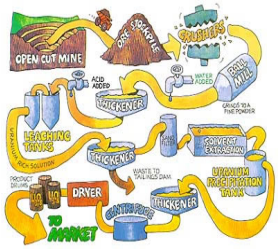
Uranium Mining and Milling

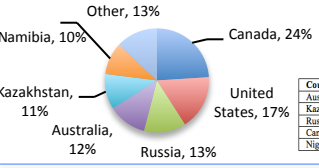
- Uranium can be mined from open pit, underground and in situ mines.
- Uranium is extracted from crushed rocks and mixed with sulfuric acid and other chemicals where it is dried into yellowcake, U_3O_8 , and sold as nuclear fuel.

United States

Year	U_3O_8 Production (lb.)
2009	3,708,358
2010	4,228,192
2011	3,990,767
2012	4,145,647
2013	4,807,709



U.S Uranium Purchased

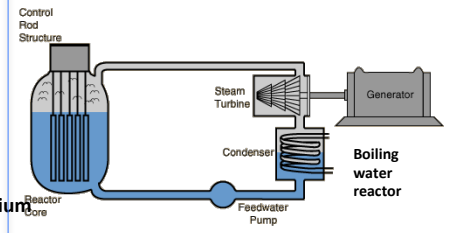


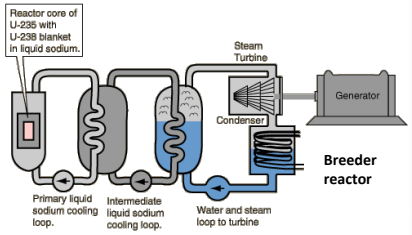
Known Recoverable Amount of Uranium

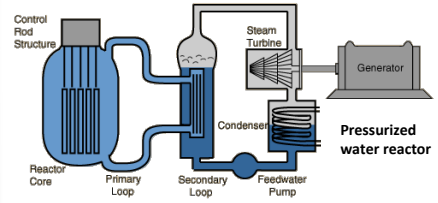
Country	Tonnes U	% Of World	Country	Tonnes U	% Of World
Australia	1,661,000	31%	South Africa	279,100	5%
Kazakhstan	629,000	12%	Brazil	276,000	5%
Russia	487,200	9%	Namibia	261,000	5%
Canada	468,700	9%	USA	207,400	4%
Niger	421,000	8%	Rest of world	608,400	12%

Nuclear Reactors

- Boiling water reactor - Water is used as moderator, coolant and steam source.
- Pressurized water reactor - Water used in the core is isolated from the turbine.
- Breeder reactor - The uranium used to create heat for the turbine produces plutonium, which is reused as fuel.

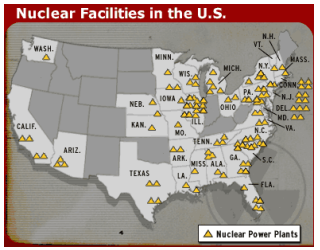




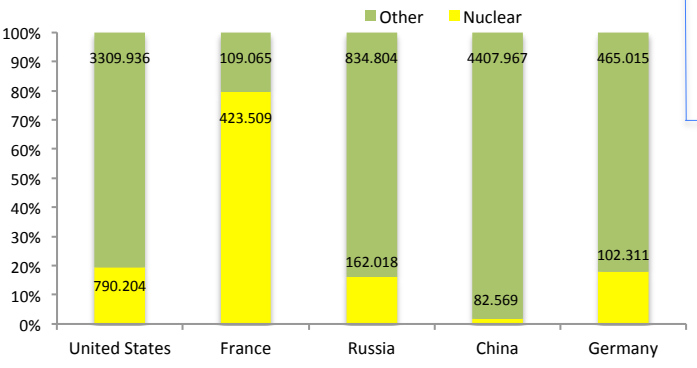


U.S Nuclear Statistics

- 100 nuclear facilities, most by any country
- 35 boiling water reactors, 65 pressurized water reactors
- Largest plant produces 3,937 MW
- 5 New plants under construction
- Generates power at 86% capacity factor
- 1,000 MW plant at 90% capacity can produce 7.9 billion KWh, enough to supply 690,000 households in a year, using 20 metric tons of uranium.



% Nuclear Generation to Total Production(Billion KWH)



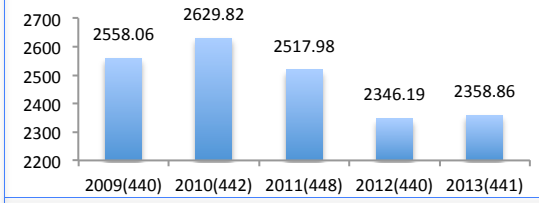
How Nuclear Reactors Work

- Uranium fuel consists of small, hard ceramic pellets that are packaged into long, vertical tubes.
- Enriched uranium gives off energy through nuclear fission by splitting of atoms of uranium in a nuclear reactor.
- The heat produced from fission heats water, which creates steam and is pushed through a turbine, charging a generator.
- Nuclear power plants do not emit carbon dioxide, sulfur dioxide, or nitrogen oxides as part of the power generation process.

World Statistics

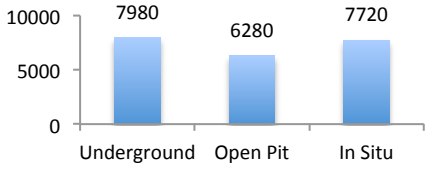
- 435 nuclear facilities in the world
- 30 countries operate nuclear reactors
- Total electrical capacity: 372,751 MW

yr.(# of reactors with data) **World Electricity supplied (TWh)**

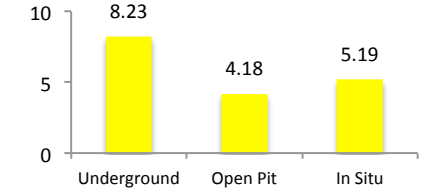


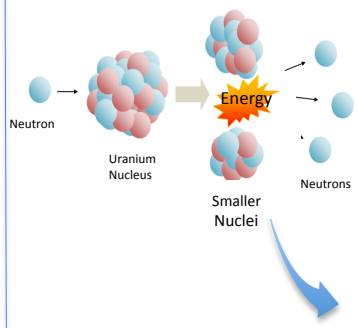
U.S Uranium Reserves

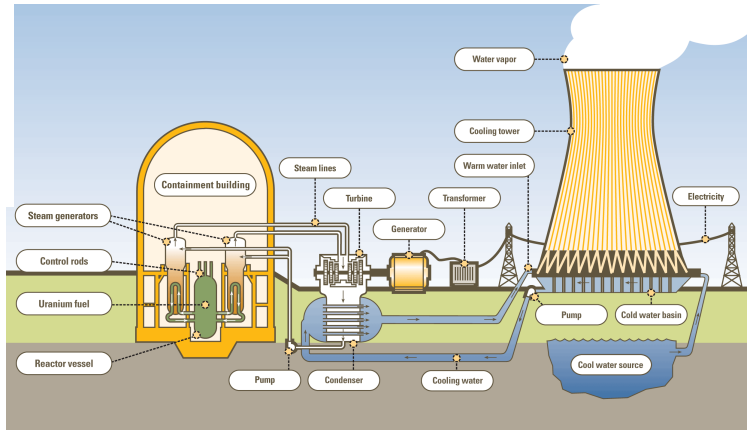
Uranium Ore (million pounds)



Yellowcake(million pounds)







Safety and Costs

- Fossil fuel emissions are associated with the uranium mining, uranium enrichment and transportation.
- One uranium pellet is equivalent to 1 short ton of coal or 17,000 ft^3 of natural gas, which can power the average U.S home for two months.
- Production of energy is ¢2.4 per kWh.
- Nuclear energy prevented 569.7 million metric tons of CO_2 and 1 million short tons of SO_2 emissions.
- Spent fuel is stored at nuclear plants in large steel canisters.
- Nuclear plants discharge heavy metals and salts into water source.
- Waste generated from uranium mining operations and rainwater runoff can contaminate groundwater and surface water.

Uranium Mining and milling

New Mexico Bureau of Geology and Mineral Resources
http://geoinfo.nmt.edu/resources/uranium/mining.html

World Nuclear Association
http://www.world-nuclear.org/info/nuclear-fuel-cycle/mining-of-uranium/uranium-mining-overview/

Clockwise from top left:

1. Chart data from U.S Energy Information Association (EIA) Domestic Uranium Production Report (2013 Data is predicted)
2. Picture from World Nuclear Association
3. Chart data from World Nuclear Association Supply of Uranium (As of 2011)
4. Chart data from EIA Today in Energy (Data from 2012)

% Nuclear Generation

Data from:
Energy Information Association
http://www.eia.gov

Data from 2011 electricity generation

Uranium Reserves

Data from:
Energy Information Association
http://www.eia.gov/uranium/reserves/table2.cfm

Estimated Data as of 2008, Released in 2010

Reactors

Data and Pictures from:
Georgia State University
http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/reactor.html#c1

New York Times
http://www.nytimes.com/interactive/2011/06/18/world/asia/JAPAN_NUCLEAR.html?ref=asia

Reactors Work

Nuclear Energy Institute
http://www.nei.org/Knowledge-Center/How-Nuclear-Reactors-Work

Environmental Protection Agency
http://www.epa.gov/cleanenergy/energy-and-you/affect/nuclear.html

Pictures from (L to R):
UC Davis
NuclearPlants.com

Units

KWH – Kilowatt hour
TWH – Terawatt hour
MW - Megawatt
U – Uranium
1 Short ton – 2000 lb.
Tonne (metric ton) - 2204.6 lb.
CO_2 – Carbon Dioxide
SO_2 – Sulfur Dioxide

U.S. Nuclear Statistics

Nuclear Energy Institute (Data from 2012)
http://www.nei.org/Knowledge-Center/Nuclear-Statistics/US-Nuclear-Power-Plants

International Atomic Energy Agency (Data as of 2014)
http://www.iaea.org

Picture from CBS news

World Stats

Data from:
International Atomic Energy Agency (Data as of 2014)
http://www.iaea.org

Safety and Costs

Environmental Protection Agency
http://www.epa.gov/cleanenergy/energy-and-you/affect/nuclear.html

Nuclear Energy Institute
http://www.eia.gov
http://www.eia.gov