AQA Geography A-level

3.2.5: Resource Security

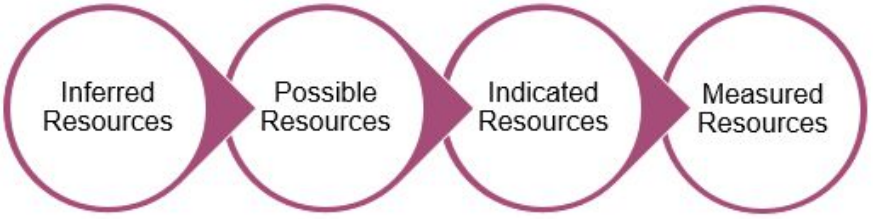
Essential Notes

Resource Types

A **resource** is any type of **asset, commodity or item** which has value to **enhance the quality of human life** or help it **function more effectively**. You will study **water, energy and mineral** resources. They can be categorised into different types:

Stock Resources: **Finite** and will run out eventually e.g. fossil fuels.
Flow Resources: **Infinite** and can be replenished and renewed e.g. biofuels.

Natural resources are those that exist without human intervention and can include **stock and flow** resources. To use resources they must be exploited and this follows a process of exploration:



Inferred: Economic viability of resource is uncertain
Possible: Expected that inferred resource could become indicated with further exploration
Indicated: Conditions and location of resource can be predicted to allow initial planning
Measured: Detailed mine planning possible

Resource exploration for **stock resources** may include assessing the **grade of deposit** (percentage quantity of desired resource in all the material that is being exploited).

Resource Exploration and Exploitation

Exploration is the process of searching for available resources and then upgrading the resource from **inferred to measured** if appropriate. Resources are difficult to find due to their **uneven global distribution**, but new technologies such as **remote sensing**, allow **more efficient exploration**. **Exploitation** is the process of extracting the material from the ground and its use is dependent on the **economic viability** of a resource. This varies due to:

Grade of Deposit	Geological Structure of the Ground	Proximity to Markets
•High grade deposit is more viable •Quantity of high grade ore decreases, as more resources are exploited •Remaining high grade deposits are difficult to access/exploit	•Resources close to the surface are easier and cheaper to exploit in open pit mining •Resistant rock will take longer and be more expensive to exploit	•Stock resources are often bulky, so large travel distances have a cost •For more expensive materials such as diamond, this is less important

Resource Frontier

A **resource frontier** is the **boundary** between exploited areas and areas considered too difficult to exploit under **current political and technological conditions**. Resource frontiers are changing as **technology advances** to allow new areas to be exploited. **Changing/warmer climates** may allow areas such as Antarctica to be exploited.

Resource Peak

The amount of the resource being extracted will **vary over time** but usually follows a long-term trend known as **'Hubbert's Curve'**. Production **increases exponentially** until it **peaks around halfway through available resources** and is followed by **decreasing production**. **Not all production follows this curve precisely**, as demonstrated by the graph showing US crude oil production. However, on a global scale, the production will follow the **bell-shaped** curve. There will be **fluctuations from the expected curve** and recent data on global oil production demonstrates this. It is predicted that **in 2030, peak oil** will occur.

The time at which **peak production** occurs is dependent on:

- The **availability and discovery** of reserves
- Development of **new technologies**
- **Demand** for the resource (may decrease or increase suddenly as a result of research into a material or new uses that are found for a material). How will electric vehicles affect the demand for oil in ten years time?
- **Grade of available resources**

Sustainable Resource Development

A **sustainable resource development** involves **long-term planning** that ensures extraction does not increase too quickly or rise to **unsustainable levels**. Sustainable Resource Development will include an **EIA**.

Environmental Impact Assessment (EIA)

EIA's are used to assess the possible **environmental impacts** of a **resource development project** and should be **completed before the project is approved**. It states the **potential environmental disturbances** caused by a project across **different areas of the environment**, from the flora and fauna to the physical landscape. It suggests ways to **mitigate and reduce** any environmental impacts. A project may **not be approved** if the environmental costs are too high, though **money** for a project is likely to **dominate over any environmental worries**. An **EIA** leads to an **Environmental Impacts Statement (EIS)**. Companies such as the mining **TNC Rio Tinto**, also create a **Social and Environmental Impact Assessment (SEIA)**.

Mineral Security

A **mineral** is a **naturally occuring compound** formed by chemical processes. They are **not organic**. Minerals are often found in **veins** (lines of material) in rock and most commonly in **igneous rock**, but also in some **metamorphic rock**.

Global Mineral Distribution

You should know the **locations of global deposits of minerals**. Technological advances and the development of LIC countries has **increased the global demand for resources and changed trading patterns**. Manufacturing of technological devices mostly occurs in **Asian NIC's** such as Taiwan, though the majority of consumption is in North America, Europe and developed Asian countries. This creates a **global trading network**, where minerals are **shipped from all over the world to Asia for manufacturing and then shipped back across the world for consumption**.

To **reduce the environmental impacts** of a **mineral resource project**, strategies are implemented at **each stage of the process**:

Extraction:

- Water sprayed on mine roads to reduce toxic dust in the air
- Choosing not to mine environmentally sensitive areas
- On-site processing reduces emissions of transportation as waste material is not transported

Transport:

- Driverless trains and trucks are being used by Rio Tinto mining operations in Australia, which are more efficient than human drivers, decreasing carbon emissions from transport
- Increasing capacity of ships and using more efficient fuels

Processing:

- Rio Tinto have created a new process for making aluminium which produces only oxygen as a bi-product, so is carbon neutral to a certain extent
- Efficiency of all mining processes is constantly being improved
- Powering processing plants by solar power is more sustainable

Site Restoration:

- Planting trees and restoring the environment around a mine
- Stabilising overburden and tailings. . TMF's are used to store tailings. The piles are vegetated with plants

Recycling:

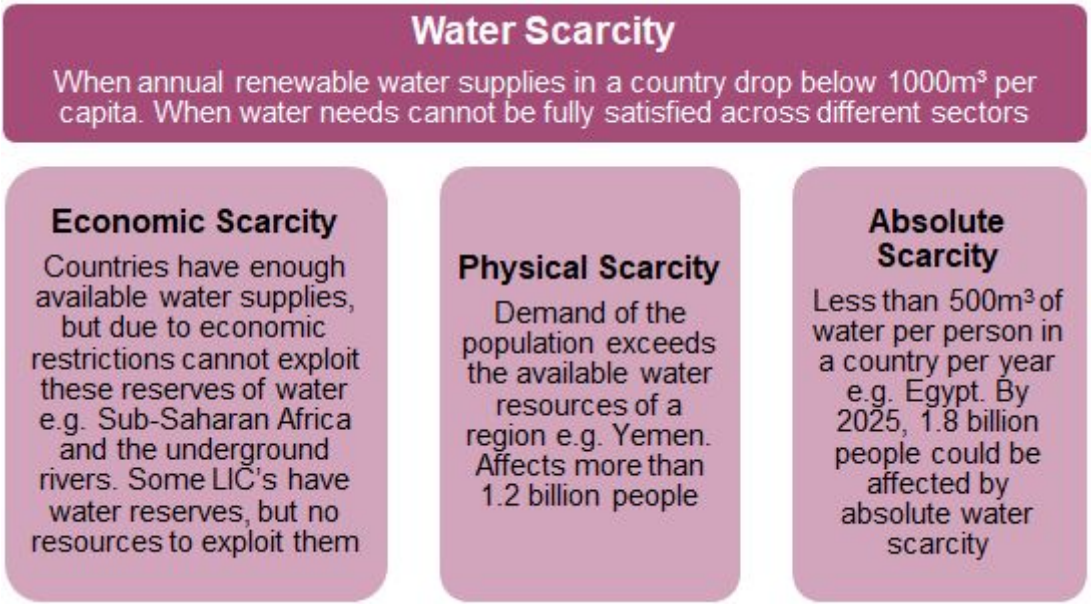
- Copper and aluminium are widely recycled, reducing the amount of mining required
- Increasing recycling, reduces demands on mines so they can be exploited more sustainably

Mining companies **work with community projects, governments and train workers after a mine closes to ensure economic, social and political sustainability**.

Water Security

Global renewable internal freshwater resources per capita (cubic meters) have decreased from **13,206 in 1962 to 5,925 in 2014**. This trend is continuing due to development and population growth, which is predicted to increase water demand up to **55% by 2050** as economic activities such as manufacturing and agriculture increase. The following terms relate to **water security**:

Water Stress: **Demand exceeds** the available amount of **clean, non-polluted water** during a certain period. Leads to **over-exploitation of long-term water stores** such as aquifers. Renewable water in a country decreases to **less than 1700m^3 per capita**.



Water Inequality and Insecurity

Water is **distributed unevenly** across the globe. 66% of the world's population only have access to 25% of the world's annual rainfall. **Conflict** can further limit accessibility to water sources.

Demand for water has increased due to:

- **Population Growth** - More people requires more water
- **Socio-Economic Factors** - Growing middle class population
- **Development** - Greater demand in industry and agriculture

Supply cannot meet demand because:

- Aquifers are being over-exploited
- Water is being utilised in long-term stores, faster than it is being recharged
- Climate change is causing extended drought periods
- Water tables are decreasing

Water Supply and Physical Geography

The **quantity and quality** of a water supply can be **affected by physical geography**.

Geology

Permeable rocks can be infiltrated and water stored in **aquifers**, providing a long-term water store. If the ground is **impermeable**, **surface storage** is more important increasing the **risk of drought**. Water quality in surface stores is likely to be lower, if the water is not flowing. Mountainous regions encourage **relief rainfall**.

Climate

Seasonal variations affect water supply. **El Niño events** may decrease water supply in some areas. Climate change is predicted to **decrease summer rainfall**, but **increase winter rainfall and storm events**.

Drainage

A greater **drainage density** and number of inputs to a river helps ensure a **consistent water supply**. If one supply of water decreases, the other water sources (e.g. **groundwater flow**) ensure the overall impact on the **drainage basin** is not significant.

Methods of Increasing Water Supply

Storage	Diversion	Water Transfer	Desalination	Catchment
• Constructing dams to raise upstream water levels and create reservoirs • Reservoirs may be created by other means • Dams may be temporary (inflatable coffer dams), which are raised in the wet season to store water that can then be used for irrigation during the dry season	• Water is moved from one area to another, within the same drainage basin • This can provide water for cities, or irrigation for fields • Can have significant environmental impacts as seen on the Colorado River in America • Due to over abstraction, no water from the Colorado River ever enters the sea	• Water is moved from areas of surplus to areas of deficit. It usually means transporting water between different drainage basins • Engineering advances have allowed mega-transfer projects in China and Lesotho • Can dry up water source areas	• Converting sea water (or saline groundwater) into freshwater for drinking • High energy demand, but is a viable in desert countries such as Saudi Arabia, where other options don't exist • Expensive due to the advanced technology involved • Causes environmental damage if it sucks marine life and may pollute other groundwater • If solar or wind energy was used to power a plant, it would be a more sustainable option	• Wetland restoration improves supply and quality of the water by filtering the water • Afforestation can have similar benefits and helps to create important wildlife habitats • Blocking drainage channels such as on UK moorland • Farmers shifting to arable farming to reduce runoff and increase infiltration • Potentially the most sustainable method of increasing water supply as it aims to restore the natural environment through the process of rewilding

Overall, human actions over the past 200 years have decreased global water supply through **deforestation, urbanisation and groundwater abstraction**.

Environmental Impacts of Major Water Supply Schemes

Hydropower is a popular renewable energy and there are over 20,000 dams in China alone. Dams may also use **canals, channels and tunnels** to supply water to different areas. There are **significant environmental impacts** of these schemes:

- Dams **flood upstream areas**, creating **large lakes. Greenhouse gas emissions** and people forced to relocate without compensation
- **Prevent sediment from travelling downstream** reducing nutrients for fish
- **Prevent fish from travelling further upstream**
- Impact the river regime. **Floodplains** no longer flood downstream. Lakes dry out
- **Dry out wetlands** and other stores downstream
- Need **expensive end of life decommissioning projects**
- **Reduce drinking water supply downstream** to many rural areas, even if cities benefit
- **Trap nutrients leading to eutrophication** in dam reservoirs and spreads diseases such as **schistosomiasis** which now affects 200 million people in 75 countries worldwide
- May **promote earthquakes** which could lead to floods downstream and dam collapse, with threat to thousands of lives

Sustainable Water Management

Agriculture accounts for around 67% of all water extracted and industrial water consumption is increasing, especially in **developing and industrialising countries**. Over 20% of all extracted water is used in industries and for energy production. Water management solutions:

- **Recycling Wastewater** - Most cost-effective in areas of high demand
- **GM Crops** - Crops which are tolerant of dry and saline conditions
- **Plasticulture** - Plastics are used to help reduce water usage by 50-70%. Also using micro-irrigation can help increase crop productivity by 30-100%
- **Catchment** - Restoration of damaged lakes, rivers and wetlands to increase storage
- **Reduce Leakages** - In the UK leakages represent 10-20% of water used every day. More water may be wasted through leakages in developing countries
- **Food Consumption** - Sourcing food from regions not suffering from water stress and purchasing food seasonally
- **Appliances** - More efficient washing machines and dishwashers
- **Water Meter** - Fitting a water meter could reduce water use by 10-15% in every household

Reducing Your Water Footprint

Virtual water or water footprint is the water demand of the services you use and products you buy. It takes 6,840 litres of water to produce a pair of jeans, 120,000 litres of water to produce a car and 200 litres of water to produce one litre of milk. **Reducing your footprint**:

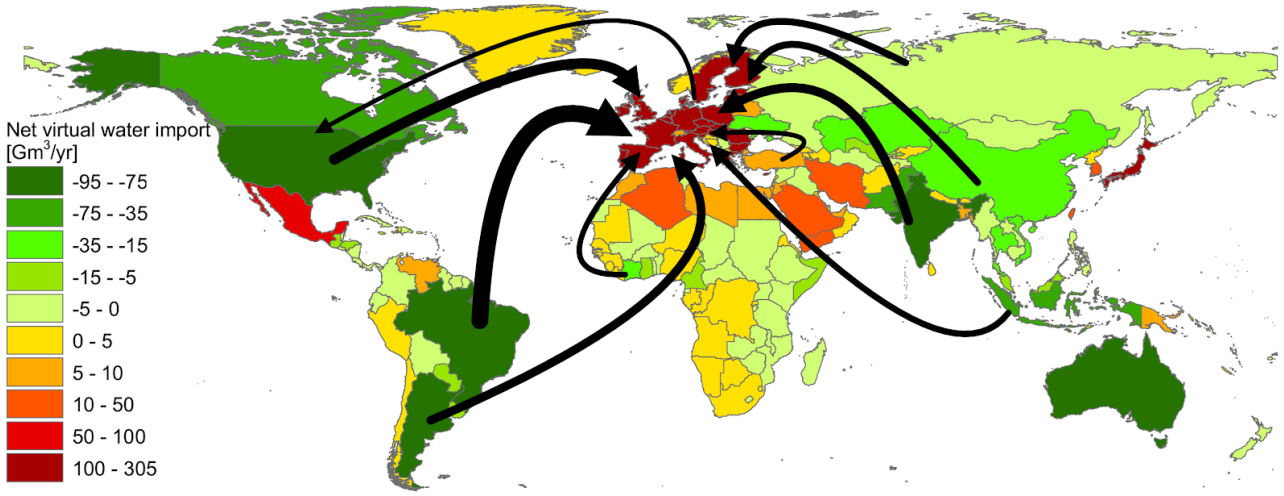
- Shower for shorter periods of time and use an eco shower head
- Buy less clothing. Not buying a pair of jeans could save an equivalent of 50 days of normal water usage
- Reuse water where possible
- Research the environmental impact of the clothes you buy: https://goodonyou.eco/
- Water gardens early in the morning or late in the evening to reduce water loss to evaporation

Greywater recycling is the process of **reusing water from washing machines, showers and sinks**, that may be dirty, but is **clean enough** to be used for irrigating plants in gardens. **Greywater** may be cleaned for reuse as water in washing machines and toilets, but this is **expensive**, so most users are industrial who have **more money and/or a larger water demand**.

Rainwater Harvesting Systems (RHS) store water collected by roofs, clean it (if necessary) and transfer it to the mains supply of a home. **Rainwater** is cleaner and safer to use than **greywater**.

Virtual Water Trade

Virtual water trade refers to the process of **trading items that have a water footprint.** LIC countries suffering from water shortages such as India, are ironically **exporting** the greatest amount of **water intensive products**. In future these **patterns may change**, so that countries under **water stress** import water through the products they trade, to **reduce water stress**..



Water Conflict

Water conflict concerns any disagreement between countries or different groups over water resources, and may lead to **violence at any level**, from protests to war on different **scales of conflict** (local, national and international):

Water conflict may occur as a **result of diminishing water supplies** which, make the **resource more valuable**. People are willing to **fight over water resources**. **Causes of conflict**:

- **Terrorism**
- **Development**
- **Water Shortages**
- **Political Motives**

Water conflict kills many people each year and is being **used as a weapon of war**. **WaterAid** explain that water is being used as a method to wage conflict around the globe:

- Attacks on Water and Sanitation Infrastructure
- Stopping the Flow of Water
- Contaminating Water
- Attacks on Water and Sanitation Workers
- Denial of Humanitarian Access

Energy Security

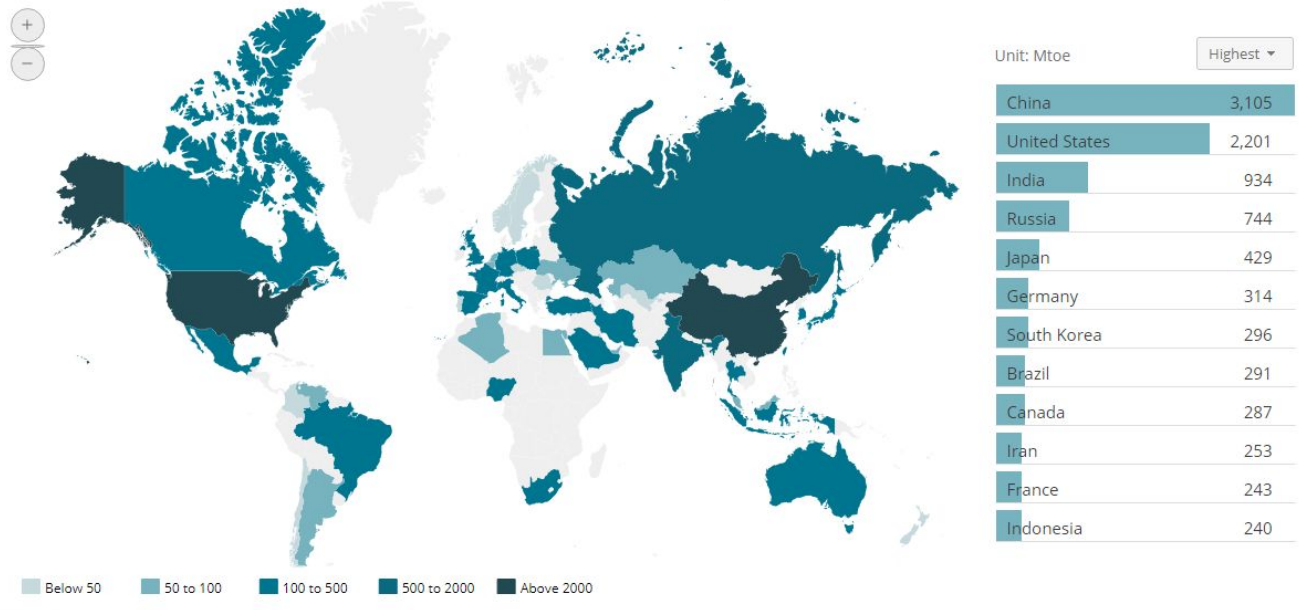
We can produce energy as **electricity** using **stock** and **flow** resources, using **primary and secondary** methods of production. The **energy mix** refers to the **range and proportion** of energy produced by methods of production. The **global energy mix** is **dominated by fossil fuels**.

	Stock Energy Sources			
Source	**Coal**	**Oil**	**Gas**	**Uranium**
% of Global Production*	27%	32%	22%	4%
Usage	👇	👆	👆	👇 - unclear

	Flow Energy Sources						
Source	**Solar**	**Wind**	**Wave**	**Tidal**	**Geothermal**	**Biomass**	**HEP**
% of Renewables**	7%	21%	>1%	>1%	>1%	8%	62%
Usage	👆	👆	👆	👆	👆	👆	👆

*Global energy production - Check for latest figures!
**Renewable electricity production

Fossil fuels produce around 85% of global energy but only 75% of global electricity, with renewables contributing the remainder.



The Effect of Physical Geography on Energy Supply

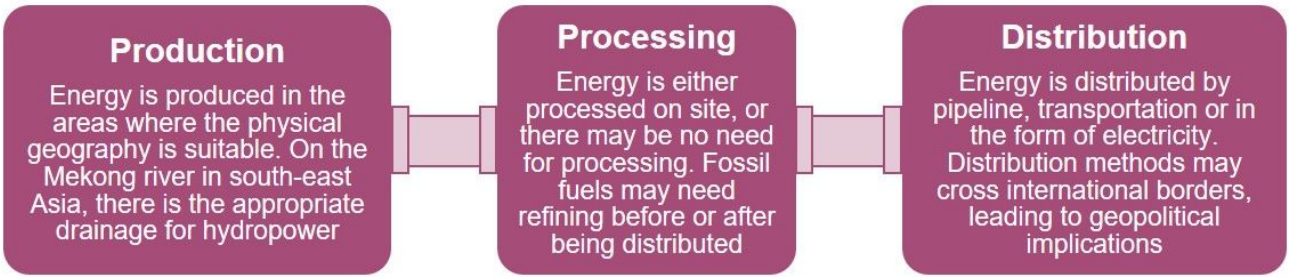
Physical geography will impact a country's energy mix:

- **Geology**
- **Climate**
- **Drainage**

Larger countries are likely to have a **diverse physical environment**, which influences the **energy mix**. Using a **range of energy sources** assures there is no reliance on one source, so if **market prices** shifted for fossil fuels, the impact on the **energy mix** would not be as severe. A **good quality energy supply** is **consistent and secure** and can be **relied upon** year round. There is unlikely to be any **geopolitical problems** and there is little risk from changing **climatic conditions** or **natural hazards**.

The Effect of Human Geography on Energy Supply

Most countries are **interdependent** for energy sources - they import energy from other countries. This has **geopolitical implications** and **requires the cooperation** of other countries:



Any stage in the energy supply chain may be used by countries as a **political tool**, to **cause or resolve tension** between countries. Different countries have varying '**national interests**'.

Environmental Impacts of Different Energy Sources

Many factors concern the environmental impacts of energy sources and everyone has a **subjective opinion** on what is best. Some consider **hydropower** as a positive renewable energy, but others believe it **destroys the environment** that dams are supposed to be protecting.

Strategies of Increasing Energy Supply

Global energy demand is likely to increase until it **peaks** between **2035 and 2050**. Energy demand will be affected by **growing populations** and the **development of LIC countries**, leading to more **energy intensive lifestyles** and a **greater need for manufacturing**. The greatest growth in energy demand will be in developing countries. In developing countries a current reliance on biofuel and other polluting fuel types such as kerosene will change with **globalisation**.

1.2 billion people currently have no electricity. If these people come to rely on fossil fuels, then it could have a significant negative impact on the environment. However, projects and products are such as the **Honnold Foundation** and **Gravity Light** aim to mitigate this problem.

It is likely that **renewable energy will double in the energy mix** by 2035 and **natural gas use will increase** as countries such as China move away from coal. **Coal is likely to increase**, as it is currently the cheapest available fuel for many countries, despite the subsequent costs related to **climate change and air pollution**. **Nuclear power is likely to increase.**

Oil and Gas Exploration

As reserves of oil and gas begin to diminish, new reserves and technologies are being developed to **support further resource exploitation**. Currently new reserves are being discovered at a **lower rate than they are being exploited**. **Fracking** is a new source of energy that involves exploiting **natural gas** found in **shale reserves:**

Advantages:

- Less polluting than coal or oil
- Requires large amounts of water
- Could provide boost to the economy
- In the UK, the Royal Academy of Engineers believe we can make fracking safe

Disadvantages:

- Wastewater needs treating due to chemical contents
- May pollute groundwater aquifers. In the USA the water has become flammable due to pollution by fracking
- Earthquakes of low magnitude may occur, though they are not usually strong enough to pose a risk to humans. They may damage fracking infrastructure, causing further leakages
- The IPCC suggest it would be irresponsible to use shale gas

Nuclear Power

Nuclear power is a contentious issue and its popularity varies widely. Nuclear disasters such as **Fukushima and Chernobyl** have had significant impacts on health and caused **1000's of deaths**. But global warming as a result of burning fossil fuels may cause **billions of deaths**. Due to **media portrayal** of nuclear bombs, the public are concerned about nuclear power and this impacts upon its use.

Nuclear Power

Advantages	Disadvantages
Very low carbon footprint	Large-scale disasters do occur
High efficiency	Produces radioactive waste which is difficult to dispose of
Safety always improving	Very high cost
May have fewer negative impacts than fossil fuels	Lack of support from general public
Technology becoming more affordable and accessible for NIC's	

Development of Renewable Resources

Each renewable resource has **advantages and disadvantages**, though as time progresses the **disadvantages will decrease** as the technologies are improved. All have the disadvantage of being **visually unappealing** and causing **minor disturbances to the local environment.**

Solar Power

Source: Green Energy Times

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

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

Wind Power

Source: The Balance

Description: Wind drives large turbines and generators that produce electricity

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

Wave Power

Source: E360 Yale University

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

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

Tidal Power

Source: Renewable Energy World

Description: Incoming tides drive turbines in similar way to hydropower

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

Geothermal

Source: Daniel Allen

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

- 👍 Low maintenance costs
- 👍 Suitable where other technologies might not be
- 👎 High installation cost
- 👎 Risk during earthquakes etc.

Managing Energy Consumption

Energy demand management reduces the overall consumption of energy by consumers. Shifting a countries' **energy mix** away from **low efficiency** sources such as coal, to **more efficient resources** such as **nuclear power**. Energy consumption may be managed by the inclusion of **subsidies from governments** that provide financial aid to economic sectors. The UK renewables subsidies have now been **significantly decreased**.

More subsidies are paid into fossil than into renewables, encouraging fossil fuel exploration projects. The **UK Climate Change Levy** was created in 2002 as a **mandatory tax** that all businesses have to pay. Businesses receive incentives for **improving their environmental credibility**. As a result, more businesses are **investing in green technology** to save their business money in the long-term.

Decentralised Energy (DE) Production

DE is produced away from the **national grid** and close to where it will be used. This reduces energy losses during transmission to **maximise the overall efficiency** of production. **Energy security is increased** as there is more reliance on a greater number of energy sources. DE schemes are often powered by **Combined Heating and Power (CHP)** systems that allow production of energy and then reuse of surplus heat in **District Heating (DH)** schemes.

Carbon Trading

Encourages organisations to **reduce their carbon emissions** by introducing a **carbon emissions cap**. If factories, countries, etc are above this cap, they have to **trade** with other groups who are below the cap, so they too are below the cap. The **Kyoto protocol** proposed **emission controls** at the international level for the first time and started in 2008 with the aim is to **reduce greenhouse emissions by an average of 5%** (1990 levels) by 2012. It ended in 2012 and was fairly successful in the countries where it operated, though **overall emissions were not reduced** as emissions of developing countries such as China inevitably increased.

Sustainability of Energy Production

Acid Rain

Acid rain can **destabilise whole ecosystems** when the rain decreases the pH level in the rivers. It can cause forests to die as seen across Europe in the 1970's. This lead to the **1979 Geneva Convention, Clean Air Acts** and the development of technical solutions such as **catalytic converters** in car exhausts and **sulphur dioxide** scrubbing systems in power stations. Whilst these measures were successful, **developing countries** such as India are now experiencing **acid rain**. Acid rain is a **transboundary pollution event**, requiring international solutions as countries which are not responsible for emissions may also be affected.

Nuclear Waste

Nuclear waste is a major problem with nuclear energy as there is no ideal solution for its disposal. After **reusable uranium has been extracted** at processing plants, remaining waste needs to be stored or buried deep underground where it can safely emit any remaining radiation. Currently, no **HLW** is buried, only intermediate level waste **(ILW)**. **HLW** must be stored in an area that is secure and will be **safe from terrorism and natural hazards**. The impact of storing nuclear waste on the **local economy** must also be considered. This leads to higher costs which have limited the spread of nuclear power as a **viable technology**. **Transportation** of radioactive waste is also considered as it occurs when the levels of **radioactivity** of the nuclear fuel is highest.

Energy Conservation

Homes and buildings, may account for **more than 30% of total greenhouse gas emissions**. New technologies are constantly being developed: LED's, PV Windows/Roof Tiles, Better Insulation, Lower Carbon Footprint Materials. The UK government introduced schemes such as the **Zero Carbon Homes Strategy** and the **Code for Sustainable Homes**. Both have now been withdrawn.

Resource Futures

You should be aware of **current and contemporary developments relating to mineral, water and energy security and new technologies, political agreements, economic strategies and environmental policies**. Whilst they are discussed in detail throughout these notes (and in our case studies) it is advisory that you conduct further research into each resource. You could use the following table to help format your findings:

Resource Type:	Environmental	Political	Economic	Technology
Current Problems				
Current Solutions				
Future Problems				
Future Solutions				