

EXEMPLIFYING EXAMINATION PERFORMANCE

AS Environmental Technology

Introduction

These materials illustrate aspects of performance from the 2014 summer AS examination series of CCEA's revised GCE Specification in Environmental Technology.

Students' grade A responses are reproduced and accompanied by commentaries written by senior examiners. The commentaries draw attention to the strengths of the students' responses and indicate, where appropriate, deficiencies and how improvements could be made.

It is intended that the materials should provide a benchmark of candidate performance and help teachers and students to raise standards.

For further details of our support package, please visit our website at www.ccea.org.uk

Best wishes

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AS1:

The Earth's capacity to support activity

Q1a

Explain with the aid of an example, the following terms:

(i) Fossil fuel [2]

Student's response

Fuel that will form naturally, these fuels form from died plants and animals, that decay under anaerobic conditions, they will eventually run out, such as oil

Examiner's Comments

The candidate was awarded 2 marks for correctly explaining the term 'fossil fuel' as being formed from dead plants and animals. The candidate listed oil as an example.

(ii) Renewable energy source [2]

Student's response

These energy sources uses sources that will continuously generate energy and will not run out, these include using the Sun for photovoltaic panels.

Examiner's Comments

The candidate was awarded 2 marks for correctly explaining that a renewable energy source would not run out. The candidate also correctly used solar PV as an example.

Q1b

The Brundtland report defines sustainability as 'the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.' Our Common Future (1987)

With reference to this definition, state the main European, UK and Northern Ireland government targets with regards to the continued use of fossil fuels as an energy resource, as we approach 2020. [3]

Student's response

2009 European targets known as 20-20-20, these include 20% cut in greenhouse gas emissions by 2020, a 20% increase in energy from renewable energy sources, and 20% cut in energy demand by 2020, these targets are still meeting needs of present and will continue to meet needs of future generations.

Northern Ireland targets were 40% increase in energy from renewables by 2020 and 35% cut in energy demand by 2020.

Examiner's Comments

The candidate correctly stated all three of the targets.

- 20% increase in use of renewables;
- 20% cut in emissions; and
- 20% reduction in energy consumption.

3 marks were awarded for this response.

Q1c

Carbon trading has been put forward as a method of monitoring and reducing global carbon emissions. Describe two issues surrounding the use of carbon trading. [2]

Student's response

Two issues include that some developed industries may settle for carbon trading but will not reduce their emissions.

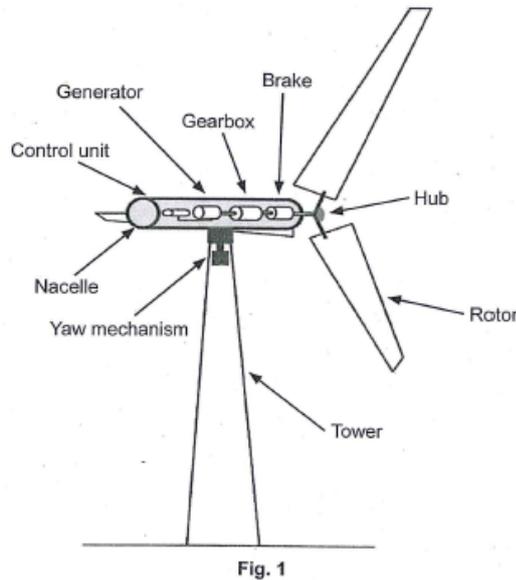
Another is that the emission levels for a country may be too high to give incentive to lower emissions.

Examiner's Comments

The candidate has correctly described two issues associated with carbon trading; countries settling for simply trading carbon instead of reducing emissions and the problem when emission levels have been set too high for a country so that there is little incentive to reduce emissions. 2 marks were awarded for this response.

Q2a

(i) Identify the main energy transformations that take place in the wind turbine. [2]



Student's response

Kinetic energy generated in motion of rotor to electrical energy

Examiner's Comments

The energy transformations have been correctly identified as Kinetic Energy changing to Electrical Energy. 2 marks have been awarded for this response.

(ii) Describe the purpose of the Yaw mechanism. [2]

Student's response

Yaw allows the nacelle and blades to rotate about a point to face the direction of the wind, maximising energy output.

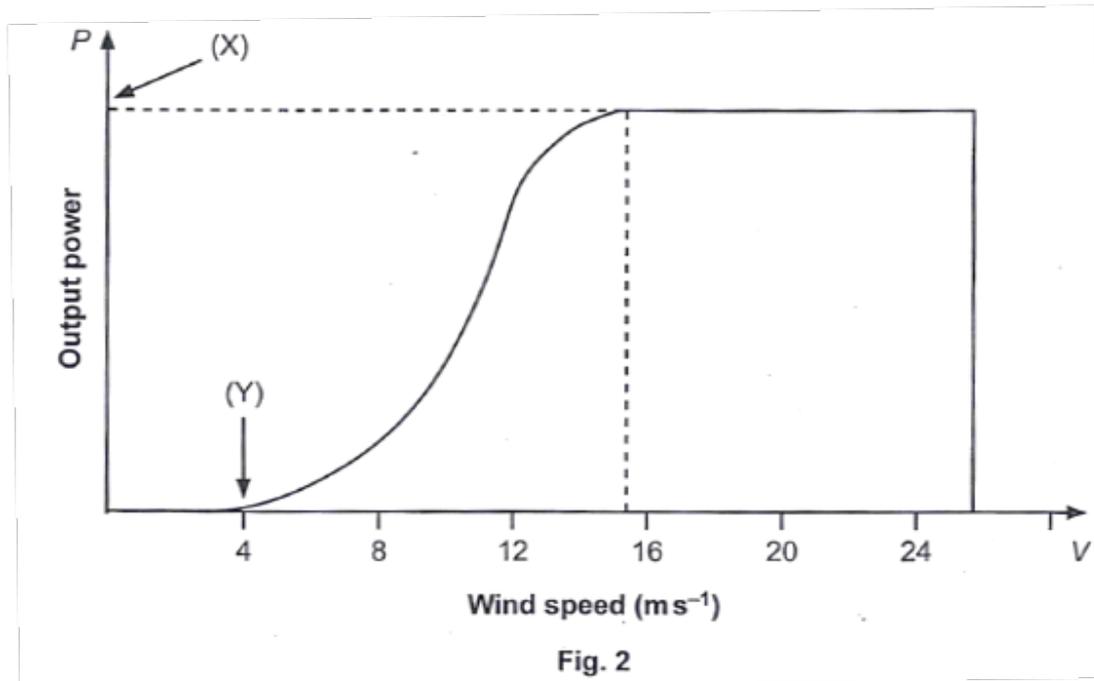
Examiner's Comments

The purpose of the Yawing mechanism has been correctly described as being to rotate the blades into the wind to extract maximum energy from it. The candidate has been awarded 2 marks for this response.

Q2b

Fig. 2 illustrates a typical wind power curve. Identify and explain the following annotated points on the graph:

(i) X [2]



Student's response

Output power – this is the maximum amount of power the turbine will generate

Examiner's Comments

The candidate has correctly identified Point X on the power curve as the 'maximum output power' and explained its significance. The candidate has been awarded 2 marks for this response.

Fig. 2 illustrates a typical wind power curve. Identify and explain the following annotated points on the graph:

(ii) Y [2]

Student's response

cut in speed – is the speed of wind that the turbine starts turning and generating power.

Examiner's Comments

The candidate has correctly identified Point Y on the power curve as 'cut-in speed' and explained its significance as the point at which the turbine begins to turn and generate power. 2 marks were awarded for this response.

Q2c

(i) With reference to Fig. 3 explain the following relationships for a typical horizontal axis wind turbine.

- Power output and swept area. [1]

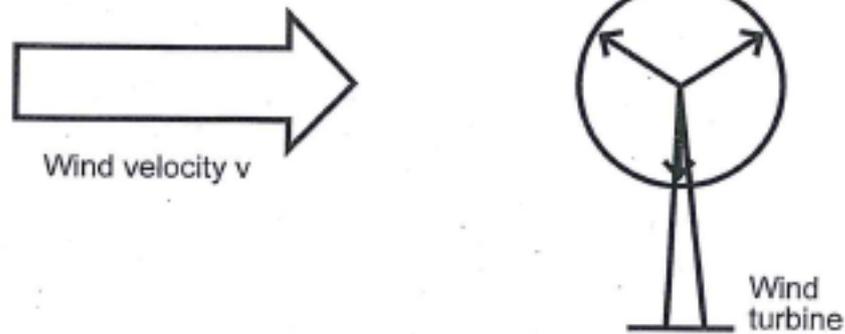


Fig. 3

Student's response

The larger the swept area the more power will be generated, if blade size is doubled, four times more power generated.

Examiner's Comments

The candidate has correctly explained that power output increases with swept area (doubling area multiplies power by four) and also with wind speed (doubling wind speed multiplies power by eight). 2 marks were awarded for this response.

(ii) Calculate the wind speed required to produce 17280 joules of energy from 540 kg of air. [3]

Student's response

$$17280 \div 540 = 32 \text{ m/s}$$

Examiner's Comments

The candidate did not know the correct equation or how to apply it. No marks were awarded for this response.

Q3a

(i) State three factors which should be considered when calculating the roof area required to install flat plate thermal solar panels on a house. [3]

Student's response

The angle of the roof
 The number of panels needed to meet the need of amount of hot water
 The direction the roof faces in, South facing would be best.

Examiner's Comments

The candidate stated three relevant factors; roof angle; amount of hot water required; and the direction that the roof is facing. 3 marks have been awarded for this response.

(ii): A household uses 6500 kWh of hot water per year. If the owners wish to install a solar thermal hot water system to meet at least 65% of their annual hot water demand, what area of solar panel (flat plate) would provide a practical solution?
 (Assume 1m² of a flat plate collector provides 450 kWh of useful heat per year)
 [3]

Student's response

65% of 6500 = 10,000 kw
 $10,000 \div 450 = 22.2$
 To meet at least 65% of annual hot water they would need around 23m² plate collectors.

Examiner's Comments

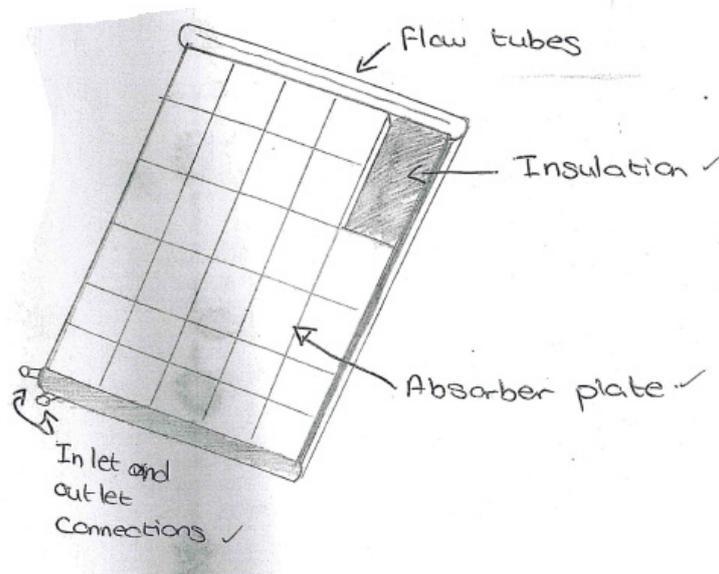
Although the candidate did not correctly calculate how much energy the solar thermal system was required to produce, the subsequent calculation of how many m² of panel was required and rounded up to a whole number of panel was carried out clearly and accurately. Accordingly this candidate was awarded 2 marks for this response.

Q3b

In the space below sketch a diagram of a typical flat plate thermal solar panel and clearly label the following:

- Inlet and outlet connections
- Flow tubes
- Absorber plate
- Insulation [4]

Student's response



Examiner's Comments

The candidate produced a very neat sketch showing inlet/outlet connections, absorber plate and insulation. However the flow tubes were incorrectly labelled. 3 marks were awarded for this response.

Q3c

(i) State one advantage provided by an evacuated tube solar collector compared to a flat plate solar collector. [1]

Student's response

More Sun light is taken in by evacuated tube than flat plate, as they have rounded sides.

Examiner's Comments

Being able to take in more sunlight was correctly stated as an advantage of evacuated tube collectors over flat plate collectors. The candidate was awarded 1 mark for this response.

(ii) Explain the main benefit to households of installing a flat plate solar collector. [1]

Student's response

They are cheaper to install.

Examiner's Comments

The candidate explained how cheaper installation costs was the main benefit of installing a flat plate solar collector. 1 mark was awarded for this response.

Q4a

(a) Fig 4 below shows the typical arrangement of a PV Cell. Explain the following:
(i) The purpose of the anti-reflection coating. [1]

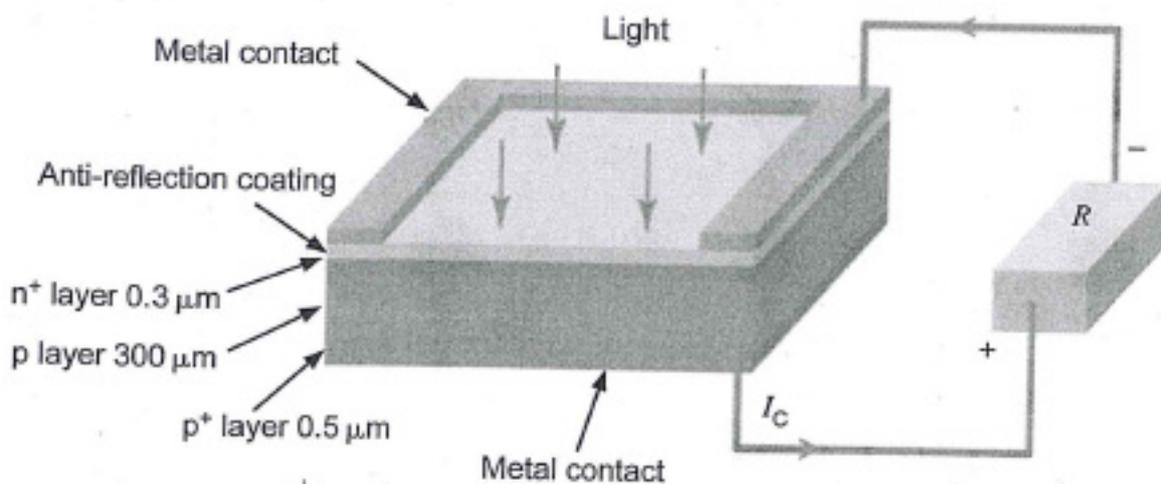


Fig. 4

Student's response

Stops sun light from being reflected, so more sun light is conducted.

Examiner's Comments

The function of the anti-reflection coating has been correctly explained as stopping sunlight from being reflected and ensuring that it is conducted. The candidate was awarded 1 mark for this response.

(ii) The role of the metal contacts. [1]

Student's response

Allows an electrical current to flow through panel.

Examiner's Comments

The candidate has correctly explained the purpose of the metal contacts as being to conduct electricity through the panel. 1 mark was awarded for this response.

(iii) The operation of the PV cell. [3]

Student's response

PV (photovoltaic) panels produce electricity, they are made from cells, each cell is half a layer of semi-conducting material such as silicon, this conducts the sun's rays and creates a photoelectrical field.

Examiner's Comments

The candidate knew that the PV panels produced electricity but failed to correctly explain properly how electrons travel through a semi-conducting material in the PV cell. 1 mark was awarded for this response.

Q4b

(i) Describe one advantage and one disadvantage of monocrystalline PV modules. [2]

Student's response

Advantage is they are most efficient of 20%.
However they are the most expensive.

Examiner's Comments

The candidate correctly described one advantage; higher efficiency and one disadvantage; more expensive of mono-crystalline PV modules. 2 marks were awarded for this response.

Name two other material types of PV modules. [2]

Student's response

Polycrystalline
Thin film

Examiner's Comments

The candidate correctly named two other types of PV modules; Polycrystalline and Thin Film. 2 marks were awarded for this response.

Q4c

With reference to Fig. 5, explain how an automated tracking system can maximize energy output from solar devices. [3]

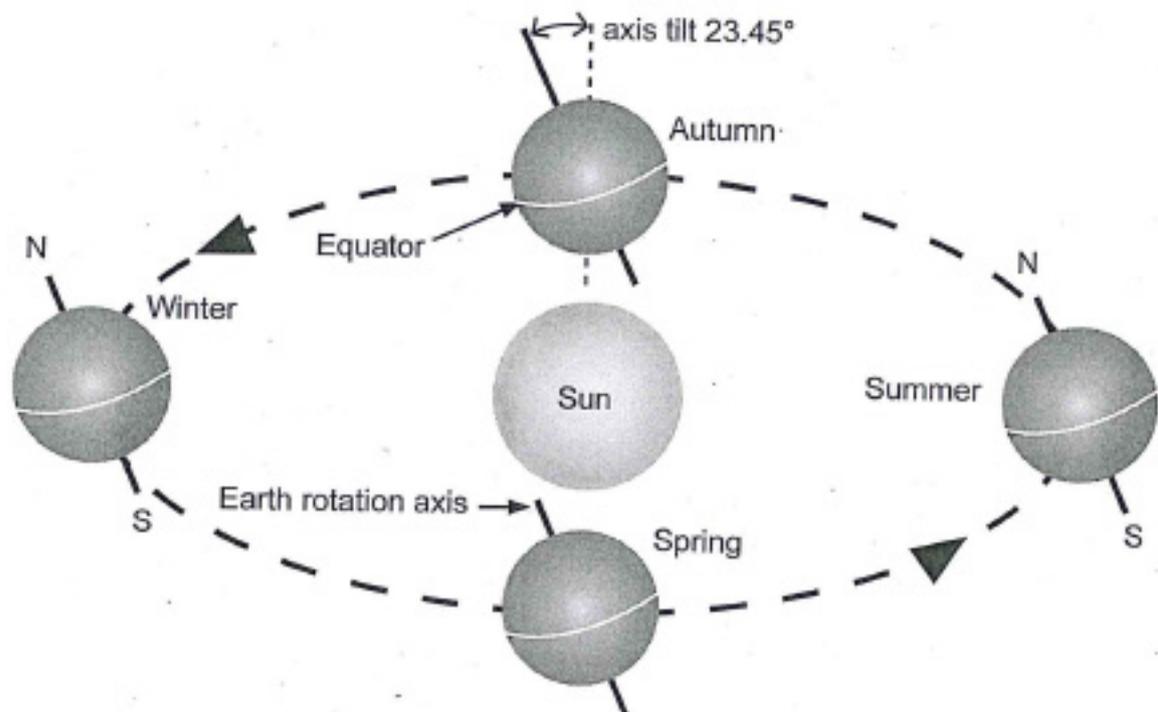


Fig. 5

Student's response

Solar panels are put onto a single axis, this allows the panel to follow the Sun throughout the day, so the panel is continually getting sunlight, even when the sun is highest or lowest in the sky, which this allows electricity to be generated all day long instead of only a few hours a day.

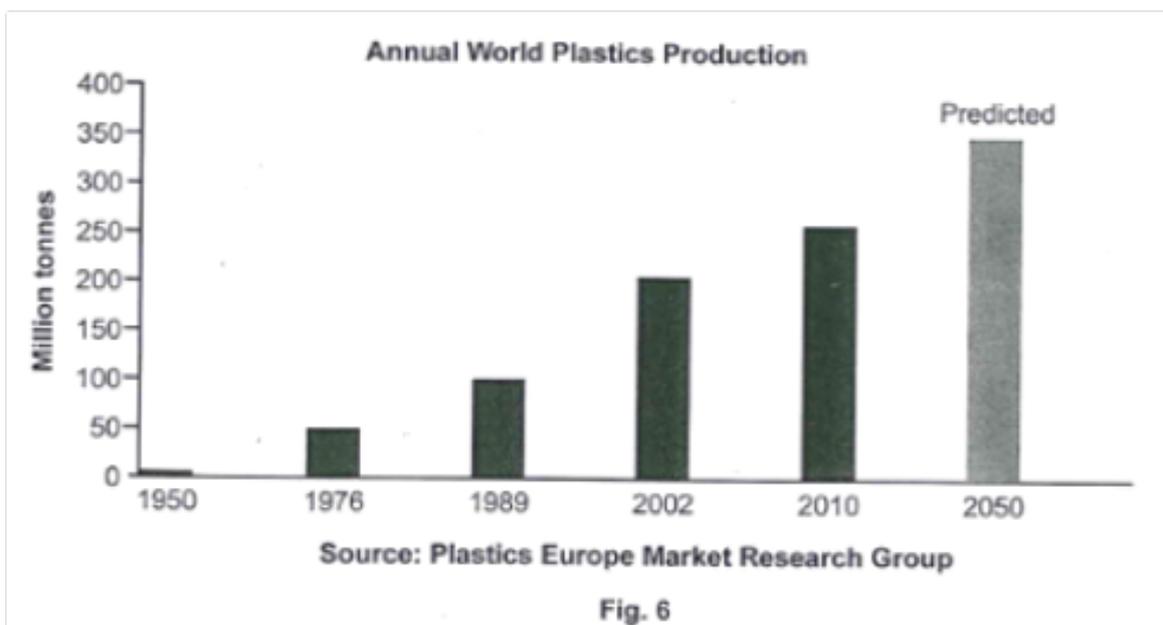
Panels can also be put on dual axis to follow the sun throughout the year.

Examiner's Comments

The candidate correctly explained how automated tracking solar devices followed the sun at different times of the day and at different times of year. However, the candidate did not make clear how the panel was adjusted to face into the sun to achieve maximum energy. 2 marks were awarded for this response.

Q5a

Question 5 (a) Fig. 6 details annual world plastic production. Comment on the trend shown and explain why there is a need for a global move towards more sustainable manufacture and use of plastics. [2]



Student's response

In 1950's plastic production was lowest at around 5 million tonnes however it is predicted to be around 360 million tonnes by 2050, we need to use plastic more sustainable to decrease pollution and waste, and increase recycling of plastics

Examiner's Comments

From the bar chart (Fig.6), the candidate correctly deduced that global production of plastics was increasing and then explained the need for a move towards more sustainable manufacture of plastics in order to reduce pollution and waste. 2 marks were awarded for this response.

Q5b

(i) Explain the term 'sustainable manufacture of plastics'. [2]

Student's response

Where plastics are made that they are better for the environment and will last longer, and can be recycled.

Examiner's Comments

The candidate did explain that sustainable plastics are those that would be better for the environment and could be recycled but did not refer to the use of efficient manufacturing and production techniques. 1 mark was awarded for this response.

(ii) The production of bioderived polyethylene (BPE), is often described as not being 'a sustainable manufacturing process'. Why is this so? [2]

Student's response

Because there is still greenhouse gas and carbon emissions being given off during the manufacture, and it still contains polymers which aren't bio degraded

Examiner's Comments

The candidate was aware that oil was still used in the production of BPE and also explained that BPE still contains non-biodegradable polymers. 2 marks were awarded for this response.

Q6a

(i) Explain the following terms:

- Biomass [1]

Student's response

Material derived from growing plants or animal manure

- *Energy density [1]*

Student's response

The amount of energy stored in a given mass or volume of material.

Examiner's Comments

The candidate correctly explained the term biomass as being material derived from plants or animal manure and was also aware that energy density represented how much energy a material contained per unit mass or unit volume. 2 marks were awarded for this response.

Q6a

(ii) Outline the process of gasification in relation to biomass. [2]

Student's response

Gasification is the process of breaking down carbon based products such as wood into carbon monoxide and hydrogen to produce Syngas.

Examiner's Comments

The candidate was aware that gasification involved the breaking down of carbon-based products into carbon Monoxide and Hydrogen and then from this producing Syngas. 2 marks were awarded for this response.

Q6b

Local commercial businesses are considering the use of anaerobic digestion facilities on their premises.

(i) State one advantage and one disadvantage of using commercial anaerobic digesters. [2]

Student's response

There is less carbon dioxide and greenhouse gases going into atmosphere reducing greenhouse affect.

However they can leak causing land & water pollution.

Examiner's Comments

A reduction in the emission of CO₂/GHGs was correctly stated as being an advantage of commercial anaerobic digestion. However the candidate did not state a relevant disadvantage. 1 mark was awarded for this response.

(ii) Briefly describe the global debate that surrounds farmers growing crops for energy. [2]

Student's response

Farmers are growing crops for energy and not for food, some LADC countries find it expensive and hard to grow crops, so while we are using crops for energy they are starving

Examiner's Comments

The candidate's answer showed a good understanding of the 'food versus fuel' debate surrounding the use of crops for energy. 2 marks were awarded for this response.

Q7

In 2013, Northern Ireland's Department of Enterprise, Trade and Investment (DETI) announced that there is 'an exciting opportunity for Northern Ireland to take a leadership role in the expansion of smart grid solutions.'

Discuss the main factors that must be considered when assessing the future opportunity of smart grid.

Your response should include reference to:

- *The concept of smart grid;*
- *Problems associated with delivering energy from renewable sources to the grid;*
- *The need to develop energy storage facilities capable of storing energy from renewable energy sources;*
- *The use of interconnectors between European countries in a smart grid scenario;*
- *Potential benefits of smart grid to the Northern Ireland economy.*

The quality of written communication is assessed in this question. [15]

Student's response

Smart grid is an electrical network that uses computer controlled systems to divert energy from one renewable to another as demand varies over grid.

What renewables can be used should be considered as wind turbines need to be in an open place with strong winds, mainly mountains, Northern Ireland doesn't get sunlight all year round, causing intermitted supply for solar photovoltaic panels, all renewables give intermitted supply, causing them to be unreliable. There is also planning permission issues to be able to build renewable energy sources in suitable locations.

Also if energy is created by tidal power which is out at sea, the energy created has to travel further to a grid, meaning energy will be lost as it has to travel so far to be distributed. Batteries are a good energy storage as they can hold large amounts of energy, but over time they leak and energy is lost, so more sustainable storages need to be developed into smart grids. Compressed air storage is the best storage of energy where energy is stored in underground geological reservoirs or pumped hydro storage which is the oldest type of energy storage.

Interconnections between European countries has its benefits but it's down sides as well, it will improve the security of renewable energy supply, there will also be a greater use of renewables throughout Europe, and it means if one country loses power, another country can give it an energy supply.

However, it may be affected by geopolitical conflict. And connects may be cut off, also to set up a smart grid is expensive.

Benefits of smart grid to Northern Ireland economy will be that they won't be producing as much carbon dioxide and greenhouse gas emissions, and they are signed to carbon trading, meaning they could sell their units of emissions to countries who need them, making them profit.

Also the demand for energy will be managed better so they won't have to spend as much money on building more turbines or solar photovoltaic farms. Smart grid is needed to help manage the demand of electricity, increase the use of renewables and cut emissions of greenhouse gases.

Examiner's Comments

The candidate provided an answer of high quality and clearly had an excellent understanding of all 5 key reference areas in the question:

1. The concept of a smart grid. The candidate discussed computerised control of systems so that production is diverted from one renewable source to another as demand varies.
2. The problems associated with delivering energy from renewable sources to the grid. The candidate discussed intermittency/ geographical factors influencing viability of various renewable energy types/ planning issues/ transportation of the energy created in remote locations back to the grid.
3. Energy storage facilities. The candidate discussed problems of energy storage within batteries than the alternatives of pumped hydro and compressed air energy storage.

4. The use of interconnectors between European countries in a smart grid. The candidate discussed improved energy security, improved and more widespread use of renewables; the candidate also noted that there could be geopolitical obstacles and cost barriers to setting up a European smart grid;
5. The potential economic benefits the candidate discussed the reduction in emissions of CO₂ and GHGs as well as the better management and optimum use of our renewable sources. Northern Ireland might also be able to take part in Carbon Trading thereby generating profit.

The candidate's discussion was clearly and logically set out. It used appropriate specialist terms e.g. Compressed Air Energy Storage, Solar Photovoltaic farms etc. The form and style were of an excellent standard. Grammar, spelling and punctuation were of a good standard throughout. The candidate was awarded 13 marks for this response.

AS1:

The Earth's capacity to support activity

Q1a

Explain with the aid of an example, the following terms:

(i) Fossil fuel [2]

Student's response

Fossil fuel e.g coal a substance that is made of organic materials that have died and compacted over millions of years.

Examiner's Comments

The term 'fossil fuel' was correctly explained as being formed from dead organic materials and an appropriate example was given. 2 marks were awarded for this response.

(ii) Renewable energy source [2]

Student's response

An energy source that will never run out, that can be transformed from an infinite source into useful energy - e.g wind turbines.

Examiner's Comments

The candidate was awarded 2 marks for correctly explaining that a renewable energy source would not run out stating wind turbines as an example.

Q1b

The Brundtland report defines sustainability as 'the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.' Our Common Future (1987)

With reference to this definition, state the main European, UK and Northern Ireland government targets with regards to the continued use of fossil fuels as an energy resource, as we approach 2020. [3]

Student's response

The targets are to use 20% less energy overall, to produce 20% of our energy from renewable resources and to reduce our carbon emissions by 20% by 2020.

Examiner's Comments

The candidate correctly stated two of the targets: 20% cut in emissions and 20% reduction in energy consumption. 2 marks were awarded for this response.

Q1c

Carbon trading has been put forward as a method of monitoring and reducing global carbon emissions. Describe two issues surrounding the use of carbon trading. [2]

Student's response

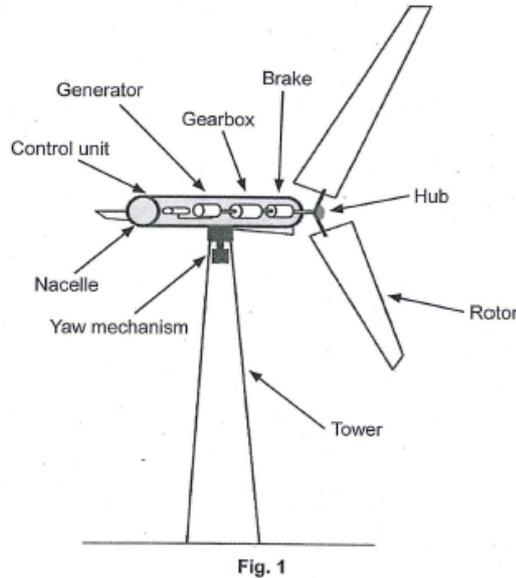
Size of unit - the carbon emission limits may be set too high thus not reducing emissions at all measuring carbon emission - it is too difficult to accurately measure the amount of CO₂ a country releases.

Examiner's Comments

The candidate has correctly described two issues associated with carbon trading; carbon emissions are very difficult to measure and the problem when emission levels have been set too high for a country so that there is little incentive to reduce emission. 2 marks were awarded for this response.

Q2a

(i) Identify the main energy transformations that take place in the wind turbine. [2]



Student's response

Kinetic energy from the wind is turned into mechanical energy turning the generator which changed mechanical energy into electrical.

Examiner's Comments

The energy transformations have been correctly identified as Kinetic Energy changing to Electrical Energy. 2 marks have been awarded for this response.

(ii) Describe the purpose of the Yaw mechanism. [2]

Student's response

If the wind changes directions sensors on the windmill tell the control unit to turn the yaw mechanism turning the blades back into the wind.

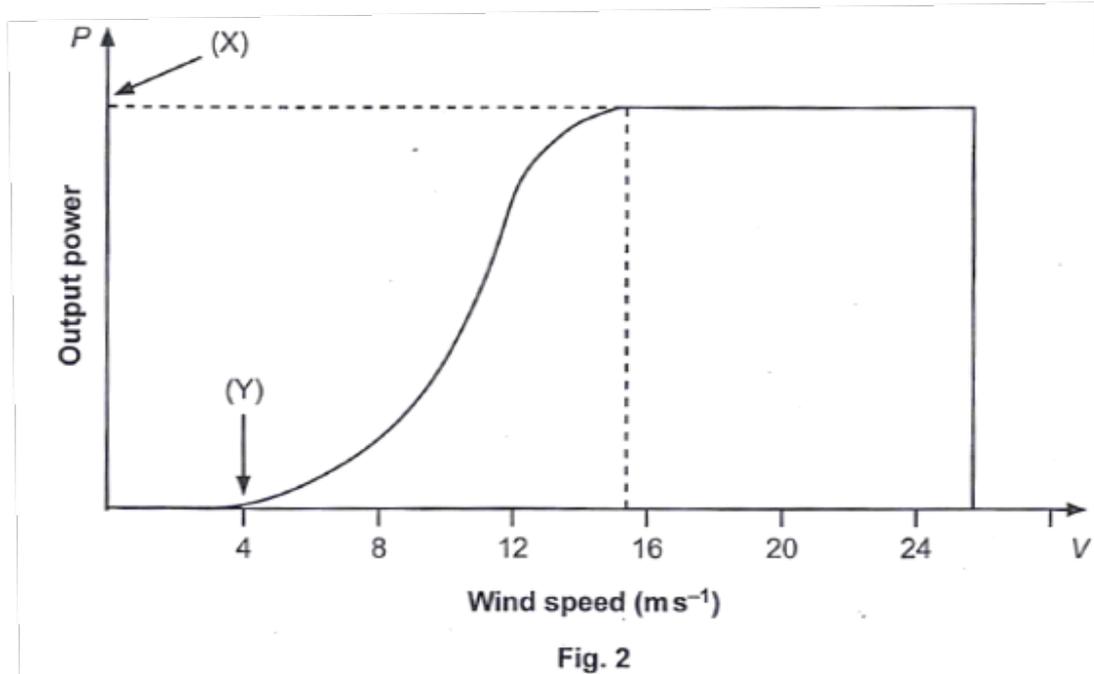
Examiner's Comments

The purpose of the Yawing mechanism has been correctly described as being to turn the blades into the wind but the candidate has not indicated that the purpose of this is to extract maximum energy from the wind. 1 mark has been awarded for this response.

Q2b

Fig. 2 illustrates a typical wind power curve. Identify and explain the following annotated points on the graph:

(i) X [2]



Student's response

Rated power output – the highest amount of power the turbine produces.

Examiner's Comments

The candidate has correctly identified Point X on the power curve as the 'rated power output' and explained its significance. The candidate has been awarded 2 marks for this response.

Fig. 2 illustrates a typical wind power curve. Identify and explain the following annotated points on the graph:

(ii) Y [2]

Student's response

cut in Speed – the lowest wind speed that the turbine produces power.

Examiner's Comments

Point Y on the power curve has been correctly identified as the 'cut-in speed' and the candidate has explained its significance as the lowest wind speed at which the turbine generates power. 2 marks were awarded for this response.

Q2c

(i) With reference to Fig. 3 explain the following relationships for a typical horizontal axis wind turbine.

- Power output and swept area. [1]

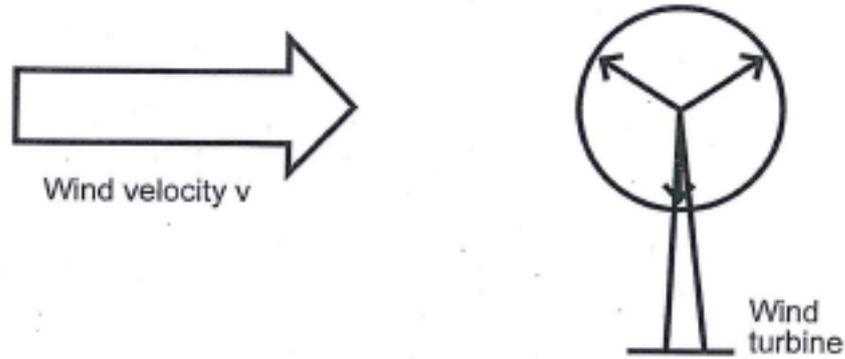


Fig. 3

Student's response

The larger the swept area, the larger the power output – doubling the swept area multiplies the output by 4.

- Power output and wind speed [1]

Student's response

The higher the wind speed to a certain point the larger the power output doubling the wind speed multiplies the output by 8.

Examiner's Comments

The candidate correctly explains that power output increases with swept area by factor of four and also with wind speed by factor of eight. 2 marks were awarded for these responses.

(ii) Calculate the wind speed required to produce 17280 joules of energy from 540 kg of air. [3]

Student's response

$$\frac{KE}{\frac{1}{2} m \times v^2} = \frac{17280}{270} = v^2$$

$$v^2 = 64$$

$$v = \sqrt{64} \quad \boxed{v = 8 \text{ m/s}} \quad [3]$$

Examiner's Comments

The candidate knew the relevant equation and correctly applied it to the scenario given. 3 marks were awarded for this response.

Q3a

(i) State three factors which should be considered when calculating the roof area required to install flat plate thermal solar panels on a house. [3]

Student's response

The amount of hot water/kwh needed for the home. The hours that the panels will be exposed to the sun. The angles of the roof that the solar panels will be on.

Examiner's Comments

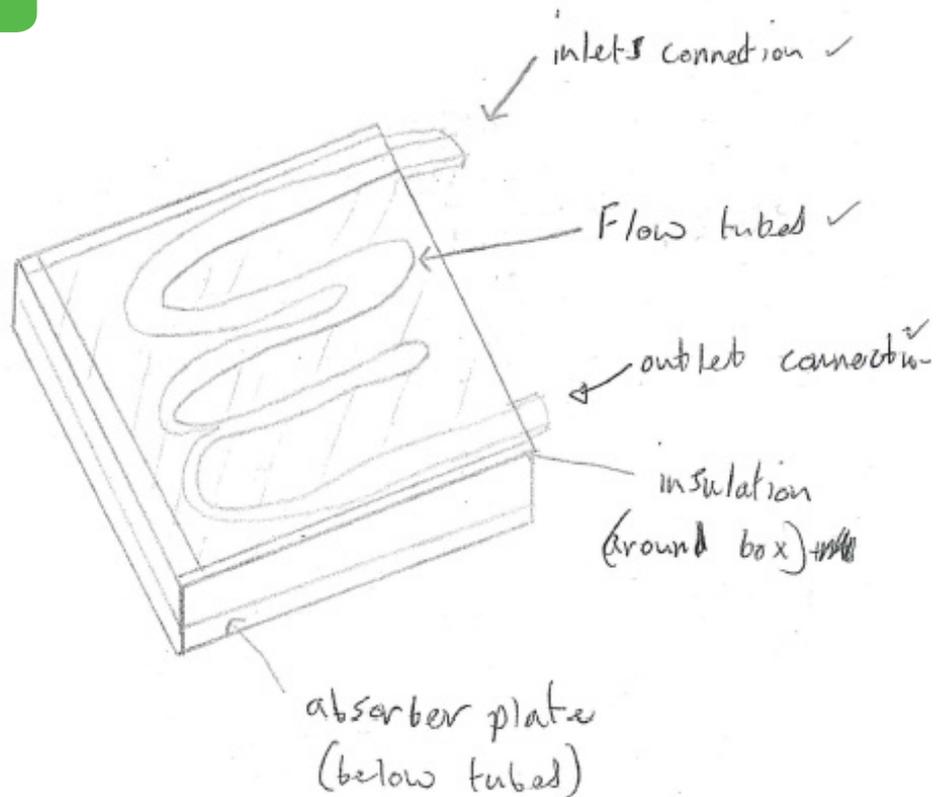
The candidate stated three relevant factors in the amount of hot water required; length of daylight hours; and roof angle. 3 marks have been awarded for this response.

Q3b

In the space below sketch a diagram of a typical flat plate thermal solar panel and clearly label the following:

- Inlet and outlet connections
- Flow tubes
- Absorber plate
- Insulation [4]

Student's response



Examiner's Comments

The candidate produced a neat sketch correctly showing flow tubes and inlet/outlet connections. However, the absorber plate and insulation were shown in the incorrect position. 3 marks were awarded for this response.

Q3c

(i) State one advantage provided by an evacuated tube solar collector compared to a flat plate solar collector. [1]

Student's response

evacuated tubes minimize the radiation heating the thermal panel thus increasing heat energy.

Examiner's Comments

The reduced energy loss was correctly stated as an advantage of evacuated tube collectors over flat plate collectors. This response was awarded 1 mark.

Q3c

(i) State one advantage provided by an evacuated tube solar collector compared to a flat plate solar collector. [1]

Student's response

hot water is produced which can be used for cleaning and showering. Renewable source used.

Examiner's Comments

The candidate explained that provision of hot water from a renewable source was a main benefit of installing a flat plate collector. 1 mark was awarded for this response.

Q4a

(a) Fig 4 below shows the typical arrangement of a PV Cell.

Explain the following:

(i) The purpose of the anti-reflection coating. [1]

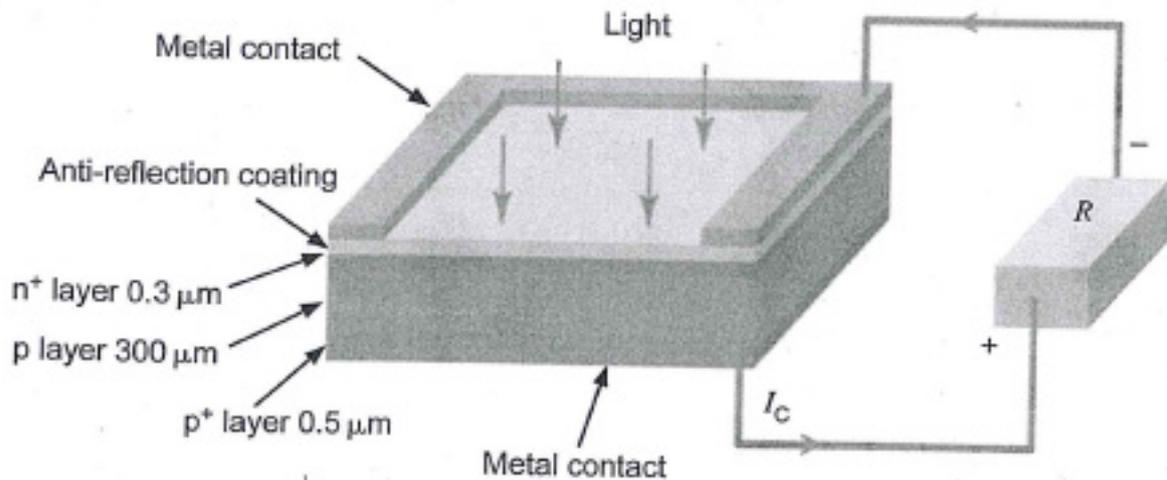


Fig. 4

Student's response

To minimize the light being reflected off the solar panel.

Examiner's Comments

The function of the anti-reflection coating has been correctly explained as minimising the amount of sunlight from being reflected off the panel. The candidate was awarded 1 mark for this response.

(ii) The role of the metal contacts. [1]

Student's response

To create voltage thus creating current.

Examiner's Comments

The candidate was not aware of the purpose of the metal contacts as being to conduct electricity through the panel. No mark was awarded for this response.

(iii) The operation of the PV cell. [3]

Student's response

The pv cells N layer have extra electrons the photons from the sun knock these extra electrons off onto the p layer as it is missing electrons the voltage difference cause current to flow.

Examiner's Comments

The candidate understood that the electrons are moved from the N layer and travel to the P layer of the semi-conducting material in the PV cell, but does not explain how this movement occurs through metal contacts. 2 marks were awarded for this response.

Q4b

(i) Describe one advantage and one disadvantage of monocrystalline PV modules. [2]

Student's response

advantage - high efficiency - more crystalline pv modules have a high efficiency
disadvantage - expensive - made from a single crystal - they are high in price.

Examiner's Comments

The candidate correctly described one advantage, higher efficiency, and one disadvantage the more expensive of mono- crystalline PV modules. 2 marks were awarded for this response.

(ii) Name two other material types of PV modules. [2]

Student's response

Polycrystalline pv module. Thin film around pv module.

Examiner's Comments

The candidate correctly named two other types of PV modules, Polycrystalline and Thin Film. 2 marks were awarded for this response.

Q4c

With reference to Fig. 5, explain how an automated tracking system can maximize energy output from solar devices. [3]

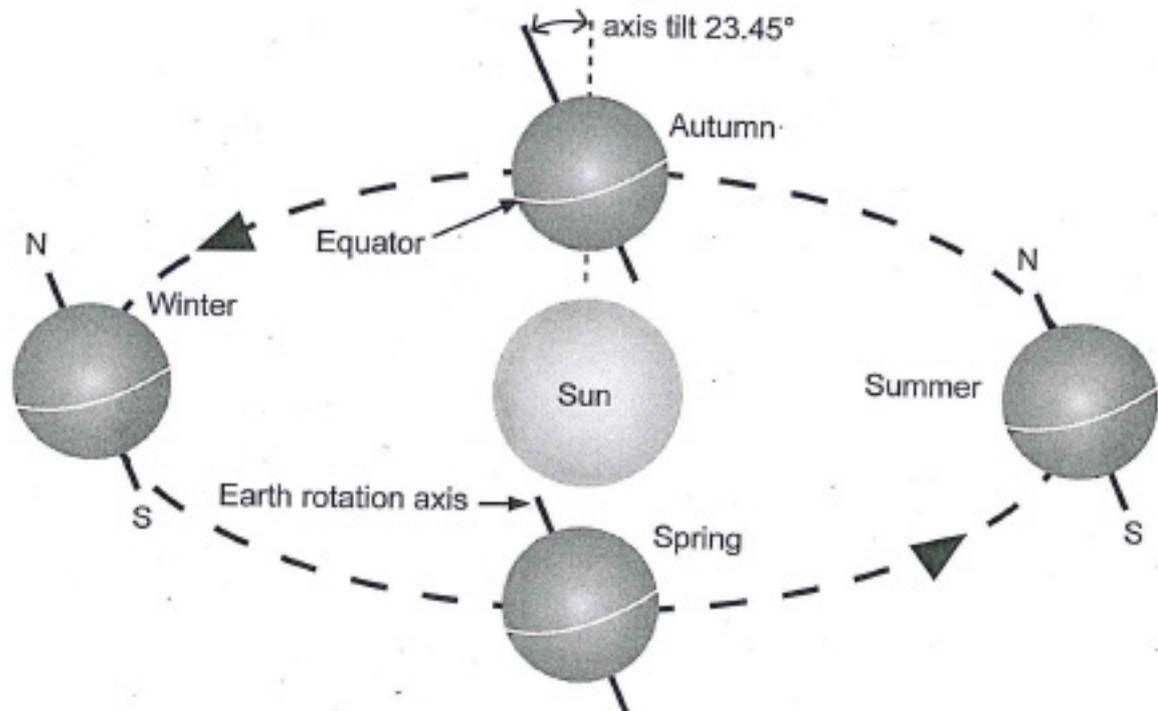


Fig. 5

Student's response

an automated tracking system maximized output as it reduces the angle the incidence ray makes with the normal - when the incidence ray is closest to the normal it produces a higher output. The tracking system also increases the time that the solar panels are in direct sunlight = increasing output.

Examiner's Comments

The candidate had a limited understanding of automated tracking but did know that it would increase the amount of time that the panels were in direct sunlight thus increasing output. 1 mark was awarded for this response.

Q5a

Question 5 (a) Fig. 6 details annual world plastic production. Comment on the trend shown and explain why there is a need for a global move towards more sustainable manufacture and use of plastics. [2]

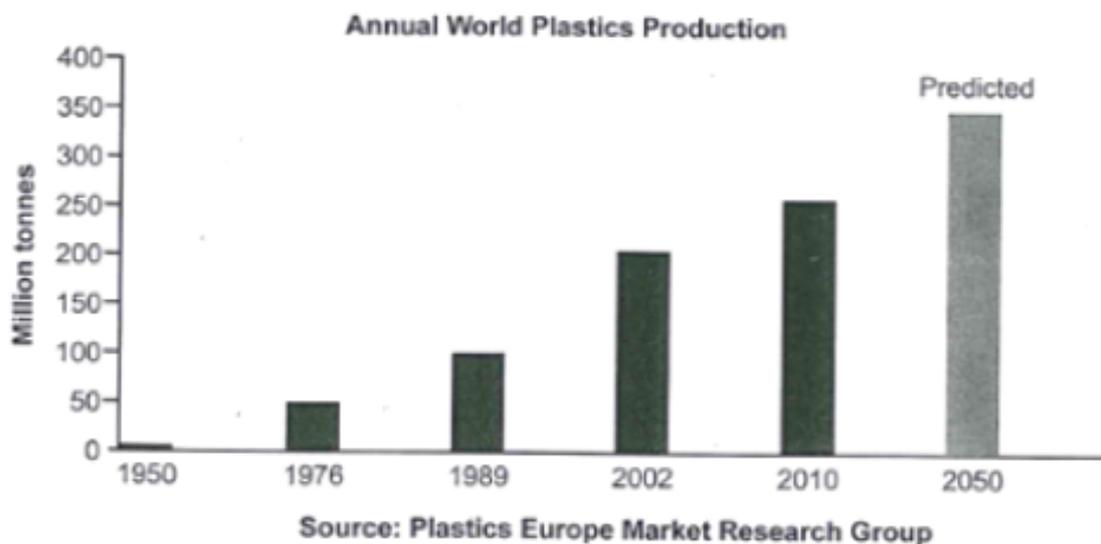


Fig. 6

Student's response

As time goes by our plastic production is increasing. We need to use sustainable plastics like BPE to decrease the amount of oil that is being used reducing land fill pollution.

Examiner's Comments

From the bar chart (Fig.6), the candidate correctly deduced that global production of plastics was increasing and then explained the need for a move towards more sustainable manufacture of plastics in order to reduce usage of oil and also landfill pollution. 2 marks were awarded for this response.

Q5b

(i) Explain the term 'sustainable manufacture of plastics'. [2]

Student's response

Manufacturing plastics from renewable materials so we can produce them indefinitely, also the plastics are biodegradable so they don't have to be incinerated releasing toxic fumes..

Examiner's Comments

The candidate did explain that sustainable plastics are those that are made from renewable materials and are biodegradable. 2 marks were awarded for this response.

(ii) The production of bioderived polyethylene (BPE), is often described as not being 'a sustainable manufacturing process'. Why is this so? [2]

Student's response

As the plastic is not fully broken down by micro-organisms cannot break down the small particles left behind, they have to be photodegraded.

Examiner's Comments

The candidate was not aware that oil is still used in the production of BPE but did explain that it is not fully biodegradable. 1 mark was awarded for this response.

Q6a

(i) Explain the following terms:

- *Biomass [1]*

Student's response

An organic substance that can be used as an energy source.

- *Energy density [1]*

Student's response

The energy stored per m³.

Examiner's Comments

Biomass was correctly explained as being an organic substance that can be used as an energy source. The candidate was also aware that energy density represented how much energy a material stored per unit volume (m³). 2 marks were awarded for this response.

Q6a

(ii) Outline the process of gasification in relation to biomass. [2]

Student's response

The biomass is heated to high temperatures this releases gases from the biomass the gases are hydrogen + methan leaving behind char.

Examiner's Comments

The candidate understood that gasification involved the breaking down of biomass at high temperatures thereby releasing gases. However there was no mention of the gas finally produced (syngas). 1 mark was awarded for this response.

Q6b

Local commercial businesses are considering the use of anaerobic digestion facilities on their premises.

(i) State **one** advantage and **one** disadvantage of using commercial anaerobic digesters. [2]

Student's response

Advantage – energy produced from waste that would otherwise be taken to landfill – disadvantage – it is a long process that takes days.

Examiner's Comments

The production of energy from waste was correctly stated as being one advantage of commercial anaerobic digestion. The length of the process was also stated as one disadvantage. 2 marks were awarded for this response.

(ii) Briefly describe the global debate that surrounds farmers growing crops for energy. [2]

Student's response

Farmers want to use their land to grow crops for energy but this produces problems like monoculture, less biodiversity and less land for food.

Examiner's Comments

The candidate's answer showed a good understanding of the 'food versus fuel' debate surrounding the use of crops for energy and the consequent effect on bio-diversity and the availability of land for food production. 2 marks were awarded for this response.

Q7

In 2013, Northern Ireland's Department of Enterprise, Trade and Investment (DETI) announced that there is 'an exciting opportunity for Northern Ireland to take a leadership role in the expansion of smart grid solutions.'

Discuss the main factors that must be considered when assessing the future opportunity of smart grid.

Your response should include reference to:

- *The concept of smart grid;*
- *Problems associated with delivering energy from renewable sources to the grid;*
- *The need to develop energy storage facilities capable of storing energy from renewable energy sources;*
- *The use of interconnectors between European countries in a smart grid scenario;*
- *Potential benefits of smart grid to the Northern Ireland economy.*

The quality of written communication is assessed in this question. [15]

Student's response

A smart grid is a type of grid that communicates within itself using sensors this means that a supply of energy can be turned on or off depending on demand, it also means when demand is low non important tasks can be carried out e.g dishwashers this reduces peaks in demand. The grid at its current state cannot handle intermittent renewable sources and when the demand is high, these renewable sources are unpredictable and cannot be relied on and may not be able to meet the peaks of demand. A smart grid would be able to turn an energy storage facilities that would release the energy stored from the intermittent renewables. An example of an energy storage facility would be a water pump hydro electronic power plant when the demand is high the water turns turbines flowing from a higher reserve to produce electricity when the demand is low the water is then pumped back up to the higher reserve for when it is needed again. The use of interconnectors between different countries would allow countries where the demand is low to sell electricity to countries where the demand is high thus boosting the economy. The benefits to the economy to building a smart grid include creating more jobs to build the grid. Also creates jobs to help maintain the grid and makes jobs to build the sensors and program for control systems. A compressed air system is another example of a storage facility which compresses air into a cavern when demand is low and uses this in gas turbines when demand is high.

Examiner's Comments

The candidate provided an answer of satisfactory quality and clearly had a reasonable understanding of the key reference areas in the question:

1. The concept of a smart grid. The candidate discussed computerised control of systems so that non-essential consumption is moved to off-peak times;
2. The problems associated with delivering energy from renewable sources to the grid. The candidate discussed intermittency of renewable energy supplies;
3. Energy storage facilities. The candidate discussed solutions to energy storage problems by using pumped hydro and compressed air energy storage;
4. The use of interconnectors between European countries in a smart grid. The candidate had a limited understanding of how this could get around problems with intermittency of renewable energy supply; and
5. Potential economic benefits. The candidate discussed the creation of jobs to build the smart grid system.

The candidate used appropriate specialist terms e.g. Compressed Air Energy Storage, Pumped Hydro energy storage etc. The form and style were of a reasonable standard. Grammar, spelling and punctuation were of a reasonable standard throughout. The candidate was awarded 9 marks for this response.

AS1:

The Earth's capacity to support activity

Q1a

Explain with the aid of an example, the following terms:

(i) Fossil fuel [2]

Student's response

a common fossil fuel would be coal, oil or gas and it is the remains of a dead plant or animal that have been compressed and heated over thousands of years, they are also a finite source.

Examiner's Comments

The candidate was awarded 2 marks for correctly explaining the term 'fossil fuel' with the aid of an example.

(ii) Renewable energy source [2]

Student's response

a common renewable energy source would be wind, solar and biomass, they are an environmental friendly option and are not finite.

Examiner's Comments

The candidate correctly explained that a renewable energy source was not finite and gave at least one example of a renewable energy source. 2 marks were awarded for this response.

Q1b

The Brundtland report defines sustainability as 'the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.' Our Common Future (1987)

With reference to this definition, state the main European, UK and Northern Ireland government targets with regards to the continued use of fossil fuels as an energy resource, as we approach 2020. [3]

Student's response

the main EU targets are 20% increase in renewable resources, 20% increase in efficiency and a 20% cut in emissions, these are the same as the UK's and Northern Ireland only Northern Ireland aims for 40% increase in renewables. these targets fit within the boundaries of the Brundtland report because the 20% cut in emissions will help to stop globe warming and the 20% increase in renewables will "meet the needs of the present"

Examiner's Comments

The candidate correctly stated two of the targets; a 20% increase in the use of renewables and a 20% cut in emissions, but did not state that the target for 20% reduction in energy consumption. 2 marks were awarded for this response.

Q1c

Carbon trading has been put forward as a method of monitoring and reducing global carbon emissions. Describe two issues surrounding the use of carbon trading. [2]

Student's response

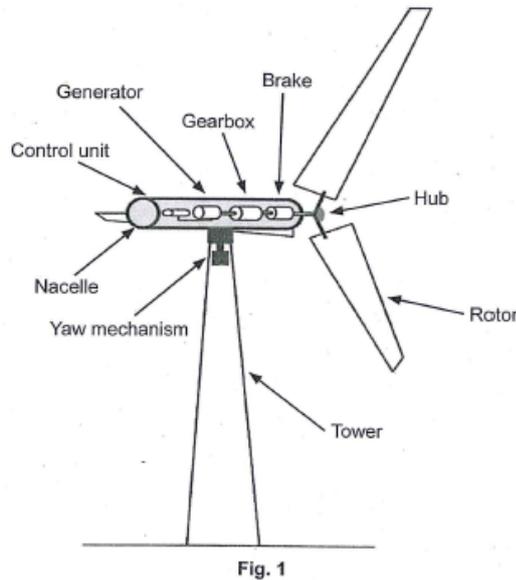
One issue with carbon trading would be that some companies may just buy credits from poorer countries who are not industrialised so that they do not have to increase their efficiency or their use of renewables. Another issue would be that some countries would get more credits for political reasons for example China would get more credits than Thailand because China is a global super power.

Examiner's Comments

The candidate has correctly described two issues associated with carbon trading - the incentive to simply trade carbon instead of reducing emissions and the political manipulation of the credit system by powerful nation. 2 marks were awarded for this response.

Q2a

(i) Identify the main energy transformations that take place in the wind turbine. [2]



Student's response

A wind turbine will take the kinetic energy from the wind and convert it into electrical energy using a generator.

Examiner's Comments

The energy transformations have been correctly identified as Kinetic Energy changing to Electrical Energy. 2 marks have been awarded.

(ii) Describe the purpose of the Yaw mechanism. [2]

Student's response

The Yaw mechanism is to make sure that the wind turbine is always facing the wind so that it gets the most energy out of it.

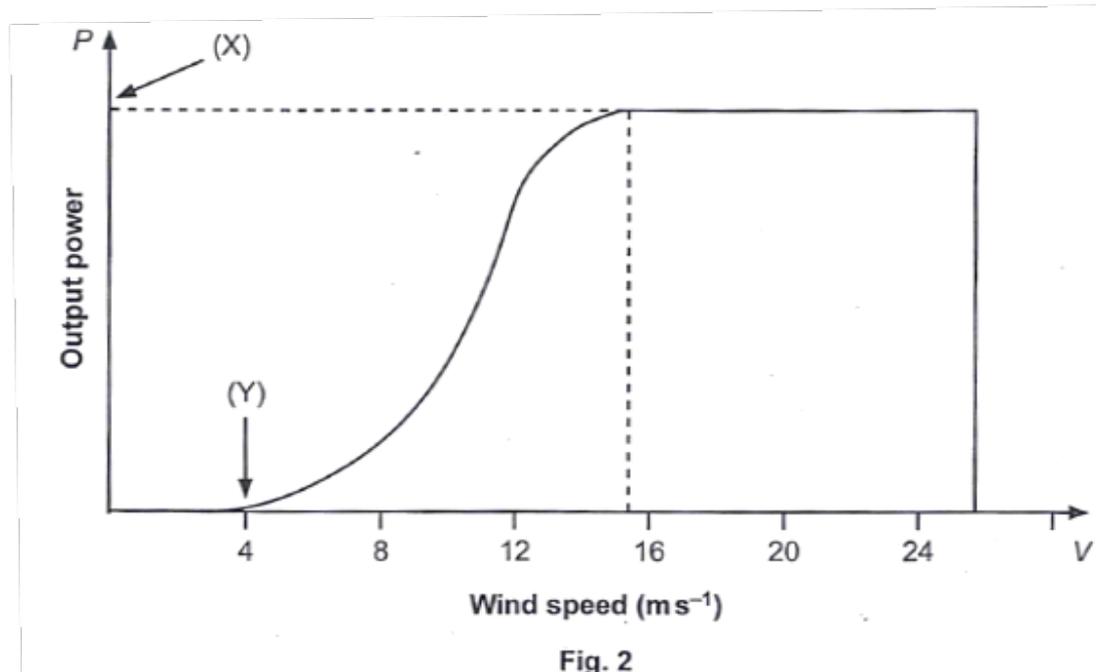
Examiner's Comments

The candidate has correctly described the purpose of the Yawing mechanism as being to face the turbine into the wind to extract maximum potential energy from it. The candidate has been awarded 2 marks for this response.

Q2b

Fig. 2 illustrates a typical wind power curve. Identify and explain the following annotated points on the graph:

(i) X [2]



Student's response

X is the maximum power output. This is the maximum amount of energy the wind turbine can produce.

Examiner's Comments

Point X on the power curve was correctly identified as the 'maximum power output' and its significance explained. The candidate has been awarded 2 marks for this response.

Fig. 2 illustrates a typical wind power curve. Identify and explain the following annotated points on the graph:

(ii) Y [2]

Student's response

this is the cut in speed and this is the point at which electricity will start to be generated.

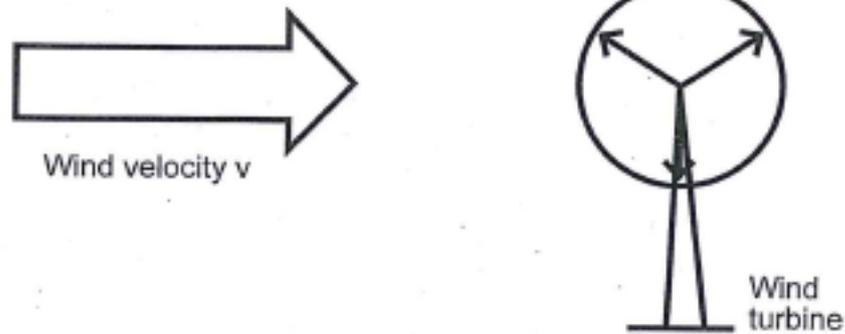
Examiner's Comments

The candidate has correctly identified Point Y on the power curve as 'cut-in speed' and explained its significance. 2 marks were awarded for this response.

Q2c

(i) With reference to Fig. 3 explain the following relationships for a typical horizontal axis wind turbine.

- Power output and swept area. [1]



Student's response

Fig. 3

The power output will increase in theory by 8 times if you increase the swept area Once.

- Power output and wind speed [1]

Student's response

The higher the wind speed to a certain point the larger the power output doubling the wind speed multiply's the output by 8.

Examiner's Comments

The relationships between power output and both swept area and wind speed were not correctly explained. No marks were awarded for these responses.

(ii) Calculate the wind speed required to produce 17280 joules of energy from 540 kg of air. [3]

Student's response

$$J = m \times v^3 \times x$$

Examiner's Comments

The calculation was not attempted. No marks were awarded for this response.

Q3a

(i) State three factors which should be considered when calculating the roof area required to install flat plate thermal solar panels on a house. [3]

Student's response

the size of the pannels. the space needed for addtiononal run of pipes and wires and the gap between them.

Examiner's Comments

The candidate failed to state any relevant factors. No marks have been awarded for this response.

(ii): A household uses 6500 kWh of hot water per year. If the owners wish to install a solar thermal hot water system to meet at least 65% of their annual hot water demand, what area of solar panel (flat plate) would provide a practical solution?

(Assume 1m² of a flat plate collector provides 450 kWh of useful heat per year) [3]

Student's response

$$6500 \div 100 = 65 \quad + \quad 65 = 4225$$

$$4225 \div 450 = 9.38, \text{ round up to } 10$$

they will need 10 m² of flat plate.

Examiner's Comments

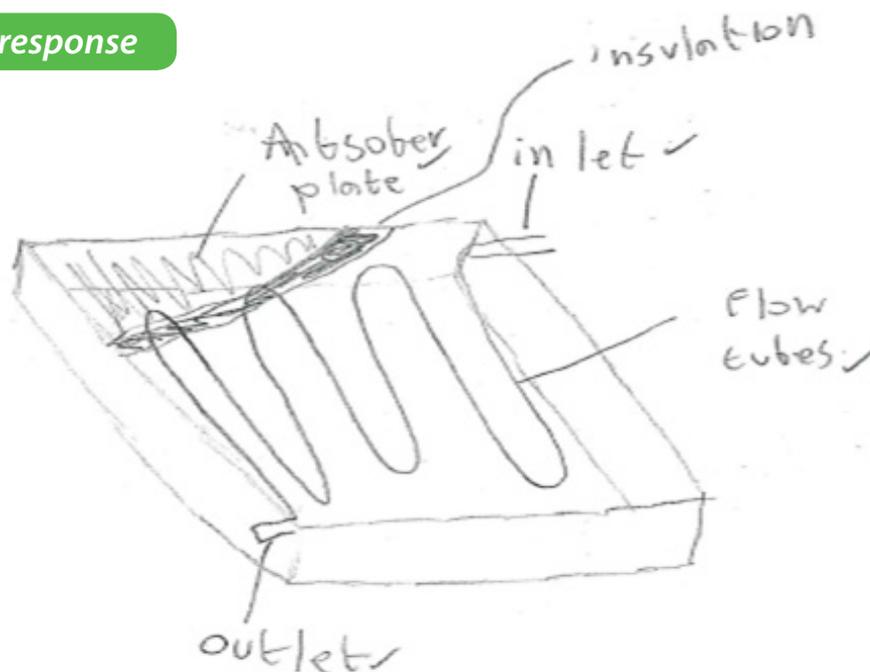
This question required candidates to correctly calculate how much energy the solar thermal system was required to produce, how many m² of panel was required and rounded this to a whole number of panels. This candidate carried out all sections correctly and was awarded 3 marks for this response.

Q3b

In the space below sketch a diagram of a typical flat plate thermal solar panel and clearly label the following:

- Inlet and outlet connections
- Flow tubes
- Absorber plate
- Insulation [4]

Student's response



Examiner's Comments

The candidate produced a clear sketch showing inlet/outlet connections and flow tubes. However the absorber plate and insulation were incorrectly labelled. 3 marks were awarded for this response.

Q3c

(i) State one advantage provided by an evacuated tube solar collector compared to a flat plate solar collector. [1]

Student's response

it is more effisient.

Examiner's Comments

Greater efficiency was correctly stated as an advantage of evacuated tube collectors over flat plate collectors. The candidate was awarded 1 mark for this response.

(ii) Explain the main benefit to households of installing a flat plate solar collector. [1]

Student's response

it will in theroy reduce the cost of heating bills.

Examiner's Comments

The candidate explained how a reduction in heating bills was a main benefit of installing a flat plate collector. 1 mark was awarded for this response.

Q4a

(a) Fig 4 below shows the typical arrangement of a PV Cell. Explain the following:
(i) The purpose of the anti-reflection coating. [1]

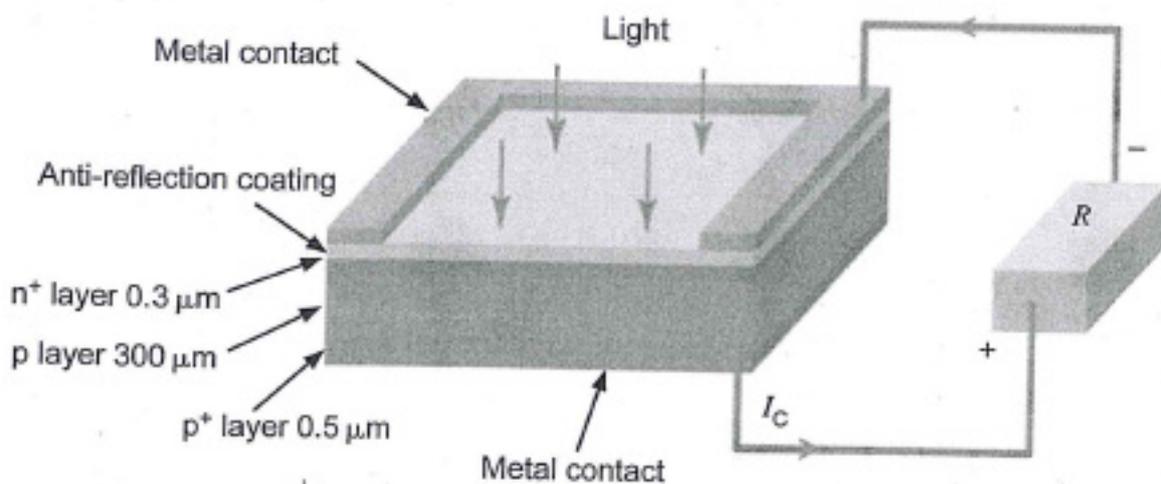


Fig. 4

Student's response

So that it will absorb the most light as possible.

Examiner's Comments

The function of the anti-reflection coating has been correctly explained as maximising the absorption of light. The candidate was awarded 1 mark for this response.

(ii) The role of the metal contacts. [1]

Student's response

to hold it together

(iii) The operation of the PV cell. [3]

Student's response

The PV cell will take the sun's light and convert it from chemical energy into electrical energy.

Examiner's Comments

In question 4(a)(ii)&(iii) the candidate failed to correctly explain the function of the metal contacts or the operation of the PV cell. No marks were awarded for these responses.

Q4b

(i) Describe one advantage and one disadvantage of monocrystalline PV modules. [2]

Student's response

Monocrystalline is more efficient than other PV modules. However it is relatively expensive.

Examiner's Comments

The candidate correctly described one advantage; greater efficiency and one disadvantage; the greater expense of mono- crystalline PV modules. 2 marks were awarded for this response.

Name two other material types of PV modules. [2]

Student's response

Polycrystalline and polymono-crystalline.

Examiner's Comments

The candidate was awarded 1 mark for correctly naming only one other type of PV module Polycrystalline.

Q4c

With reference to Fig. 5, explain how an automated tracking system can maximize energy output from solar devices. [3]

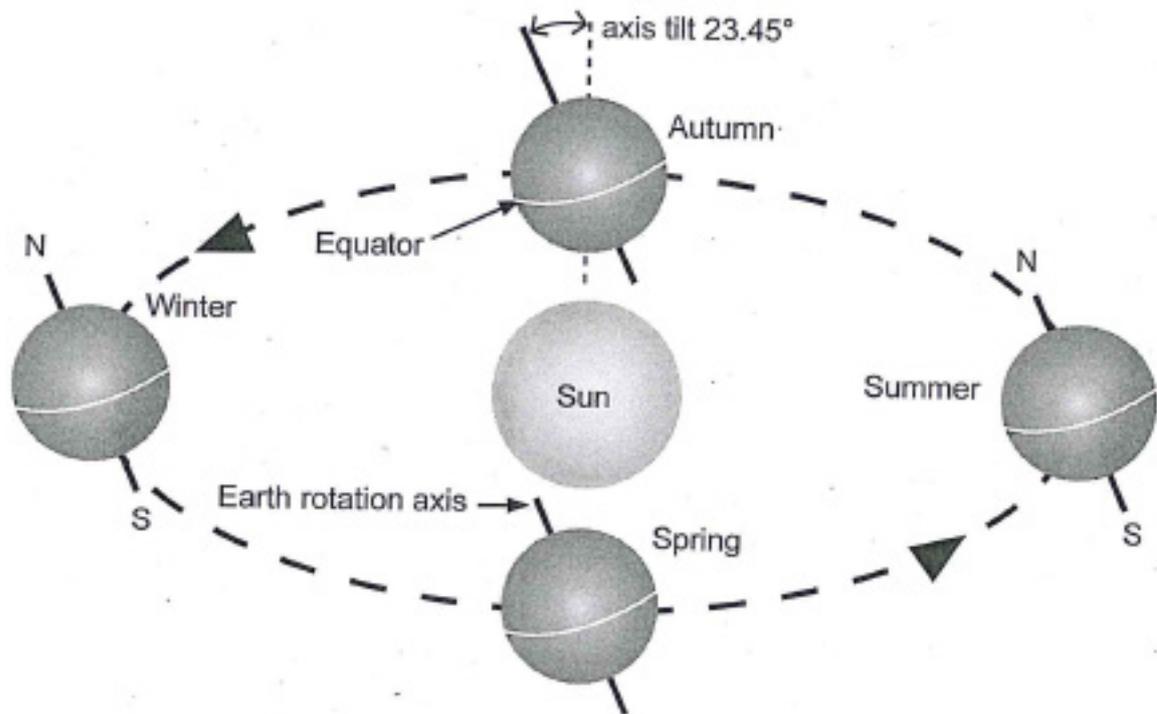


Fig. 5

Student's response

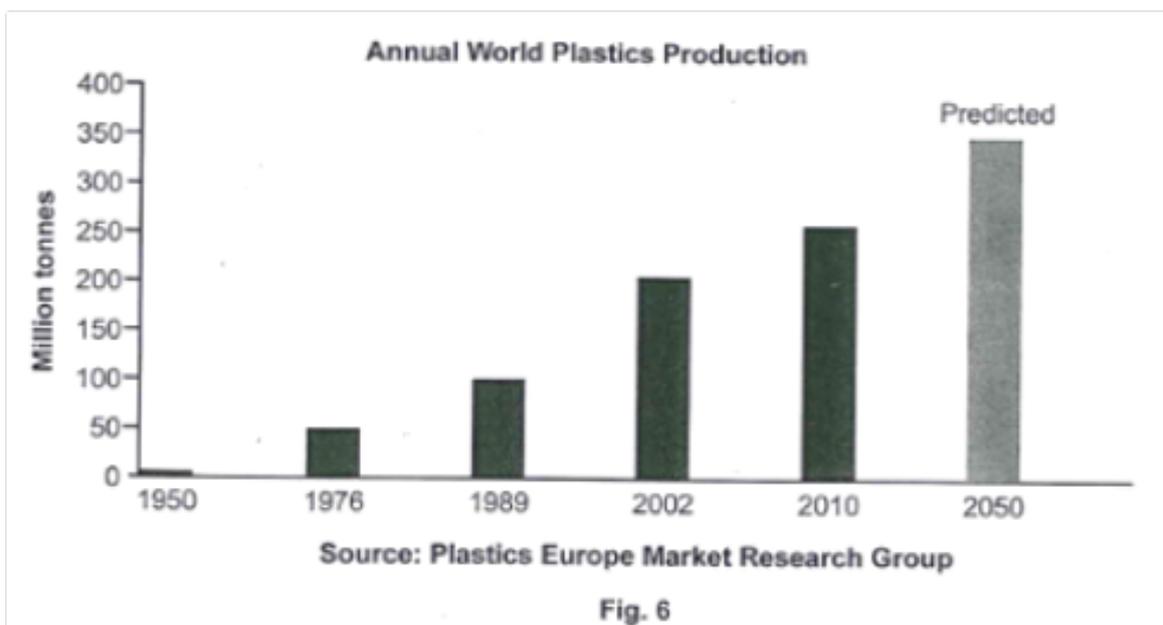
Tracking systems can increase the output of solar panels because it will automatically rotate and angle itself so it is facing the sun at the optimal angle no matter what time of the year, it will always be facing the sun no matter what time of the day and will rotate to keep facing the sun.

Examiner's Comments

The candidate correctly explained how automated tracking maximised energy output from solar devices by adjusting to face into the sun at optimal angle at different times of the day and at different times of year. 3 marks were awarded for this response.

Q5a

Question 5 (a) Fig. 6 details annual world plastic production. Comment on the trend shown and explain why there is a need for a global move towards more sustainable manufacture and use of plastics. [2]



Student's response

The graph shows that our use of plastics is rising and we need to move to a sustainable development of plastics because they are made from oil which is a finite resource.

Examiner's Comments

From the bar chart (Fig.6) the candidate correctly deduced that global consumption of plastics was increasing and then explained the need for a move towards more sustainable manufacture of plastics since it is made from oil which is a finite fossil fuel. 2 marks were awarded for this response.

Q5b

(i) Explain the term 'sustainable manufacture of plastics'. [2]

Student's response

The term means plastics that are both reusable and can be made from material that is not finite.

Examiner's Comments

The candidate did explain that sustainable manufacture of plastics involved use of renewable materials but did not refer to the use of efficient manufacturing and production techniques. 1 mark was awarded for this response.

(ii) The production of bioderived polyethylene (BPE), is often described as **not** being 'a sustainable manufacturing process'. Why is this so? [2]

Student's response

It is described as not being sustainable because you still use oil in its manufacture despite the fact you are using some bio oils and materials like corn to subsidise the use of oil.

Examiner's Comments

The candidate did explain that oil was still used in the production of BPE but did not explain that this is also an energy intensive process. 1 mark was awarded for this response.

Q6a

(i) Explain the following terms:

- Biomass [1]

Student's response

A type of organic matter.

- **Energy density [1]**

Student's response

The amount of energy that a substance holds.

Examiner's Comments

The candidate correctly explained the term biomass as being a type of organic matter but was not aware that energy density represented how much energy a material contained per unit mass or unit volume (i.e. J/kg or J/m³). 1 mark was awarded for this response.

- (ii) **Outline the process of gasification in relation to biomass. [2]**

Student's response

(No response)

Examiner's Comments

The candidate did not attempt this question. No mark was awarded for this response

Q6b

Local commercial businesses are considering the use of anaerobic digestion facilities on their premises.
(i) State one advantage and one disadvantage of using commercial anaerobic digesters. [2]

Student's response

One advantage of anaerobic digestion is that it is a renewable resource. One disadvantage is that there is a risk of explosion because of the use of methane.

Examiner's Comments

The use of a renewable resource was correctly stated as being an advantage of commercial anaerobic digestion. However the candidate did not state a relevant disadvantage. 1 mark was awarded for this response.

(ii) Briefly describe the global debate that surrounds farmers growing crops for energy. [2]

Student's response

The debate is that if farmers produce crops for energy usage there will not be enough crops to feed people and this could lead to deforestation an example the Amazon being cut down to grow fuel/food crops.

Examiner's Comments

The candidate described the issue of energy crops using up land that might be needed for food production and how it could also lead to deforestation. 2 marks were awarded for this response.

Q7

In 2013, Northern Ireland's Department of Enterprise, Trade and Investment (DETI) announced that there is 'an exciting opportunity for Northern Ireland to take a leadership role in the expansion of smart grid solutions.'

Discuss the main factors that must be considered when assessing the future opportunity of smart grid.

Your response should include reference to:

- *The concept of smart grid;*
- *Problems associated with delivering energy from renewable sources to the grid;*
- *The need to develop energy storage facilities capable of storing energy from renewable energy sources;*
- *The use of interconnectors between European countries in a smart grid scenario;*
- *Potential benefits of smart grid to the Northern Ireland economy.*

The quality of written communication is assessed in this question. [15]

Student's response

A smart grid is a smart energy grid that will know how much energy an area requires and how much energy is being produced. It will have full control over energy generation from different sources and will have the use of energy storage facilities. Some of these facilities could be pumped hydro electric and compressed air storage.

the advantages of a smart grid are that it will be extremely efficient. It will use all the energy resources at its disposal – for example in an European – wide smart grid it would use pumped hydro in Norway and Solar Power in Spain. These could help offset power shortages in Northern Ireland if our wind turbines are not generating and vice versa if the sun is not shining in Spain. Another advantage would be that in the short-term jobs would be created in the building of the smart grid and a few long-term jobs created for its maintenance and operating. This could improve the economies of European Countries like Northern Ireland. Another advantage would be that we would be mainly using renewable energy which would offset global emissions and reduce climate change, however this does not mean that there would not be any fossil fuel power stations in operation as these would need to offset their intermittency of some renewables.

Disadvantages – A disadvantage of a smart grid would be the actual building of it as it would be a mammoth construction task and would require the linking up or complete redoing of a nation's energy grid. Another drawback of a smart grid is the need to improve energy storage facilities as currently batteries are inefficient and pumped hydro is also inefficient. We would need to use compressed air storage and systems like ADELE to store energy and this will cost a lot of money. There would also be the political aspect of it as let's say a major contributor to the smart grid e.g in a European smart grid Germany decides to pull out of the smart grid. It would mean the other countries would need to find some ways to offset Germany's absence which would be highly impractical. Another drawback to a smart grid would be the intermittency of the renewables in use as while in theory you can use other renewables to offset the others lackings, a situation would arise where there is no wind blowing where there is wind turbines and where there is no sun where there are solar panels and there is no energy stored in the energy storage systems meaning that there would be a large gap between energy output and energy needed.

Another disadvantage of a smart grid would be the sheer complexity of it. You would need to know every piece of information coming from every renewable resource and power station in an area the size of Great Britain or Europe and a computer system may not be able to handle this.

Examiner's Comments

The candidate provided an answer of high quality and clearly had a good understanding of all 5 key reference areas in the question:

1. The concept of a smart grid. The candidate discussed computerised control of energy production from a range of sources coupled with energy storage.
2. The problems associated with delivering energy from renewable sources to the grid. The candidate discussed intermittency/matching supply with demand.
3. Energy storage facilities. The candidate discussed both pumped hydro and compressed air energy storage as well as specifically referring to the Adele CAES system.
4. The use of interconnectors to widen the pool of renewable resources which we can draw upon. The candidate discussed Pumped Hydro from Norway and Solar from Spain.

5. The potential economic benefits. The candidate discussed creation of short term jobs in creation of the smart grid; long term jobs in operation and maintenance.

The candidate's discussion was clear and well-structured and used appropriate specialist terms. Form style, grammar, spelling and punctuation were all of a very good standard throughout. The candidate was awarded 14 marks for this response.

