Past-paper walk-through

Wind Energy ▪ 6.12

eXercise

Questions in this set

- 2018 Q2

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 2

2018 ▪ Q2

2. An offshore wind farm project using turbines to generate electricity is to be built along the Atlantic coast of the United States. It will be located about 13 km from the coast in water with an average depth of 10 m.

   (a) **Describe** one environmental benefit associated with an offshore wind project.

   (b) **Identify** and **describe** one potential economic effect of an offshore wind project.

   (c) **Describe** one additional way, other than wind power, that oceans can provide renewable energy for the generation of electricity.

   The project will consist of 200 wind turbines, each with a capacity of 4 megawatts (MW). Each turbine costs $1.2 million to build. Electrical demand in the area to be served by the project is expected to be 2.0×10^6 MWh per year.

   (d) **Calculate** how much electricity (in MWh) the wind project needs to generate per year in order to provide 80% of the annual electrical demand in the service area. Show all work.

   (e) Customers in the service area pay $0.20/kWh for electricity. **Calculate** how much revenue will be produced if the wind turbines provide 80% of the annual electrical demand in the service area. Show all work.

Question 2

(f) Assuming all turbines are operating, **calculate** how many hours the wind turbines must operate to provide 80% of the annual electrical demand in the service area. Show all work.

Solution 2

(a) Mark scheme

- 1 point for a correct description of an environmental benefit of an offshore wind project. Accept any one of: reduced environmental damage from decreased reliance on fossil fuels (less habitat/ecosystem destruction from mining/drilling; less air/soil/water pollution from transporting fuels; less air pollution/greenhouse gases from combustion); reduced environmental damage from decreased reliance on nuclear power (no risk of radioactive release from accidents; no hazardous/radioactive waste to store; less uranium ore exploration/extraction/processing); increased aquatic habitat/artificial reefs for barnacles, sponges, other invertebrates, fish.

Solution 2

(b) Mark scheme

- 2 points: 1 for identifying a potential economic effect of the offshore wind project, 1 for describing that effect (the description point cannot be earned without a correct identification). Example identify/describe pairs: Job creation (+) — jobs created in construction, operation, maintenance; Additional income (+) — municipalities receive more tax revenue, or the wind company profits long-run; Decreased electricity costs (+) — lower production costs reduce consumer electricity rates; Less reliance on foreign energy resources (+) — reduced fuel-transport costs; High initial construction/maintenance costs (–) — local taxes/fees rise to cover construction costs, parts/personnel must be transported offshore; Decreased property value (–) — coastal property values fall due to

Solution 2

unfavorable aesthetics; Loss of income (–) — turbines hurt tourism/fishing/whale-watching aesthetics, disrupt local fishing, or reduce fossil-fuel company revenue; Job loss (–) — jobs lost in traditional energy sectors (coal, nuclear); Subsidies cost (–) — state subsidies for construction/transmission lines increase (may be recovered via taxes). Any one matched identify+describe pair earns both points.

Solution 2

(c)

Mark scheme

- 1 point for a correct description of an ocean energy source other than wind. Accept any one of: use of tidal movement/currents to turn turbines; a device designed to capture energy from wave motion; harnessing the solar energy absorbed by oceans/using the natural thermal gradient in tropical and temperate oceans (Ocean Thermal Energy Conversion, OTEC); harvesting algae and converting it to biofuel.

Solution 2

(d)

Mark scheme

- 2 points: 1 for the correct setup, 1 for the correct final answer. Setup: (0.80) $\times$ (2.0 $\times$ 10^6 MWh) = electricity the wind project must generate. Answer: 1.6 $\times$ 10^6 MWh.

Solution 2

(e)

Mark scheme

- 2 points: 1 for the correct setup, 1 for the correct final answer. Setup: 1.6 $\times$ 10^6 MWh $\times$ $(0.20/kWh)\times(1\times10^3 kWh/1MWh) = 1.6\times10^6\times200$ =3.2 $\times$ 10^8. Answer: $320,000,000$(=320 million).

Solution 2

(f)

Mark scheme

- 2 points: 1 for the correct setup, 1 for the correct final answer. Setup: 1.6 $\times$ 10^6 MWh $\div$ (200 turbines $\times$ 4 MW/turbine) = 1.6$\times$10^6 MWh $\div$ 800 MW. Answer: 2 $\times$ 10^3 hr = 2,000 hours.