NON-RENEWABLE ENERGY RESOURCES

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Natural resources are any kind of natural substance required or desired by humans. Natural resources used to generate heat and/or electricity are known as energy resources.

NON-RENEWABLE ENERGY RESOURCES

Non-renewable energy resources are **finite**. They cannot be easily replaced on human timescales, and we are exploiting them faster than they are being made. There are two main types of non-renewable energy: **fossil fuels** and **nuclear energy**.

FOSSIL FUELS

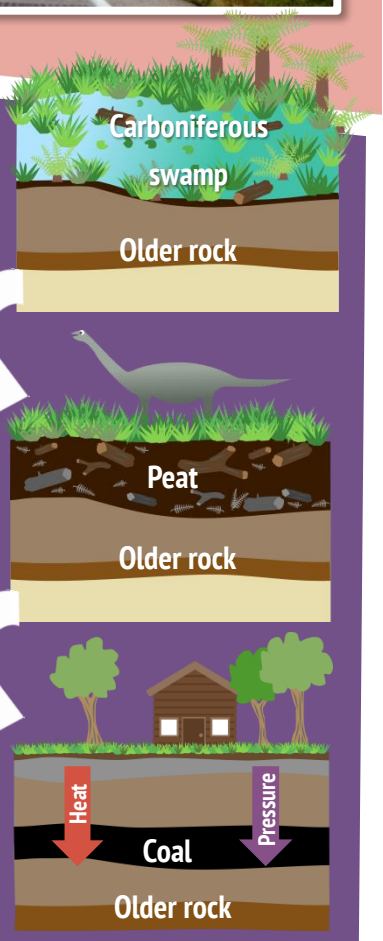
Fossil fuels are **hydrocarbons** formed from **organic matter**. They primarily come in the form of **coal**, **crude oil** and **natural gas.** People have been burning fossil fuels to produce heat and electricity for the past 250 years.

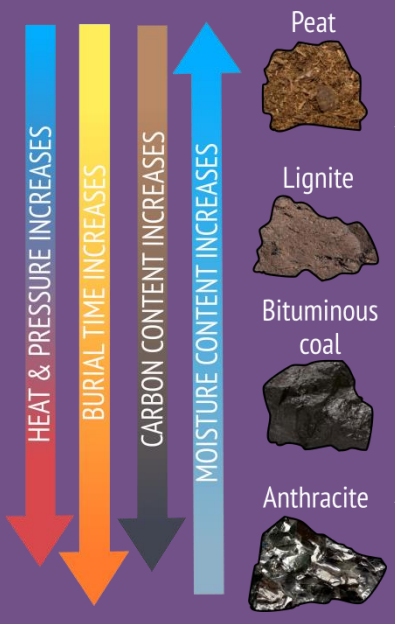
Fossil fuels are **efficient** as burning a small amount of oil, gas or coal releases a lot of energy. Extraction of fossil fuels from the ground can be cheap, and because extraction doesn't require any particular environmental conditions (e.g. wind or sunshine), they are reliable sources of energy. Fossil fuels are also relatively easy to transport by roads, rail and pipelines.

Burning fossil fuels generates heat and electricity, but also released **carbon dioxide** (CO_2) gas. The CO_2 in the Earth's atmosphere traps excess heat from the sun in a process known as the '**greenhouse effect**'. Over the past 250 years, increasing amounts of CO_2 (currently at ~410 parts per million) have caused the Earth's atmosphere and oceans to heat up, this is known as **global warming.**

COAL

Most of the Earth's coal was formed in the **Carboniferous period** about 360 to 299 million years ago, when much of the Earth was covered in tropical swamps. When Carboniferous plants such as **ferns** and **cycads** died, they sank to the bottom of these swamps, creating dense layers of squashed plant material. As they were buried the thick plant layers were heated and compressed into **peat**, a brown, spongey precursor to coal. Over millions of years, in a gently **subsiding** (sinking) basin, thick layers of sediment built up on top of the peat and buried it deeper. Heat and pressure increased and eventually turned the peat into coal.





Peat

Peat, which can take thousands of years to develop, is the first step in the formation of coal, but is it not classified as a coal. It has a very high moisture content and a low carbon content so does not make an efficient fuel.

Lignite

Lignite, or brown coal is generally less than 250 million years old. Moisture content is still high and carbon content low. Lignite is mostly used in power plants.

Bituminous coal

Bituminous coal is the most commonly used coal. It burns more efficiently than lignite but has a high sulphur content and produces smoke and ash when burnt.

Anthracite

Anthracite is the most efficient coal due to its high carbon content and very low moisture content. It burns with a pale blue flame (complete combustion) with very little smoke.

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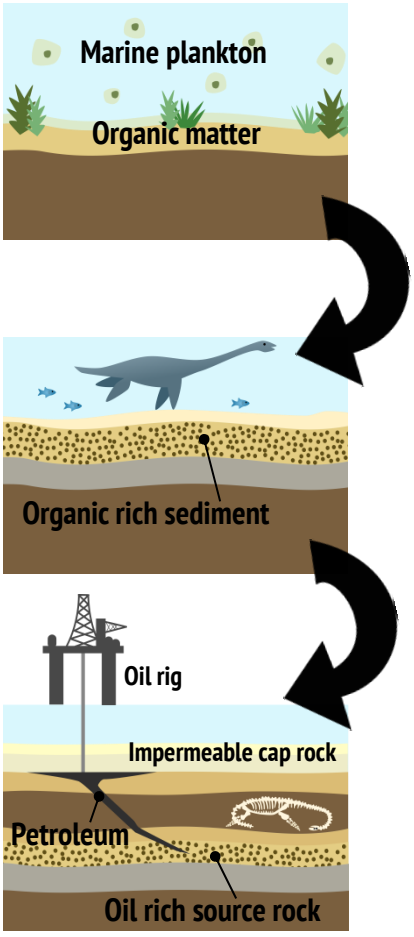
OIL AND GAS

Crude oil and natural gas are **hydrocarbons** formed from marine **phytoplankton** (plant) and **zooplankton** (animal). When these microorganisms die, they sink to the bottom of the ocean and are gradually covered in layers of sand and mud creating **organic-rich sediments**. Environments with high **primary productivity** of plankton and conditions that prevent this organic matter from **decomposing** have the best prospects for developing organic-rich source rocks.

As organic-rich rocks are buried over millions of years, heat and pressure rises and the organic matter in the sediment is transformed into crude oil and natural gas. These **hydrocarbons** are less dense than the surrounding rock so migrate upwards through tiny pores and fractures in the surrounding rock. They can rise through these fractures to the surface or become trapped in **reservoirs** under **impermeable** layers of rock, known as **seals** or **cap rocks**. It is over these trapped deposits that engineers drill to extract the oil which is then refined into different hydrocarbons.



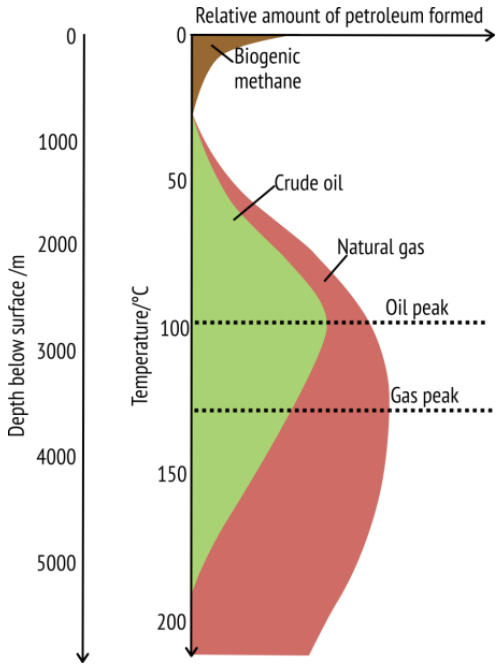


Figure 1: Temperature and burial depth determine whether you get oil or gas and how much is formed

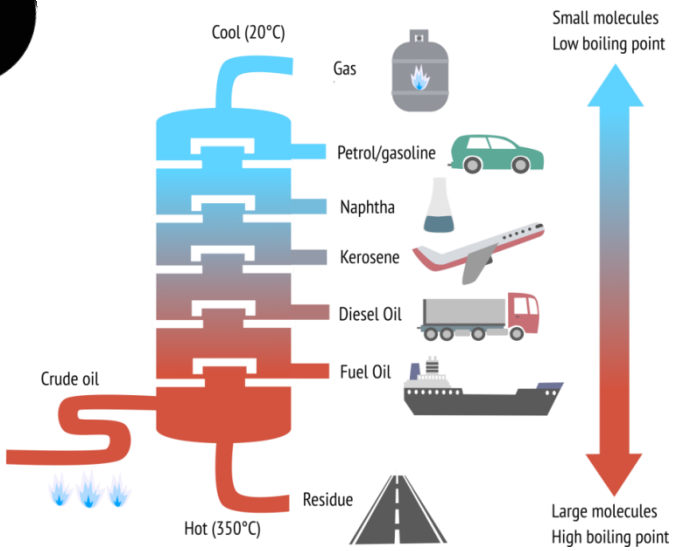


Figure 2: Fractional distillation - crude oil is evaporated and hydrocarbons condense at different temperatures in the fractionating column.

NUCLEAR POWER

Uranium and plutonium are highly **radioactive** elements, which decay over time releasing energy as heat. In nuclear power stations uranium and plutonium fuel rods are involved in **nuclear fission** reactions where atoms are split into smaller nuclei to release large amounts of energy. The heat energy released causes the reactor vessel to heat to about 300°C. This heat is used in steam turbines (kinetic energy) to drive generators and produce electricity.

PROS

- High fuel to power ratio, means a highly efficient way to produce energy
- Low greenhouse gas emissions, means energy is produced with low CO_2 release
- Reliable source of energy that is not weather dependent
- Nuclear reactors produce cheaper electricity than fossil fuels.
- Uranium is a fairly cheap fuel source

CONS

- Hazardous radioactive waste by-product must be stored and buried in special containers
- Nuclear accidents can release harmful levels of radiation into the environment (e.g. Fukushima Daiichi disaster in 2011)
- Costly to set up and decommission
- Not renewable so will eventually run out

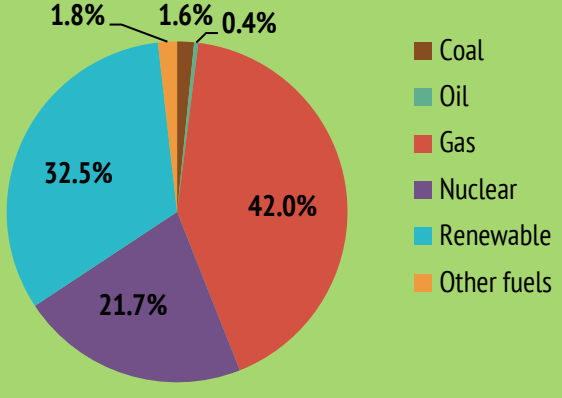


Figure 3: Electricity generation in Q2 2018. Data from the Department for Business, Energy and Industrial Strategy.