

Key Terms

Fossil fuels
Non-renewable
Renewable
Recyclable
Stock Resources
Flow resources
Fracking
Bitumen
Groundwater

What impact does extracting energy have on the environment?

One of human's biggest and most significant impact on the environment is extracting and using energy. The impacts can vary by scale such as locally in terms of aesthetics, regional—air pollution and globally with the rising threat of climate change.

The impacts of solar energy:

- Land use
- Potential deforestation
- Landscape scarring

The impacts of drilling:

- Landscape scarring
- Carbon emissions
- Oil spills
- Deforestation
- Migration patterns impacted

The impacts of HEP:

- Flooding
- Landscape scarring
- Deforestation
- Migration patterns impacted



The impacts of mining on the environment:

- Landscape scarring
- Carbon emissions
- Deforestation
- Migration patterns impacted



The impact of wind turbines:

- Landscape scarring
- Migration patterns change for birds



Topic 9: Consuming Energy Resources

Energy resources can be classified in different ways and their extraction has consequences

We can classify energy sources as non-renewable, renewable and recyclable.

Fossil fuels (non-renewable resources) have fuelled economic development since the industrial revolution, whilst causing significant environmental damage. Over 86% of the world's energy come from fossil fuels in 2014, such as coal, oil and gas. Non-renewable resources are finite or stock resources meaning no more are being created and they will eventually run out.

Renewable energy resources are energy sources that will never run out such as wind, solar, tidal, geothermal and hydro-electric power.

These can also be known as flow resources. Only 9.3% of the world's energy is created using renewable sources.

Recyclable energy resources can be reused into the future such as biofuels and nuclear power, where the uranium fuel is reprocessed and used again.

Overtime the world's energy demand has increased and the balance of energy types has changed.

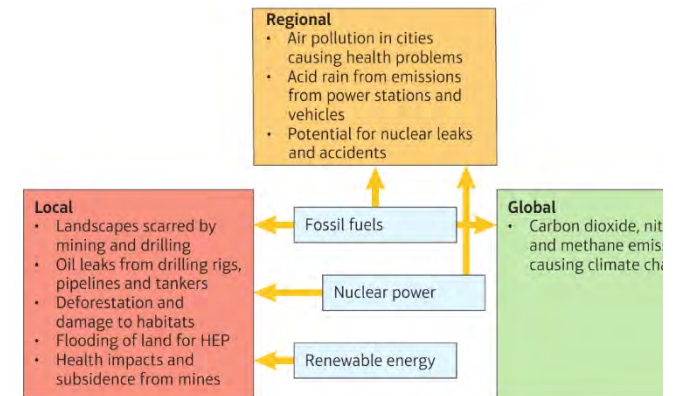


Figure 5 The impacts of energy production and use on the environment

Exam questions

1. State the 3 types of energy resources (3)
2. Explain the views on oil extraction of different groups of people. example consider the government, an oil company, businesses and industries, local people and an environmental pressure group in answer. (8)
3. What impacts on the environment are caused by exploiting energy and by using energy? (4)
4. Compare the impact of nuclear power, fossil fuels and renewable energy on the environment (6)

Key Terms

Reserves
Geology
Relief
Climate
Accessibility
Development
Biomass
Economic Development
Economic sectors
Traditional fuel sources

Questions

1. Explain why the USA may be concerned about oil supply in the future. (2)
2. Explain why falling oil prices may affect Saudi Arabia's economy. (2)
3. Explain 3 factors that can affect the distribution of energy resources (6)
4. Explain what causes a variation in energy use around the world (6)
5. Explain why energy use has changed over time (3)
6. Which regions consume the most energy? (3)

Access to energy resources is not evenly distributed which has implications for people.

Accessibility to energy resources across the world are uneven. Countries that have fossil fuel reserves have become very wealthy and dominate the energy supply. There are three main factors that affect the uneven distribution in energy:

Geology—

- Sedimentary rocks contain most of the world's fossil fuels. The Middle Eastern countries such as Saudi Arabia and Iran have 48% (2012) of the world's oil and 43% (2012) of gas reserves. Coal is widely distributed around the world. Most of the reserves are in Russia, USA and China.
- Geothermal energy is generally only accessible in areas close to plate boundaries such as New Zealand and Iceland. The volcanic activity creates heat stored in magma beneath the Earth's surface, creating a natural geothermal system which can be used to heat water and generate electricity.

Relief and climate—

- Regions with high rainfall and suitable relief are often good locations for HEP. A large volume of water is needed, and steep sided valleys are often chosen for dam construction.
- Climatic are also important to harness the potential of wind and solar power. Areas exposed to high winds are good for wind farms and places that receive long hours of sunshine are good for solar farms.

Accessibility and Development—

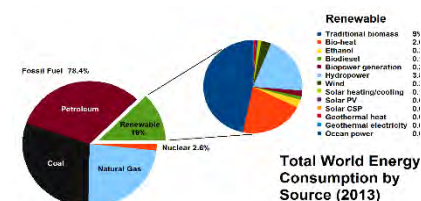
- How economically developed a region is influences its ability to invest in new technology? Some resources are in remote regions making them expensive to exploit. Many developing and emerging countries use biomass for energy.

Variations in energy use:

Economic development— For countries to develop economically energy is vital to power industry, transport, information technology as well as heating and cooling buildings. The countries with the highest demand for energy are developed countries so they are able to invest in technology. This investment in technology creates new opportunities for energy supplies from renewable and recyclable sources as well as other non-renewable sources such as fracking. However, developing countries have limited access to energy resources as well poor distribution systems. This restricts economic growth.

Economic Sector— With a changing economy and technology the type of energy use changes. Most energy in developed countries is for transport. Little energy is used for farming. In contrast developing and emerging countries use most of their energy for industries and farming.

Traditional fuel sources – Traditional biomass fuels are used for domestic use in many rural areas in developing countries. In some regions such as the Sub-Saharan Africa there is no direct electricity source and in urban areas the supply can be inconsistent. Although Africa is rich in fuel sources access to them is limited, over 700 million people still cook over open fires.



Global patterns of energy use
Population growth in the last 100 years as well as rising incomes has increased the demand for energy. It is expected that an extra 1.6 billion people will need energy by 2035, demand will also grow as countries can become more economically developed.

The global demand for oil is increasing, but supplies are unevenly available

Oil production is one of the world's largest businesses, some of the largest TNCs are oil companies. The distribution of oil like all other fossil fuels is uneven. At present the Middle East has the largest oil reserves with an estimated 804 billion barrels of oil left. This should last approximately 200 years. The top 3 producers of oil are USA, Russia and Saudi Arabia all producing over 10 million barrels a day. Most new oil resources are found in hostile locations or far away from world markets.

Since the 1990s the global consumption of oil has been rising as the demands have increased due to a wealthier population. Rapid industrialisation and development in emerging countries has been one of the biggest factors contributing to a higher consumption of oil, especially in countries like China, where oil consumption has trebled since the 1990's. China accounts for 12.4% of global oil consumption in 2014, however the USA takes the lead with 20% of the world's oil consumption. Over 70% of oil consumption is used in transporting goods and people. On average over 1000 barrels of oil are consumed a second. The price of oil per barrel has fluctuated a lot since 1983. There are many reasons for fluctuating prices that can be local factors or global factors such as:

- An increased demand for oil due to the growth of the world's economies leading to a long term rise in the price of oil up to 2008.
- Emerging countries such as China going through rapid industrialisation in the early 21st century increased the demand for energy, which China's own oilfields could not meet. Imports had to fill the gaps.
- The price of oil fell during the global recession in 2008 as the demand for oil fell as consumers bought less goods.
- Disruptions to supply such as the oil spill in the Gulf of Mexico in 2010 by BP led to a price hike, as well as political events in the Middle East.
- Diplomatic relations and conflict between countries can lead to high prices.
- The discovery of new sources such as shale gas increased the supply and led to lower fuel prices.
- Long-term rising demands lead to pressure on oil supplies and prices.

Exam Questions

1. Describe the distribution of global oil supplies (4)
2. Explain how conflict between countries can affect global oil prices.
3. Explain what is meant by energy security (2)
4. Evaluate the advantages and disadvantages of the East Siberia-Pacific Ocean pipeline to China and Japan (8)
5. Explain the long-term and short-term factors that can lead to world oil price changes (6)
6. Explain why demand for oil has increased since the 1990s (4)

Key Terms

Consumption
TNCs
Conflicts

The East Siberia-Pacific Ocean (ESPO) geopolitics of oil

- Due to China and Japan's limited energy supply they are keen to access Russian oil to have better energy security. This will reduce their dependence on Middle Eastern oil which makes them vulnerable to price increases.
- For China's rapid economic growth, a reliable energy supply is essential. 60% of China's oil imports come from the Middle East, transported through the Strait of Malacca, which is subject to attacks by pirates. As China wants to expand its energy supply options, Russia is its best choice, however the diplomatic relationship between Russia and China is not smooth. Russia believes China is a threat so is unwilling to supply large quantities of energy. China is also wary of Russia as they know Russia has a history of switching off energy supplies with countries such as Ukraine when relationships become strained.
- Japan is the 3rd largest oil consumer in the world, however it has limited supplies, hence it is interested in Russia's supplies. Most of Japan's oil comes from the Middle East so therefore the ESPO line will reduce its dependence on Middle Eastern oil. The Japanese government offered finance to extend the ESPO pipeline closer to Japan and by 2010, Russia's exports to Japan increased rapidly.

Key Terms

Extracting
Isolated
Fracking
Groundwater
Bitumen
Contamination

The world's continuing reliance of fossil fuels increases pressure to exploit new areas

New Conventional oil and gas source—Exploring and Extracting in the Arctic

- Most of the accessible oil and gas fields had already been discovered and exploited by the late 20th Century. Demand for oil has increased in the 21st century meaning scientists are searching for new resources in increasingly remote and delicate environments such as the Arctic.
- Along the coast of the Beaufort Sea (an isolated region), Exxon Mobile Corporation has been constructing a natural gas extraction facility on flat marshy land which is said to cost US\$4 billion. The reason for this is distance the gas needs to travel from Point Thompson to the Badami oil field which is 35Km away.

Questions

1. Describe two impacts of extracting oil from tar sands (2)
2. Explain why it is expensive to drill for oil and gas in the Arctic (4)
3. What are the economic benefits to Arctic countries of developing oil and gas production? (6)
4. Explain why companies have invested in extracting oil from difficult environments like the Athabasca tar sands (6)
5. Explain why there might be opposition to fracking in a UK National Park (6)

Costs

- The cost to make the facility is US\$4 billion—the remote location might make it cost more.
- There have been many accidents and leaks.
- Any damage created in this environment lasts centuries.

Benefits

- Exxon estimates that the facility will produce 10,000 barrels a day.
- There is approx. 35 billion cubic feet of discovered gas.
- It will provide employment for up to 800 people.
- The state of Alaska will take a 25% share and investing \$5.25 billion for the project which is said to be worth \$45 billion.

The USA developed the process of fracking to collect natural gas. The fracking process involves drilling into shale deposits and injecting water, sand and chemicals at high pressure into the rock. This frees the natural gas from the rock and allows the gas to flow upwards where it flows into a well where it is stored. The USA produced 39% of natural gas through fracking in 2014. Many Americans support this as it lowered their fuel bills, created 2 million jobs and reduced the countries dependence on fuel from the Middle East. Compared to coal, gas is much cleaner. However, there are many environmental costs of fracking.

- The chemicals used to force the gas out of the rocks can leach into the local groundwater supplies impacting on the water quality. Some drinking wells located near fracking sites have 17X higher levels of methane in the water. This can damage the local ecosystems and make people who drink the water ill.
- There is a link between fracking and subsidence, as the rocks are disturbed beneath the ground. As well as this gas has been known to enter peoples water supplies making the drinking water flammable.
- Fracking leads to the loss of habitats.
- There can be an increase in local traffic as trucks carry building materials and gas.



CASE STUDY—Oil reserves at the Athabasca tar sands, Canada

This region has significant oil reserves in the form of tar sands. There is approximately 180 billion barrels of bitumen within the sand deposits that can be refined into petroleum. With dwindling oil supplies and the rising cost of oil and the development of new technology exploiting this area seemed worthwhile despite the costs. However, there are still concerns about the environmental damage.

1. Surface mining is needed to gain access to the tar sand deposits. This means deforestation occurs and a large area of land is cleared, leading to the loss of local habitats.
2. An estimated 6 barrels of water are needed for each barrel of oil produced. Therefore, large volumes of water are needed. The water is extracted from the Athabasca river, this threatens the local wildlife and locals water supplies.
3. This process releases 15% more CO₂ than refining crude oil.
4. There have been many leaks into local rivers and lakes (an estimated 11 million litres of toxic waste reaches the Athabasca river daily).

Exam Questions

1. Explain why urban transport schemes can contribute towards lowering carbon emissions (4)
2. What is the difference between a carbon footprint and an ecological footprint? (2)
3. Assess the benefits of developing energy-efficient homes and transport systems. (8)
4. Explain two benefits on the environment of developing renewable energy resources. (4)

Key Terms

Energy efficient
Energy conservation
Combined heat and power (CHP) generators
Congestion
Kinetic energy

Reducing Reliance on Fossil fuels presents major technical challenges

To reduce the demand for energy there are two options: energy efficiency and energy conservation. Energy efficiency is providing the same service but using less energy e.g energy efficient light bulbs. Energy conservation is about not using as much energy e.g switching TVs off when not in use. These are both important for reducing CO₂.

Reducing the energy demand:

- Woking Borough Council are promoting the use of energy efficiency and conservation. They have encouraged homeowners to use sustainable strategies to reduce the amount of energy they use. By 2008, the council reduced its energy consumption by 52% and carbon dioxide emissions by 82% in comparison to 1990 levels.
- Woking council set up its own utility company Thameswey Energy, it is a non-profit company and is responsible for providing sustainable energy to the council and other organisations working in the area. They use CHP and photovoltaic (PV) solar farms generate energy. The council also converted an old police house and used energy efficient and conservation technologies to educate locals on how to be more sustainable and lower their carbon footprint.

Energy efficient transport systems:

- Over 20% of worldwide energy consumption, from fossil fuels is due to transport. Sustainable transport methods use less energy and improves the quality of life for people in the city. Another method is to have congestion charging and cycling schemes so people are more likely to choose sustainable transport methods.
- Congestion from traffic is common in cities, this leads to longer journey times and lower air quality. Since 2003, London has had a congestion charge to reduce congestion and pollution. Users have to pay to drive into central areas. This scheme cost £80 million to set up but generates approximately £252 million per annum in revenue, which has helped improve public transport. The scheme has reduced CO emissions by 19% and reduced fuel use by 20%. There has been a 45% increase in users and air quality has improved by 12%.
- Paris launched a city-wide cycling scheme in 2007, Velibs. This was to reduce traffic congestion. It is a self-service system which includes 23,500 bikes parked at 1400 stations around Paris, for €29 membership fee. The first 30 minutes on the bike is free, after that hourly rental increases. However, it is still much cheaper than bus, trains and cars. In the first 3 months' CO₂ emissions fell by 32,330 tonnes, 100,000 people used the bikes and people travelled an estimated 300,000Km. By 2012, Parisians made 130 million trips on bikes and vehicle traffic decreased by 25%.

Type of alternative energy	Costs	Benefits
Wind Energy— Wind turbines generate electricity through kinetic energy.	<ul style="list-style-type: none"> Locals state they spoil their view of the landscape. Offshore windfarms are too far away so expensive transmission lines are needed. Turbine blades cause 4 bird deaths per year on average. 	<ul style="list-style-type: none"> Clean energy—no pollution Can generate hundreds of megawatts (MW) of electricity. Cheapest renewable energy source for consumers.
Solar Energy— This technology uses PV cells to convert light into electricity. The cells do not require direct sunlight to work.	<ul style="list-style-type: none"> Large solar farms can take up valuable agricultural land. Making the solar panels can harm the environment as toxic chemicals are used like mercury, lead and cadmium. Ecosystems can be damaged whilst solar farms are constructed. 	<ul style="list-style-type: none"> It is creating hundreds of jobs. Requires little maintenance No noise is created Cheap No pollution once they are up and running
Hydro-electric power— Water turbines use kinetic energy to generate electricity.	<ul style="list-style-type: none"> Expensive to build and can spoil natural landscapes Displace people and animals due to flooding Changes in river flow which can impact wildlife and ecosystems. 	<ul style="list-style-type: none"> Reliable and consistent Production can be altered to meet demands Can help conserve water with dams and reservoirs
Biofuels— Biofuel crops are grown instead of food crops.	<ul style="list-style-type: none"> Large amounts of water are needed. Competition for land from food farmers. Deforestation can increase where supplies can't meet the demand. 	<ul style="list-style-type: none"> Fewer carbon emissions are created Cheaper than fossil fuels You can reuse and recycle materials to make biofuels.
Hydrogen—Hydrogen is burnt to create a fuel source as opposed to petrol and diesel.	Energy is needed to release hydrogen gas from water, therefore fossil fuels could be needed. It is difficult to store hydrogen safely/	<ul style="list-style-type: none"> Clean energy Made from water Efficient

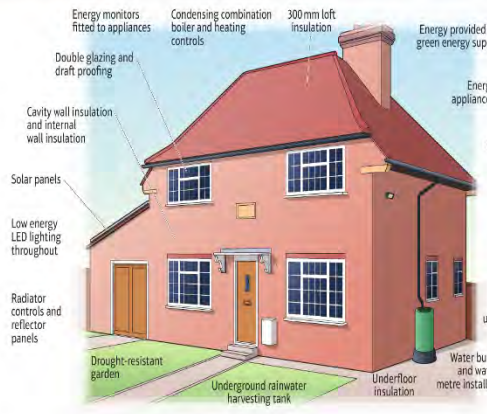


Figure 13 Oak Tree House, low-carbon home

Exam questions

1. Assess the reasons why opinions about the use of renewable energy vary (8)
2. Assess the following statement 'ordinary people hold the key to solving the energy issues of the world' (8)
3. Explain why some homeowners are in favour of lowering their eco and carbon footprints, while others are against it (4)
4. Explain how organisations have a responsibility to lower their carbon and eco-footprints (6)
5. Explain how education is helping to change people's views about energy (4)

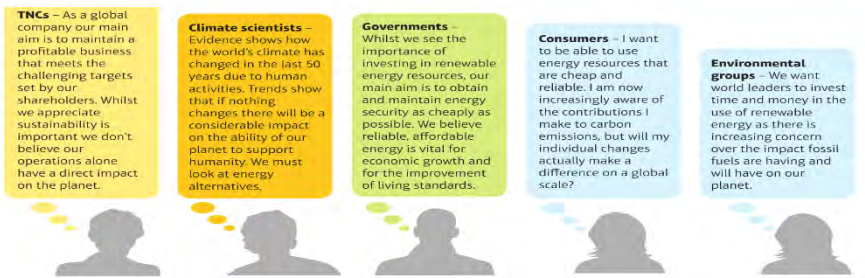


Figure 15 The different views about energy futures

How do attitudes to the exploitation and consumption of energy vary?

Scientists predict that from 2013-2035 the global demand for energy will increase by 37% due to population increase and better living standards. If fossil fuels continue to dominate the global energy mix it will be catastrophic for climate change. Stakeholders have different views on what our 'energy future' holds. This ranges from business as usual to more sustainable approaches.

How are attitudes changing?

It was predicted in 2015 that by 2020 the use of non-renewable energy sources would decrease to 76%. This is due to a number of factors such as:

Increased affluence—people are supporting the investment of clean and sustainable energy as rising incomes generally means a rise in the demand for energy.

Environmental concerns— with more research and awareness of the impact fossil fuels have on the environment, there has been a worldwide demand for a change to sustainable and clean energy.

Education—the UN, schools and governments have made people increasingly aware of the alternatives to fossil fuels and the importance of sustainable and clean energy which has changed people's views.

Key Terms

Affluence
Education
Carbon footprint
Ecological footprint



Different attitudes:

Individuals— People can measure their carbon footprint which shows their impact on the environment. This raises people's awareness of how much energy use and how much it is costing them economically and environmentally. This helps people make changes to reduce their carbon emissions. The carbon footprint shows people how to become energy efficient. Generally domestic heating is the biggest user of energy in houses (15%), and most of the energy used is lost due to poor insulation. Powering homes uses 12% of energy and again most of this energy is lost through appliances which are switched on, but are not used. Finally, private transport is the 3rd biggest user of energy for individuals (10%), individuals can reduce this by car sharing, taking the bus, walking or cycling.

Organisations— Large organisations such as Google and McDonalds have applied a sustainable approach to their business operations. However, as the price of fossil fuels is currently cheaper than renewable energy and the technology is already in place for fossil fuels, companies like McDonalds and Google still rely on them. NGO's like Greenpeace feel that changes need to be more significant and companies should take more responsibility for the environment, and become more sustainable.

Governments— The UK was one of 195 countries to attend the UN climate change summit in Paris. In 2015. They pledged to limit the global temperature rise to 2degrees Celsius. Individual countries set their own targets to reduce carbon emissions, and developed countries set up a £100 billion fund to help developing countries be more sustainable. The UK's targets are:

1. Set carbon budgets to limit the greenhouse gas emissions.
2. Invest in low carbon technology so that by 2050 the UK produces 80% less carbon than it did in 1990.
3. Reduce the demand for energy by implementing smart meters in homes and businesses.
4. Create a public report of carbon emissions to allow people to assess their impact on climate change.

Some countries such as India, an emerging country have difficulty in becoming more sustainable. This is due to them needing cheap energy to improve standards of living and for economic growth.

An ecological footprint can show people's impact on the planet in order to provide all the resources we use and how we dispose of our waste.

