GCSE GEOGRAPHY
UNIT 2 – CHALLENGES IN THE HUMAN ENVIRONMENT
SECTION C THE CHALLENGE OF RESOURCE MANAGEMENT

Student Name: ____ Class: ___________

Specification Key Ideas:

Key Idea	Oxford text book
Resource management	P256-P263
• Food water and energy are fundamental to human development	P256-257
• The changing demand and provision of resources in the UK create opportunities and challenges	P258-63
Energy	P288-299
• Demand for energy resources is rising globally but supply can be insecure, which may lead to conflict.	P288-291
• Different strategies can be used to increase energy supply.	P292-299

Scheme of Work:

Lesson	Learning intention:	Student booklet
1	The global distribution of resources	P7-P8
2	Provision of food in the UK	P9-P10
3	Provision of water in the UK	P10-P13
4	Provision of energy in the UK	P13-P15
5	Global energy supply and demand	P16-P19
6	Impacts of energy insecurity	P19-P22
7	Strategies to increase energy supply	P22-P26
8	Gas-a non-renewable resource & Case Study: Extracting natural gas in the Amazon	P26-P29
9	Sustainable energy use	P30-P37
	Case Study: The Chambamontera micro-hydro scheme (Peru)	

AQA GCSE GEOGRAPHY(8035)

3.2.3 Section C: The challenge of resource management In this section, students are required to study <u>Resource management</u> and one from Food or Water or <u>Energy</u>.

3.2.3.1 Resource management

Food, water and energy are fundamental to human development

- The significance of food, water and energy to economic and social well-being.
- An overview of global inequalities in the supply and consumption of resources.

The changing demand and provision of resources in the UK create opportunities and challenges. An overview of resources in relation to the UK.

- Food:

- The growing demand for high-value food exports from low income countries and all-year demand for seasonal food and organic produce larger carbon footprints due to the increasing number of 'food miles' travelled, and moves towards local sourcing of food.
- The trend towards agribusiness.

- Water:
  - The changing demand for water
  - Water quality and pollution management
  - Matching supply and demand – areas of deficit and surplus
  - The need for transfer to maintain supplies.
- Energy:
  - The changing energy mix – reliance on fossil fuels, growing significance of renewables
  - Reduced domestic supplies of coal, gas and oil
  - Economic and environmental issues associated with exploitation of energy sources.

3.2.3.4 Energy

Demand for energy resources is rising globally but supply can be insecure, which may lead to conflict.

- Areas of surplus (security) and deficit (insecurity):
  - Global distribution of energy consumption and supply
  - Reasons for increasing energy consumption: economic development, rising population, technology
  - Factors affecting energy supply: physical factors, cost of exploitation and production, technology and political factors. Impacts of energy insecurity – exploration of difficult and environmentally sensitive areas, economic and environmental costs, food production, industrial output, potential for conflict where demand exceeds supply.

Different strategies can be used to increase energy supply

- Overview of strategies to increase energy supply:
  - Renewable (biomass, wind, hydro, tidal, geothermal, wave and solar) and non-renewable (fossil fuels and nuclear power) sources of energy
  - An example to show how the extraction of a fossil fuel has both advantages and disadvantages.

- Moving towards a sustainable resource future
  - Individual energy use and carbon footprints. Energy conservation: designing homes, workplaces and transport for sustainability, demand reduction, use of technology to increase efficiency in the use of fossil fuels
  - An example of a local renewable energy scheme in an LIC or NEE to provide sustainable supplies of energy.

This is the glossary of key terms and definitions for **Chapter 19: Resource management.**

Key term	Definition
Agribusiness	intensive farming aimed at maximizing the amount of food produced
Carbon footprint	measurement of the greenhouse gases individuals produce, through burning fossil fuels
Development	the progress of a country in terms of economic growth, the use of technology and human welfare
Energy conservation	reducing energy consumption by using less energy and existing sources more efficiently
Energy mix	the range of energy sources of a region or country, both renewable and non-renewable
Energy security	uninterrupted availability of energy sources at an affordable price
Food miles	the distance covered supplying food to consumers
Fossil fuels	a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms
Fracking	the process of extracting gas from gas shale where fluids at high pressure are injected to fracture the shale rock, allowing the gas to escape
Grey water	recycled domestic waste water
Import	goods and services bought by residents of a country from another country
Organic produce	food produced without the use of chemicals such as fertilisers and pesticides

Renewable energy	a resource that cannot be exhausted, e.g. wind, solar and tidal energy
Resources	a stock or supply of something that has value or a purpose
Resource management	control and monitoring of resources so that they do not become exhausted
Undernourishment	a food intake below that needed to sustain a healthy life
Undernutrition	when people do not eat enough nutrients to cover their needs for energy and growth, or to maintain a healthy immune system
Water deficit	when demand for water is greater than supply
Water quality	measured in terms of the chemical, physical and biological content of the water
Water stress	when the demand for water exceeds supply in a certain period, or when poor quality restricts its use
Water surplus	when the supply of water is greater than demand for water
Water transfer	matching supply with demand by moving water from an area with water surplus to another area with water deficit

This is the glossary of key terms and definitions for **Chapter 22: Energy management.**

Key term	Definition
Biofuel	energy produced from organic matter
Carbon footprint	measurement of the greenhouse gases individuals produce, through burning fossil fuels
Economic impacts	the effects of an event on the wealth of an area or community
Energy conservation	reducing energy consumption by using less energy and existing sources more efficiently
Energy deficit	when demand for energy exceeds the available supply of energy
Energy exploitation	developing and using energy resources to the greatest possible advantage, usually for profit
Energy insecurity	without reliable access to sufficient energy sources at an affordable price
Energy mix	the range of energy sources of a region or country, both renewable and non-renewable
Energy security	uninterrupted availability of energy sources at an affordable price
Energy surplus	when the supply of energy exceeds the demand for energy
Environmental impacts	the effects of an event on the landscape and ecology of the surrounding area
Flashpoints	areas where the transport of oil is at risk from political conflicts, terrorism, hijack or collision

Fossil fuels	a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms
Fracking	the process of extracting gas from gas shale where fluids at high pressure are injected to fracture the shale rock, allowing the gas to escape
Geothermal energy	energy generated by heat stored deep in the Earth
Hydroelectric power (HEP)	electricity generated by turbines that are driven by moving water
Micro-hydro	the exploitation of water power as a renewable source of energy
Natural gas	a fossil fuel formed from the decomposition of organisms deposited on the seabed millions of years ago
Non-renewable energy	unsustainable resource that will eventually run out, or the economic and environmental cost become too high
Nuclear power	energy released by a nuclear reaction, especially by fission or fusion
Renewable energy	a resource that cannot be exhausted, e.g. wind, solar and tidal energy
Shale gas	natural gas that is found trapped within shale formations of fine-grained sedimentary rock
Social impacts	the effects of an event on the lives of people or community
Solar energy	sun’s energy exploited by solar panels, collectors or cells to heat water or air or to generate electricity
Subsistence farming	a type of agriculture producing only enough food and materials for the benefit of a farmer and their family

Lesson 1-The Global Distribution of Resources

What are resources?

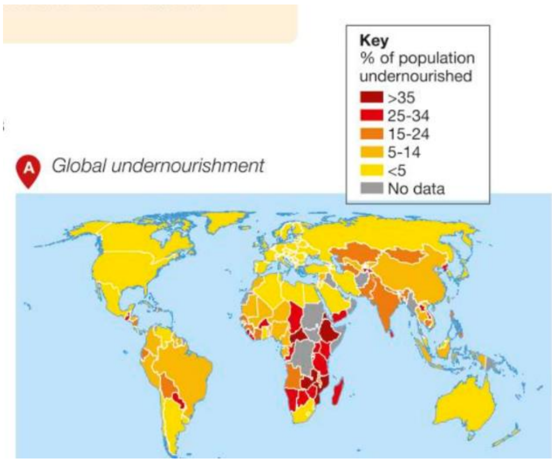
A resource is a stock or supply of something that has a value or purpose. The three most important resources are food, energy and water. Adequate supplies of these are essential for countries to develop.

These resources are unevenly distributed across the world. Most HICs have plentiful supplies and enjoy a high standard of living. But many of the world's poorer countries such as those in sub-Saharan Africa, lack resources and struggle to progress or improve the quality of life for their people. As the world's population continues to grow, resource management will present many challenges.

Food

Your health is affected by how much you eat and the food's nutritional value. The World Health Organisation (WHO) suggests that we need 2000-2400 calories per day to be healthy. Over one billion people in the world fall below this level and are described as malnourished.

A further two billion people suffer from **undernutrition** (malnutrition)- a poorly-balanced diet lacking in minerals and vitamins. This can result in a range of illnesses and diseases. It can also have economic effects. People need to be well fed to be productive at work and contribute to the economic development of the country. Obesity (being overweight) is an increasing problem. See map A for an indication of the countries that are experiencing undernourishment



Water

Think about how much water you have used and drunk today. Imagine that if you had just one bucket of water to use each day, including water for drinking. Both the quantity and the quality of water are important for our well-being and for our economic development (table B).

Country	Gross National Product (GNP) per head (US$)	Human Development Index (HDI) Ranking	Water per head (m^3)
Canada	22480	1	94000
Australia	20210	7	185000
Saudi Arabia	10120	78	2176
Burkina Faso	1010	171	1535
Niger	850	173	346

B

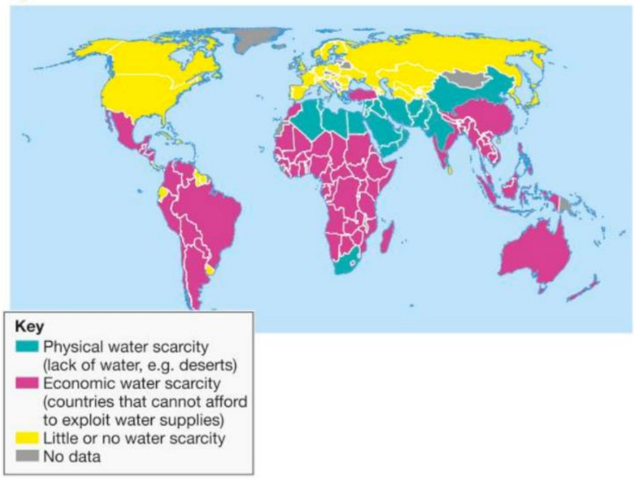
Figure B: How water supply relates to development

Water is not only essential for people and animals to drink but it is vital for crops and the food supply. It is also important as a source of power for producing energy (hydroelectricity). As the world's population grows, more people are faced with a shortage of water.

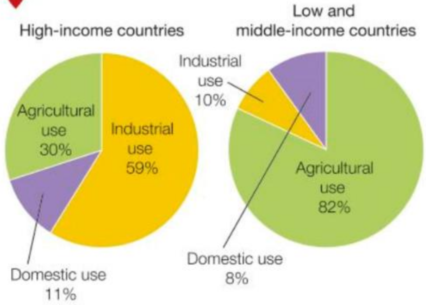
The imbalance in the water supply is due mainly to variations in climate and rainfall. Rainwater needs to be captured and stored in reservoirs or taken from rivers or aquifers deep underground. All of these are very expensive and require high levels of investment.

Many of the world's poorest countries particularly in Africa, have a shortage of water. They become trapped in a cycle of poverty. The UN estimates that by 2025 there will be 50 countries facing water scarcity (map C).

C *Projected areas of water scarcity by 2025*



D *How water use links to a country's income*

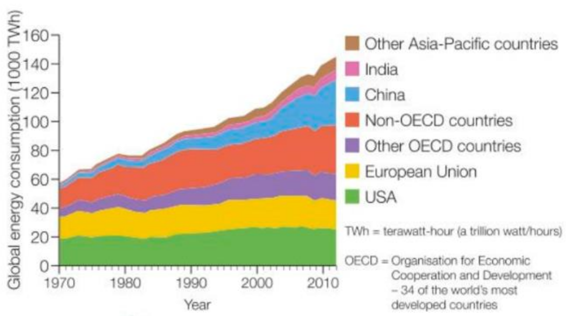


There are significant differences in water use between low/middle and high-income countries (graph D). Low/middle-income countries use a higher proportion of water to agriculture compared to high income countries where most water is used for industry.

Energy

Think of the energy needed in your home and school for light and heat to power things like cookers, TVs and tables. Energy is required for economic development. It powers factories and machinery and provides fuel for transport. In the past many countries could depend on their own energy resources. Today the situation is more complex , with energy being traded worldwide.

Energy consumption is increasing as the world becomes more developed and demand increases (graph E). The world's richest countries use far more power than countries in Africa and the Middle East. The Middle East supplies much of the world's oil yet its own consumption is relatively small.



ght and E *Global energy consumption*

As NEEs become more industrialised, the demand for energy will increase and the patterns of energy trading will change.

How is the demand for food changing in the UK?

By 2037 the population of the UK is expected to rise to 73 million (form 64 million in 2015). This will increase the future demand for food. Despite the UK's efficient and productive farming sector the UK is not self-sufficient for food supplies. In fact the UK imports about 40% of the total food consumed and this proportion is increasing. Diagram **A** shows reasons why the UK imports such a high proportion of food.

A *Why is the UK not self-sufficient in food?*

What is the impact of importing food?

Map **D** shows the distances travelled by foods imported to the UK- known as **food miles.** Transporting food by air is very expensive. Importing food also adds to our **carbon footprint**- the emission of carbon dioxide into the atmosphere. This comes from producing the energy for commercial cultivation, and from transport by planes and lorries.

have high levels
chemicals.

D *Distances travelled by UK imported food*

Importing high-value foods: vegetables from Kenya

The growing of vegetables such as mangetout is Kenya's biggest source of income (photo **B**). The cost of air freight to keep produce fresh is very high. UK customers are prepared to pay higher prices for vegetables when they are not in season in the UK.

B *Vegetables produced in Kenya*

Kenyan farmers only earn a fraction of the price of the vegetables in a UK supermarket (table **C**). Two-thirds are casual labourers with no job security or benefits and are paid very little.

Stage	Price per tonne (£)	% of final price
Producer	630	12
Exporter	290	6
Packaging	280	5
Air freight/handling	1040	20
Importer	620	12
Supermarket	2500	45
Total price	5360	100

C *Price breakdown for one tonne of Kenyan mangetout*

Maths skills

Draw a pie graph to show the breakdown of the price of imported mangetout.

How is the UK responding to the challenges?

There is a concern that the UK's dependency on foreign food imports and the need for greater food security. This has led to a growing interest in sourcing food locally to reduce carbon emissions. People are being encouraged to eat seasonal foods produced in the UK.

There are two major recent trends in UK farming:

- **Agribusiness**- intensive farming aimed at maximising the amount of food produced. Farms are run as commercial businesses. They have high levels of investment, and use modern technology and chemicals.
- **Organic produce**-grown without the use of chemicals. Organic food has become increasingly popular, although higher labour costs often make it more expensive. Organic food production is often associated with buying local produce and producing seasonal foods.

Examples:

Lynford House Farm – an agribusiness

Lynford House Farm in East Anglia is a large arable farm of 570 hectares. As an agribusiness it has high inputs of chemicals, machinery and other investments.

- The flat, fertile land is intensively farmed to maximise productivity and profitability.
- The main crops are wheat, sugar beet and potatoes which are well suited to the fertile soils and a warm, sunny climate.
- Chemicals are widely used as pesticides and fertilisers.
- Machinery costs are high but make the farm efficient. It only employs a small number of workers.
- The farm has invested in a 54-million litre reservoir to tackle frequent water shortages in this dry area.

Riverford Organic Farms

Riverford Organic Farms began as an organic food and dairy farm in rural Devon. It supplied local people with fresh boxes of food delivered weekly. The company now delivers boxes of vegetables around the UK from its regional farms in Devon, Yorkshire, Peterborough and Hampshire. These farms help Riverford to:

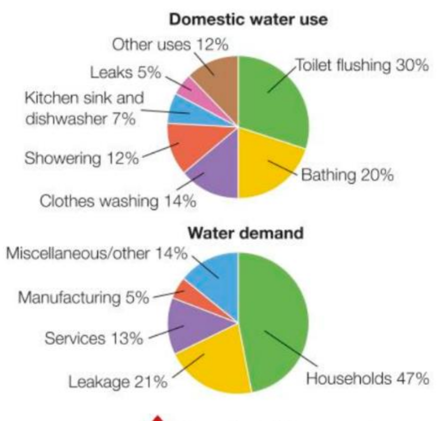
- reduce food miles
- support local farmers
- provide local employment
- build a strong link between grower and consumer.

See what your global footprint is, by taking this survey: http://footprint.wwf.org.uk/

<u>L3: Provision of water in the UK</u>

What are the demands for water in the UK?

Think about all the ways you use water, for washing, drinking, flushing the toilet, cleaning and cooking. Almost 50% of the UK's water supply is used domestically. But 21% is wasted through leakage (graph **A**).



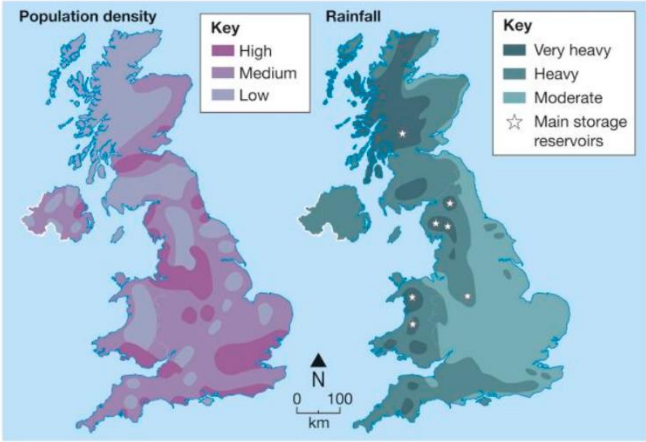
A *How the UK uses water*

The environment agency estimates that the demand for water in the UK will rise by 5% by 2020 because of:

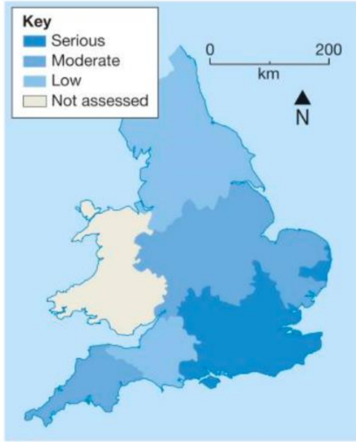
- The growing population
- More houses being built
- An increase in the use of water-intensive domestic appliances (dishwashers etc)

How far does the UK's water supply meet demand?

The main sources of water in the UK are rivers, reservoirs and groundwater aquifers. The UK currently receives enough rain to supply the demand, but rain doesn't always fall where it is most needed (map **B**).



B UK population density and water supply



C Water stress in England

- The north and west of the UK has a **water surplus** where supply exceeds demand. There is high rainfall, lower evaporation rates and plenty of potential reservoir sites. These areas have a relatively low population density.
- The south and east of the country has a high **water deficit w**here demand exceeds supply. This is the most densely populated part of the country and has the lowest amount of rainfall.

Water stress (where demand exceeds supply) is experienced in more than half of England (map **C**). The south east of England ranks very low in the world in terms of water availability. The situation is worse in times of drought, such as in 2010-2012.

How can water be saved?

➢ Saving water can help manage water supplies, savings can be made by:

- The use of domestic water meters
- Increasing the use of recycled water
- More efficient use of domestic appliances

Waste water (grey water) from people's homes can recycled and put to good use. It can be used to irrigate both food and non-food plants. The phosphorous and nitrogen in the water are an excellent source of nutrients.

➢ Water transfer:

In 2006 the government proposed to establish a water transfer grid to transfer water from areas of water surplus to areas of water deficit. The enormous cost of such an engineering project has stopped it from happening. Water is only transferred via the Rivers Tyne, Derwent, Wear and Tees to as far south as Yorkshire.
There is a growing need to increase water transfer in order to meet demand (map D). But there is opposition to large-scale water transfer because of:

- The effect on land and wildlife-river habitats would need to be protected
- The high costs involved
- The greenhouse gases released in the process of pumping water long distances

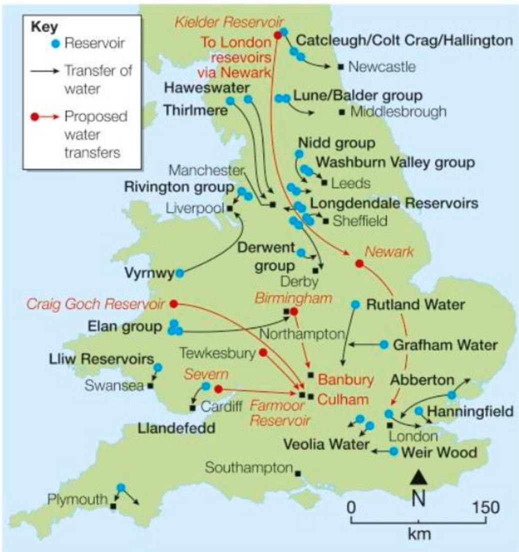
➢ Managing water quality

Water quality is just as important as water quantity. Much has been done to improve the quality of the UK rivers and water sources. The Environment agency manages water quality by:

- Monitoring the quality of the river
- Filtering the water to remove sediment
- Purifying water by adding chlorine
- Restricting recreational use of water sources
- Imposing strict regulations on the uses of water

But some groundwater sources have been deteriorated as a result of pollution due to:

- Leaching from old underground mine workings
- Discharge from industrial sites
- Runoff from chemical fertilisers used on farm land
- Water used for cooling in power stations released back into rivers



'der to meet
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D Water transfer schemes in England and Wales

An example of management of water usage in the UK

Elan Valley Water Transfer Scheme

Much of Birmingham's tap water comes from over 100 km away. There are five dams in the Elan Valley which can supply Birmingham with 160 million litres of water a day.

Reasons for choosing the Elan valley location

- Deep narrow valleys to hold the water in.
- Impermeable rock means the water wouldn't leak away.
- A high annual rainfall of 1830 mm.
- The area is higher than Birmingham, so the water can flow using gravity rather than pumps.

The Craig Goch Dam, Elan Valley.

Pen-Y-Garreg reservoir, Elan Valley

Future expansion of the scheme raises problems. The local environment would be damaged. There would be increased traffic and noise from the construction of dams to provide extra capacity. The river flow downstream would be affected, along with the wildlife. Also more land would be affected when pipes are run across it.

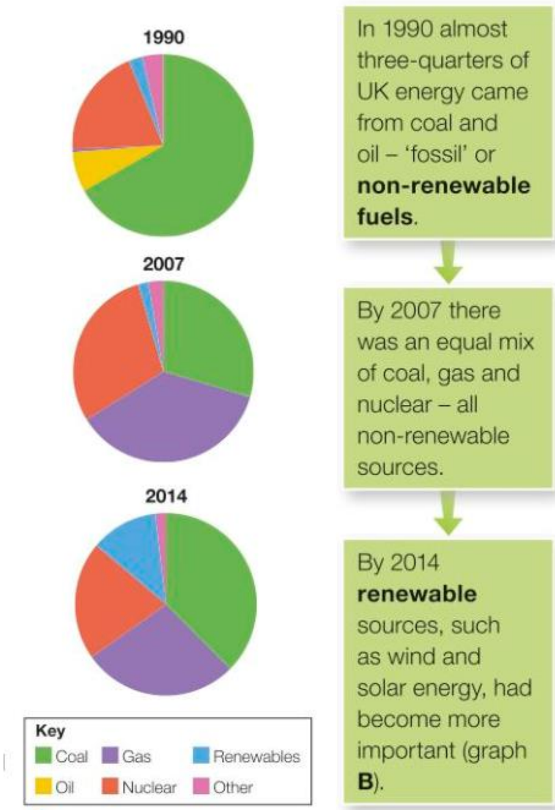
L4 provision of energy in the UK

How is the UK's energy demand changing?

Despite increasing demand for electricity in the UK, energy consumption has fallen in recent years. This is due mainly to the decline of heavy industry and improved **energy conservation**. Low-energy appliances, better building insulation and more fuel-efficient cars have resulted in a 60% fall in energy use by industry and a 12% fall in domestic energy use.

How has the UK's energy mix changed?

The UK's energy mix (the range and proportions of different energy sources) has changed in the last 25 years (See figure A). By 2020 the UK aims to meet 15% of its energy requirement from renewable sources. However, in 2015 the government decided to phases out subsides for wind and solar energy development.

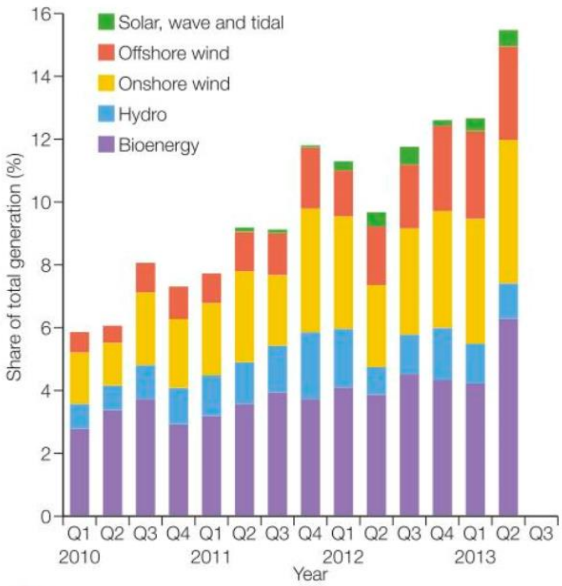


A The UK's changing energy mix

How has the UK's energy mix changed?

The UK is no longer self-sufficient in energy. About 75% of the UK's known oil and natural gas reserves have been exhausted. By 2020 the UK is likely to be importing 75% of its energy. The UK's **energy security** is affected as it becomes increasingly dependent on imported energy.

Two-thirds of UK gas reserves remain, with oil remaining in less accessible oilfields. The remote Mariner oilfield (150km east of the Shetland Isles) will start producing in 2017, but UK oil production overall has declined by 6% each year during the last decade.



B The renewable share of total electricity generation

The major change in the UK energy mix has been the decline of coal. Between 1990 and 2007 there was a steady decline because of concerns about greenhouse gas emissions and ageing coal-fired power stations.

However, fossil fuels are likely to remain important in the future because:

- The UK's remaining reserves of fossil fuels will provide energy for several decades.
- Coal imports are cheap-over three-quarters of the UK's coal now comes from abroad, mainly from Russia, Colombia and the USA.
- Existing UK power stations use fossil fuels-all coal fuelled power stations are to be closed by 2025.
- Shale gas deposits will be exploited in the future.

What is the fracking issue?

The UK has rich reserves of natural gas trapped deep underground shale rocks. To extract the gas, high pressure liquids (water, sand and chemicals) are introduced to fracture the shale and release the gas. This process is called **fracking**.

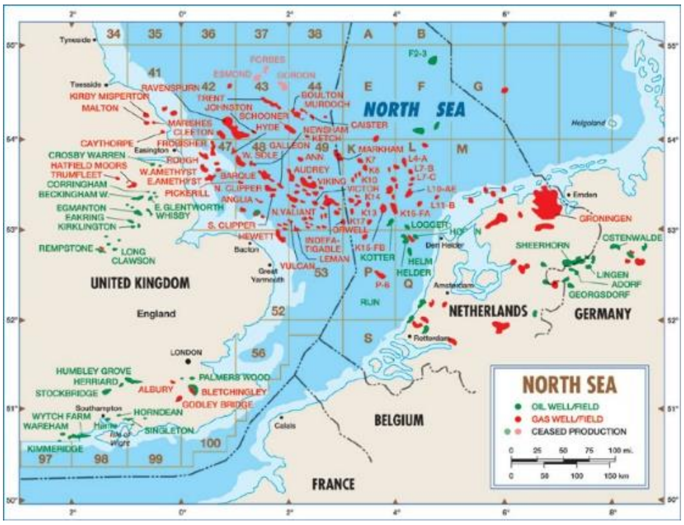
Fracking has become a very controversial issue (photo C). People are concerned about:

- The possibility of earthquakes
- Pollution of underground water sources
- The high costs of extraction.

C An anti-fracking protest

Figure E UK oil refinery in the North Sea

Figure F North Sea and surrounding oil and gas map



The impacts of energy exploitation

Energy exploitation can have both economic and environmental impacts. Table **D** focuses on two important energy sources being developed in the UK.

D *The economic and environmental impacts of nuclear and wind power development*

	Economic	Environmental
Nuclear	• Nuclear power plants are very expensive to build. The proposed new Hinkley Point plant (page 46) could cost £18 billion, with funding from China. • High costs for producing electricity. • Decommissioning old nuclear power plants is expensive. • Construction of new plants provides job opportunities and boosts the local economy.	• The safe processing and storage of the highly toxic and radioactive waste is a big problem. • Warm waste water can harm local ecosystems. • The risk of harmful radioactive leaks.
Wind farms	• High construction costs. • May have negative impacts on local economy by reducing visitor numbers. • Some wind farms attract visitors by becoming tourist attractions. • At Delabole wind farm in Cornwall, the UK's first commercial wind farm, local homeowners benefit from lower energy bills. The wind farm has also set up a Community Fund.	• Visual impact on the landscape. In the Lake District, concerns about falling visitor numbers have resulted in several plans being rejected. • Wind farms avoid harmful gas emissions and help reduce the carbon footprint. • Noise from wind turbines. • Construction of a wind farm and access roads can impact on the environment.

Fuel	Cost now	Future cost	Carbon emissions g/KWh	UK supplies
Coal	very low	moderate	1,100	moderate
Gas	very low	moderate low	400	poor
Oil	moderate	high	900	very poor
Shale gas	moderate	moderate	500	excellent
Nuclear	low	moderate	20	very poor ***
Wind offshore	moderate	low	11 *	excellent
Wind onshore	low	low	11 *	excellent
Solar	moderate high	low	45 *	moderate
Tidal barrage	moderate high	moderate	9	good
Biomass	low	low	40	moderate
HEP	very low	very low	7	poor **

Figure G

The costs of energy

(*producing and installing equipment, ** lack of mountainous areas, *** no UK uranium)

Lesson 5 Energy Management: Global Energy Supply and Demand

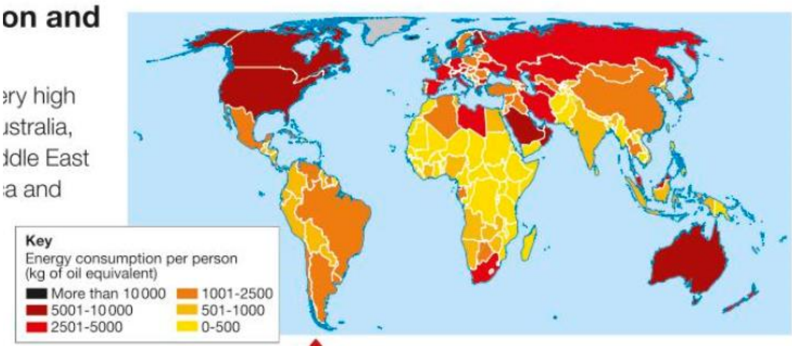
https://www.youtube.com/watch?v=FJW_qYUds2I

The outlook for energy demand and supply options over the next 20 years.

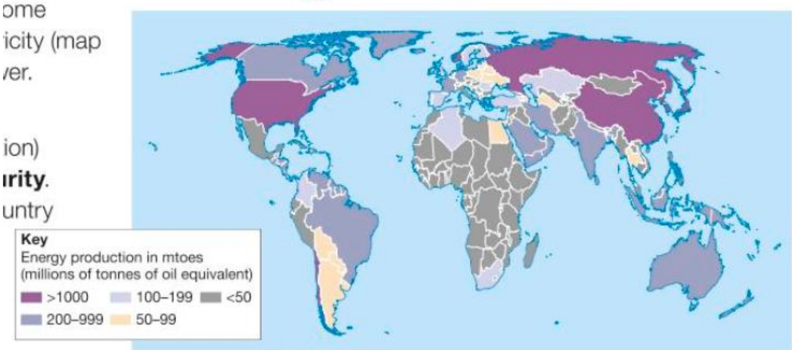
Global energy consumption and supply.

Energy consumption per person is very high in countries like the USA, Canada, Australia and much of Europe, and parts of the Middle East (map **A**). It is low across most of Africa and parts of south east Asia. In regions of high energy consumption there is a growing demand for industry, transport and domestic use.

Some regions have energy resources such as coal, oil or gas. Some areas are also able to produce electricity (map **B**) , for example by using nuclear power.

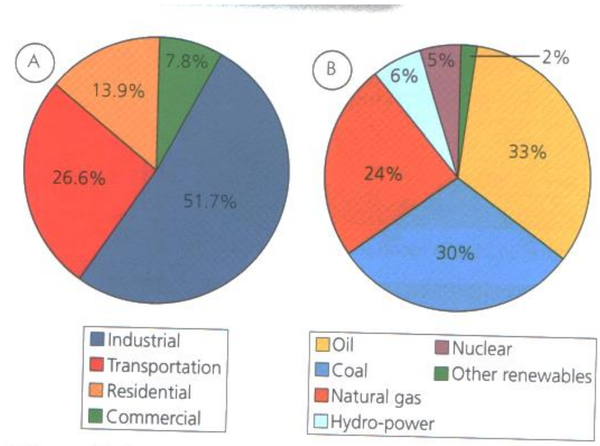


A Global energy consumption



B Global energy supply (production)

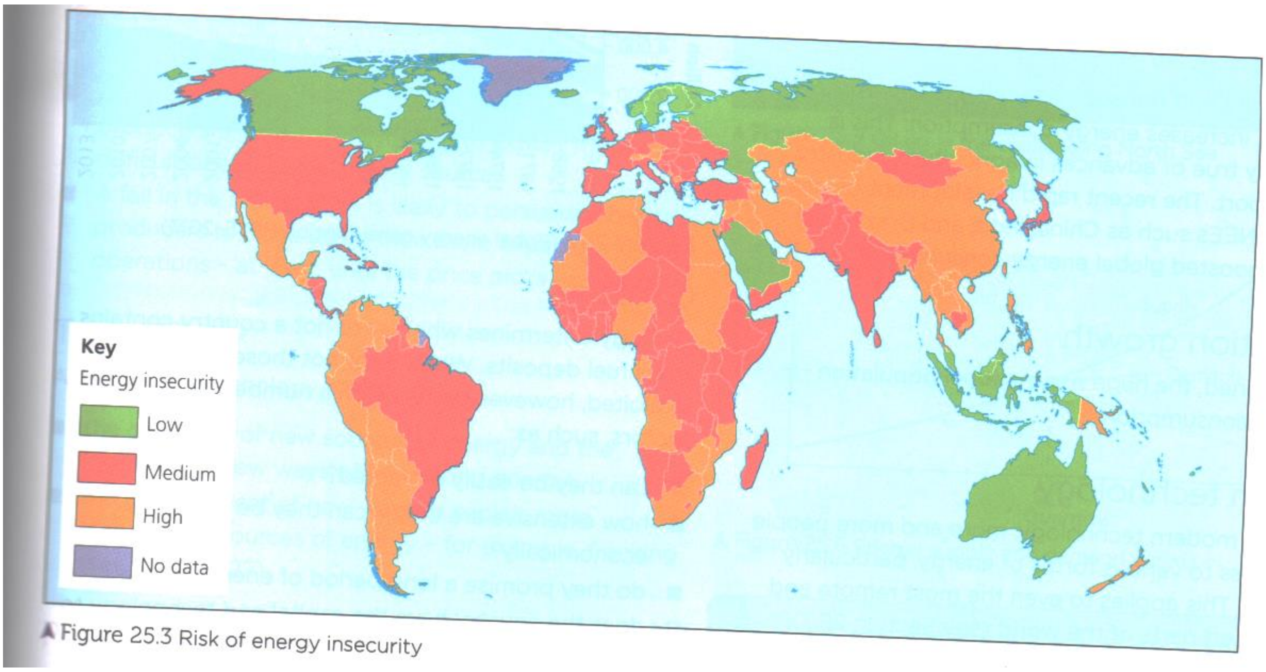
The balance between energy supply and (production) and demand (consumption) determines the level of **energy security.** If supply exceeds demand then a country has an energy surplus. If demand exceeds production, there is an energy deficit and the country suffers from energy insecurity (table **C**) .



▲ Figure 25.1 a) Global energy consumption; b) Global energy supply

Figure 25.1 b shows that nearly 90% of the world's energy supply comes from three non-renewable fossil fuels: oil, natural gas and coal. The other renewables in this category are made up of geothermal, wind and solar energy, biofuels, biomass and waste. All are mainly used to generate electricity. If we compare the global maps of energy production **Fig A** and **Fig B** above, we note two significant things:

- The world's major consumers of energy are also the major producers of energy: they are mainly high income countries (HICs). They mostly have **energy security**, where energy is **available to all** at an **affordable price**.
- Energy production is low in those countries where the demand for energy is also low; they are mainly low-income countries (LIC's). They mostly have **energy insecurity.**



▲ Figure 25.3 Risk of energy insecurity

The parts of the world with **lowest risk** of **energy insecurity** include Canada, Russia, most Middle Eastern countries, Indonesia and Australia (**See fig 25.3 and fig C**). High risk countries occur in Africa as well as in parts of Asia and Latin America. But in some of these countries there is no need to import large quantities of energy as their demands are small.

What is the energy gap?

An increasing number of countries face an energy gap. In the UK and elsewhere, the energy gap is becoming wider. The use of fossil fuels particularly coal, is being deliberately phased out. But the resulting loss of energy is greater than the amount of energy being produced by alternative renewable resources. These countries therefore have **energy balances** increasingly in **deficit.** In short, energy insecurity is increasing, particularly where there is more reliance on imported supplies of energy.

C Energy security status, by region

Region	Energy security	Energy sources
Russia and Eastern Europe	Energy surplus	• Large reserves of natural gas and oil. • Uranium resources which can be used for nuclear energy.
Western Europe	Energy insecurity (deficit)	• Dependent on energy imports, particularly oil and gas. • Low energy efficiency.
Middle East	Energy surplus	• Large oil reserves. • Unstable political regimes affect fuel supply.
North America	Energy insecurity	• Large coal reserves. • Opportunity to exploit oil reserves in sensitive areas like the Arctic. • Huge energy consumption. • Deficit in energy until technological advances allowed exploitation of oil shale.
Asia	Energy insecurity	• Large coal and uranium deposits. • Rapidly increasing demand outstrips supply.
Sub-Saharan Africa	Energy insecurity	• Depends on foreign TNCs to exploit reserves, for example Nigerian oil. • Limited energy supplies with rising rates of consumption.

What factors affect energy supply?

What factors affect energy supply?

Costs of exploitation and production

Some energy sources are costly to exploit. Oil rigs and pipelines require huge investment. Nuclear power stations are expensive to build.

Physical factors

The geology of an area determines the location and availability of **fossil fuels**. Coal is formed from vegetation laid down and altered by pressure and heat over millions of years. Natural gas and oil is trapped in folded layers of rocks. **Geothermal energy** is produced in areas of tectonic activity like Iceland and the Pacific Rim.

Technology

Technological advances have allowed energy sources in remote or difficult environments, such as the North Sea and the Arctic, to be exploited. They can also reduce costs. Technology has made possible the exploitation of shale gas by fracking (see page 263).

Political factors

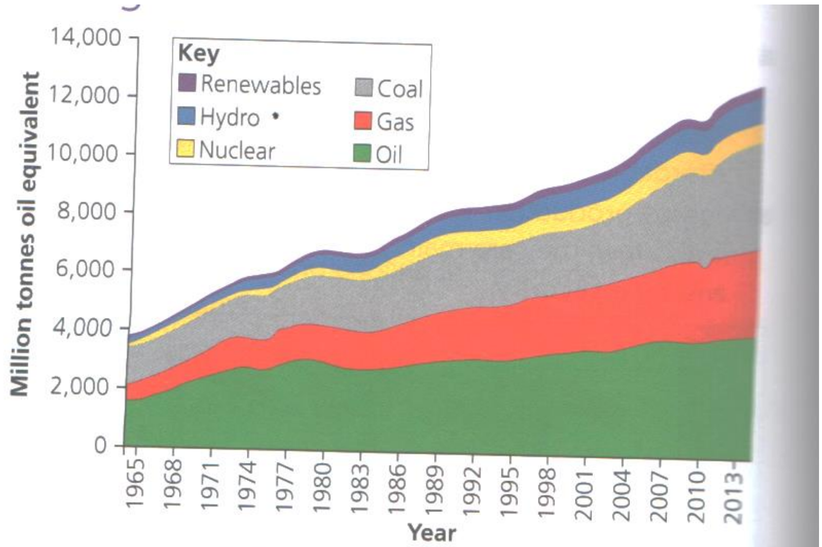
Political factors affect decisions about which energy sources to exploit and from which countries energy can be obtained.

- Political instability in the Middle East has meant that many oil-consuming countries are looking for alternative sources of energy.
- Some Western countries and Israel currently want to stop Iran developing nuclear power. They fear it will be used for non-peaceful purposes.
- The German government is planning to stop generating nuclear power by 2020.
- The UK government has decided to cut subsidies for renewable energy such as solar and wind.

Climate

The amount of sunshine and wind influence the availability of **solar energy** and **wind energy**. Tidal power needs a large tidal range in order to be effective. HEP needs a suitable dam site, often in sparsely populated mountainous areas with high rainfall.

Why is energy consumption increasing?



▲ Figure 25.4 Global energy consumption (1965–2013)

- **Economic development**
  As countries develop their demand for energy supplies rises. NEEs will account for more than 90% of the growth in demand for energy to 2035. Recent growth in Asia's energy demand has been led by China, but this has now started to slow down. Greater energy demand is expected to accompany rapid economic growth in India other parts of the south east Asia. This is due to industrialisation and greater wealth.

- **Rising population and technology**
  In 2015 the world's population was 7.5 billion. By 2050 it is predicted to rise to 9 billion. All these extra people will use more energy. Many will grow up in an increasingly energy thirsty world.

  The increasing use of technology, like computers and other electrical equipment, means a greater demand for energy. As quality of life improves and prosperity increases, the demand for vehicles, lighting and heating also increases.

Lesson 6 Impacts of energy insecurity

What can be done about energy insecurity?

Many countries experience energy insecurity. In order to secure their future energy needs, they must consider a range of options. To increase its energy supply a country may:

- Try to further exploit its own energy sources
- Reach agreements with other countries to import energy
- Reduce its energy consumption through new technologies or greater energy saving.

A country may be forced to take risks with the environment:

- Clearing forests for wood and then using the land to grow biofuels as in the tropical rainforests of Brazil.
- Drilling for oil and gas in environmentally sensitive areas, as on Alaska's North Slope, where great damage has been done to the tundra (Figure 25.7)

- Flooding valleys to generate more hydroelectric power, as in the Three Gorges projects in China, displacing people and depriving them of their livelihoods.
- Building wind and solar farms in areas of scenic beauty, as in the Scottish Highlands and Cornwall.

Exploiting resources in difficult and sensitives areas

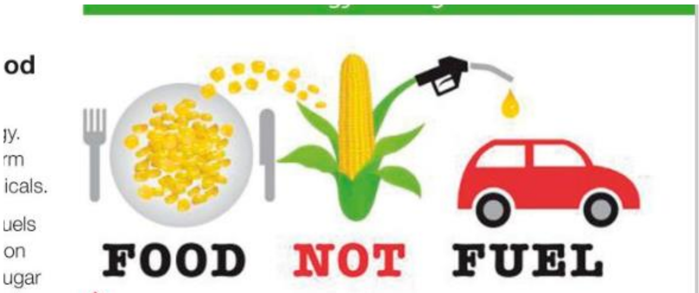
In the past, energy resources were relatively easy to exploit. For example, coal seams have been exposed at the Earth's surface. Today, complex techniques and expensive equipment are needed to extract oil and gas reserves in sensitive areas, such as deep below the North Sea.

Energy resources exist in some of the world's most hostile, dangerous and environmentally sensitive regions. These include the Amazon and Antarctica. Exploiting these resources in future will depend on:

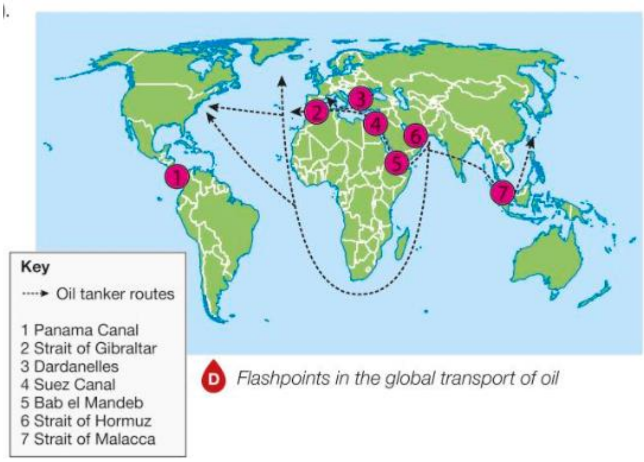
- The development of technologies that make exploitation cost-effective.
- The environmental implications of energy exploitation in areas that are extremely sensitives and could easily be damaged.

Impacts of energy insecurity on food production

Food production uses 30% of global energy. Modern, large-scale agriculture uses vast amounts of energy, from irrigation rigs, milking machines and feed mills to tractors and combine harvesters. Energy is also used to manufacture fertilisers and chemicals. Farming and food production is therefore vulnerable, particularly to any rises in energy prices demanded by foreign energy suppliers. Such rises not only make home food production more expensive, but they are likely to sharpen competition from foreign food suppliers in countries that are more energy secure.



C ActionAid's 'Food not fuel' campaign



D Flashpoints in the global transport of oil

Agriculture is also an **energy generator**. Use of biofuels has increased in response to concerns about carbon dioxide emissions. . Use of biofuels like maize and sugar cane have contributed significantly to increased food prices. In addition, biofuels are grown on land previously used for growing food crops (**cartoon C**).

In some LICs such as Tanzania and Mali firewood is the main source of energy. Instead of working on the land, people-often women have to spend hours walking to collect the wood. This impacts on food production in regions with high food insecurity.

Impacts of energy insecurity on industry

Energy is essential for industry as a source of power and a raw material. Oil, for example has many uses in manufacturing chemicals, fuels, plastics and pharmaceuticals.

Some countries suffer from shortfalls in electricity production, resulting in frequent power cuts. In Pakistan, regular power cuts can last for 20 hours a day. This costs the country an estimated 4% of its GDP. Energy shortages have left the closure of more than 500 companies in the industrial city of Faisalabad alone. Pakistan relies heavily on imported oil which makes energy expensive as well as insecure.

Potential for conflict

- Shortages of the energy can lead to political conflict when one state holds a bigger share of an energy resource. For example, Russia controls 25% of the world's natural gas supplies. It could put pressure on its customers-mostly in Western Europe-by raising prices or even cutting off supplies.

- The Middle East produces 40% of the world's gas and 56% of its oil. The Gulf and Iraq wars in the 1990s and 2000s were driven by the West's fear of a global oil shortage and rising prices.

- There are flashpoints where the transport of oil is at risk from political conflicts, terrorism, hijack or collision (**map D**).

- There could be conflict between the main energy consumers: people, agriculture, industry and transport-as they compete for what energy is available and push-up the price. In the UK, it is likely that agriculture and poor households will be the losers.

- Conflicts between home-produced goods and imported goods, particularly if those foreign goods come from countries where energy costs are less. Chinese manufacturing have access to energy that is much cheaper than in most of Europe. This, plus cheaper labour, means that Chinese manufactured goods compete on price.

- Conflict between those countries with sufficient energy supplies and those without. For example, it is thought that Argentina's claim on the Falkland Islands, owned by the UK, maybe to do with untouched reserves of oil and gas supplies located within the territorial waters of the island.

- Where pipeline or power cables cross, countries located between the supplier and the consumer might be a conflict flashpoint, for example, the dispute over the pipelines that move Russian natural gas across Ukraine to its markets in Europe.

Exploiting energy resources in the Arctic

Map **A** shows energy resources in the Arctic. This region holds an estimated 13 per cent (90 billion barrels) of the world's undiscovered oil resources and 30 per cent of its unexploited natural gas.

This region has great potential to supply energy in the future, but exploitation is difficult and expensive. The environmental consequences of an oil spill, for example, would be catastrophic for the fragile Arctic ecosystem. Recovery from damage would be slow given the low temperatures and short growing season.

To exploit energy resources in the Arctic, several economic and environmental factors need to be addressed (figure **B**).

A *Oil and natural gas resources in the Arctic (yellow shading)*

B *Economic and environmental costs of oil and gas exploitation in the Arctic*

B *Economic and environmental costs of oil and gas exploitation in the Arctic*

<u>Lesson 7 Strategies to increase energy supply</u>

What is the energy supply challenge?

The challenge facing the world today is how to increase energy supply in ways that:

- Do less damage to the environment
- Are affordable
- Suit the available technology
- Do not increase energy insecurity

Non-renewable energy sources

Non-renewable energy resources are unsustainable. At some point the economic environmental costs of these resources will become too high. Or they will run out.

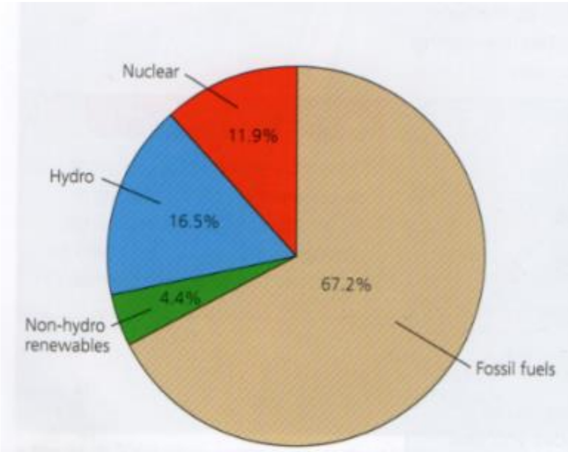
So, do fossil fuels have a future?

Fossil fuels are sources of energy formed from organic matter millions of years ago. They include coal, oil and gas. Although limited, there are still plenty of resources left in the world. Despite high carbon dioxide emissions they remain important for electricity production.

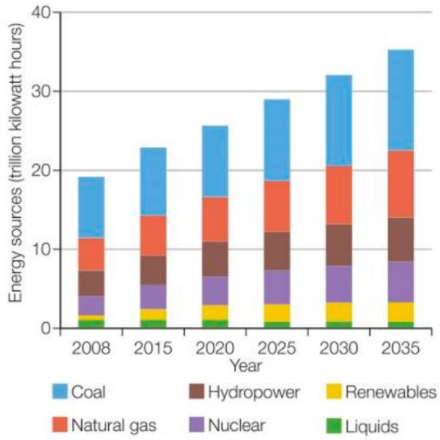
Growing concern about global warming and climate change has persuaded many governments to reduce their use of coal, oil and gas. The burning of these fossil fuels is pumping huge quantities of carbon dioxide and other greenhouse gases into the atmosphere. These fuels account for nearly all the global energy supply. Figure **25.9** shows that two thirds of all electricity comes from the burning of fossil fuels. Carbon capture techniques can help overcome the environmental impact.

- To combat this people could:
    - Rely more on alternative energy sources (renewables)
    - Make more use of natural gas, the cleanest of all the fossil fuels, as the overall reliance on fossil fuels is gradually reduced

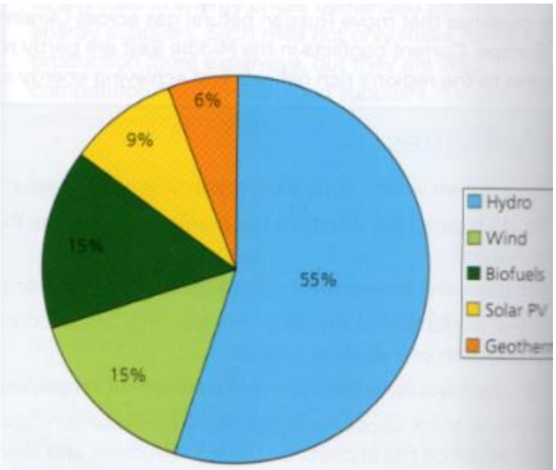
- o Find ways of reducing the emissions of carbon dioxide and make fossil fuels a little more environmentally friendly



▲ Figure 25.9 Fuels used to generate electricity



A Global energy sources for electricity production



▲ Figure 25.10 Global sources of renewable energy

Can energy supply ever be 'green' enough?

Despite a huge efforts over the last two decades, less than 10% of the world energy supply comes from renewable sources. To date, the main renewables have been hydro and wind power, and biofuels (**figure 25.10**).

Biofuels (also referred to as biomass) ore often thought to be newcomers to the world of energy. The term is a broad one that includes the earliest fuel known to humans- wood, which is still widely used throughout many LICs. Today's biofuels include:

- Biodiesel and ethanol made from made from crops made from crops such as sugar cane and soy beans
- Methane captured from the decomposition of rubbish in landfill sites.

Other renewables include geothermal energy, tidal and wave power. It is hoped that new technologies will allow the sources, particularly the last two, to make a bigger contribution to society.

Most people say they want some energy supply to become greener. However, proposals to build the new reservoir, Wind or solar farm are usually greeted by public outcry and protest. Even when a wind farm project is to be located well offshore, the tourist industry claims that it will ruin the tourists' view and their business. Renewable energy is unlikely to be able to supply all the energy needed globally, and of course, much of the world would need to be covered by reservoirs, wind, solar and biofuel farms.

Nuclear power stations

https://www.youtube.com/watch?v=rcOFV4y5z8c

Today, 5% of global energy comes from nuclear-power. All this power is used to generate electricity (15% of the world supply). Uranium is the fuel used in a process known as nuclear fission. The process creates great heat, which is then used to raise the steam that drives the electric turbines.

As nuclear power needs the mineral uranium, it is classified as a non-renewable source of energy. However, the quantity of uranium needed is very small. Nuclear power stations are very expensive to build. However, the cost of the raw material uranium is relatively low because only small amounts are used.

The main problem with nuclear power is the disposal of radioactive waste. It can remain dangerous for longer than 100 years. Despite a good safety record, there is considerable opposition. There is a fear of further accidents like those at Chernobyl, or Fukushima after the Japanese tsunami in 2011.

Will nuclear power be part of the strategy to increase the supply of energy?

Not all high income countries are in agreement on this issue. For example, Germany has indicated that it favours a non-nuclear energy strategy. Japan is thinking about abandoning its nuclear power stations.

A key feature of any supply-increasing strategy must be to find the right energy mix. The mix should:

- Meet the present and future energy needs
- Make the best use of energy sources within the country
- Understand the strengths and weaknesses of available technology- the nuclear power option would not be suitable for low-income country. A HEP plant maybe more appropriate.

Other renewable sources that might make a greater contribution to energy supply in the future include:

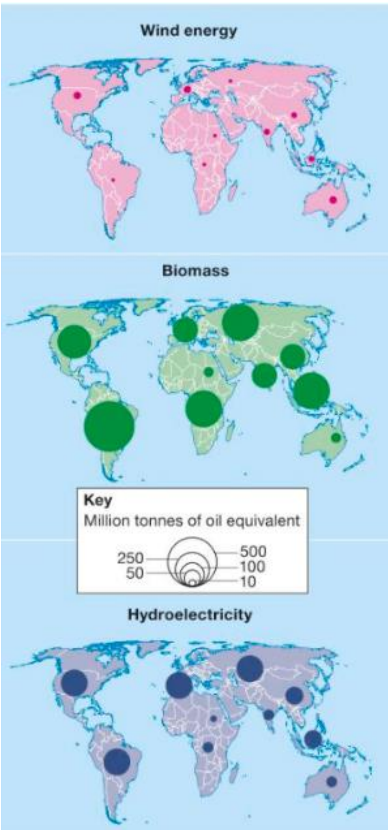
- Geothermal energy is thermal energy that is generated and stored in the Earth. It is ta tapped by drilling holes deep into the earth's crust. It generates electricity and provides hot water to residential areas. It is cost-effective, reliable, sustainable and environmentally friendly. So far it's exploitation has been limited to areas near tectonic plate margins.
- Tidal power converts the energy from the tides into electricity (**fig 25.11**). The world’s first large-scale tidal power plant became operational in France in 1966. Over the years, proposals have been made to harness the tidal power in the River Severn’s estuary. Technologically this is possible, but there has always been objections, mainly related to the negative impact on the environment and wildlife.

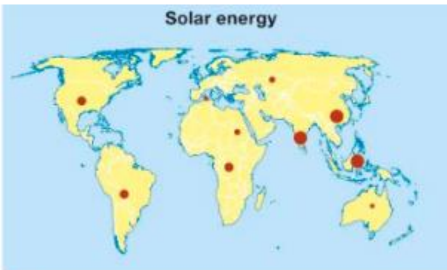
Wave power is a potentially great source of energy for conversion into electricity. The energy comes from the up and down motion of passing waves. Research is underway to develop an efficient wave energy converter.

The last two energy sources are sustainable, but they are only possible options for countries with coastlines. But not all of these countries will have to either the tidal range or the ocean swell to make them viable options.

Renewable energy sources

Renewable energy source	How does it work?	Can it increase energy supplies?
Biomass	Energy produced from organic matter includes: • burning dung or plant matter • the production of biofuels, by processing specially grown plants such as sugar cane.	• Using land to grow biofuels rather than food crops is very controversial. • Burning organic matter can create smoky unhealthy conditions. • Fuelwood supplies are limited.
Wind	Turbines on land or at sea are turned by the wind to generate electricity.	• In 2014, wind power met 10% of the UK's electricity demand. • Unpopular, but considerable potential.
Hydro (HEP)	Large-scale dams and smaller micro-dams create enough water to turn turbines and generate electricity.	• Large dams are expensive and controversial. • Micro-dams are becoming popular options at the local level. • An important energy source in several countries. It currently contributes 85% of global renewable electricity.
Tidal	Turbines within barrages (dams) built across river estuaries use rising and falling tides to generate electricity.	There are few tidal barrages (the largest is the Rance in France) due to high costs and environmental concerns.
Geothermal	Water heated underground in contact with hot rocks creates steam that drives turbines to generate electricity.	Limited to tectonically active countries: • the USA (has the most geothermal plants – 77) • Iceland (provides 30% of the country's energy) • the Philippines and New Zealand.
Wave	Waves force air into a chamber where it turns a turbine linked to a generator.	• Portugal has built the world's first wave farm, which started generating electricity in 2008. • There are many experimental wave farms but costs are high and there are environmental concerns.
Solar	Photovoltaic cells mounted on solar panels convert sunlight into electricity.	• Energy production is seasonal. • Solar panel 'farms' need a lot of space. • Great potential in some LICs with high levels of sunshine.





B *Potential sites for global renewable energy production*

Figure 25.11 A tidal power hub

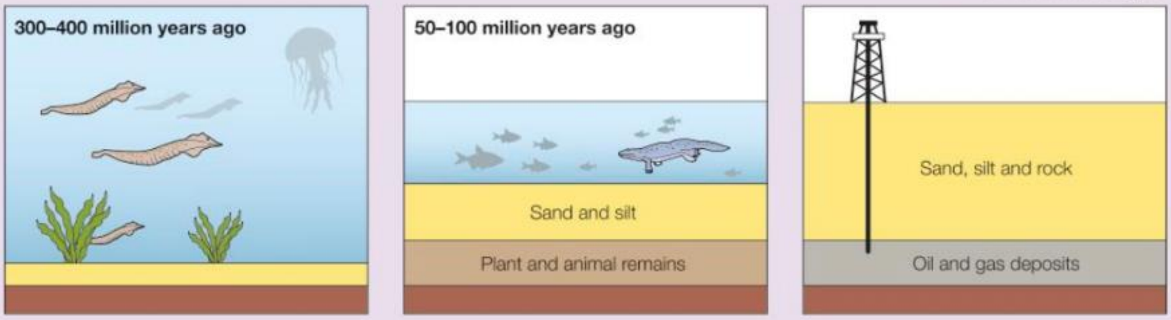
Lesson 8 Gas-a non-renewable resource

What is natural gas?

Natural gas is a hydrocarbon. Like oil, natural gas forms from the decomposition of organisms deposited on the seabed millions of years ago (diagram **A**). This is why it is called a fossil fuel. The organic matter was buried by layers of sediment and heated by compression. Lack of oxygen produced thermal reactions that converted the organic material into hydrocarbons.

The colourless and odourless natural gas rises up through cracks and pores (holes) in the overlying rocks. It then collects in concentrations called reservoirs. It is from these reservoirs that natural gas is extracted.

A The formation of oil and natural gas



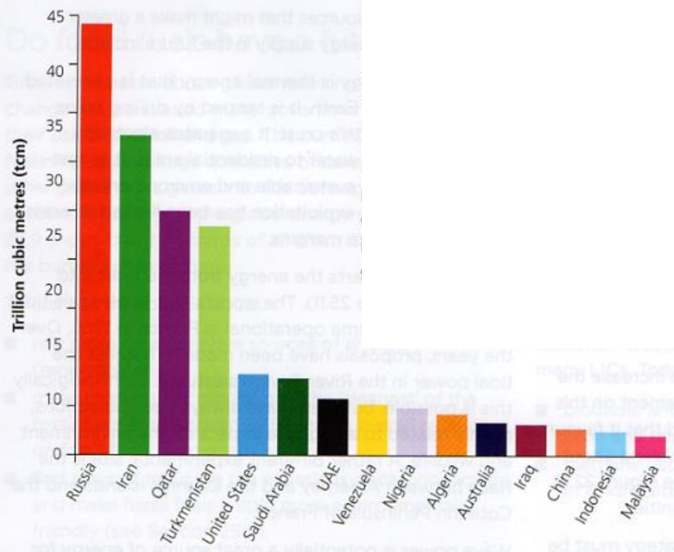
Remains of tiny sea plants and animals buried on ocean floor. Over time these are covered by sand and sediment.

Over millions of years the remains are buried deeper. Enormous pressure and heat turns them into hydrocarbons (oil and gas).

Today, oil and gas deposits are reached by drilling down through layers of sand, silt and rock.

Natural gas provides 24% of the worlds energy supply. It was around the middle of the 20th century that oil took over from coal is the main source of energy (**see fig A**). It is only since the 1970s that natural gas has begun to challenge the other two fossil fuels.

Natural gas was formed from decaying animal and plant matter that lived millions of years ago. Today, it is found underground, mainly trapped in deep shale rock formations. Wells are drilled and the gas comes to the surface, either under its own pressure or forced up by pumped water. Once at the surface, the gas is pumped through the pipeline to where it is used. This transfer often involves pumping the natural gas to ports, where it is shipped in huge tankers. At some point in its transmission, the gas will be refined to remove unwanted chemical impurities.
Figure **25.12** shows the 15 countries that between them hold over 80% of the world's **proven reserves** of natural gas. The rankings are well dominated by Russia and some Middle Eastern and Asian countries. The USA is well-placed, but Russia is the only European Country shown. The largest gas field in Western Europe is at Groningen in the Netherlands.



▲ Figure 25.12 The world's largest natural gas reserves

Country	Production in million m^3
Russia	48
Iran	36
Qatar	25
Saudi Arabia	9
Turkmenistan	8
United Arab Emirates	7
Venezuela	6
Nigeria	5.5
Réunion	5.5
China	4.5

B *The top ten gas-producing countries in 2015*

Where is natural gas found?

Nearly 60 per cent of known natural gas reserves are in Russia, Iran and Qatar (table **B**). These reserves are sufficient to last for the next 54 years at the current rate of production.

Recently technology has allowed **shale gas** to be extracted (map **C**). Shales are black sedimentary rocks formed from the same organic matter that is the source of oil and gas. To extract shale gas, the rock is broken up by a process called fracking. This process is very controversial and there is a lot of opposition (see page 263).

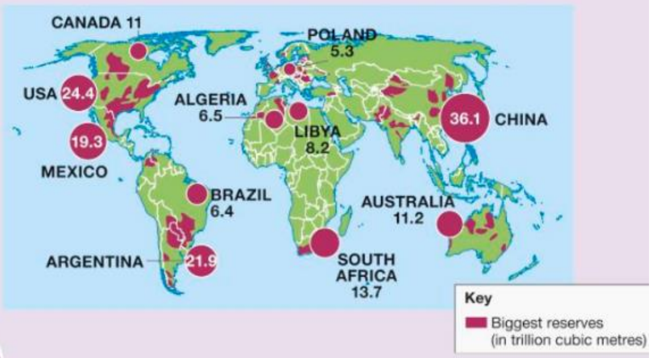
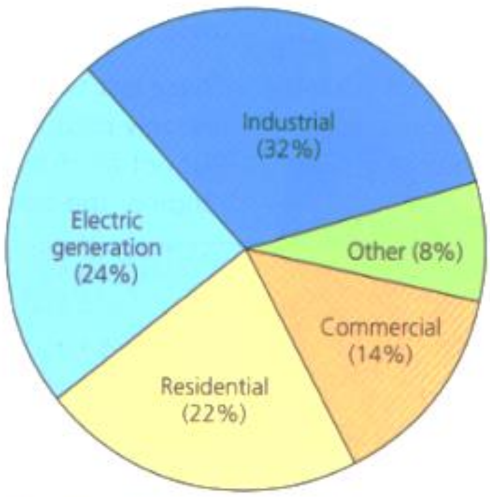


Figure C Global shale gas deposits

How is it used?



▲ Figure 25.13 Natural gas use by sector

Figure 25.13 shows that natural gas has a wide range of uses. Most natural gas is burnt to create heat that is either used directly in factories, the home, commercial premises and transport or is converted into electricity.

Extracting natural gas

Figure 25.14 summarises the main advantages and disadvantages of natural gas.

	Advantages	Disadvantages
Environmental	• A cleaner fuel producing less carbon emissions - 45 per cent less than coal and 30 per cent less than oil • Does not produce waste, such as coal ash • The extraction infrastructure causes less damage to the ground surface. • It is lighter than air and therefore disperses quickly in the case of leakages	• Leakages can be very dangerous, causing explosions and fire. If inhaled, the gas is very toxic • Burning releases greenhouse gases into the atmosphere, but less so than coal or oil • Ground subsidence and earthquakes caused by pumping of gas and fracking
Practical	• Can be used for many different purposes • An economic and instant fuel for heating water and large areas, as well as for cooking • Ideal because it allows precise control and quick results • More abundant than other fossil fuels with large proven reserves • Easy to distribute via pipelines	• Is odourless and leaks cannot be detected unless some odorant is added to the gas
Economic	• Cheaper than electricity • Also produces competitively priced electricity	• The infrastructure for extraction and distribution is fairly expensive • As motor vehicle fuel gives less mileage than petroleum (refined oil)

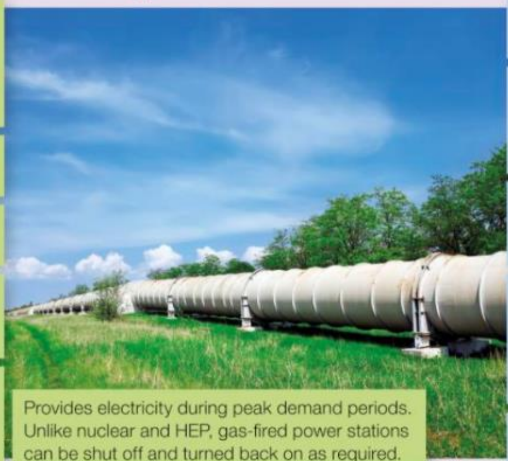
▲ Figure 25.14 The advantages and disadvantages of natural gas

Extracting natural gas

Advantages

- Cleanest of the fossil fuels with 45% less CO_2 emissions than other non-renewable sources and less toxic chemicals like NO and SO_2.
- Less risk of environmental accidents than oil.
- Provides employment for 1.2 million people.
- Can be transported in a variety of ways, i.e. through pipelines or by tankers over land and sea.
- Relatively abundant compared to other fuels. This is increasing as technology makes exploitation of shale gas more economic.
- Provides electricity during peak demand periods. Unlike nuclear and HEP, gas-fired power stations can be shut off and turned back on as required.

D *A gas pipeline*



Disadvantages

- Dangerous if handled or transported carelessly.
- Some gas reserves are in countries that are politically unstable or prepared to use gas supply as a political weapon.
- Contributes to global warming by producing CO_2 and methane emissions.
- Fracking is controversial. Lots of water is needed. Wastewater and chemicals could contaminate groundwater and minor earthquakes are possible.
- Pipelines are expensive to build and maintain.

What is the overall verdict on natural gas?

Natural gas is not a perfect source of energy-there is not one known to us at the moment! But the important valuation shows there's much more to commend it: the large proven reserves; it's relative cleanness and its versatility. Overall, is this compares more favourably with the other two major fossil fuels, coal and oil, but of course there are issues with fracking as the method of extraction.

Case Study: Extracting natural gas in the Amazon

Extracting natural gas in the Amazon

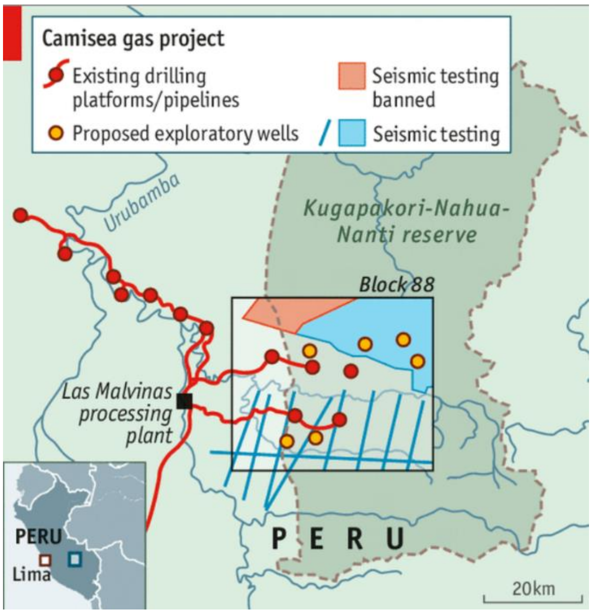
The Camisea project began in 2004 to exploit a huge gas field in the Amazonian region of Peru. The project has brought both advantages and disadvantages for Peru.

Advantages

- It could save Peru up to US$4 billion in energy costs.
- Peru could make several billion dollars in gas exports – up to US$34 billion over the 30-year life of the project.
- It provides employment opportunities and helps boost local economies.
- Improved infrastructure could bring benefits to local people. Agriculture could become more productive.

Disadvantages

- Deforestation associated with the pipeline and other developments will affect natural habitats.
- The project could impact on the lives of several indigenous tribes, affecting their traditional way of life and their food and water supplies.
- Local people have no immunity to diseases introduced into the area by developers.
- Clearing routes for pipelines has led to landslides and pollution of streams resulting in decline of fish stocks.

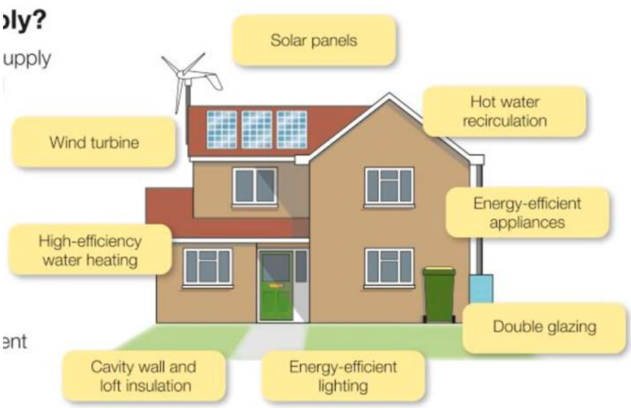


<u>Lesson 9 Sustainable energy use</u>

What is a sustainable energy supply?

A sustainable energy supply involves balancing supply and demand. It also involves reducing waste and inefficiency. Moving towards a more sustainable needs individual actions and decisions made by businesses, councils and national governments.

To increase energy supply, renewable sources of energy can be developed from fossil fuels can be exploited more efficiently. Energy demand can be reduced by increasing energy conservation and designing more energy efficient homes and workplaces (**see diagram A and B**).



A Energy conservation in the home

Reducing the use of fossil fuel and increasing efficiency will help reduce carbon dioxide emissions and our **carbon footprint**.

Calculate your footprint: http://footprint.wwf.org.uk/

Figure B: Making the home more energy efficient

- Switch off lights, power sockets, phone chargers and televisions when not in use
- Use energy-efficient light bulbs and rechargeable batteries
- Only use the washing machine or dishwasher when they have a full load
- Use curtains and blinds to provide insulation - from heat in summer and from heat loss in winter
- Wear warm clothing indoors in winter and turn down the central heating
- Walk and cycle more and become less reliant on transport over short distances
- Spend less time on the internet, playing electronic games and texting friends

▲ Figure 25.15 Some ways of reducing personal energy use

- Use public transport rather than private cars.
- Use smaller, more energy-efficient hybrid cars.
- Use alternative, cleaner fuels, such as electricity.
- Car-share when commuting to school or work.
- Reduce the number of aircraft journeys taken, especially short-haul flights.
- Cut down on the number of holidays taken abroad.

▲ Figure 25.18 Some ways of energy saving on transport

Sustainable energy development example:

Sustainable energy developments in Malmo, Sweden

To improve energy conservation, we need to consider sustainable approaches to the design of homes, workplaces and transport systems. These can be seen in innovations in Malmo, an industrial city of about 300 000 people on Sweden's west coast.

Malmo's Western Harbour (figure **B**) is one of the best examples of sustainable urban redevelopment in the world. The houses have been designed to generate and conserve energy and the transport system aims to reduce car usage.

B Malmo's Western Harbour

https://www.bbc.co.uk/education/clips/zc69wmn

Reducing energy demand

There are several ways of reducing energy demand. These can include:

- Financial incentives
- Raising awareness of the need to save and use energy more efficiently
- Greater use of off-peak energy tariffs
- Using less hot water for domestic appliances (reducing the washing machine temperature from 40c to 30c).

Reducing energy demand at Marriott hotels

The chain of Marriott hotels in the UK and Europe spends £60 million a year on energy. An automated system places the hotel chain on energy-saving standby if the national electricity supply grid needs to reduce demand.

Everything from air conditioning to ice coolers in the corridors can be turned down at a moment's notice without customers noticing. Not only will this reduce energy demand but the hotel chain is paid a supplement for reducing its energy use.


C An energy-saving Marriot hotel

How can technology increase efficiency of fossil fuels?

Vehicle manufacturers are using technology to design more fuel-efficient cars to reduce oil consumption and their carbon footprint. These developments include the use of carbon fibre, which is lighter than conventional steel, improved engines and aerodynamic designs to increase fuel efficiency.

The recent development of electric and hybrid cars will increase the efficient use of fossil fuels (**photo D**). In the USA the growth in the use of electric cars could reduce the use of oil for transport by up to 95%.

The development of biofuel technology in car engines can reduce the use of oil. Brazil has reduced its petrol consumption by using sugar can ethanol (**photo E**). Around 90% of all new cars in Brazil can run on both ethanol and petrol. Brazilians are increasingly choosing environmentally friendly ethanol because it is cheaper than petrol. However, growing biofuels rather than food crops is a controversial issue in Brazil.

D An electric car

E Ethanol fuel at a gas station in São Paulo, Brazil

The following information is part of the wider reading for lesson 9:

The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65602/6927-energy-efficiency-strategy--the-energy-efficiency.pdf

New petrol and diesel cars banned in UK from 2040 (there is a video on the website)
https://news.sky.com/story/petrol-and-diesel-cars-banned-from-uk-roads-by-2040-10962075

Energy Saving Trust quick wins. This is shown in pounds to **encourage people to save energy.**
http://www.energysavingtrust.org.uk/home-energy-efficiency/energy-saving-quick-wins

Sustainable living in Bed Zed- A UK example (for further reading)

Bed Zed: https://www.bbc.co.uk/education/clips/ztmc87h

The Beddington Zero Energy Development (BedZED) is the largest UK eco-community project experimenting in sustainable living. This report explains how urban planners are experimenting with designing homes to cope with the temperature rise predicted by 2080 to shut out the summer heat, conserve water and minimise energy. BedZED comprises homes with no central heating or air conditioning but instead makes full use of natural heating and lighting. The community boasts its own eco-friendly single generator of electricity and is able to capture rainwater which is then used for flushing toilets.

Beddington Zero Energy Development is an environmentally-friendly-housing development near Wallington, England, in the London Borough of Sutton. It was designed by the architect Bill Dunster, who was looking for a more sustainable way of building housing in urban areas. 99 homes, and 1,405 square metres of work space were built in 2000–2002. The project was shortlisted for the Stirling Prize in 2003.

Introduction

Located in Wallington, South London, BedZED comprises 100 homes, community facilities and workspace for 100 people. Residents have been living at BedZED since March 2002.

Due to BedZED's low-energy-emission concept, cars are discouraged; the project encourages public transport, cycling, and walking, and has limited parking space.

Sustainable Transport

The development is within about five minutes walk of Hackbridge station, which services trains from London Victoria and St Pancras International via London Blackfriars. There is a Tramlink service from Croydon or Wimbledon to Mitcham Junction station, which is within 15 minutes walk of BedZED.

The BedZED project introduced the first legally binding Green Transport Plan as a condition of planning permission. On-site charging points for electric cars are available in Sutton town centre.

Government Policy

- Zero energy—The project is designed to use only energy from renewable sources generated on site. There are 777 m² of solar panels. Tree waste fuels the development's cogeneration plant (downdraft gasifier) to provide

Technology/Design Principles of BedZED

- District heating and electricity-The gasifier is not being used, because of technical implementation problems, though the technology has been and is being used successfully at other sites.
- High quality—The apartments are finished to a high standard to attract the urban professional.
- Energy efficient—The houses face south to take advantage of solar gain, are triple glazed, and have high thermal insulation.
- Water efficient—Most rain water falling on the site is collected and reused. Appliances are chosen to be water-efficient and use recycled water when possible. A "Living Machine" system of recycling waste water was installed, but is not operating.
- Low-impact materials—Building materials were selected from renewable or recycled sources within 35 miles of the site, to minimize the energy required for transportation.
- Waste recycling—Refuse-collection facilities are designed to support recycling.
- Transport—The development works in partnership with the United Kingdom's leading car-sharing operator, City Car Club. Residents are encouraged to use this environmentally friendly alternative to car ownership; an on-site selection of vehicles is available for use.
- Encourage eco-friendly transport—Electric and liquefied-petroleum-gas cars have priority over cars that burn petrol and diesel, and electricity is provided in parking spaces for charging electric cars.

Was the scheme a success?

Monitoring conducted in 2003 found that BedZED had achieved these reductions in comparison to UK averages:

- Space-heating requirements were 88% less
- Hot-water consumption was 57% less
- The electrical power used, at 3 kilowatt hours per person per day, was 25% less than the UK average; 11% of this was produced by solar panels. The remainder normally would be produced by a combined-heat-and-power plant fuelled by wood chips, but the installation company's financial problems have delayed use of the plant.
- Mains-water consumption has been reduced by 50%, or 67% compared to a power-shower household.
- The residents' car mileage is 65% less.

CASE STUDY: Chambamontera-

An example of a local renewable energy scheme in an LIC to provide sustainable supplies of energy

A Location map of Chambamontera

Where is Chambamontera?

Chambamontera area is in an isolated community in the Andes mountains of Peru (**Map A**). It is more than two hours drive on a rough track from Jaen, the nearest town.

Why does Chambamontera need a sustainable energy scheme?

Most people in the area are dependent on subsistence farming with some small-scale coffee growing and the rearing of livestock (Photo B). Development has severely restricted by a lack of electricity for heat, light and power. Despite farming being efficient, nearly half of the population survive on just US$2 a day.

The steep slopes rise to 1700 m and the rough roads are impassable in winter. This makes Chambamontera a very isolated community. Due to the low population density it was uneconomic to build an electricity grid to serve the area.

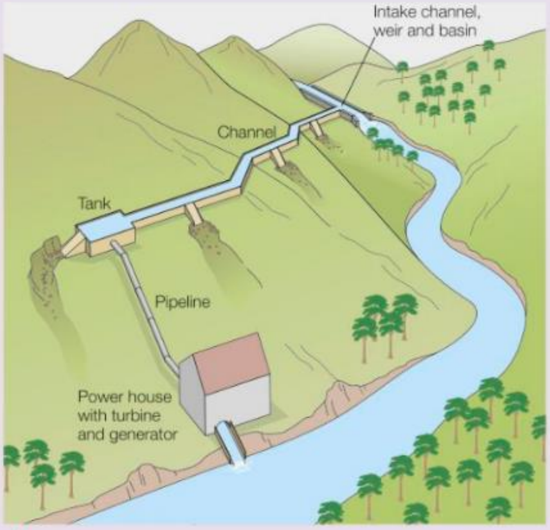
What is the Chambamontera micro-hydro scheme?

The solution to Chambamontera's energy deficit involves the construction of a micro-hydro scheme supported by the charity Practical Action. The high rainfall, steep slopes and fast flowing rivers make this area ideal exploiting water power as a renewable source of energy (**diagram C**).

This type of Micro-hydro scheme is the run-of-the-river type. They do not need a dam or reservoir to be built, but instead divert water from a stream or river. This water is then channelled to a tank. There is a basin that helps to remove the damaging sediment from the water before it falls to the turbine via the pipeline. The small turbine drives a generator that provides the electricity to the local community.

By not requiring an expensive dam and reservoir for water storage, run-of-the-river systems are a low-cost way to produce power. They also avoid the damaging environmental and social effects that larger HEP schemes causes, including a risk of flooding.

B Agriculture in the Andes



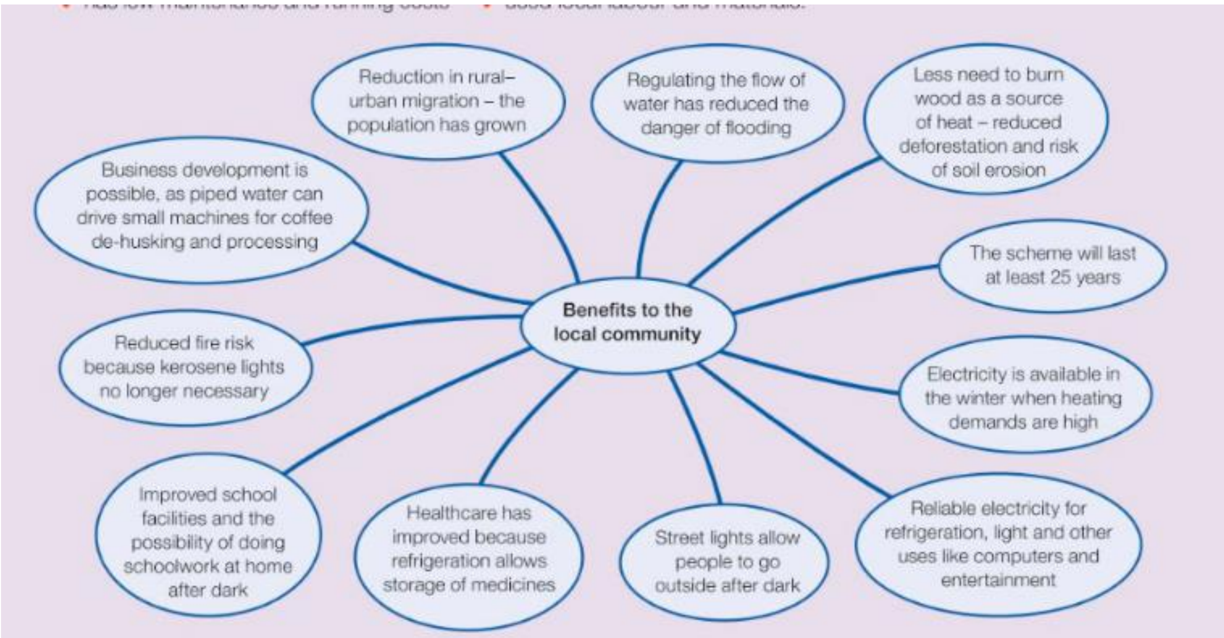
C How the scheme works

The total cost of the scheme was US$51,000. There was some government money and investment from Japan, but the community had to pay part of the cost. The average cost per family was US$750. Credit facilities were made available to pay for this.

How has the scheme benefited the community?

The micro-hydro scheme has benefited this isolated community in many ways. The scheme has provided local people with a sustainable source of energy. It enables them to make a more productive living. The scheme:

- Provides renewable energy
- Has little environmental impact
- Have low maintenance and running costs
- Used local labour and materials



D Local people carry the turbine to the micro-hydro site

Further reading about Chambamontera:

http://www.thematthiesenfoundation.org/docs/48285110431ec.pdf