

Objectives:

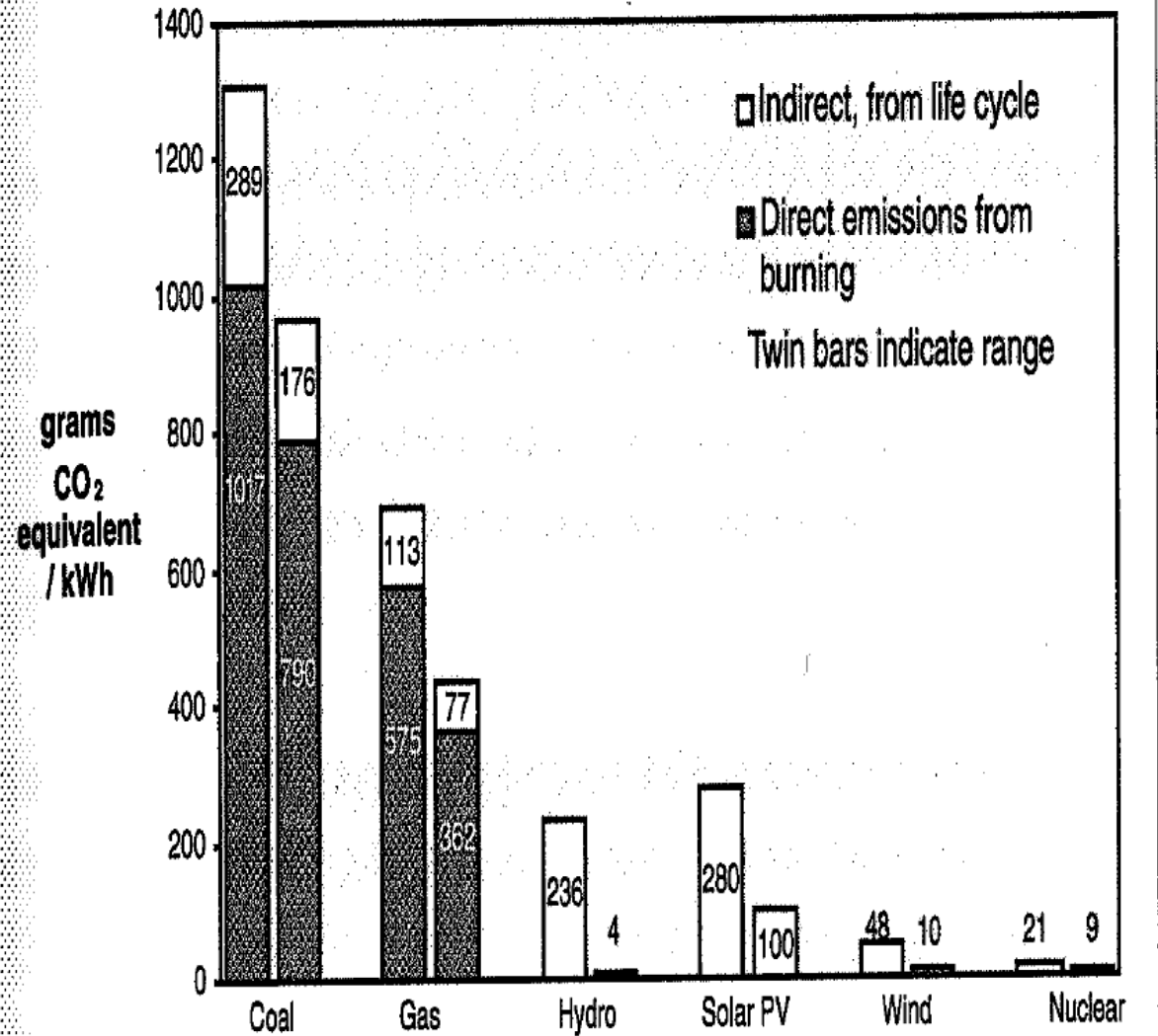
1. Presentations.
2. Short video on nuclear power.
3. Learn how to solve radioactive decay problems

Warm Up:

What is the China Syndrome?

1. U 235 .7% in ground but purified to 3%. 8.5 g = 1 ton coal or 4 barrels of oil.
2. Fuel rod – 100 rods of uranium pellets, 4 m long. Core = 100 tons of U.
3. Control rods- neutron absorber either made of Boron or Cadmium. Water to absorb heat.
4. Neutron slams into U235 – splits atom which releases a large amount of energy & releases 2 neutrons.
5. Pressurized water reactor. Water is 317C pressure 2200 psi, steam is released to turn the turbine.
6. Chernobyl- 1986; 32000 deaths , 62000 mi² contaminated. \$ 400 B Design & human error.
- B. Three mile Island 1979: Partial core meltdown in U.S. ? Reactor. = No deaths or
7. PIUS process inherent ultimate safety for a light water reactor system.
8. Breeder reactor – takes uranium & produces plutonium.
9. Disposal / land A. 1st large pool on site until the material has sufficiently decayed. B. Ocean disposal; Monitored retrieval storage: ex. Yucca mountain in Nevada.
10. Decommissioning: Costs 2 – 10% more money to dispose of properly.
11. Nuclear fusion – 4 H fuse together to create 1 He atom + a tremendous amount of energy.
12. Fukushima nuclear disaster, March 2011. 1st earthquake, then tsunami pushed debris and blocked any efforts.
13. Globally 13 to 14% electricity; U.S. approx. 20%; MD – 29%
14. France 78.8% Japan
15. Amount of waste comparison: Coal over 125,000 tons of ash, 198,000 tons of sludge. Nuclear is around 47,000 tons waste per year.

Greenhouse Gas Emissions from Electricity Production



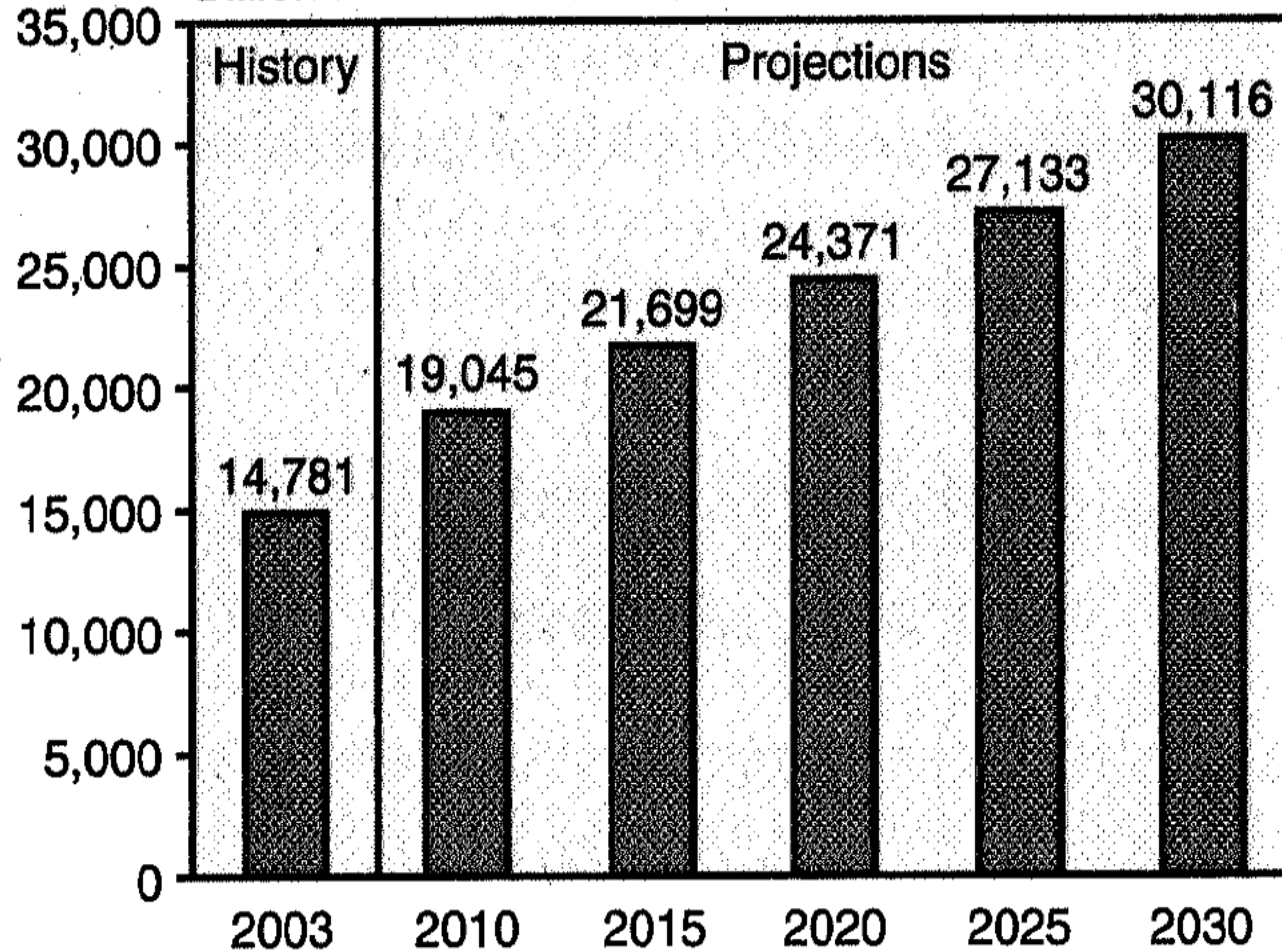


890 pounds



World Net Electricity Consumption, 2003–2030

Billion Kilowatt-hours



Sources: **2003:** Energy Information Administration (EIA), *International Energy Annual 2003* (May–July 2005), website www.eia.doe.gov/iea/. **Projections:** EIA, *System for the Analysis of Global Energy Markets* (2006).

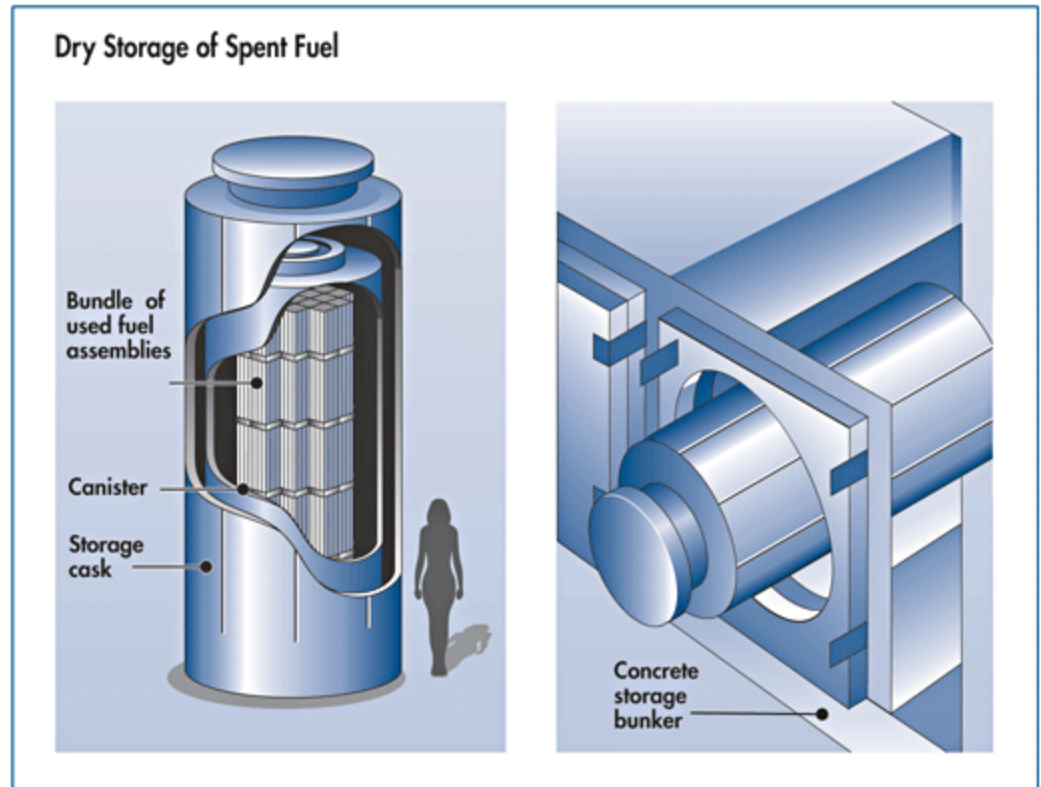
Objectives:

**SWBAT describe how a nuclear power plant creates electricity.
SWBAT solve a radioactive decay problem.**

Warm Up:

How is electricity created at most power plants?

Fuel that has been stored for at least five years in water has cooled sufficiently, and its radioactivity decreased enough, for it to be removed from the spent fuel pool and loaded into casks. This frees up additional space in the pool for storing spent fuel newly removed from the reactor.



Dry casks typically consist of a sealed metal cylinder containing the spent fuel enclosed within a metal or concrete outer shell. In some designs, casks are placed horizontally; in others, they are set vertically on a concrete pad. The NRC reviews and approves the designs for spent fuel dry storage systems. The NRC's regulations for review are developed through a public process and provide a sound basis for determining whether use of a proposed storage system will protect public health and safety and the environment.

Decay of Uranium:

Uranium 235 has a $\frac{1}{2}$ life of 710 million years. It was determined that a certain amount of stored U-235 will be considered safe only when its radioactivity has dropped to 0.10 percent (0.001) of the original level. Approximately how much time must U-235 be stored securely to be safe?

Each $\frac{1}{2}$ life decreases the radioactivity of that sample by $\frac{1}{2}$.

So the 1st 710 million years later there will be only 0.50 radioactive.

2nd 710 million years = 0.25, 3rd = 0.125, 4th = 0.0625,

5th = 0.03125, 6th = 0.0156, 7th = 0.0078, 8th = 0.0039, 9th = 0.00098,

Therefore: After 9 $\frac{1}{2}$ lives, each 710 million years long the Uranium will be safe.

$(7.10 \times 10^8) \times 9 = 7.1 \times 10^9$ Actually it is closer to 6.39×10^9

How urgent is the situation?

Fairly urgent. The NRC predicts that at the rate we're discarding rods—about 2,000 tons a year—we'll run out of existing storage space by 2015.....

Radioactive fuel rods: The silent threat – *The Week, 9 April 11, Japan's nuclear crisis has highlighted the danger of the spent fuel rods piling up outside America's nuclear plants*

What are fuel rods?

They're the source of the fission reaction that makes nuclear plants work. Fuel rods are long metal tubes filled with uranium that's been formed into pellets. When these rods are placed inside the reactor, nuclear fission occurs, generating heat. That in turn boils water and creates steam, which powers turbines and produces electricity. When the uranium fuel is used up, usually after about 18 months, the spent rods are generally moved to deep pools of circulating water to cool down for about 10 years, though they remain dangerously radioactive for about 10,000 years.

How do the Japanese store their spent fuel rods?

The same way we do in the U.S. When the earthquake and tsunami knocked out the cooling systems at the multiple nuclear reactors at the Fukushima Daiichi plant, it wasn't just the reactors that were affected. Several spent-fuel-rod pools also lost electric power, shutting down pumps. Water in the cooling pools stopped circulating and began to boil off or leak out. As the water level fell, the spent fuel rods were exposed, and their temperatures soared. Several began to melt down, releasing extremely high levels of radiation into the air.

Could that happen in the U.S.?

It's within the realm of possibility. The U.S. has 104 operating nuclear plants, and most store all the spent fuel rods they've ever used right on-site. All told, there are 71,900 tons of spent fuel rods at U.S. nuke plants—the vast majority of them sitting in pools that today are mostly full, according to a recent state-by-state tally by the Associated Press. “The spent-fuel pools are currently holding, on the average, four times more than their designs intended,” said Robert Alvarez, of the Institute for Policy Studies. U.S. officials insist they have stricter safety standards for the pools than Japan does. But former Nuclear Regulatory Commission member Peter Bradford said, “The phrase ‘it can't happen here’ is an invitation to disaster.”

Is there a threat of terrorism?

There's little doubt of that. The National Academy of Sciences warned Congress in 2006 that if terrorists flew a plane into the pools, or bombed the pools after crashing through a plant's security perimeter, they could expose the fuel rods, causing “the release of large quantities of radioactive materials to the environment.” David Lochbaum, head of the nuclear-safety program for the Union of Concerned Scientists, told a congressional hearing last week that while nuclear fuel inside reactors is protected by multiple thick layers of metal and concrete shielding, spent-fuel pools are typically covered with sheet-metal roofs, “like that in a Sears storage shed.” Pete Stockton, a former security expert with the Department of Energy, warns that if fuel rods were exposed and melted down near a populated area, the resulting radiation would force a massive evacuation. The Indian Point plant 35 miles north of Manhattan, for example, could “take out New York City,” Stockton said.

How urgent is the situation?

Fairly urgent. The NRC predicts that at the rate we're discarding rods—about 2,000 tons a year—we'll run out of existing storage space by 2015.....