

Nuclear Power Past, Present, and Future

June 15, 2012

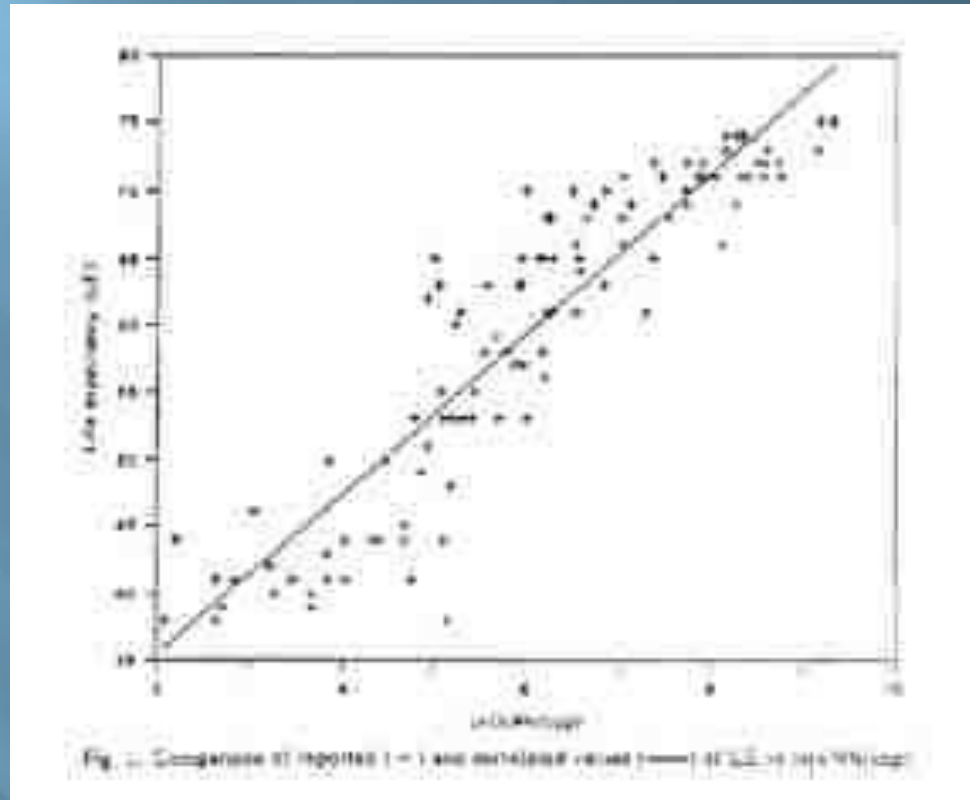
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Overview

- ▣ Importance of energy
- ▣ Role of nuclear energy
- ▣ Nuclear utility industry – US
 - Past
 - Present
- ▣ Nuclear power worldwide
- ▣ Policy issue
 - ▣ Nuclear Waste
- ▣ Future of nuclear power
- ▣ Other nuclear engineering careers

Note: all charts, diagrams, pictures, etc. from internet – various sources

Importance of Energy

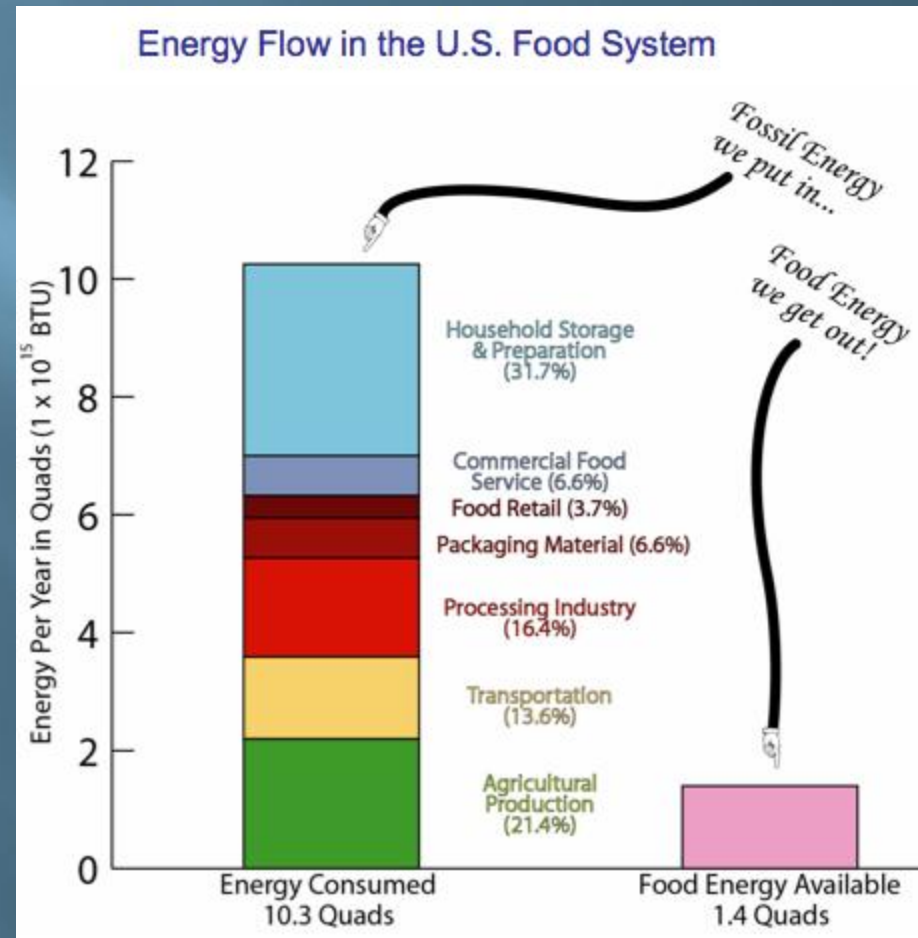


x-axis: per capita electricity consumption (for 112 countries)

y-axis: quality of life based on life expectancy, infant mortality, and literacy rates

Importance of Energy – examples

- ▣ Food
- ▣ Water
- ▣ Health Care
- ▣ Shelter
- ▣ Education
- ▣ Information
- ▣ Communication



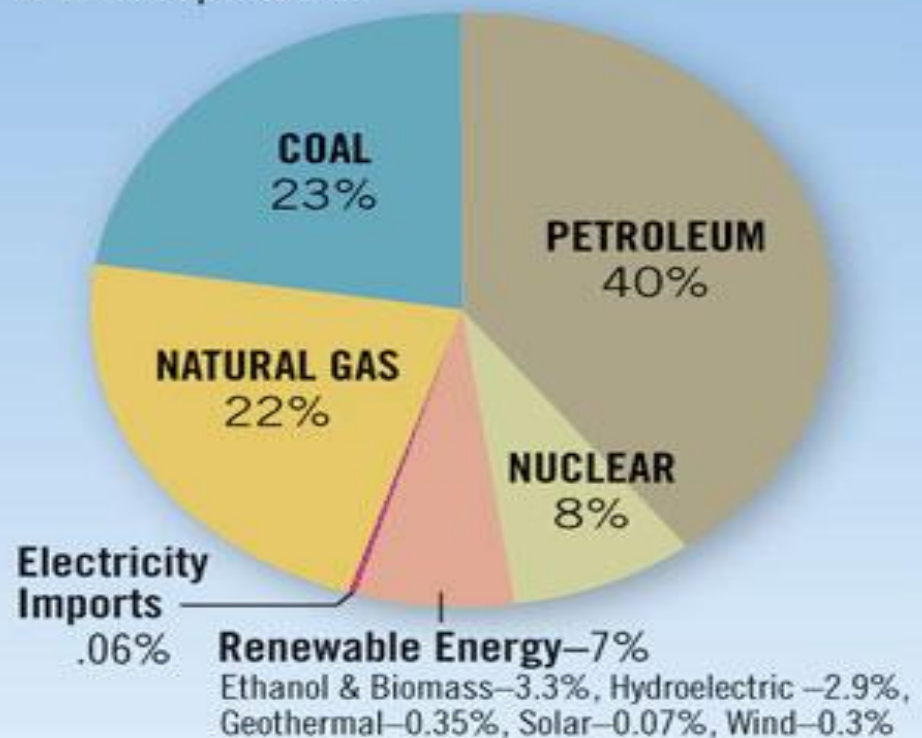
We Need a Lot of Energy

The world uses almost 400 quadrillion Btu of energy each year. This is roughly equivalent to using 180 million barrels of crude oil each day.

300 million people in the U.S. use almost 100 quadrillion Btu of energy each year -- about 25 percent of the world's consumption

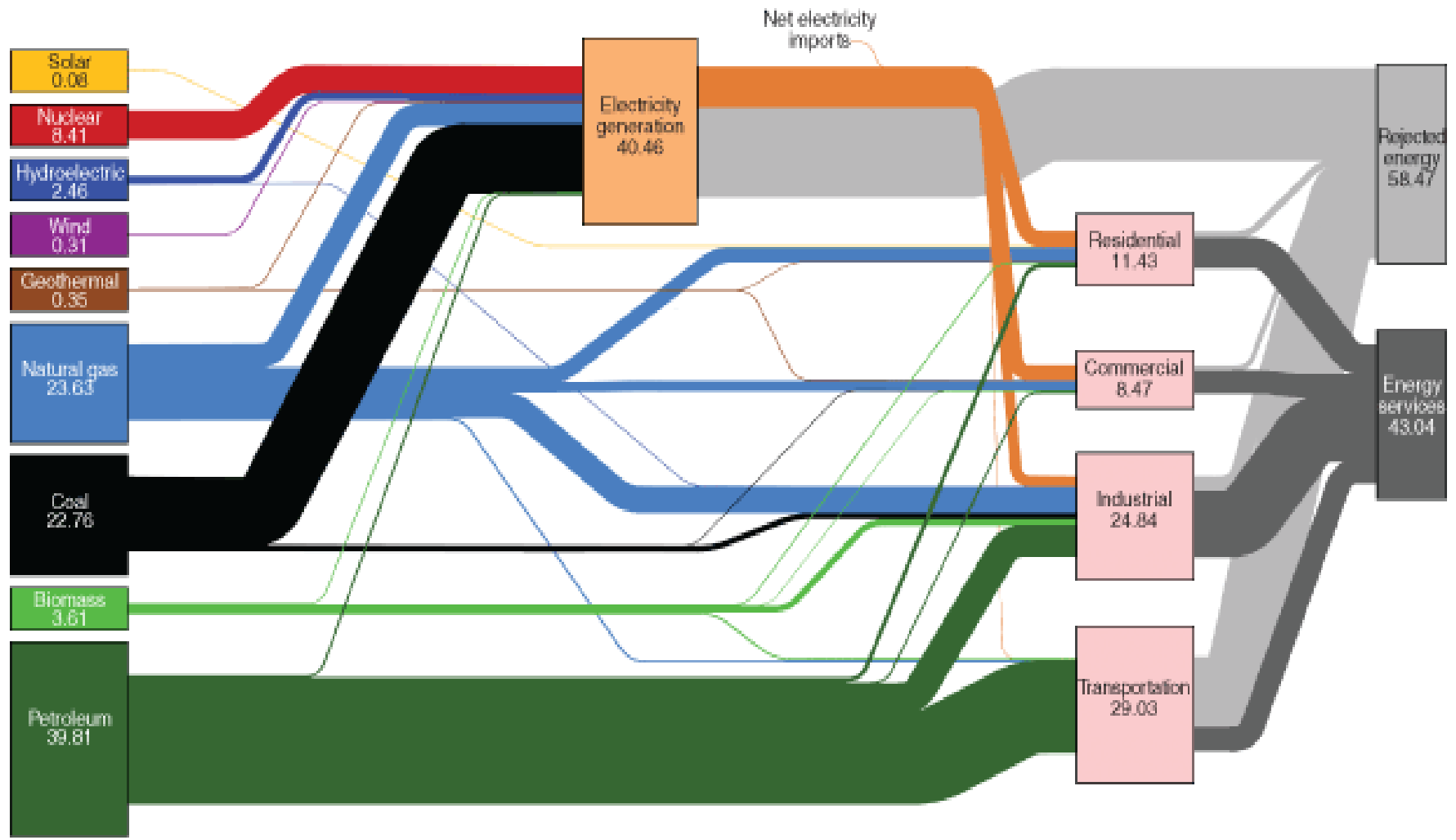
Consuming Energy

Total U.S. energy use, including electrical and transportation

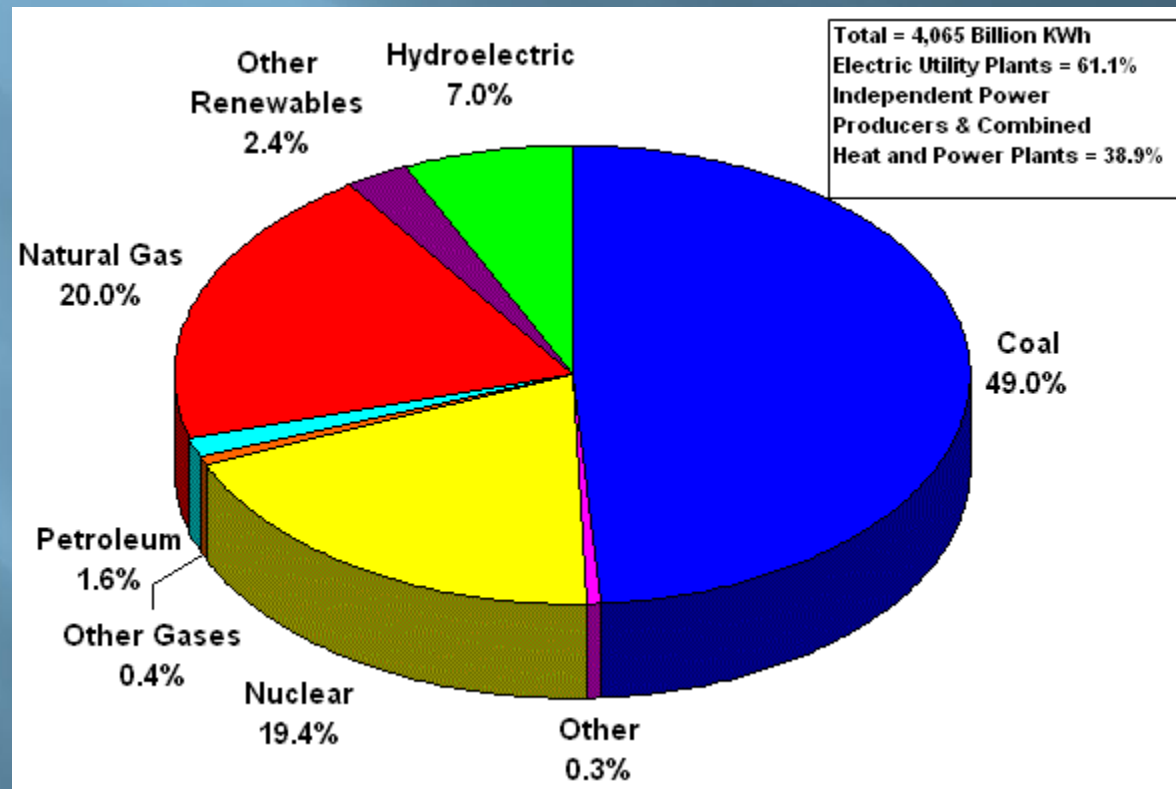


*Totals may not equal sum of components because of rounding
Source: U.S. Energy Information Administration

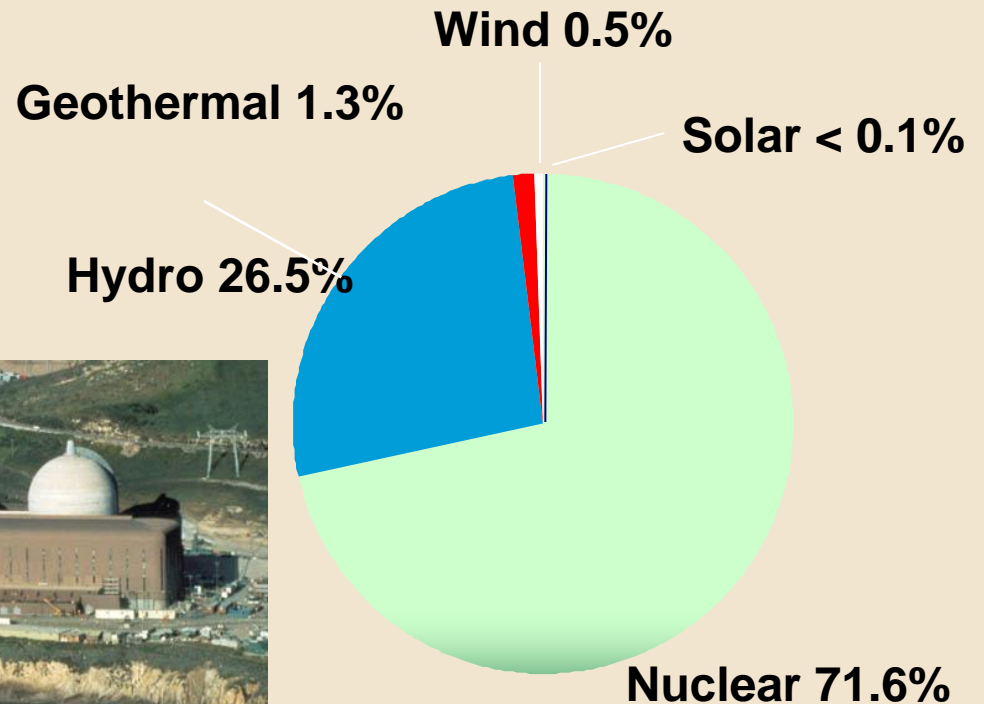
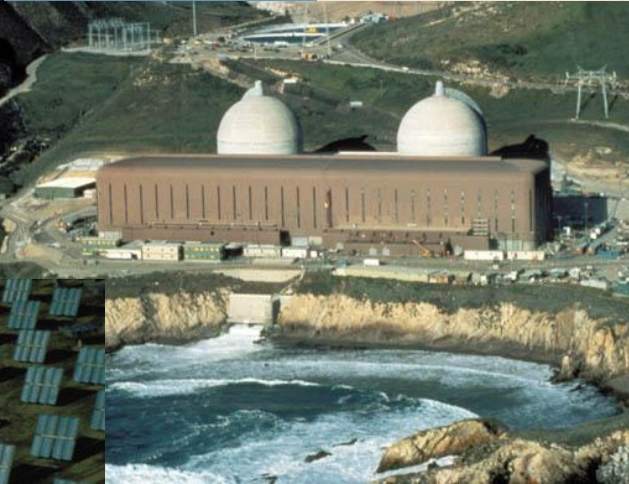
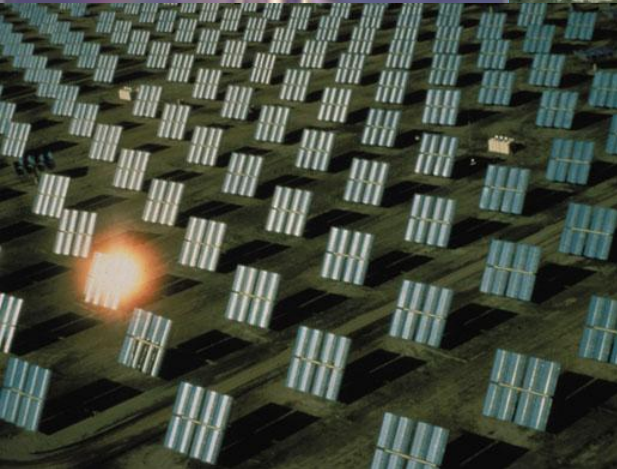
Energy Utilization - US



Role of Nuclear Energy in Electricity Generation in US



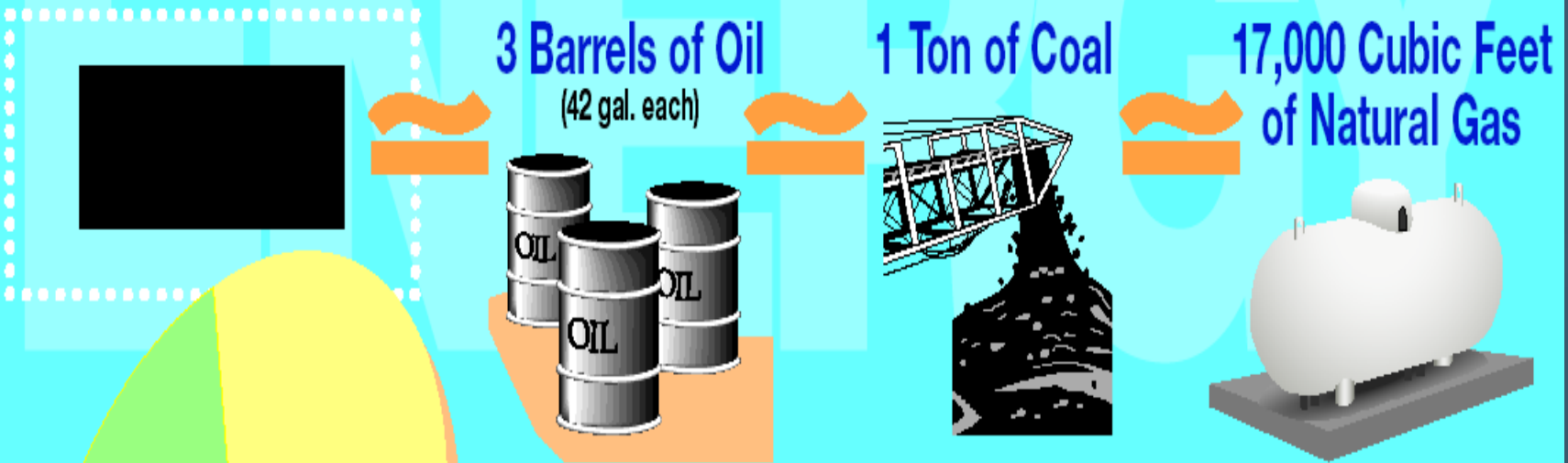
U.S. Sources of Low-Emission Generation



If We're Serious About Reducing Pollutants, Nuclear Is A Clear Choice – The Only Large Scale Solution

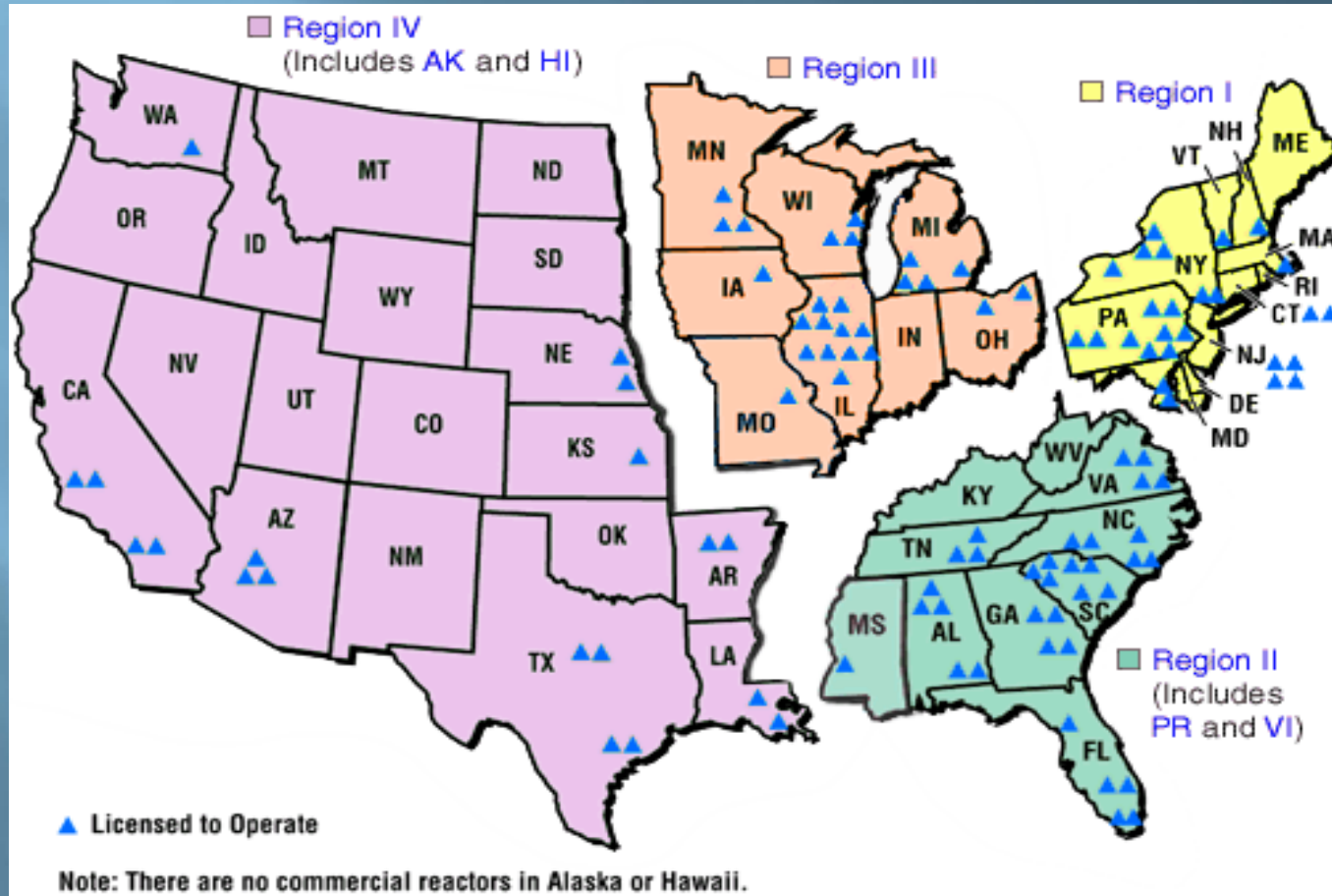
How much energy can nuclear fuel produce?

1 Uranium Fuel Pellet, without being reprocessed and recycled, has about as much energy available in today's light water reactor AS...
(simulated below)



US Nuclear Utility Industry

US Nuclear Industry - 104 plants

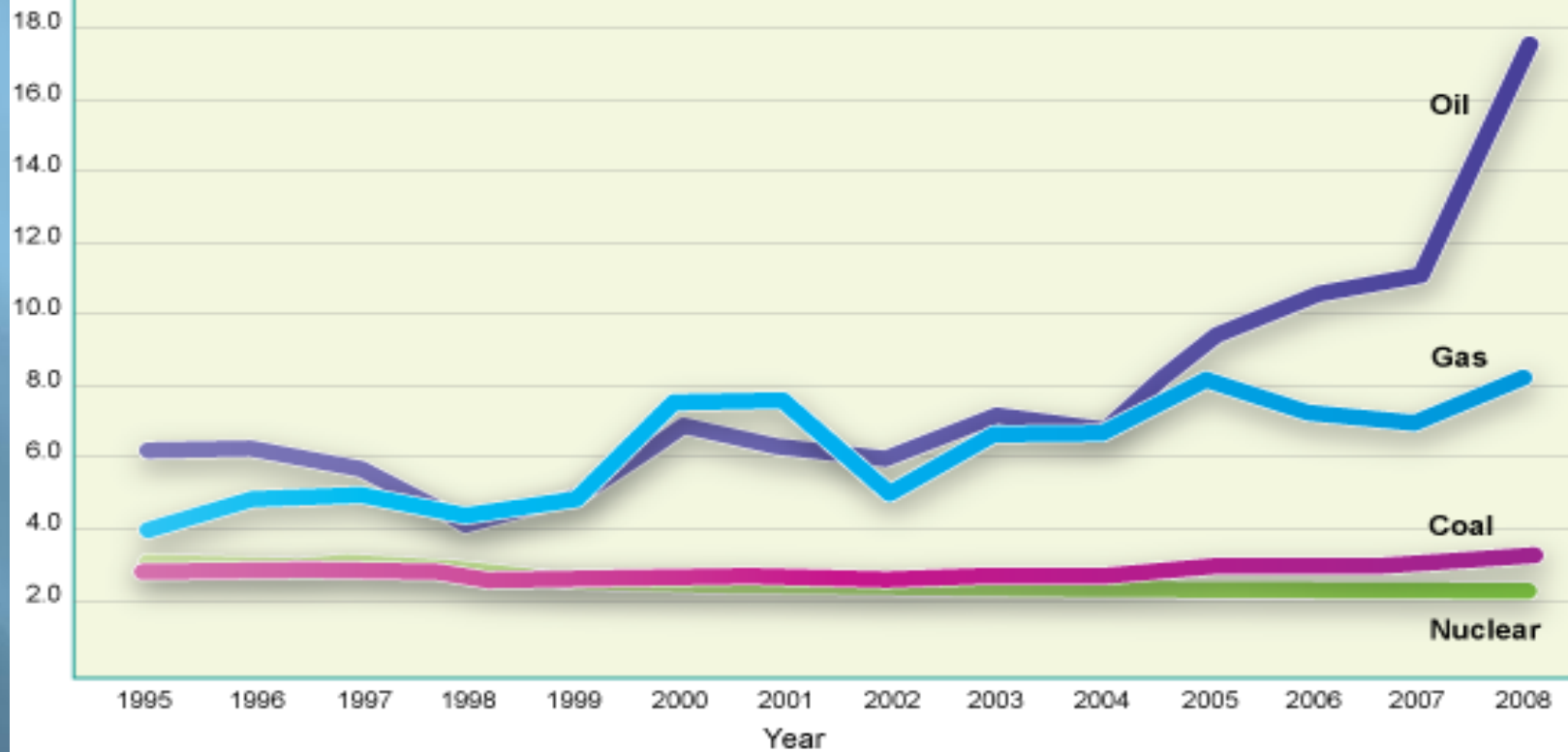


Some History

- ▣ 1957 first commercial nuclear plant
- ▣ 1978 last commercial plant licensed in 1900s
- ▣ 1979 Three Mile Island accident - 200 nuclear power plants canceled
- ▣ 1990s began closing plants
- ▣ 1998 last time a commercial plant was decommissioned (total of 19 closed)
- ▣ 2005 National Energy Policy Act – incentives to build new nuclear plants
- ▣ 2012 Four new nuclear power plants licensed

US Electricity Production Costs 1995-2008

in 2008 cents per kilowatt-hour



Production Costs = Operations & Maintenance + Fuel. Production costs do not include indirect costs or capital.

Source: Ventyx Velocity Suite, via NEI

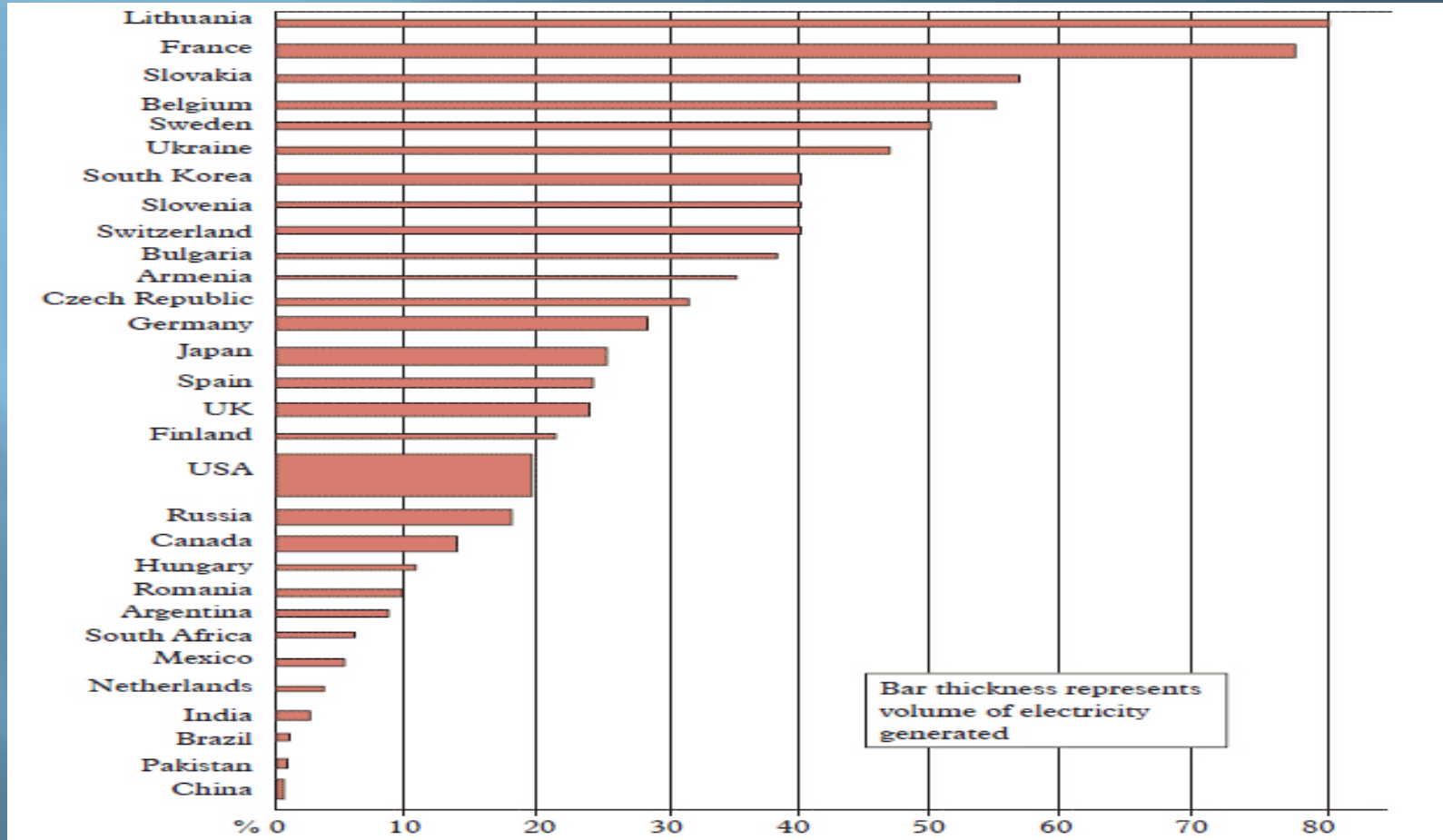
Nuclear Power Worldwide

Nuclear Power Worldwide

2011 International Atomic Energy Agency reports

- ▣ 433 nuclear power plants operating worldwide
- ▣ In 31 different countries
- ▣ Producing 17% of world's electricity

Percentage of Electricity from Nuclear

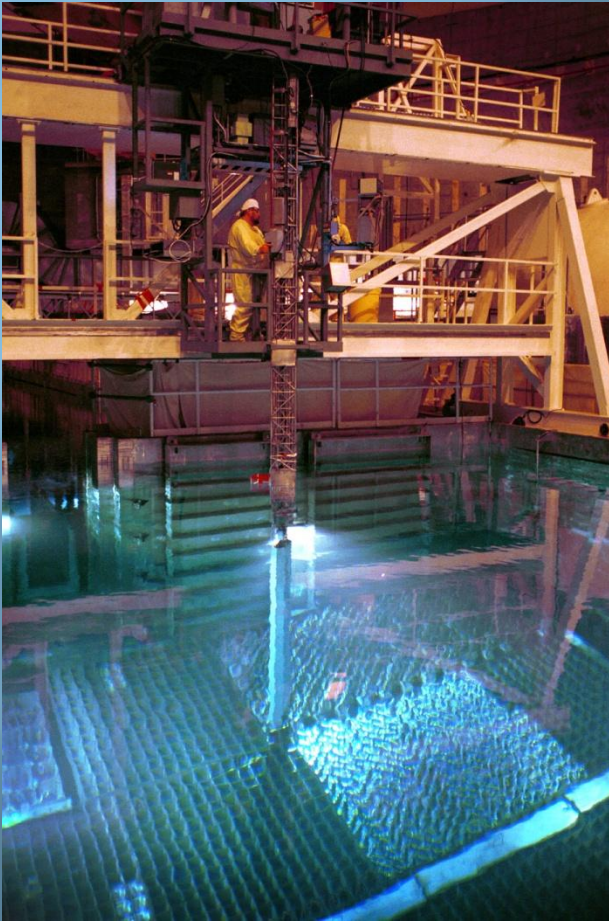


What to do with nuclear waste?

Options for Dealing with Used Fuel

- ▣ Store in spent fuel pools – until they fill up
- ▣ Store in dry storage casks at reactor site
- ▣ Store in dry storage casks away from reactor
- ▣ Bury used fuel assemblies
- ▣ Reprocess/recycle used fuel
& bury remaining waste (~5% of total)

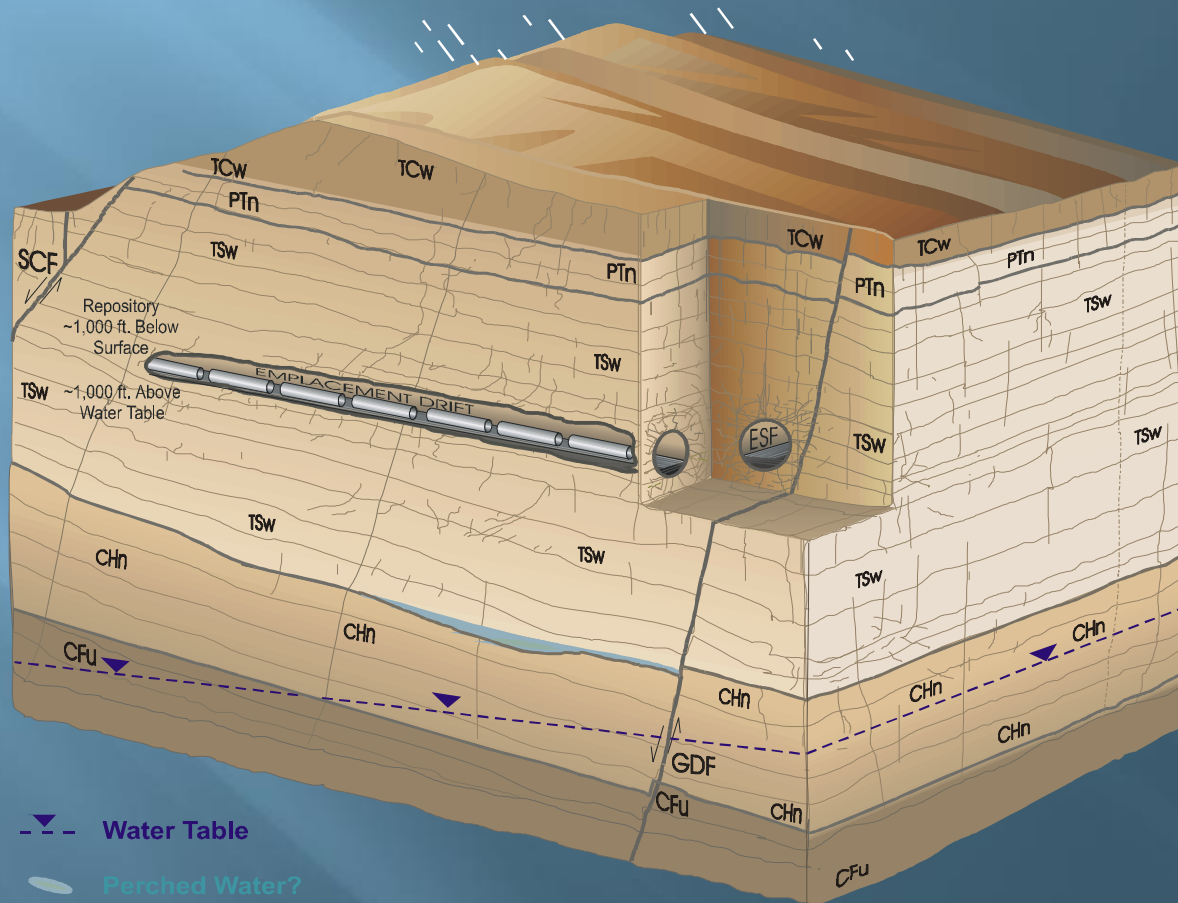
What to do with used fuel?



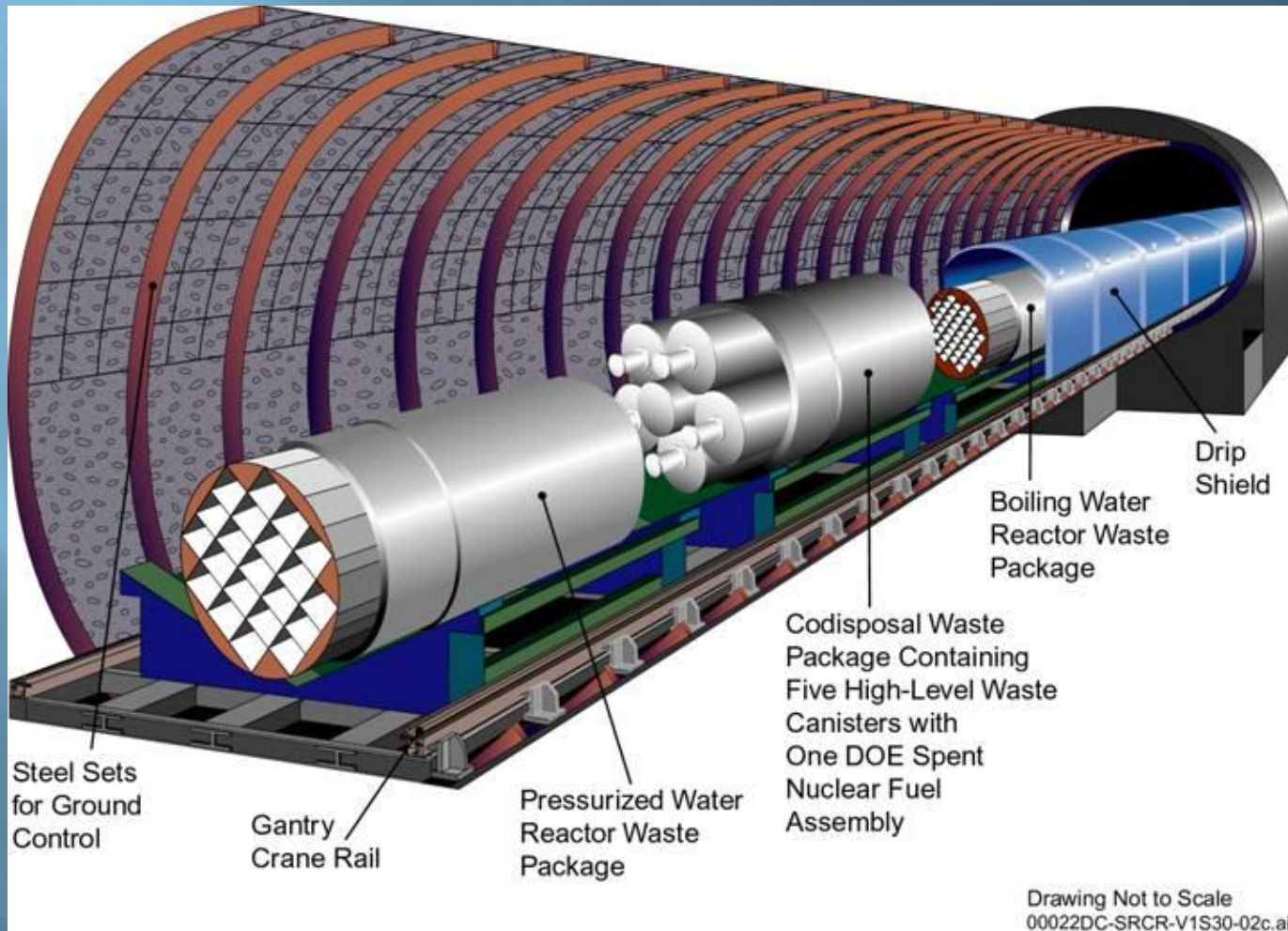
Yucca Mountain Project



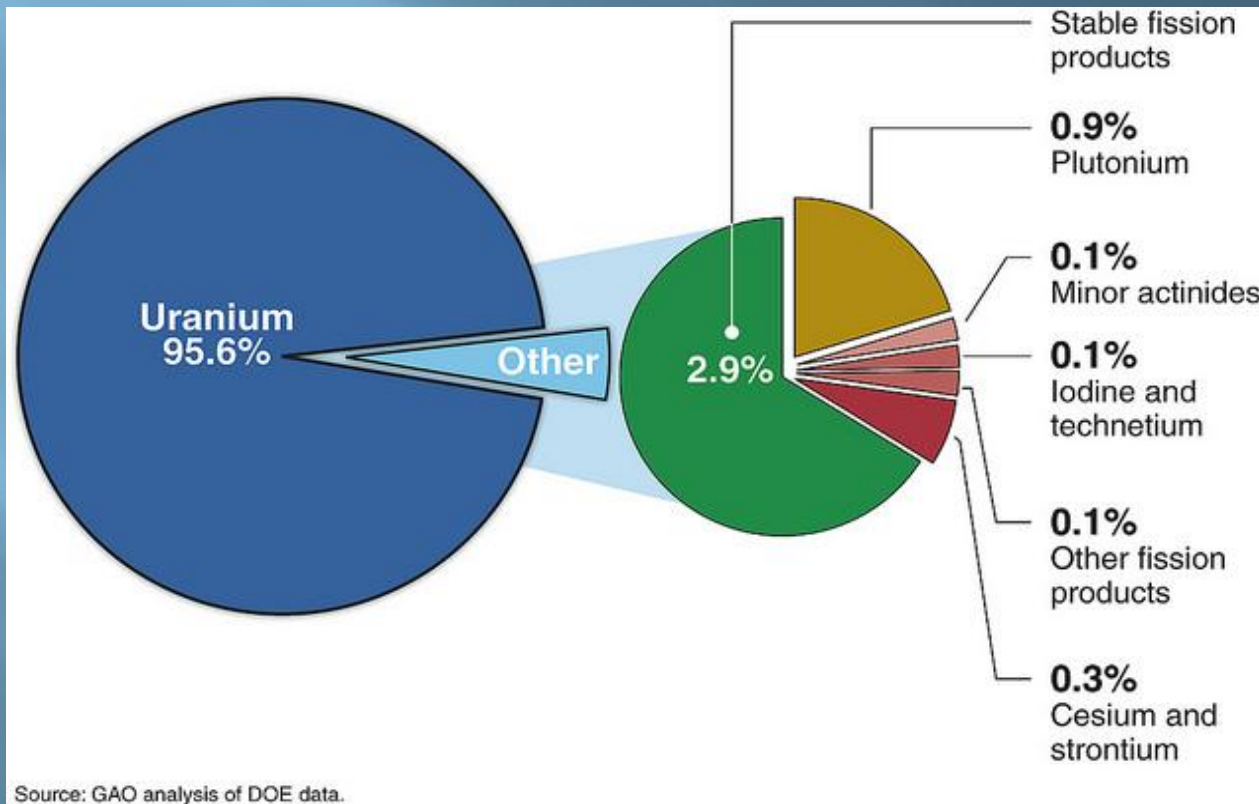
Cutaway of Yucca Mountain - Plans



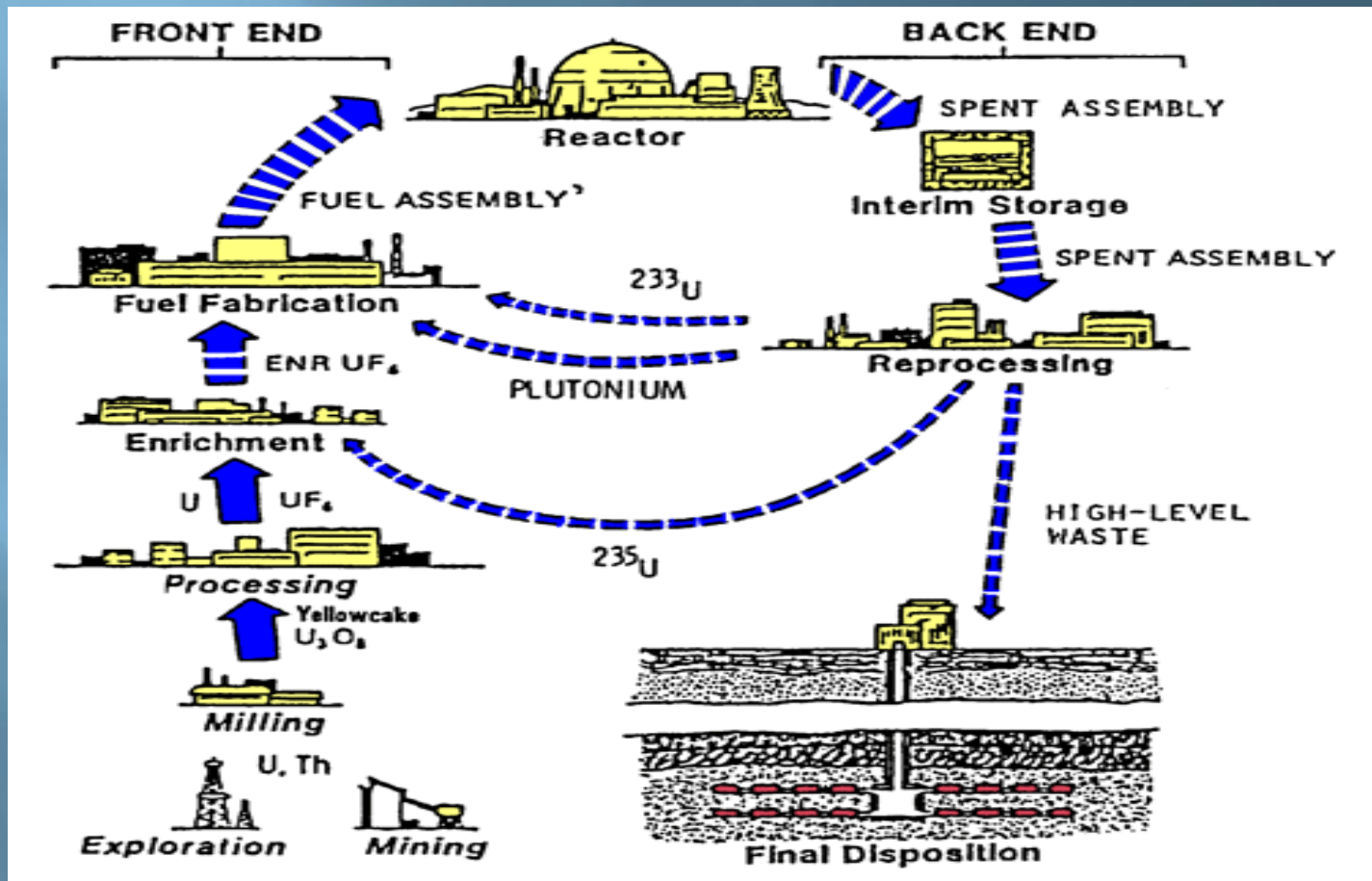
Casks Inside Yucca Mountain - Plans



Recycling Used Nuclear Fuel



Nuclear Fuel Cycle - with Reprocessing

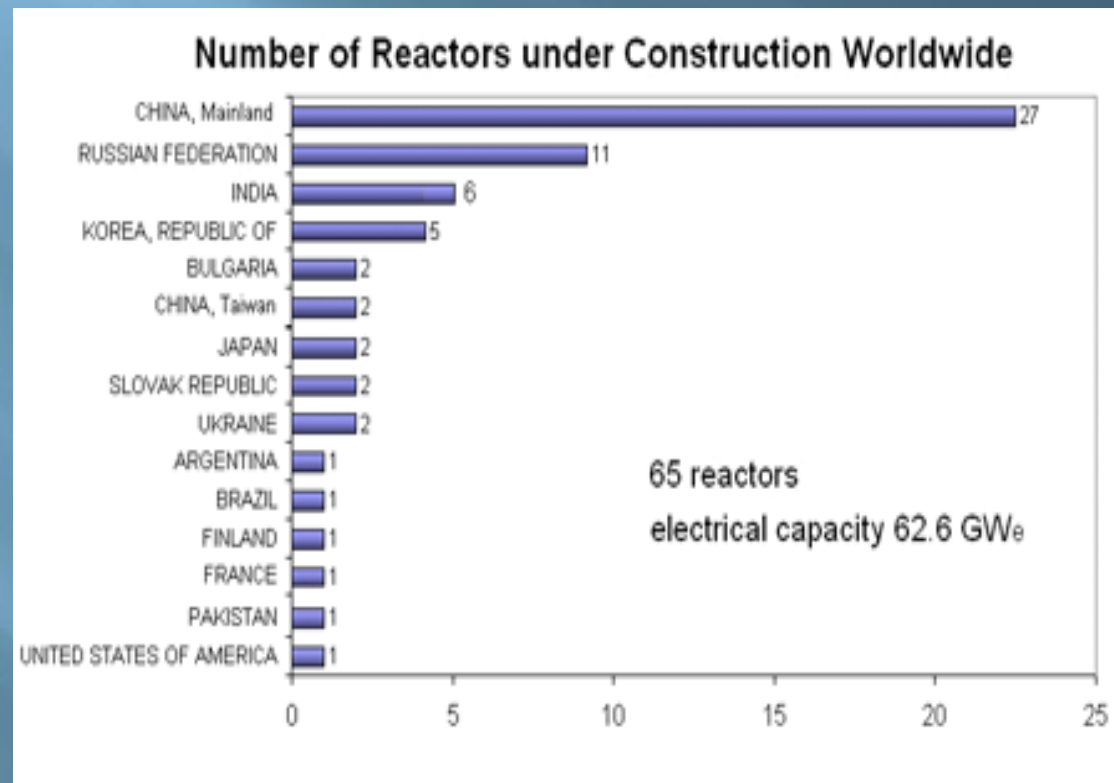


Future of Nuclear Power

In the United States

- ▣ License renewals (extend lifetime from 40 to 60 yrs)
 - 48 extensions granted
 - 12 extensions under review
 - 22 plants preparing to request extensions
 - 22 no decision yet
- ▣ License applications for 26 new plants
 - 4 new licenses approved

Worldwide Construction 2011



Emphasis on Small Reactors



- Easier manufacturing
- Less expensive
- “Right sized”
- Refueled infrequently
- Good for remote locations
- Electricity +

Other Nuclear Engineering Careers

- ▣ Nuclear power production
 - Utilities
 - Vendors/suppliers
 - Fusion research
- ▣ Nuclear power regulation
 - Nuclear Regulatory Commission (NRC)
 - International Atomic Energy Agency (IAEA)
- ▣ Energy research
 - National Laboratories
 - Large private corporations
 - Start-up corporations

More Nuclear Engineering Careers

- ▣ Engineering education
- ▣ Radiation protection
- ▣ Nuclear medicine
- ▣ Waste/resource management
- ▣ Homeland security
- ▣ Food, medical supply irradiation

Questions?