RADLEY

Nuclear fission

A.C. Norman

Bishop Heber High School

Nuclear fission

Today we shall

- *find out how nuclear fission can be used to generate energy*
- *know how a nuclear power station works and*
- *be able to explain how a chain reaction occurs.*

Specification Requirement

c) Particles

7.17 understand that a nucleus of U-235 can be split (the process of fission) by collision with a neutron, and that this process releases energy in the form of kinetic energy of the fission products

7.18 understand that the fission of U-235 produces two daughter nuclei and a small number of neutrons

7.19 understand that a chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei

[Edexcel iGCSE in Science (Double Award) Specification, © 2015]

How do we get electricity from coal?

1 Write a description of what happens in a coal-fired power station. Use these keywords:

- turbine
- generator
- energy
- electricity

2 Draw a block diagram for the stages / sections of a coal-fired power station:

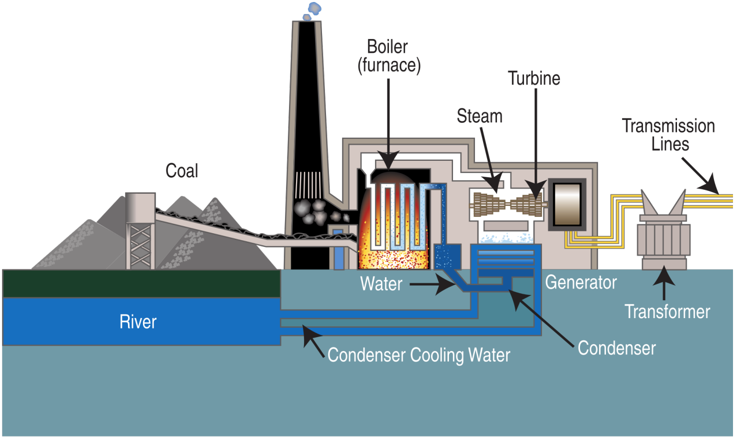
How do we get electricity from coal?

1 Write a description of what happens in a coal-fired power station. Use these keywords:

- turbine
- generator
- energy
- electricity

2 Draw a block diagram for the stages / sections of a coal-fired power station:

Coal is burnt to release heat energy. . .

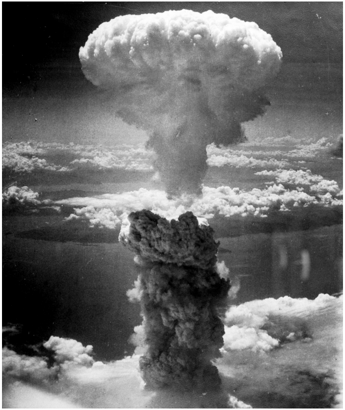


Coal is burnt to release heat energy. . .

. . . which can be used to heat water and turn it into steam in a *boiler*. The steam drives a *turbine*, which is connected to a *generator* and generates *electricity*.

Coal furnace → Boiler → Turbine → Generator → National grid

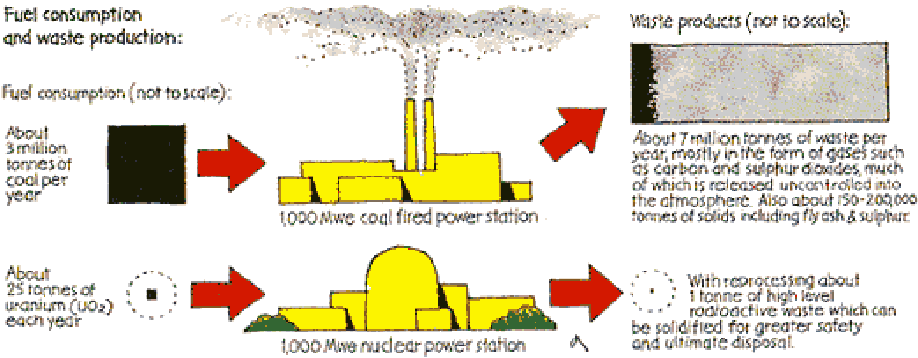
Nuclear reactions release lots more energy than chemical reactions



(Nagasaki bomb, 9 August 1945, 18 km mushroom cloud)

The nuclear energy available per atom is roughly one million times bigger than the chemical energy available per atom.

The amount of fuel (and waste) at nuclear reactors is very small



[Image: © World Nuclear Association]

The amount of fuel (and waste) at nuclear reactors is very small

The "average British person" consumes 16 kg of fossil fuels per day

- 4 kg coal
- 4 kg oil
- 8 kg gas

This all has to be dug up, transported, processed, and burned, making 30 kg of CO_2 per day. Imagine if you had to do all that yourself!

The amount of fuel (and waste) at nuclear reactors is very small

The same amount of energy could be obtained from 2 g of uranium fuel!

- Only 1% of the uranium is ‘used up’ in this process
- 200 g of uranium ore must be dug up
- There would be a quarter of a gram of waste

Nuclear power stations get heat energy from *fission*

Coal power station:

Coal furnace → Boiler → Turbine → Generator → National grid

Nuclear power station:

Nuclear reactor → Boiler → Turbine → Generator → National grid

Nuclear power stations get heat energy from *fission*

Coal power station:

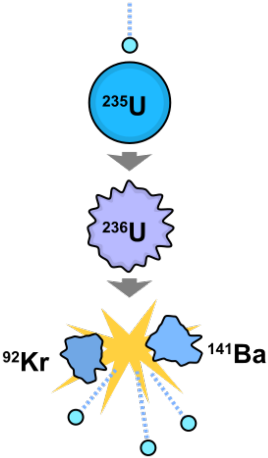
Coal furnace → Boiler → Turbine → Generator → National grid

Nuclear power station:

Nuclear reactor → Boiler → Turbine → Generator → National grid

These are almost the same
(except for how the heat energy is generated!)

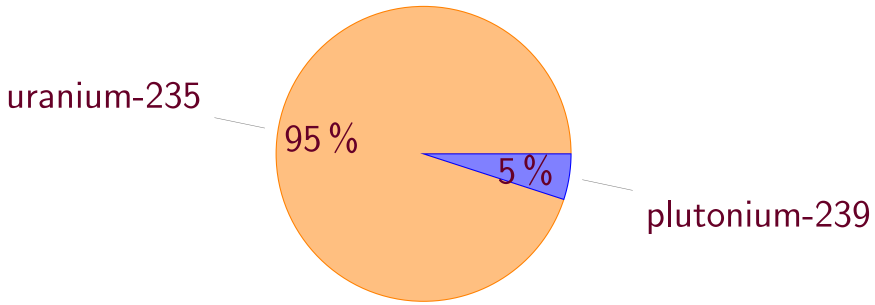
Nuclear *fission* is the splitting of nuclei



^{235}U nucleus absorbs neutron then splits

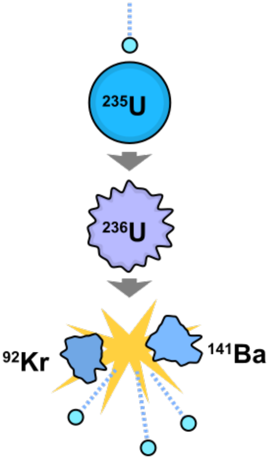
- For fission to occur, the uranium-235 nucleus must first absorb a neutron.
- An *fissionable* isotope is one that splits when it absorbs a neutron.
- There are two fissionable substances in common use in nuclear reactors: uranium-235 and plutonium-239.

Most nuclear fuel is uranium-235

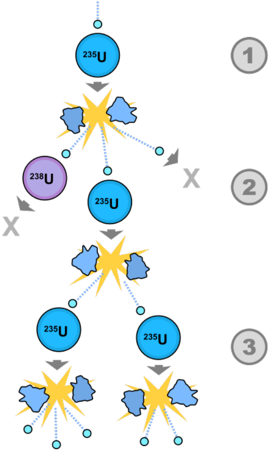


There are 439 nuclear power reactors in operation. All use uranium-235, around 50 use up to half plutonium-239 fuel.

Fission produces two smaller nuclei, 2–3 neutrons, and energy



The extra neutrons may cause more fissions



This is called a *chain reaction*, in which the neutrons released in one step go on to cause more nuclei to split up in the next.