IG.P8 Energy Resources and Electricity Generation

EDEXCEL 4PH1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 State two examples of non-renewable energy resources named on the Edexcel 4PH1 specification, in the context of national electricity generation.

(Total for Question 1 is 1 mark)

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2 State two examples of renewable energy resources named on the Edexcel 4PH1 specification, suitable for electricity generation.

(Total for Question 2 is 1 mark)

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3 Describe, in the context of a thermal power station that burns coal, how burning the fuel leads to electricity generation. Include the main energy transfers.

(Total for Question 3 is 2 marks)

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4 Describe briefly how nuclear fuel in a nuclear power station supplies energy to boil water and drive a turbine, naming the primary physical process inside the reactor.

(Total for Question 4 is 2 marks)

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

(Total for Question 5 is 2 marks)

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

(Total for Question 6 is 1 mark)

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7 Describe one environmental advantage and one environmental disadvantage of building a large hydroelectric dam compared with a coal-fired power station, in terms of emissions and habitat change.

(Total for Question 7 is 2 marks)

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

(Total for Question 8 is 1 mark)

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

(Total for Question 9 is 2 marks)

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10 State one practical limitation of relying on tidal power for a country's electricity generation, referring to timing or geography.

(Total for Question 10 is 1 mark)

11 A country plans to add 150 MW of extra generating capacity. Explain one reason why building a natural gas plant might be chosen over building an equivalent total area of solar farms, considering reliability and space requirements.

(Total for Question 11 is 3 marks)

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

(Total for Question 12 is 2 marks)

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13 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 13 is 4 marks)

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14 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 14 is 6 marks)

15 A proposed new power station will burn natural gas and have an efficiency of 50%. If the chemical energy input from the gas is 800 MW, calculate the electrical power output expected and state the amount of energy lost as waste heat.

(Total for Question 15 is 4 marks)

Mark scheme · IG.P8 Energy Resources and Electricity Generation

Question 1

- **B1** any one valid non-renewable resource named, e.g. coal, oil, natural gas, uranium/nuclear fuel
- **Answer: Any one of: coal, oil, natural gas, nuclear fuel**

Question 2

- **B1** any one valid renewable resource named, e.g. solar, wind, hydroelectric, tidal, geothermal, biofuel
- **Answer: Any one of: solar, wind, hydroelectric, tidal, geothermal, biofuel**

Question 3

- **B1** states that burning coal releases thermal energy heating water to make steam
- **B1** states that steam drives a turbine connected to a generator that produces electricity
- **Answer: Burning coal releases heat that boils water to make steam; the steam drives a turbine which turns a generator to produce electricity**

Question 4

- **B1** names nuclear fission as the process where heavy nuclei split and release energy
- **B1** states that the released energy heats water to make steam which drives a turbine
- **Answer: Nuclear fission releases energy when heavy nuclei split; this energy heats water to make steam which turns a turbine to drive a generator**

Question 5

- **B1** 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
- **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 6

- **B1** states that burning coal produces carbon dioxide (CO_2) emissions that contribute to global warming
- **Answer: Produces carbon dioxide emissions, contributing to global warming**

Question 7

- **B1** advantage: hydroelectric dams produce little or no CO_2 during operation compared with coal which emits CO_2
- **B1** disadvantage: dams flood large areas and disrupt ecosystems and human settlements, whereas coal does not cause large-scale flooding
- **Answer: Advantage: hydroelectric produces little CO_2 in operation compared with coal. Disadvantage: dams flood and disrupt habitats and communities on a large scale, unlike coal plants which have different local impacts**

Question 8

- **B1** states that geothermal uses heat from the Earth which is continuously available or replenished
- **Answer: Uses heat from the Earth that is continuously available, so the energy source is effectively replenished**

Question 9

- **B1** states that solar has high initial setup costs for panels and land but low running fuel cost
- **B1** states that coal has comparatively lower initial plant cost per unit but higher ongoing fuel and emissions-related costs
- **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 10

- **B1** states a limitation such as: tidal power is location dependent and only works where tidal ranges are large, or it produces power only at certain times following tidal cycles
- **Answer: It is location dependent and only produces power at certain times of the tidal cycle**

Question 11

- **B1** states that gas plants can provide continuous, on-demand power and are dispatchable
- **B1** explains that solar output is intermittent and requires much more land area for the same capacity
- **B1** connects these points to the choice: gas ensures stable supply with smaller footprint, while solar may need storage or backup and large land area
- **Answer: Gas provides on-demand, reliable power and requires less land area than the equivalent solar arrays, so it may be chosen to guarantee supply without needing large storage or backup**

Question 12

- **B1** 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
- **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 13

- **B1** 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
- **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**

Question 14

- **Level 1** (1-2): Limited evaluation, makes a few relevant points and simple comparisons, with little or no justification or balancing of factors
- **Level 2** (3-4): Reasonable evaluation, compares reliability, costs and environmental impacts with some justification and a tentative conclusion
- **Level 3** (5-6): Clear, balanced evaluation weighing multiple factors, acknowledges trade-offs and reaches a justified recommendation
- **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 CO2; wind produces almost no CO2 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

Question 15

- **M1** states the equation efficiency = useful output / total input
- **M1** substitutes and rearranges to useful output = efficiency x total input = 0.50 x 800 MW
- **A1** uses calculation to give electrical output = 400 MW cao
- **A1** states waste heat = 800 MW - 400 MW = 400 MW cao, with units
- **Answer: Electrical output = 400 MW; waste heat = 400 MW**