3.8 Energy Resources and Electricity Generation: 30-minute Pack

Total Marks

EDEXCEL 4PH1 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 In an illustrative trial with equal total energy inputs, station X wastes 180 MJ and station Y wastes 160 MJ. State which station transfers less energy to the surroundings.

(Total for Question 1 is 1 mark)

2 A turbine turns the generator in a power station. State the useful energy conversion that takes place in the generator.

(Total for Question 2 is 1 mark)

3 State what an efficiency of 100% would mean for the energy transfers in an electricity generator.

(Total for Question 3 is 1 mark)

4 State one major environmental impact associated with burning coal in power stations, referring to a greenhouse gas.

(Total for Question 4 is 1 mark)

5 State one reason why geothermal power is considered a renewable resource in electricity generation.

(Total for Question 5 is 1 mark)

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6 State two ways in which biofuel electricity generation can have environmental benefits compared with burning coal.

(Total for Question 6 is 2 marks)

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7 A student claims that a power station with high efficiency must use a renewable energy resource. Explain why efficiency alone cannot establish whether an energy resource is renewable. Refer to what efficiency measures and what makes a resource renewable.

(Total for Question 7 is 2 marks)

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8 An illustrative thermal power station has a total energy input of 950 MJ and a useful electrical output of 361 MJ during a trial. Calculate its percentage efficiency. Write the efficiency equation and show the substitution. Give the percentage to 1 decimal place.

(Total for Question 8 is 3 marks)

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9 Compare the reliability and the running cost of natural gas power stations with wind farms for providing continuous national electricity supply.

(Total for Question 9 is 2 marks)

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10 Compare the setup cost and the running cost of solar photovoltaic farms with those of a conventional coal-fired power station.

(Total for Question 10 is 2 marks)

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11 Compare tidal power and wind power in terms of predictability and typical scale of individual installations when used to supply a national grid.

(Total for Question 11 is 4 marks)

12 Evaluate which of coal and wind would be a better primary source for generating most of a temperate country's electricity over the next 30 years. In your answer consider reliability, greenhouse gas emissions, running and setup costs, and environmental impact. The country has available coastline for offshore wind but also domestic coal reserves. You are expected to write a short evaluative argument.

(Total for Question 12 is 6 marks)

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Mark scheme · 3.8 Energy Resources and Electricity Generation: 30-minute Pack

Question 1

Station Y **B1**

Answer: Station Y

Question 2

kinetic energy to electrical energy **B1**

Answer: Kinetic energy -> electrical energy.

Question 3

all input energy becomes useful electrical output, with no wasted energy **B1**

Answer: All the input energy would become useful electrical energy, with no energy wasted.

Question 4

states that burning coal produces carbon dioxide (CO_2) emissions that contribute to global warming **B1**

Answer: Produces carbon dioxide emissions, contributing to global warming

Question 5

states that geothermal uses heat from the Earth which is continuously available or replenished **B1**

Answer: Uses heat from the Earth that is continuously available, so the energy source is effectively replenished

Question 6

states one valid benefit, e.g. biofuels can be carbon neutral over a lifecycle if regrown **B1**

states a second valid benefit, e.g. biofuel combustion may produce lower sulfur emissions or use waste products **B1**

Answer: e.g. biofuels can be nearer carbon neutral if crops regrow and they can use waste materials, reducing landfill and possibly emitting less sulphur

Question 7

efficiency measures the fraction or percentage of input energy transferred to useful output **B1**

renewability depends on natural replenishment on a human timescale, which efficiency does not measure **B1**

Answer: Efficiency measures the fraction of input energy transferred to useful output. A renewable resource is replenished naturally on a human timescale; efficiency does not tell us whether that replenishment occurs.

Question 8

efficiency = useful energy output / total energy input x 100 for a percentage **M1**

substitutes 361 / 950 x 100 **M1**

38.0% to 1 decimal place **A1**

Answer: Efficiency = useful energy output / total energy input x 100 = 361 / 950 x 100 = 38.0%.

Question 9

states that natural gas plants are more reliable for continuous supply because they can run on demand **B1**

states that running cost of gas is typically higher fuel cost than wind which has very low running fuel cost **B1**

Answer: Gas is more reliable for continuous supply as it can be run on demand; wind is intermittent. Gas has ongoing fuel costs, whereas wind has low running fuel cost after installation

Question 10

states that solar has high initial setup costs for panels and land but low running fuel cost **B1**

states that coal has higher ongoing fuel and emissions-related costs (the usual answer is also that its initial plant cost is comparatively lower, but accept any correct statement about coal's build cost, which varies with site and scale) **B1**

Answer: Solar needs large upfront investment for panels and installation but has very low running fuel cost; coal plants may be cheaper to build per unit capacity but have high ongoing fuel and emissions costs

Question 11

states that tidal power is highly predictable because tides follow lunar cycles **B1**

states that wind is less predictable and depends on weather, though patterns can be forecasted short term **B1**

states that individual tidal installations like barrages or lagoons are often large infrastructure projects **B1**

states that wind installations are modular with many turbines and can be scaled up in number, often spread over large areas **B1**

Answer: Tidal is very predictable but usually built as large fixed infrastructure; wind is less predictable but modular with many turbines that can be added across wide areas

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Question 12

Level 1 Limited evaluation, makes a few relevant points and simple comparisons, with little or no justification or balancing of factors	**1-2**
Level 2 Reasonable evaluation, compares reliability, costs and environmental impacts with some justification and a tentative conclusion	**3-4**
Level 3 Clear, balanced evaluation weighing multiple factors, acknowledges trade-offs and reaches a justified recommendation	**5-6**

Indicative content:

- Reliability: coal can provide continuous on-demand power; wind is intermittent and needs storage or backup but offshore wind in a temperate climate can be productive
- Greenhouse gas emissions: coal emits large amounts of CO_2; wind produces almost no CO_2 in operation, supporting decarbonisation goals
- Costs: coal may have lower capital cost per MW and existing infrastructure, but high and volatile fuel costs and possible carbon pricing; wind has high capital/setup cost but low running fuel cost and falling capital costs over time
- Environmental impact: coal mining and ash disposal damage habitats and air quality; wind offshore affects marine habitats and visual/avian considerations but less air pollution
- Long-term considerations: global policy and likely tightening of emissions limits and costs for fossil fuel emissions favour wind; dependence on domestic coal reserves gives short-term energy security but may be risky economically and environmentally
- Recommendation could favour wind for long-term sustainability if storage or flexible backup is planned, while coal might be used as short-term transitional or emergency capacity with strict emissions controls

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