

The Basics of Nuclear Power

Nuclear reactions are complex, but greatly simplified here is how a nuclear power plant works: some forms of uranium are unstable—the uranium atoms split apart. When they do, a tiny, tiny bit of their weight is converted from matter into energy. A tiny bit of matter creates a huge amount of energy: if one gram (about the weight of a dollar bill) were completely converted to energy, it would release slightly more energy than does burning 2,000 metric tons of oil. This is also the same amount of energy that was released by the Hiroshima bomb during WW-II.ⁱ

When they split, uranium atoms release subatomic particles that crash into other atoms, causing them to split. If you pack enough uranium close together, the splitting atoms release particles that crash into other atoms, causing them to split, releasing particles that crash into other atoms, etc. Each uranium atom releases energy when it splits. The process gathers steam in what is called a chain reaction. If it gathers too much steam, the chain reaction runs away, and this is what happens in a nuclear bomb. In a nuclear power plant, the chain reaction is controlled. It runs fast enough to sustain itself and create a lot of heat, but slow enough so that it doesn't explode. The heat from the chain reaction is used to boil water into steam, which then drives turbines just like in a coal fired plant. But the uranium is not on fire, the heat is created by the splitting of uranium atoms.

While the theory that lies behind nuclear power was invented early in the 20th Century,ⁱⁱ it was not used practically until WW-II, when the nuclear bomb was invented. The first nuclear reactor was built to power a submarine in 1954, and the first commercial reactor was built in 1957. In 2005, some 439 reactors were operating in 30 nations, about half in the U.S. France and Lithuania get 78% of their electricity from nuclear reactors, while the U.S. gets about 20%.^{iv} Sixty reactors are planned or in construction around the world; in the U.S., a new nuclear power plant has not been constructed in some 30 years (although that may soon change).ⁱⁱⁱ Almost 100% of the world's nuclear energy is used to generate electricity.

Radioactive substances can be deadly, often in very small amounts. Once the health effects of the Hiroshima bomb and the atmospheric testing of nuclear devices in Nevada and the U.S.S.R. became known, the public became frightened by things nuclear. The Three-Mile Island incident (1979) and the Chernobyl disaster (1986) made the public in the U.S. leery about the safety of nuclear power plants.^{iv}

Perhaps the largest challenge facing nuclear reactors is radioactive waste. A typical large reactor creates about 30 tons of waste per year that is thermally hot, highly radioactive, and extremely toxic.^{iv} In addition, parts of the reactor facility become radioactive over the life of the plant; they eventually reach the end of their useful life and must then be disposed of safely.^v What to do with this waste has been extraordinarily controversial, and a viable national policy has not yet emerged.

The promise of nuclear power is virtually unlimited energy, but serious problems make it unclear whether it will fulfill that promise or prove to be a toxic dead-end.

ⁱ For more interesting comparisons, see the Wikipedia article *Mass-energy equivalence*, http://en.wikipedia.org/wiki/Mass-energy_equivalence.

ⁱⁱ Relativity. (2007). In *Encyclopædia Britannica*. Retrieved November 26, 2007, from Encyclopædia Britannica Online: <http://www.britannica.com/eb/article-9109465>.

ⁱⁱⁱ Data from the WNA Database, Uranium Information Center, Australian Uranium Association, <http://www.uic.com.au>. However, the first new nuclear power plant in 30 years is close to being licensed to begin construction near Richmond, VA. See Flores, Chris. (11/21/2007). Feds approve site for nuclear reactor. *The Daily Press*. Viewed online 11/26/2007 at http://www.dailypress.com/business/dp-biz_dominion_1121nov21,0,2713545.story.

^{iv} Nersesian, Roy. (2007) *Energy for the 21st Century*. Armonk, NY: M.E. Sharpe.

^v *Decommissioning nuclear facilities: Nuclear issues briefing paper 13*. Uranium Information Center, Australian Uranium Association, retrieved 11/26/2007, <http://www.uic.com.au/nip13.htm>.