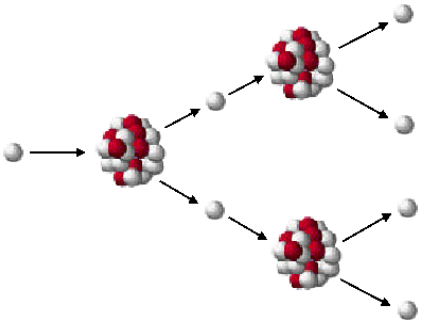
Nuclear Energy

Nuclear chain reaction → starts with 1 (often spontaneous) fission reaction and the free neutrons it produces induces more fission reactions.



The large atom is **uranium**. The small particles are **neutrons**.

When uranium splits, a large amount of energy is released.

History

Leo Szilard (Hungarian) first imagined a nuclear chain reaction in 1933. In 1938, Nazi Germany conducted the 1st nuclear fission chain reaction. Szilard understood devastating repercussions and spoke with Albert Einstein. Einstein in 1936 tries to persuade US president, Franklin Roosevelt that Americans should develop nuclear bomb. The Manhattan project was established to do this and 2 atomic bombs dropped on Japan killed 150,000 – 250,000 people. Bombs were tested up until 1963 when most countries decided to stop testing altogether.

Nuclear Energy

The technology of chain reactions is used to generate electrical energy. Nuclear power is the electricity produced from controlled nuclear chain reactions. We call these plants '**thermonuclear generating stations'**. The **nuclear reactor** is the device that creates and controls the chain fission reaction. A **stable chain** reaction is one in which 1 fission reaction causes just 1 more to occur.

Reaction → release heat energy → heats up water → produces steam → turns turbine → generates electricity. (30 – 35% efficient now)

Uranium is the substrate used. uranium-238 (most common isotope) is **fissionable** but will not start a chain reaction. Uranium-235 (rarer isotope) is **fissile**, meaning it can be split and it starts a chain reaction. Canada produces about 20% of world's uranium.

Key Concepts

- **Fuel rods** – uranium is packed into fuel pellets which are dropped into hollow fuel rods
- **Control rods** – control rate of fission reaction. They absorb neutrons. Used to slow down reaction. Cadmium or boron. Inserted when needed.
- **Moderator** – material that slows down neutrons – too fast and they don't cause a chain reaction. ie: water. Fast neutron hits water & gives some of its Ek to water & slows down.
- **Coolant** – Liquid (water) than flows around the core to remove excess thermal energy. Separate & doesn't become radioactive.
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Nuclear Waste

Ontario generates approx. 50% of its energy through nuclear plants. Reduces carbon footprint. Used fuel rods are stored in water to cool, encased in cement and shipped to storage in Kincardine. Believe this is safe for 50 years.

Nuclear Safety

3 C's – control, containment and cooling

Control – rate of reaction – control rods and moderator rods.

Containment – cement encasement for waste. Low pressure around radioactive areas so little bits don't escape.

Cooling – proper cooling reduces chain of radiation leaks. (heat can produce structural damage)

**Chernobyl in Ukraine in 1986 – runaway nuclear chain reaction – explosion – cloud 400X greater than Japanese bomb – into air. 300,000 people evacuated and resettled (only 4 killed instantly)