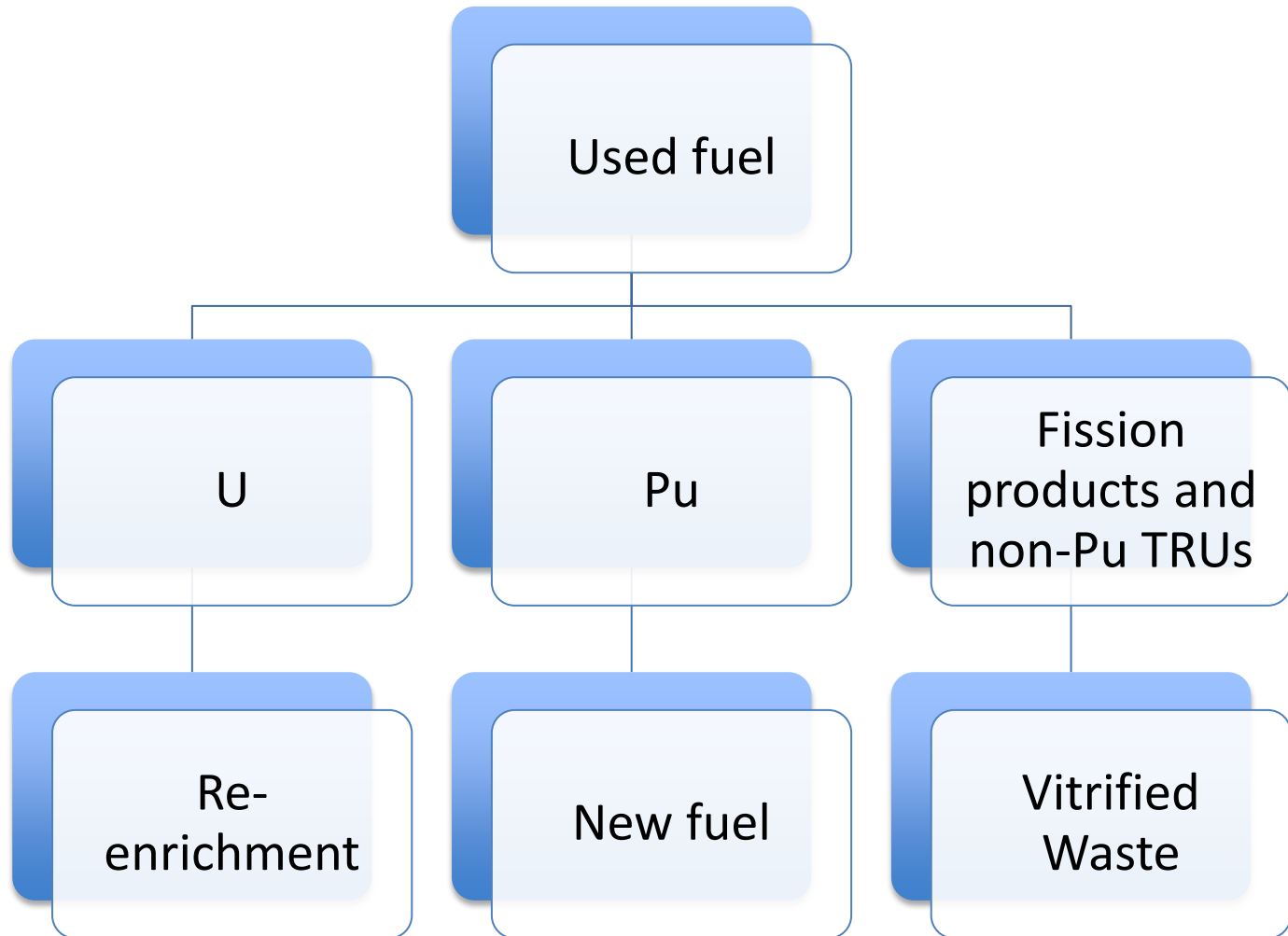


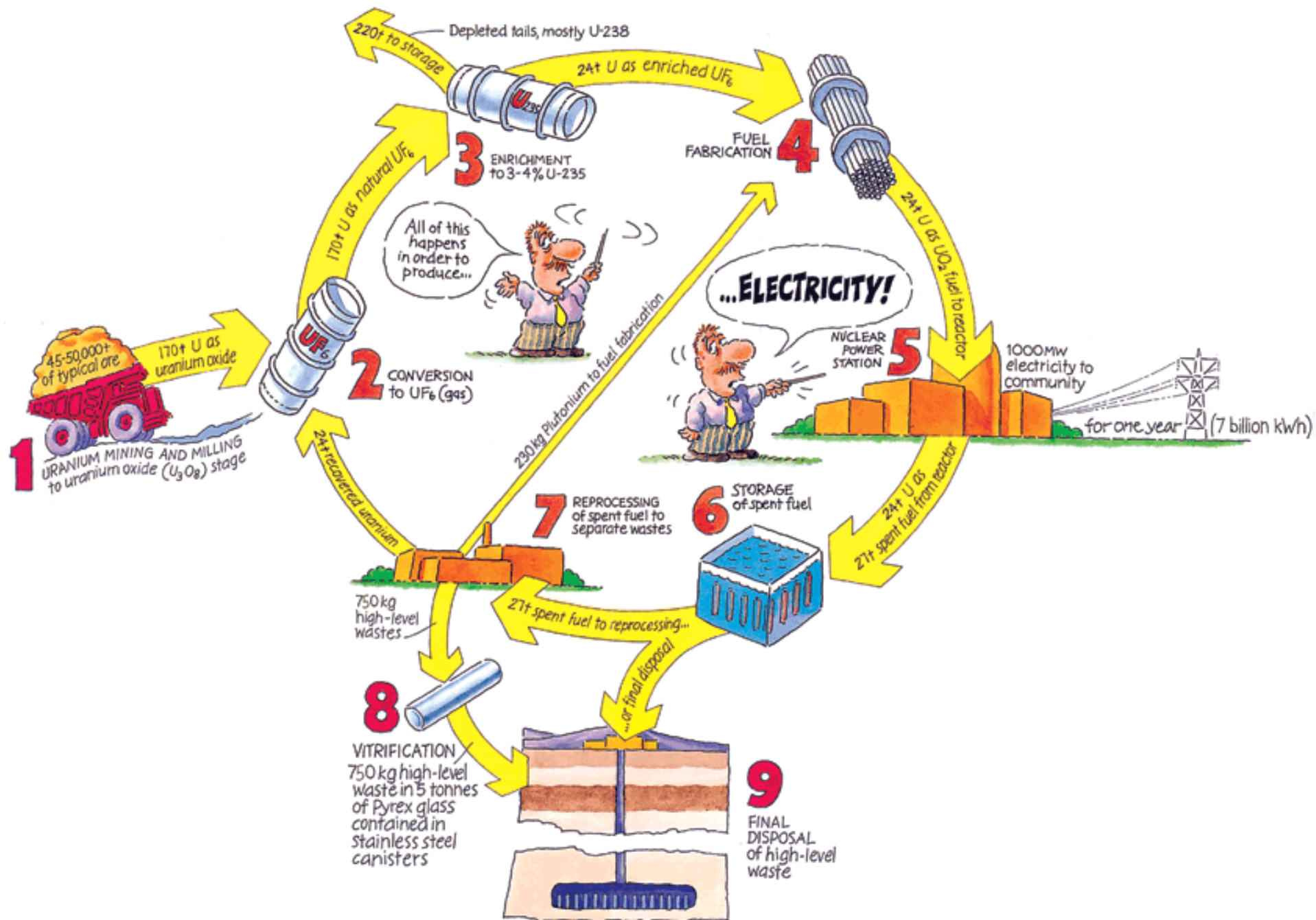


Fuel recycle/reprocessing



Fuel recycle/reprocessing





Geologic Repository

- The choice of countries worldwide
- U.S. has studied Yucca Mt., Nevada as potential location

