National and global energy resources

6.1.3 · Physics · revision notes

The energy resources we use for transport, generating electricity and heating, and how they compare. You need to sort resources into renewable and non-renewable, explain why some are more reliable than others, describe their environmental effects and explain trends in how we use them. Expect short recall questions, data questions and 6-mark 'evaluate' questions.

Key facts

- Non-renewable: coal, oil, natural gas (fossil fuels) and nuclear fuel
- Renewable = being (or can be) replenished as it is used
- Reliable: fossil fuels, nuclear, hydro-electricity, geothermal; tides are predictable
- Burning fossil fuels: carbon dioxide → global warming; sulfur dioxide → acid rain
- Renewable: bio-fuel, wind, hydro-electricity, geothermal, tides, the Sun, water waves
- Uses: transport, electricity generation, heating
- Unreliable: wind, solar, waves (depend on the weather)
- Nuclear: no carbon dioxide when generating, but long-lasting radioactive waste

Notes

Energy resources and their uses

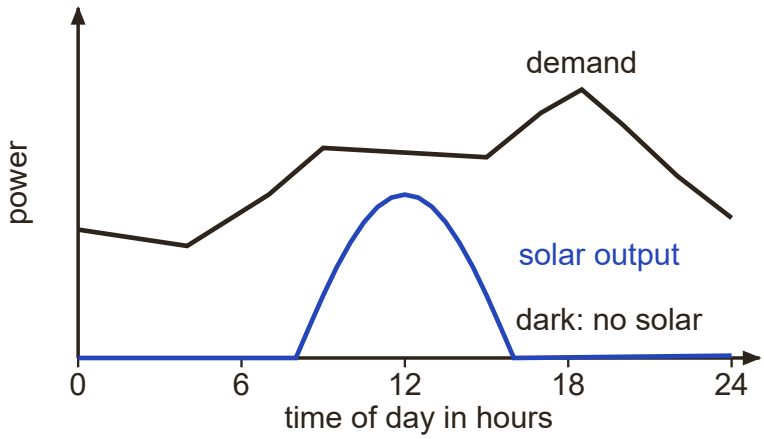
- The main energy resources: fossil fuels (coal, oil and natural gas), nuclear fuel, bio-fuel, wind, hydro-electricity, geothermal, the tides, the Sun and water waves.
- **Transport**: mainly petrol and diesel (from oil), plus bio-fuels and electricity.
- **Electricity generation**: any of the resources can be used.
- **Heating**: mainly natural gas, oil and electricity, plus bio-fuels such as wood, solar water heaters and geothermal.

Renewable or non-renewable

- A **renewable** resource is one that is being (or can be) replenished as it is used: bio-fuel, wind, hydro-electricity, geothermal, the tides, the Sun and water waves.
- **Non-renewable** resources will run out one day: coal, oil, natural gas and nuclear fuel.

Reliability

- Fossil fuels and nuclear fuel are reliable: they can generate electricity at any time. Gas power stations can also be started quickly when demand rises.
- Hydro-electricity and geothermal are reliable too, but only work in suitable places.
- Tides are predictable, but the output changes during the day.
- Wind, solar and waves are unreliable: they depend on the weather (and solar on the time of day), so their output cannot be increased to meet demand.



Sketch (no scale): solar output cannot be increased to meet the evening peak in demand.

Environmental impact

- Burning fossil fuels releases **carbon dioxide**, which contributes to global warming (climate change). Burning coal and oil can also release sulfur dioxide, which causes acid rain.
- Nuclear power releases no carbon dioxide when generating, but it makes radioactive waste that stays dangerous for a very long time.
- Bio-fuels release carbon dioxide when burned, but the plants took in carbon dioxide as they grew. Growing them uses land that could grow food.
- Wind, solar, hydro-electric, tidal and wave generators release no carbon dioxide during generation, but still have effects: wind turbines are noisy and affect views; hydro-electric dams flood valleys and destroy habitats; tidal barrages affect estuary wildlife.

Trends in energy use

- World energy demand keeps rising as the population grows and more countries become industrialised.
- In the UK, much less electricity now comes from coal and much more from renewables, especially wind, to reduce carbon dioxide emissions.
- Science can identify environmental problems, but cannot always deal with them because of political, social, ethical or economic reasons, e.g. cost, or people objecting to a wind farm near them.

How to answer each type of question

Recall: identify renewable resources

1 to 2 marks | Grade 3

1. Remember the only non-renewables are coal, oil, natural gas and nuclear fuel.
2. Tick exactly the number of boxes asked for: an extra tick loses marks.

Example. Which **two** energy resources are renewable?
Tick (✓) **two** boxes.
☐ Coal
☐ Geothermal
☐ Natural gas
☐ Nuclear fuel
☐ Tides

Model answer.

Geothermal (1)
Tides (1)

Explain why a resource is not reliable

2 marks | Grade 5

1. Say what the output depends on: the weather, the time of day or the tides.
2. Link it to demand: the output cannot be increased when more electricity is needed.

Example. Explain why solar panels cannot be relied on to supply electricity on winter evenings.

Model answer. It is dark in the evening (and light levels are low in winter), so the panels generate little or no electricity (1). Their output cannot be increased to meet demand, which is high on winter evenings (1).

Suggest reasons for a trend in the data

3 marks | Grade 5

1. Describe the trend, using figures from the data.
2. Give an environmental reason: carbon dioxide and global warming.
3. Give another reason: cost, fuels running out, or government targets.

Example. In one country, the percentage of electricity generated from coal fell from 38% to 3% over 12 years. Over the same time, the percentage generated from wind rose from 6% to 27%.
Suggest reasons for these changes.

Model answer. Burning coal releases carbon dioxide, which contributes to global warming (1). So the country set targets to reduce its carbon dioxide emissions and closed coal-fired power stations (1). Wind turbines release no carbon dioxide when generating, and they have become cheaper to build (1).

6-mark: evaluate two energy resources

6 marks **Grade 8**

1. Give advantages and disadvantages of each option: reliability, carbon dioxide, other environmental effects, renewable or not.
2. Use any data you are given, such as costs or power outputs.
3. Compare the options directly, e.g. 'the gas power station is more reliable, but…'.
4. Finish with a conclusion and a reason.

Example. A town's old coal-fired power station is closing. It could be replaced by a gas-fired power station or by a wind farm.
Evaluate the two options.

Model answer.

Marked by levels. A full answer could include:

gas: reliable, and its output can be changed quickly to match demand

gas: releases carbon dioxide, which contributes to global warming (but less than coal)

gas: non-renewable, so it will run out

wind: renewable, and releases no carbon dioxide when generating

wind: unreliable, with no electricity when the wind speed is too low or too high

wind: needs many turbines over a large area, which cause noise and spoil views

a conclusion with a reason, e.g. the wind farm, because it cuts carbon dioxide emissions, with a backup supply for calm days

Top level (5 to 6 marks): both options evaluated, with a conclusion supported by reasons.

Don’t lose marks

- Saying nuclear fuel is renewable, or that nuclear power stations release carbon dioxide or cause acid rain when they generate electricity.
- Defining renewable as 'can be reused'. It means the resource is replenished as it is used.
- Saying renewables cause 'no pollution' or 'no environmental impact'. Burning bio-fuels releases carbon dioxide, and all resources can have environmental effects.
- Mixing up the effects: carbon dioxide → global warming; sulfur dioxide → acid rain.
- Vague answers such as 'bad for the environment'. Name the effect.

More tips

Memory tricks

- There are only four non-renewables: coal, oil, gas and nuclear fuel. Everything else on the list is renewable.
- Renewables: 'Some Wild Wet Tides Give Huge Breakers': Sun, Wind, Waves, Tides, Geothermal, Hydro-electricity, Bio-fuel.
- Reliability test: does it depend on the weather? Then it is unreliable. Tides are predictable, but the output still varies.
- If it is burned (fossil fuels or bio-fuel), it releases carbon dioxide.

Exam technique

- In 'evaluate' questions, give points for and against each option, then a conclusion with a reason. A conclusion on its own earns few marks.
- Quote figures from any table or graph in the question.
- Name the gas and its effect: 'carbon dioxide, which contributes to global warming'.
- You don't need to describe how power stations generate electricity: focus on uses, reliability and environmental impact.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **List the main energy resources**
Fossil fuels (coal, oil, gas), nuclear fuel, bio-fuel, wind, hydro-electricity, geothermal, the tides, the Sun and water waves.

Grade 3 — **Define a renewable energy resource**
A resource that is being (or can be) replenished as it is used.

Grade 4 — **Sort resources into renewable and non-renewable**
Coal, oil, gas and nuclear fuel are non-renewable; all the others are renewable.

Grade 4 — **Link energy resources to their uses**
The three main uses are transport, electricity generation and heating.

Grade 5 — **Explain why some resources are more reliable**
Wind, solar and waves depend on the weather (and solar on the time of day); fossil fuels and nuclear do not.

Grade 5 — **Describe the environmental impact of each resource**
E.g. burning fossil fuels releases carbon dioxide; hydro-electric dams flood valleys.

Grade 5 — **Explain trends in energy resource use**
Use data and reasons such as cutting carbon dioxide emissions and the falling cost of renewables.

Grade 8 — **Evaluate energy resources using data**
Weigh up reliability, cost and environmental impact, then give a conclusion with a reason.

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