



2 Energy and the environment

⚡ Status	Done
# Unit No.	2

2.1 Fossil fuel formation

2.1.1: formation of the fossil fuels

2.2 Energy resources and the generation of electricity

2.2.1 & 2 Energy resources and the generation of electricity

Why the demand of energy is increasing worldwide?

How energy sources are used to generate electricity ?

How fossil nuclear power produce electricity?

Nuclear power - Nonrenewable

How fossil fuels and biofuels produce electricity?

Fossil Fuels - Non renewable

Biofuels - Renewable

How geothermal power produces electricity ?

Geothermal power - Renewable

How wind power produce electricity?

Wind Power - Renewable

How tidal power produces electricity ?

How hydroelectric power produces electricity ?

Hydroelectric power - Renewable

How solar power produces electricity ?

Solar power - Renewable

2.2.4 Environmental, Economic and Social Advantages and Disadvantages for energy resources

2.3 Energy demand

2.4 Conservation and management of energy sources

Strategies for the efficient management of energy resources:

Development of new resources:

2.5 Impact of oil pollution

2.6 Management of oil pollution

2.6.1 Reducing oil spills in marine environment :

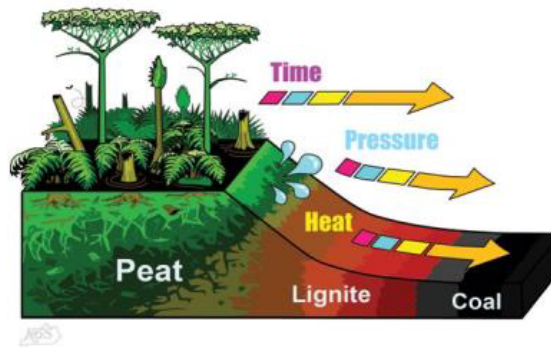
2.6.2 The impact of oil spills :

2.1 Fossil fuel formation

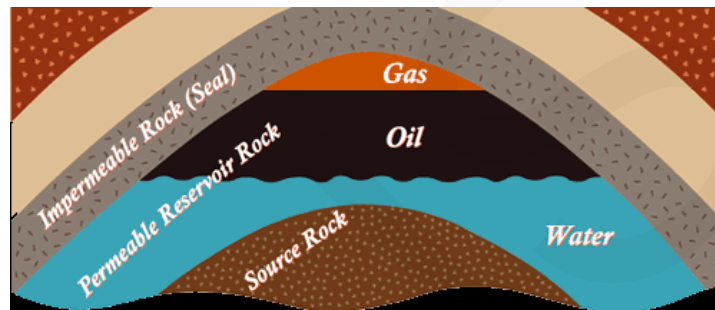
2.1.1: formation of the fossil fuels

Formation of:

- Coal
 - The vegetation of the forests dies
 - Plant decay forming a layer named peat
 - Peat is pressurized between sediments with high pressure and temperature to form coal



- Oil and gas
 - Millions of years ago plants and animal died and fell to the bottom of the ocean
 - Their remains are covered with sediments
 - The heat and pressure turn the remains into crude oil and natural gas.



2.2 Energy resources and the generation of electricity

2.2.1 & 2 Energy resources and the generation of electricity

Non renewable

fossil fuels formed over millions of years ago from the decay of living matter Coal ,Gas Oil

Renewable

Bio fuels , hydroelectric powers , tidal power , geothermal power , solar and wind power

Why the demand of energy is increasing worldwide?

- Increasing population size
- Increase in wealth
- Improvements in standards of living
- Increasing industrialization

How energy sources are used to generate electricity ?

- Turbine machine containing fins made to revolve steam gas or water and connected to generator that converts mechanical energy into electrical energy

How fossil nuclear power produce electricity?

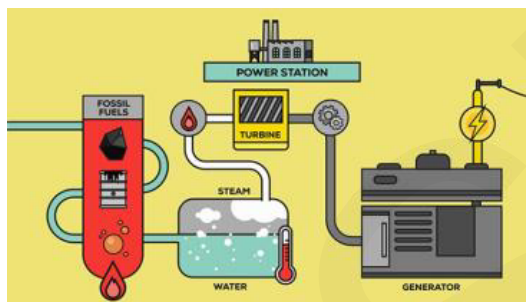
- Uranium, a radioactive element, releases huge amounts of energy when nuclear fission (splitting of the atom) occurs.
- This energy is used to heat the water, produce steam, and rotate the turbines.

Nuclear power - Nonrenewable

Advantages	Disadvantages
No CO ₂ produced so no global warming	Risk of radiation leakage
Provide job opportunity	Visual pollution
Small volume of waste	Expensive and technically difficult to build

How fossil fuels and biofuels produce electricity?

These produce a massive amount of energy during combustion that is used to heat water and convert it into steam, which thereby drives the turbines.



Fossil Fuels - Non renewable

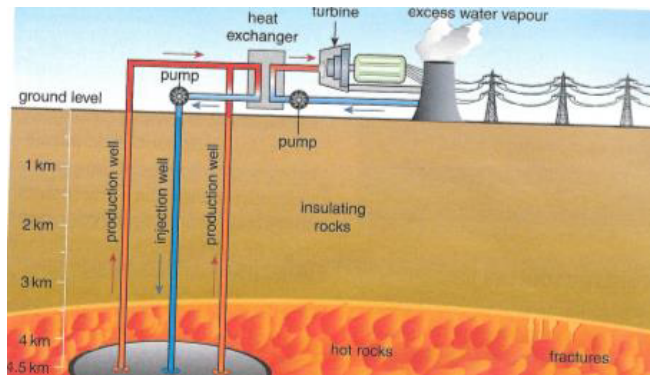
Advantages	Disadvantages
Plentiful supply	Non renewable
Provide job opportunity	Damage local area
Coal is the cheapest source of fossil fuel	Risk of oil spills
Coal is easy to store	Carbon dioxide emission is polluting to the atmosphere

Biofuels - Renewable

Advantages	Disadvantages
Renewable	CO ₂ released when burnt so contributes to global warming
Growing more plants takes more CO ₂	Shortage of land for agriculture
Lower level of air pollution	Reduce biodiversity and loss of habitat

How geothermal power produces electricity ?

1. Cold water is pumped underground into layer of hot rocks
2. Rocks heat the water
3. Water converted into steam and steam is piped to the geothermal power station
4. Steam moves the turbine which turns the generator to generate electricity

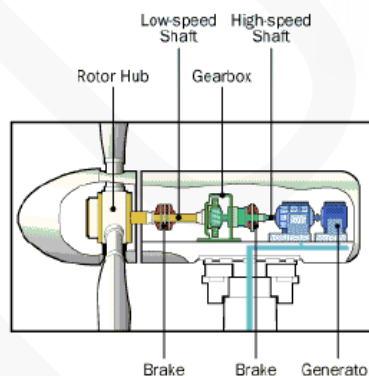


Geothermal power - Renewable

Advantages	Disadvantages
No CO ₂ produced	Only certain areas have suitable conditions
Renewable	Expensive to install and need high level of technology

How wind power produce electricity?

- Wind turbines have shafts (blades) that rotate due to wind.
- Gearbox maximises the rotation of the shaft.
- Brakes slow down or stop the rotor in very windy conditions, preventing damage to the blade.
- As the turbine rotates, the generator produces electricity.

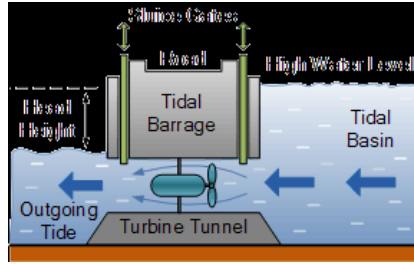


Wind Power - Renewable

ADVANTAGES	DISADVANTAGES
Does not produce carbon dioxide	Generation of electricity is weather-dependent
Doesn't contribute to global warming	Visual impact
Renewable	Uses a large area
	Only certain locations are suitable

How tidal power produces electricity ?

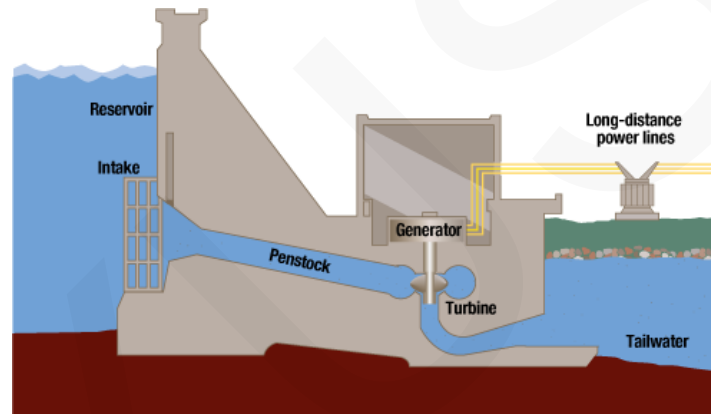
- When the levels drop water is held back by a tidal barrage which is a small dam that releases water back through a turbine that turns the generator to generate electricity



Advantages	Disadvantages
Does not produce carbon dioxide, doesn't contribute to global warming.	Limited to specific coastal areas.
Tidal movements are not weather-dependent.	Impact on tourism and local fishermen.

How hydroelectric power produces electricity ?

- Uses a dam on a river to store water in a reservoir
- Water released from the reservoir that flows through the turbine rotating it
- Turbine activates the generator that generates electricity



Hydroelectric power - Renewable

Advantages	Disadvantages
Renewable	Dams might relocate local people
Growing more plants takes more CO2	Expensive to install
Provide more job opportunity	Dams effect natural flow of water

How solar power produces electricity ?

- Uses photovoltaic cells that produce a small electric charge when exposed to light
- A bank of cells organised into solar panels produce a significant amount of electricity



Solar power - Renewable

Advantages	Disadvantages
Renewable	Solar cells are expensive
No CO ₂ produced	Energy only produced in day light
No fuel cost	Not reliable in some places

2.2.4 Environmental, Economic and Social Advantages and Disadvantages for energy resources

Energy Resource	Environmental Advantages	Environmental Disadvantages	Economic Advantages	Economic Disadvantages	Social Advantages	Social Disadvantages
Fossil Fuels	- Plentiful supply	- Carbon dioxide emissions contribute to global warming	- Provide job opportunities	- Risk of oil spills	- Job creation in the industry	- Environmental pollution
Biofuels	- Renewable	- CO ₂ released when burnt contributes to global warming	- Job creation in biofuel industry	- Shortage of land for agriculture	- Lower levels of air pollution	- Reduce biodiversity and loss of habitat
Hydroelectric Power	- Renewable	- Dams might relocate local people	- Provide more job opportunities	- Expensive to install	- Reduced reliance on fossil fuels	- Dams affect natural flow of water
Geothermal Power	- No CO ₂ produced	- Only certain areas have suitable conditions	- Renewable	- Expensive to install and requires high-level technology	- Minimal land use	- Limited to specific geographic locations
Solar Power	- Renewable	- Solar cells are expensive	- No fuel cost	- Energy production limited to daylight hours	- Distributed energy generation	- Not reliable in some places
Wind Power	- Does not produce carbon dioxide	- Generation of electricity is weather-dependent	- Renewable	- Visual impact	- Abundant energy source	- Uses a large area
Tidal Power	- Does not produce carbon dioxide	- Limited to specific coastal areas	- Renewable	- High energy density	- Predictable energy generation	- Impact on marine ecosystems

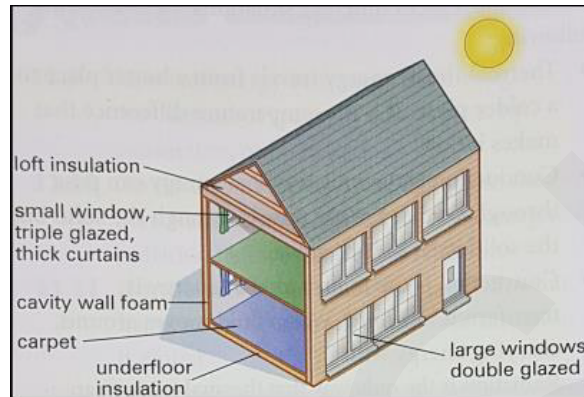
2.3 Energy demand

- Domestic demand:
 - Created by affordability, availability and social status.

- Most of the purchases that are considered as necessities now increase the demand for energy supplies, notably electricity.
- Example:
 - Fruits and vegetables, that aren't naturally available in the season locally, are produced in glasshouse or in areas with a favourable climate and are then transported.
 - In both the scenarios (glasshouse operation and transport), the energy cost is significant.
- Industrial demand:
 - Manufacturing requires the use of large amounts of energy throughout the production e.g. iron and steel production.
 - Advanced manufacturing techniques made the products, that were once luxury items, cheaper.
 - So, more people want to buy them.
 - The demand for the product increases.
 - The demand for energy (needed for production) also increases.
- Transport:
 - Manufacturers supply customers across the globe.
 - This decreases production costs in countries that import, but increases the transport costs as they require large amounts of fossil fuels to operate.
- Personal and national wealth:
 - If economic conditions are good:
 - Higher employment;
 - More money to spend on luxury items;
 - Increase in demand for the product;
 - Increase in demand for energy (for production).
 - If economic conditions are poor:
 - Families have less money to spend on luxury items;
 - Need to make savings;
 - Reduce the use of fuel;
 - Reduce the purchase and use of electrical items;
 - Decrease in the demand for energy.
 - Decline in the economy of one country can have a global impact.
 - Reduction in the economy of China meant a worldwide:
 - Reduction in production of steel.
 - Decrease in the amount of manufactured goods (transported by ships).
 - Decrease in the price of oil (energy source).
- Climate:
 - The demand for energy with regard to climate depends on the country.
 - People living in a temperate climate are likely to experience colder winters, so the energy demand for heating would be far higher.
 - They also experience fewer hours of daylight.
 - This increases the usage of electrical lighting.

- Climate change (excessive heat or cold) increased the energy consumption (particularly in urban areas).
 - Need for additional heating.
 - Installation and operation of air-conditioning units.

2.4 Conservation and management of energy sources



Strategies for the efficient management of energy resources:

- Reducing consumption:
 - Use insulation materials with good insulation properties to prevent heat loss in buildings.
 - Loft insulation: adding insulation layer into the roof space.
 - Underfloor insulation: adding insulation layer on the floor (e.g., carpet).
 - Cavity wall insulation: filling the gap between inside and outside walls with insulating material to slow down heat transfer.
 - Double glazing: using two panes of glass with a gap in the middle to act as an insulator. The gap is often filled with air or inert gas (e.g., argon).
 - Turning off electrical devices when not in use.
 - Purchasing more energy-efficient devices.
 - Developing alternative fuels for vehicles and improving engine technology.
 - Implementing "scrappage" schemes to remove inefficient machines (e.g., electrical appliances or vehicles) from use.
- Energy from waste:
 - Extracting energy from reusable materials before disposal.
 - Anaerobic digestion: breaking down organic waste (e.g., food and vegetation) using bacteria in a sealed container to release methane, which can be used for heating purposes.
 - Using composted waste as organic matter to improve soil structure.

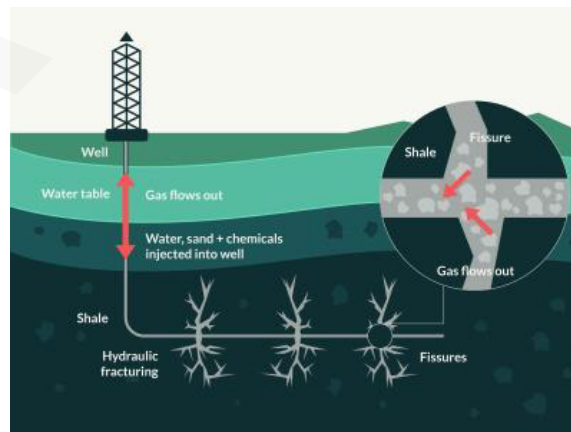
ADVANTAGES	DISADVANTAGES
Waste from burning (ash) is small in volume. Thus, it doesn't take up much space.	Produces poisonous gases during combustion

- Education:
 - Benefits of the technology must be communicated to others;
 - Promote new ways of thinking;

- The message must be that significant savings in energy bills can be made over the longer term, reducing energy use;
- Energy-efficiency ratings must be provided for new products to compare with the old ones.
- Laws passed by the government to make changes rapidly:
- Stricter building regulations: new constructions must be more energy efficient.
- Preventing the sales of inefficient types of electrical devices.
- Incentives to encourage the purchase of more efficient technologies:
- Insulating older houses that are energy efficient;
- Replacing older, inefficient electrical devices;
- Scrapping older, inefficient cars, that emit more pollutants.
- Exploiting existing energy resources:
 - The type of energy source used depends on social, environmental and economic factors.
 - The current solution is to use a renewable resource as a primary energy source when possible and have a fossil-fuel (or biofuel) powered station available as a backup when weather conditions are not suitable.
 - This is a reliable source for industry and households and reduces the amount of fossil fuels used.
- Transport policies:
 - Regulations regarding the quality of exhaust gases from vehicles;
 - Check on the fuel efficiency;
 - Restrictions on where vehicles may go;
 - Taxation on fuels;
 - Surcharges for travelling to certain places at peak times;
 - Improving public transport so it is easier and cheaper than using cars;
 - Improving routes for cyclists and pedestrians;
 - Encouraging car-sharing;
 - Restricting when cars can be used e.g. odd even rule in Delhi;
 - Providing incentives to buy more fuel-efficient vehicles and for vehicles using cleaner technology.

Development of new resources:

- Fracking: obtaining oil or gas from shale rock by splitting them open using water, sand and chemicals.



2.5 Impact of oil pollution

- Main causes of marine oil spills:
 - Offshore oil extraction: leakage from the rigs.
 - Oil pipelines: leaks in the oil pipework.
 - Shipping: risk of collision or damage to oil tankers.

ORGANISM	IMPACT OF OIL
PHYTOPLANKTON	- Oil floats on the surface of the water and blocks the sunlight from entering. The phytoplankton can't photosynthesize, so they die.
FISH	- Shortage of food; reduction in phytoplankton. - Oil floating on the surface prevents gas exchange. Fish become short of oxygen and die. - Direct contact of the fish with oil affects their gills.
BIRDS	- Shortage of food as fish and other creatures die. - May consume oil when eating fish (toxic). - When hunting for food, feathers get covered with oil, affecting their ability to fly.
MAMMALS	- Food sources are depleted. - Mammals may also swallow oil while feeding (toxic). - Coating of oil will affect their skin.
REEFS	- Complete devastation of the reef due to lack of oxygen (species die). - Areas may be covered in oil.
BEACHES	- Oil (washed by tides) coats rocks. - Organisms in shallow water and rock pools may die due to toxic effects of the oil. - Animal food sources and tourism are affected.

2.6 Management of oil pollution

2.6.1 Reducing oil spills in marine environment :

- increased use of GPS and development of more clearly defined shipping routes to reduce risk of collision
- Use of double hulled oil tanks can reduce oil spills , if one of the compartments damaged , the contents of the whole ship are still secure by the inner plate
- MARPOL were all tankers must be certified to show they have appropriate system in use Minimizing

2.6.2 The impact of oil spills :

- use of floating booms which are floating barriers that are used to trap oil slick preventing it from spreading
- Detergent sprays help break down the oil slick into smaller droplets that eventually degrade and disperse
- Skimmers removes oil from seawater surface which is then scrapped of into a container

2 Energy and the environment

2.1 Fossil fuel formation

Candidates should be able to:

- describe the formation of the fossil fuels: coal, oil and gas

2.2 Energy resources and the generation of electricity

Candidates should be able to:

- classify the following energy resources as non-renewable or renewable:
- fossil fuels, nuclear power, biofuels, geothermal power, hydro-electric power, tidal power, wave power, solar power, wind power
- describe how each of these energy resources is used to generate electricity
- describe the environmental, economic and social advantages and disadvantages of each of these energy resources

Further guidance and exemplification:

- non-renewable: fossil fuels, nuclear power using uranium
- renewable: biofuels (bioethanol, biogas and wood), geothermal power, hydro-electric power, tidal power, wave power, solar power, wind power

2.3 Energy demand

Candidates should be able to:

- describe and explain the factors affecting the demand for energy

Further guidance and exemplification:

- domestic demand
- industrial demand
- transport
- personal and national wealth
- climate

2.4 Conservation and management of energy resources

Candidates should be able to:

- describe and explain strategies for the efficient management of energy resources
- research and development of new energy resources

Further guidance and exemplification:

- reducing consumption, such as using insulation, turning electrical devices off and using energy efficient devices and vehicles
- energy from waste cooking oil
- exploiting existing energy sources
- education of people for energy conservation
- transport policies
- fracking

2.5 Impact of oil pollution

Candidates should be able to:

- describe the causes and impacts of oil pollution on marine and coastal ecosystems

Further guidance and exemplification:

- causes: off-shore oil extraction, pipelines and shipping
- impacts on ecosystems: birds, marine mammals, coral reefs, beaches

2.6 Management of oil pollution

Candidates should be able to:

- discuss strategies for reducing oil spills in marine and coastal ecosystems
- discuss strategies for minimising the impacts of oil spills on the marine and coastal ecosystems

Further guidance and exemplification:

- MARPOL (International Convention for the Prevention of Pollution from Ships)
- double-hulled oil tankers
- dealing with oil spills (booms, detergent sprays, skimmers)

Case study:

- Study the impact and management of an oil pollution event.