

# **Edexcel Geography GCSE**

## **Consuming Energy Resources**

### **Detailed Notes**

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## Resources across the Globe

There are many resources that humans **need to live** or use to enhance their living. A resource is a product that is **valuable** to living. Essential global resources can be split into three groups: **food, water and energy**.

## Types of Energy Sources

Before we talk about energy consumption and trends across the world, we need to know the **different sources** of energy first! Energy sources can be split into three groups:

- **Renewable** - This energy source can be used over and over, since there isn't a limit to the supply of materials or force that generates electricity. For example, solar or wind energy.
- **Non-Renewable** - Once used, an energy source cannot be reused and so the amount of fuel available is limited. For example, coal, oil & gas.
- **Recyclable** - Energy is provided from sources that can be recycled. Even though the amount of fuel is limited, more can be grown or made. For example, biofuels.

Each source comes with their own **benefits** and **risks**, so governments have to weigh up the pros and cons before choosing an energy source. Often, countries use a **mix** of energies so they don't rely on one source.

### Fossil Fuels - Coal, Oil, Gas



Source: DB Daily Updates

**Description:** Fuels that take thousands of years to form underground, from dead vegetation and animals.

- 👍 Cheap to mine
- 👍 High demand, since fossil fuels can be used in all countries and provide a reliable source of energy
- 👎 Polluting - releases carbon dioxide and methane, which contributes to Global Warming
- 👎 Non-renewable, so limited supply left of coal

### Nuclear Energy



Source: The Conversation

**Description:** Using Uranium (through nuclear fission) to produce energy

- 👍 Very reliable output of energy, so good base energy source throughout the year
- 👎 Risk of radiation poisoning if uncontrolled ([Chernobyl](#))
- 👎 Any waste must be sealed in concrete and glass, and left underground for hundreds of years
- 👎 When the power station is finished, it is expensive to decommission



### Solar Power



Source: Green Energy Times

**Description:** Panels that convert the sun's energy into electricity

- 👍 Costs are decreasing rapidly
- 👍 Large potential in desert areas
- 👎 Not very efficient yet (15-20%)
- 👎 Effectiveness dependent on climate and time of the year and day

### Wind Power



Source: The Balance

**Description:** Wind drives large turbines and generators that produce electricity

- 👍 Low running costs
- 👍 Can be used year round
- 👍 Plenty of suitable sites
- 👎 Bird life can be affected
- 👎 Weather dependent

### Wave Power



Source: E360 Yale University

**Description:** Waves force a turbine to rotate and produce energy - or other similar method

- 👍 Produce most electricity during winter when demand is highest
- 👍 Pioneer projects are commencing across the globe
- 👎 Very expensive and a 'perfect' solution is yet to be created
- 👎 Needs to survive storms

### Tidal Power



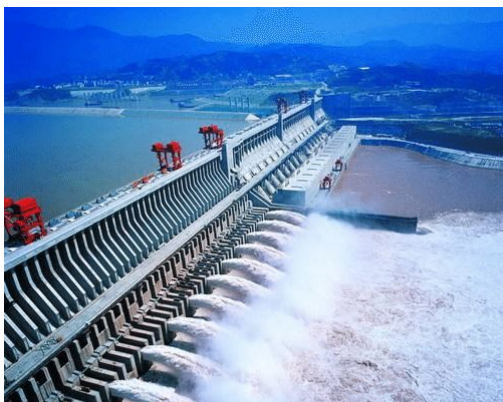
Source: Renewable Energy World

**Description:** Incoming tides drive turbines in similar way to hydropower

- 👍 Has significant potential
- 👍 Reliable source of energy once installed
- 👎 Very expensive
- 👎 Few schemes currently operating in the world
- 👎 Impact on marine life



### Hydroelectric Power (HEP)



Source: Research Gate

Description: Water from a reservoir pushes turbines built within a dam, as it escapes downhill

- 👍 Dams built for reservoirs can also generate electricity, improving clean water and energy supplies
- 👎 Large dams are expensive to build
- 👎 Disrupts fish migration along the river, as fish cannot swim through the dam

### Biomass/ Biofuel



Source: Eletimes

Description: Vegetation and waste food can be burned (as pellets or directly into the fire)

- 👍 Cheap and easy to find
- 👍 Biofuel is a renewable alternative to oil, which doesn't require car engines to be modified
- 👎 Vegetation must be found sustainably, so land shouldn't be cleared for biofuels and not replanted.

### Geothermal



Source: Daniel Allen

Description: Water is pumped beneath the ground to hot areas and the steam from the water drives turbines to produce electricity

- 👍 Low maintenance costs
- 👎 High installation cost
- 👎 Risk if earthquakes etc.

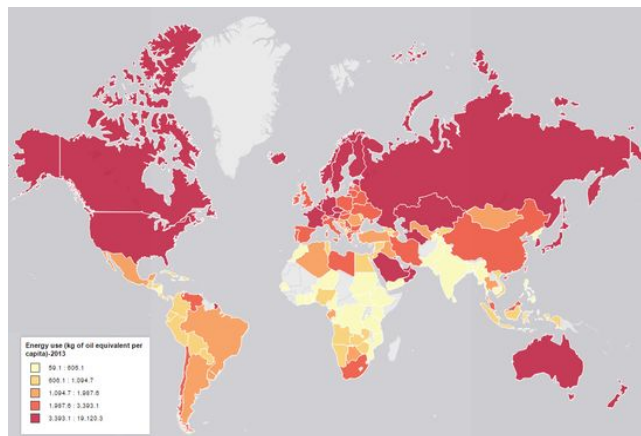
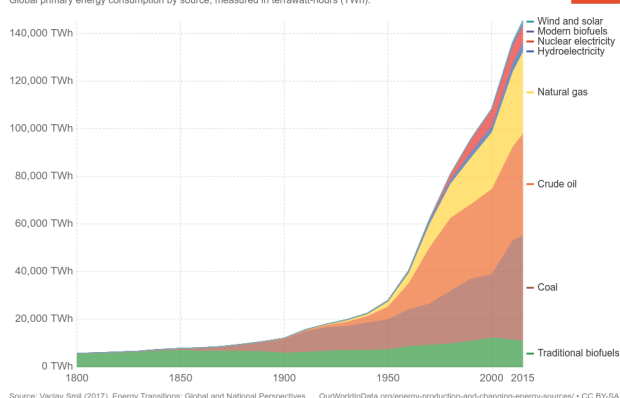




## Energy Distribution

Across the world, the **demand** for electricity varies. We require electricity for many purposes: **household appliances** (TVs, washing machines, etc), **industry** (machinery and factories), **transport** (for example trams).

Global primary energy consumption, 1800-2015



Graph A - Source: Our World in Data

Graph B - Source: secret-bases.co.uk

The consumption of energy across the world can be shown in many **different graphs**: Graph A, showing the type of energy source used and the amount of energy it contributes, or Graph B, which shows the amount of energy consumed by each country.

In general, the world is demanding more and more energy. This is because the world's **population** is growing, as is the number of **developed countries**. As countries develop, they demand more electricity for household appliances and evolving industries.

However, there are many **inequalities** between countries relating to electricity:

- The richest, more developed countries **consume** much more electricity than poorer, less developed countries.
- Not all countries have **sources of energy**. Most of the world's oil can be found in Saudi Arabia, whereas countries (such as Chad and Sudan) have no fossil fuels to burn and few bodies of water to use to generate electricity.
- In general, **fossil fuels** tend to be cheaper and easier to source than renewable sources. Therefore only the most developed, high income countries can afford to generate electricity **sustainably**.



## Energy Security

A country can have **energy surplus** or **energy deficit**. This depends on how much energy a country can produce and how much its population and industries demand. If the supply exceeds demand, the country has **energy surplus**. If the supply is less than the demand, the country has an **energy deficit**. Some examples of different countries' security is given in the table below:

Energy Surplus	Energy Deficit
<ul style="list-style-type: none"> <li>- Russia - due to its large natural gas and oil fields, as well as many nuclear plants.</li> <li>- Middle East - Saudia Arabia, Iran, Iraq &amp; Kuwait have between them 100 billion barrels of oil to be extracted, making them wealthy and energy secure.</li> </ul>	<ul style="list-style-type: none"> <li>- Western Europe - The UK has largely used up its supply of coal during the mining era.</li> <li>- Asia - Rapidly growing population means rapid demand outweighs the supply of energy.</li> </ul>

### Think Further: Energy Ownership

**Energy security** also depends on the **ownership** of power stations and mines within a country. Sometimes a country is too poor or lacking technology to exploit its own energy sources. Sometimes TNCs will help a country to **extract** its resources. For example, Shell (a Dutch owned company) has subsidiaries in Nigeria and accounts for over 21% of Nigeria's oil production. Although the money Nigeria is gaining from oil production is helping its economy develop, there are tensions within society due to the TNC being involved.

Alternatively, a country's government may **privatise** the energy industry, meaning private businesses own, operate and run power stations and electricity lines.

In either case, energy can be bought or operated by a **foreign TNC**, which will impact a country's energy security. Foreign **investment** doesn't just occur in developing countries. In the UK, the new nuclear power station called Hinkley Point C in Somerset will be paid for by EDF (a French owned company) and CGN (a state-owned Chinese company).

## Controversial Nuclear

Nuclear energy has many benefits:

- 👍 **Reliable source** of constant energy since nuclear fission is a constant process and so the same amount of energy can be produced each day.
- 👍 The fuel (Uranium) is extremely **concentrated**, so there are small mining sites required to fuel the nuclear plant.
- 👍 The nuclear industry creates many **employment opportunities** at each plant. 475,000 jobs are created in the US's nuclear sector, from head engineers to cleaners.

However, not all countries believe nuclear energy is a good idea as the biggest negative is the possibility of a nuclear meltdown, the effects of which are incredibly long lasting. The land around Chernobyl (a nuclear power station in Ukraine) is still full of radiation and the effects are still being



felt to this day. Due to this, some governments have adopted **anti-nuclear policies**. Countries such as Germany and Denmark don't use nuclear power stations to generate energy. This is because these populations share **anti-nuclear views** and are scared of the **radiation risk**. In recent years, fewer countries wish to build nuclear power plants after the [2011 Fukushima Disaster](#).

## Environmental Impacts of Energy

Our consumption of energy is **impacting** the planet in many different ways. Even renewable sources negatively impact the environment! Here are some of the ways that energy sources impact our environment:

- Many power stations and energy generators are **visually polluting**. Wind turbines and solar panels are especially **unattractive**, as they stick out from the natural surroundings.

Source: Seattle Times



- Mining** will damage the landscape and many habitats must be cleared to make room for the mine. Even if the pit head is small, there must be space on land for **waste** rubble and transport to take the coal away. **Open-cast mines** are most damaging to the landscape, as the top of the ground is dug away to reveal the fuels.

Source: Environment.co.za



- Oil spills** can be frequent and can be toxic to any wildlife nearby. The oil spill is difficult to contain, since oil spreads quickly in water. Oil spills can happen if the **oil rig** becomes damaged, an oil **freight ship** capsizes or if any pipelines leak. Following a leak, many **marine animals** will wash up dead and seabirds become unable to fly.

Source: SciTech Daily






- To make room for a power station, dam or mine, builders may **clear the land**. This means all vegetation is destroyed and trees are cut down, through **deforestation**. This means many wildlife must migrate to live elsewhere. In addition, land is cleared to grow more renewable biofuels. However, it is not environmental to clear **habitats** and endanger wildlife.





## Factors that Affect Energy Supply

There are physical and human factors that can affect the energy supply.

<p style="text-align: center;"><b>Human Factors</b></p> 	<ul style="list-style-type: none"> <li>- <b>Government policies</b> affect which types of energy can and cannot be used. This will affect the overall supply of energy for a country. For example, Germany has decided to stop using nuclear power plants, which could put pressure on its other energy sources to meet demand.</li> <li>- <b>Conflict</b> can prevent energy sources being extracted. For example, conflict in Iraq stopped oil production which impacted the price of oil in global markets.</li> <li>- The <b>development</b> of a country will affect the <b>technology available</b>. Some energy sources are difficult to extract or power stations require high tech monitoring. This means countries with low levels of technology cannot use some energy sources, such as nuclear.</li> </ul>
<p style="text-align: center;"><b>Physical Factors</b></p> 	<ul style="list-style-type: none"> <li>- Not all countries have access to all energy sources             <ul style="list-style-type: none"> <li>- Fossil fuels can be found only for <b>specific geology</b> types - either sedimentary rock or natural gas/oil has become trapped in rocks.</li> <li>- Geothermal energy can only be produced near <b>magma plumes</b>, which are only found near tectonic boundaries or in individual pockets.</li> </ul> </li> <li>- <b>Climate</b> can impact the efficiency of renewable sources             <ul style="list-style-type: none"> <li>- Solar energy relies on limited cloud cover, so rainy climates are unsuitable for lots of solar panels</li> <li>- Not all countries have wind powerful enough for wind turbines. Turbines are best out at sea, or built across low-lying plains</li> </ul> </li> <li>- For a country to use tidal energy, it must have coasts. Therefore <b>landlocked countries</b> cannot use tidal power.</li> <li>- Similarly, HEP requires dams to be built in <b>mountainous areas</b>. Therefore the shape of the land (morphology) is important.</li> </ul>
<p style="text-align: center;"><b>Economic Factors</b></p> 	<ul style="list-style-type: none"> <li>- The <b>cost</b> involved in using an energy source could be too much for a country, and make the electricity generated <b>unaffordable</b> for families. There are many different ways that cost can be added to an energy source:             <ul style="list-style-type: none"> <li>- Extraction of the energy source could require <b>specialist equipment</b> or high pressure</li> <li>- The energy source is <b>dangerous</b> (ie radioactive, or mining is hazardous) therefore wages must be higher to compensate for the risk</li> <li>- <b>Transportation</b> of energy sources from mining to processing can involve many kilometers of pipelines or regular freight ships, which are costly to use.</li> </ul> </li> </ul>





## Sensitive Energy Sources

Since we have consumed a lot of energy sources within the last century, many **easy-access** energy sources have been mined and consumed. For example, in the UK, shallow coal beds and oil fields were mined and drained up until the 1950s. As the places which are easy to extract from have all been used up, **more dangerous** or **risky environments** now have to be **exploited**. For example,

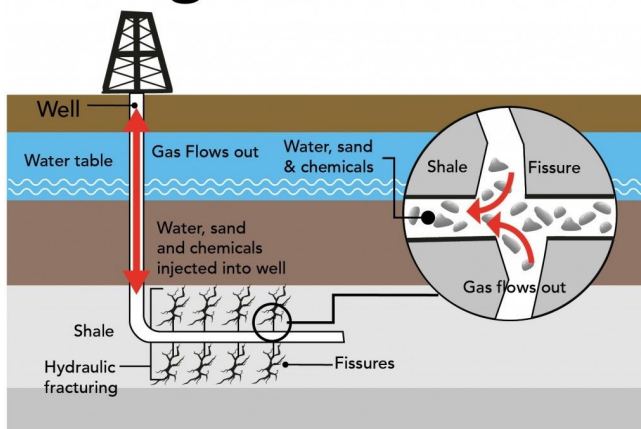
- Miners have to **drill deeper** to find coal and oil that hasn't been exploited. Drilling deeper into the ground increases the risk of **earthquakes**, mines **collapsing** and high pressure ruptures in the rock, which could release the oil and let it escape.
- Energy sources in **hostile environments** are to be exploited. For example, there are large reserves of oil locked in the Middle East. Some of the Middle East is occupied by **militant groups**, so workers are at high risk of **capture** or being hurt during conflict.
- There are some fossil fuel stores in **fragile environments**, such as the Amazon and Antarctica. Despite being fragile **ecosystems** with many rare and endangered species, some governments are looking to exploit the oil found here.

## Unconventional Fossil Fuels

### Shale Gas

Extracted through fracking, Shale Gas has received major environmental opposition. However, it provides 25% of the US's energy needs in 2015. **Fracking** is a relatively new process of extracting Shale gas. Water, chemicals and sand are pumped into the ground to break up the shale, access the hydrocarbons and force them to the surface. **Horizontal drilling** helps to remove the gas reserves. There are **benefits and costs** of fracking:

## Shale gas extraction



Source: [www.shale-safe.com](http://www.shale-safe.com)

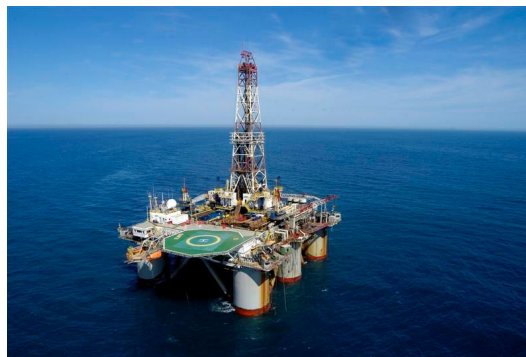
Advantages	Disadvantages
<ul style="list-style-type: none"> <li>👍 Shale gas produces half the emissions of coal, which would reduce global emissions without completely eradicating fossil fuel use.</li> <li>👍 The majority of shale gas is found in the US, which would improve the US's economy.</li> </ul>	<ul style="list-style-type: none"> <li>👎 Fracking faces large environmental opposition, especially as fracking can trigger minor tremors.</li> <li>👎 Shale gas is still more expensive to produce than conventional gas.</li> <li>👎 Earthquakes of low magnitude may occur, though they are not usually strong enough to pose a risk to humans. They may damage fracking infrastructure, causing further leakages</li> </ul>



## Deep-Water Oil

As oil supplies decrease, energy companies have begun extracting oil from deeper depths. Deep-water oil faces larger risks during extraction, and (similar to normal oil production) oil spills during transportation.

Source: [seekingalpha.com](https://seekingalpha.com)



Advantages	Disadvantages
<ul style="list-style-type: none"> <li>👍 Most engines use oil, so oil is easy to sell and consumers wouldn't need to change vehicle to use deep-water oil</li> <li>👍 Jobs working on oil rigs are high paid, offering locals a good wage (this is because of the high risk involved, and living on the rig for up to a month)</li> </ul>	<ul style="list-style-type: none"> <li>👎 Deepwater oil is more hazardous to extract. Therefore workers are at risk of death or injuries by working on the oil rig.</li> <li>👎 It is risky to extract oil from deep underground, which could lead to more frequent oil spills or small earthquakes</li> </ul>

## Tar Sands

The extraction of petroleum from sands involves high energies and boiling water, which can leave ponds of concentrated chemicals. Tar sands have a large environmental cost, but can be lucrative in profit and employment opportunities.

Source: *The Star*



Advantages	Disadvantages
<ul style="list-style-type: none"> <li>👍 Approximately 2.4 million barrels of oil are produced from tar sands each day!</li> <li>👍 Local economies can benefit largely from local tar sands. There are large profits from oil and many employment opportunities to operate machinery.</li> </ul>	<ul style="list-style-type: none"> <li>👎 It takes 12 barrels of hot water and 3 barrels of chemical waste to produce 1 barrel of bitumen</li> <li>👎 Waste chemicals are left in tailing ponds, which are open ponds of water mixed with sulfur, chlorine and ammonia. These chemicals are poisonous to consume.</li> <li>👎 Open mining involves removing the top layer of vegetation and soils to access the bitumen-sands, destroying habitats.</li> </ul>



## Increasing Energy Supplies

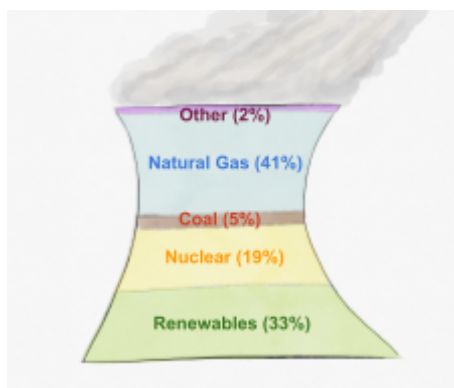
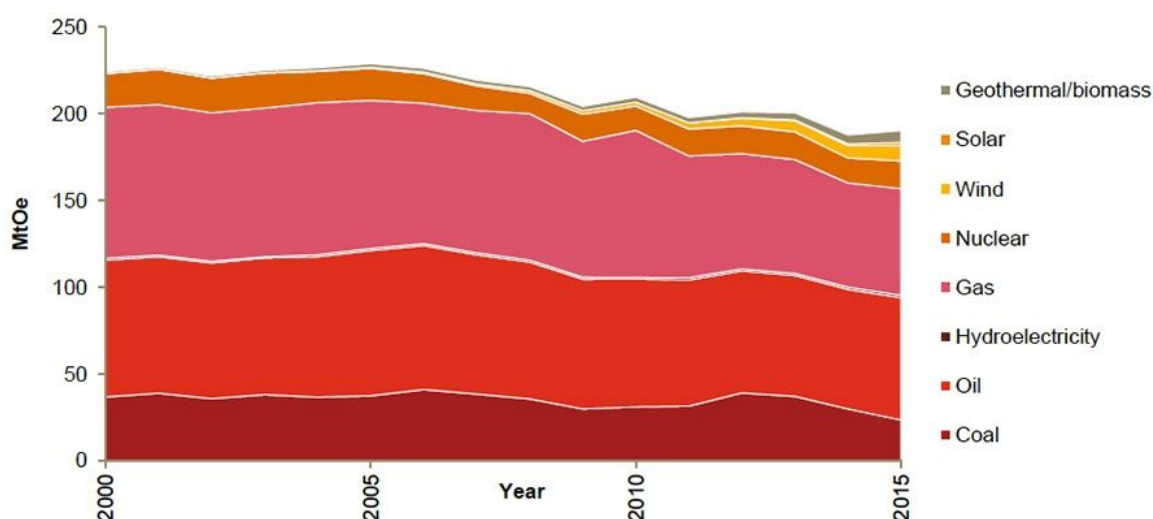
There are many countries that experience **energy insecurity** now. However, there are many more countries that will experience energy insecurity in the future. Therefore, governments are looking ahead to improve their energy sources now and for the future:

- Will the energy source run out? Is it **non-renewable**? Have we over-used this source, meaning we take more than is replaced?
- Do we rely on other countries for our energy? What if we have different **political beliefs**? Will there be conflict in the future, which could stop any energy trade?
- Could we **reduce** our energy **consumption**, especially in terms of how much energy is wasted?
- Will our climate change in the future, due to the **Greenhouse Effect**? Will the renewable sources we use now be able to be used in the future? For example, will our climate warm up so fewer vegetation can grow and be used for biofuel?

## Energy in the UK

Within the last decade, the UK's energy consumption has **decreased**. This is because the UK's **manufacturing industry** has decreased (such as the production of cars, steel and textiles) and our technology has developed to become more **efficient**. Therefore the amount of energy our household appliances waste has decreased.

UK's energy mix 2000-15



However, there is still a very high portion of **fossil fuels** burned to generate electricity. The picture to the left shows the energy mix for the UK in 2018. **46%** of the UK's energy is generated by burning coal and natural gas. In addition, nearly a fifth of the UK's energy is generated using **nuclear power plants**, which don't directly release greenhouse gases but instead pose a large **radiation risk**.

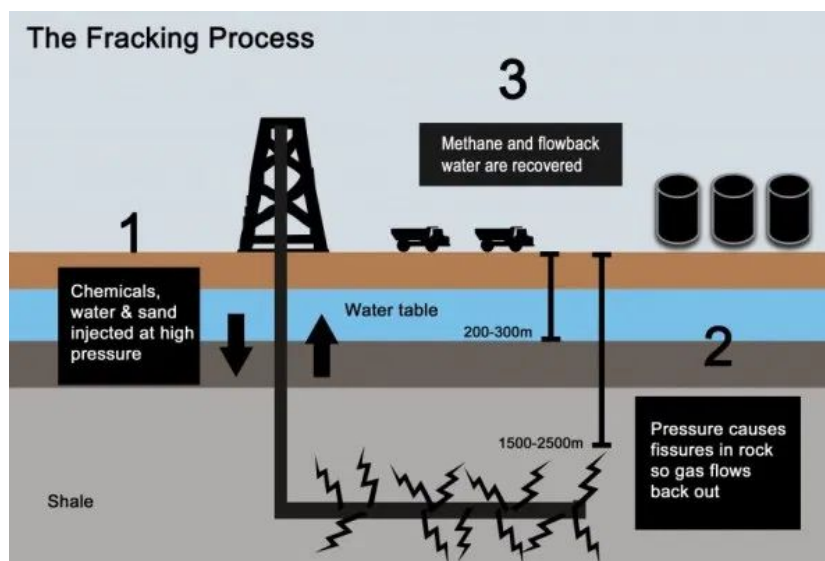


## Why has the UK's energy mix changed?

- Approximately **75%** of the UK's own energy sources (predominantly coal beds) have been **exhausted**. Therefore it became **cheaper to import** energy than to extract fossil fuels from deeper beds (which is more hazardous and not as profitable).
- Coal** has also declined due to the negative impacts of burning coal on the environment. Coal is **heavily polluting**, releasing large quantities of **carbon dioxide** when burned. This contributes to **Global Warming**. The UK Government has agreed to close all coal-powered power stations by 2025, converting them into biomass plants or decommissioning them.
- A growing awareness of **renewable sources** has meant an increase in **green tariffs** in the UK. This means that the consumer is choosing to use energy only produced using renewable or **carbon neutral** energy sources. Green tariffs may cost more, but more of the UK's population is choosing to be **environmentally friendly**.

## Fracking

In the UK, **fracking** is debated and a controversial issue. The UK has a supply of **natural gas** trapped in **shale rocks** (a sedimentary rock made from fine sands, silts and mud). To release this trapped natural gas, the process of fracking is used:



Source: No Majesty

Fracking involves pushing **high-pressure liquids** underground, which causes the shale rocks to **crack** and the natural gas to escape. There are many protests against fracking, because

- 🗨️ Fracking is an **energy-intensive** process, since pressurising the liquids requires a lot of energy. Therefore fracking is **expensive** and the price of natural gas may increase to make up for the expenses.
- 🗨️ There is a risk of **earthquakes** due to fracking, as the shale rocks crack underground. If these earthquakes are strong enough, **structural damage** to buildings on the surface could occur. However, up till now, the UK has only experienced up to 2.0 magnitude earthquakes due to fracking (not high enough to cause damage).
- 🗨️ There is also a risk that the pressurised liquids infiltrate and **pollute** underground water sources. The liquids forced underground can be mixed with **chemicals and salt**, to increase the probability that the shale rock cracks.

