

## Mark schemes

1.

- (a) minimum distance between wind turbines is at least 500 m in all directions

*turbines can rotate to face into wind and still maintain the minimum distance*

1

- (b) density = mass/volume

*allow  $\rho = m / V$*

1

- (c)  $1.2 = \frac{51000}{V}$

1

$$V = \frac{51000}{1.2}$$

1

$$V = 42\,500$$

1

$$V = 43\,000$$

1

$\text{m}^3$

*an answer of 43 000 scores 4 marks  
an answer of 42 500 scores 3 marks*

1

- (d)  $2.4 \times 10^9 / 1.6 \times 10^6$

1

1500

*an answer of 1500 scores 2 marks*

1

- (e) wind power is unreliable

1

(very) large numbers of wind turbines would need to be constructed  
*allow calculation of this (15 625)*

1

[11]

2.

(a)

<b>Level 2:</b> Relevant reasons are identified, given in detail and logically linked to form a clear account.	3-4
<b>Level 1:</b> Relevant reasons are identified, and there are attempts at logically linking. The resulting account is not fully clear.	1-2
No relevant content	0
<b>Indicative content</b> <b>nuclear</b> <ul style="list-style-type: none"> <li>no carbon dioxide released (when generating electricity) <b>or</b> doesn't release greenhouse gases</li> <li>reliable</li> <li>high energy density</li> <li>power stations already built</li> <li>other power stations being built</li> </ul> <b>wind</b> <ul style="list-style-type: none"> <li>no carbon dioxide released (when generating electricity) <b>or</b> doesn't release greenhouse gases</li> <li>renewable energy resource</li> <li>no fuel cost</li> </ul>	

4

(b) wind power is unreliable

1

(so) will be unable to meet demand when wind speed is low

**or**

when there is no wind

**or**

unable to maintain base load at all times

1

(c) electricity generation will need to increase (to meet higher demand) 1

(using)  
nuclear power

**or**

wind power

**or**

other renewables

1

so that carbon dioxide emissions don't increase

**or**

reference to Paris Climate agreement

1

[9]

3.

(a) any **two** from:

- nuclear
- oil
- (natural) gas

2

(b) 4 (hours)

1

(c) a system of cables and transformers

1

(d) The power output of wind turbines is unpredictable

1

(e) 1500 / 0.6

1

2500 (wind turbines)

1

*allow 2500 with no working shown for 2 marks*

(f) Most energy resources have negative environmental effects.

1

[8]

<b>4.</b>	(a) geothermal	1
	nuclear	1
	biofuel	1
	(b) gravitational (potential)	1
	kinetic	1
	sound	1
	(c) (i) 90% or 0.9(0) <i>an answer of 0.9(0) with a unit gains 1 mark</i>	2
	(ii) 60 (MW) <i>allow 10%</i>	1
	(iii) increased	1
		<b>[10]</b>

<b>5.</b>	(a) any <b>two</b> from:	
	<ul style="list-style-type: none"> <li>• cost per kWh is lower (than all other energy resources) <i>allow it is cheaper</i> <i>ignore fuel cost</i> <i>ignore energy released per kg of nuclear fuel</i></li> <li>• infrastructure for nuclear power already exists <i>accept cost of setting up renewable energy resources is high</i> <i>accept many renewable power stations would be needed to replace one nuclear power station</i> <i>accept (France in 2011 already had a) surplus of nuclear energy, so less need to develop more renewable capacity for increased demand in the future</i> <i>accept France benefits economically from selling electricity</i></li> <li>• more reliable (than renewable energy resources) <i>accept (nuclear) fuel is readily available</i> <i>ignore destruction of habitats for renewables</i></li> </ul>	2

(b) any **two** from:

- non-renewable  
*allow nuclear fuel is running out*
- high decommissioning costs  
*accept high commissioning costs*
- produces radioactive / nuclear waste  
*allow waste has a long half-life*
- long start-up time
- nuclear accidents have widespread implications  
*allow for nuclear accident a named nuclear accident  
eg Fukushima, Chernobyl  
ignore visual pollution*

2

(c) 0.48 (kW)

*allow 1 mark for correct substitution  
ie  $0.15 = P / 3.2$   
an answer of 480 W gains 2 marks  
an answer of 48 or 480 scores 1 mark*

2

(d) the higher the efficiency, the higher the cost (per m<sup>2</sup> to manufacture)  
*accept a specific numerical example*

1

more electricity could be generated for the same (manufacturing) cost using lower efficiency solar panels

**or**

(reducing the cost) allows more solar panels to be bought  
*accept a specific numerical example*

1

**[8]**

6. (a) (i) infrared (radiation) 1  
*accept IR (radiation)*
- (ii) (heated) water turns to steam 1  
*ignore reference to fossil fuels*  
*do **not** accept water evaporates to steam*
- steam turns a turbine 1
- turbine turns a generator 1  
*accept turbine connected to a generator*
- (b) (i) (so the molten salts) can store large amounts of energy 1  
*accept there is a small temperature change for a large energy transfer*  
*accept heat for energy*
- (ii) 16 (hours) 1  
*an answer that rounds to 16 gains 2 marks eg 15.71*  
*allow 1 mark for a correct substitution ie  $2\,200\,000 = 140\,000 \times t$*  3
- (iii) the number of daylight hours varies 1  
*less sunlight is insufficient*
- the (mean) power (received from the Sun per square metre) varies 1  
*accept an answer in terms of maximum possible electrical output only possible during Summer for 1 mark*

- (c) (i) non-renewable power stations have higher Capacity Factors than renewable power stations

1

fuel (for non-renewable power stations) is always available

*reference to non-renewable power stations operating all the time is insufficient*

*non-renewable energy sources are reliable is insufficient*

1

(most) renewable energy sources are unpredictable / unreliable

*accept (most) renewable energy sources depend on the weather*

1

- (ii) the (proportion of) time that solar storage power stations can generate electricity is greater (than for other renewable energy sources)

1

[14]