



General Certificate of Education
Advanced Level Examination
June 2013

General Studies (Specification A)

GENA4/PM

Unit 4 A2 Science and Society

Case Study Source Material

For use with **Section A**

- The material consists of five sources (A, B, C, D and E) on the subject of **natural and renewable forms of energy**. These extracts are being given to you in advance of the Unit 4 examination to enable you to study the content and approach of each extract, and to consider issues which they raise, in preparation for the questions based on this material in Section A.
- A further Section A source (F) will be provided in the examination paper.
- Your teachers **are** permitted to discuss the material with you before the examination.
- You may write notes in this copy of the Source Material, but you will **not** be allowed to bring this copy, or any other notes you may have made, into the examination room. You will be provided with a clean copy of the Source Material at the start of the Unit 4 examination.
- To gain an understanding of the detail that it contains and to consider the issues that are raised it is suggested that three hours' detailed study is required for this purpose.
- In the examination room you are advised to spend approximately one hour and fifteen minutes reading a previously unseen extract and answering a range of Section A questions based on all the source material.

Source A: Figures 1–7

Figure 1 – What is renewable energy?



Images: [Thinkstock](#)

Renewable energy is energy that can be indefinitely replenished as it comes from natural resources such as geothermal heat, wind, tides and sunlight. Renewable energy is much better for the environment and much more sustainable for our economies and socio-political stability than non-renewable sources such as coal and oil. Humans have been using forms of renewable energy for centuries – it wasn't until the Industrial Revolution that fossil fuel energy became popular.

Renewable energy is most often used to create electricity for use in homes, offices and industrial processes, but it can also be used to heat and cool homes directly as well as for fuel for transportation. The most important benefit of renewable energy is that it helps to slow climate change by not producing greenhouse gases.

There are many types of renewable energy available for human consumption:

- **Biomass:** This is derived from resources such as wood, solid waste, biofuels and biogas.
- **Geothermal:** By tapping into the earth's internal heat, geothermal energy can be used to produce electricity, to warm and cool buildings and to heat water.
- **Hydrogen:** The most abundant element on the planet which, if it can be harnessed, can provide fuel for vehicles or electricity.
- **Hydropower:** One of the oldest forms of renewable energy which works by capturing the energy flowing in water. It minimises flooding, displacement of communities and disruption of local ecosystems.
- **Tidal/Wave:** As with the flow of fresh water, marine water also contains a lot of energy as it moves through the hydrologic cycle. Harnessing this energy with offshore turbines has tremendous promise as a source of renewable energy.
- **Solar:** Solar energy is produced by capturing the sun's energy directly, either to heat homes and water or to generate electricity.
- **Wind:** As air moves around the earth, driven by the energy of the sun, it also has the potential to produce energy.

Source: adapted from Ecolife, www.ecolife.com

Figure 2 – A community kick-start and renewable energy in 2010

In the distant background is a cityscape of residential buildings, mainly medium-height flats.
 In the foreground is a group of 15 people, ranging in age between small child and grandparent.
 They are standing on a small grassed area and gravel path, which is a green space for community use, just in front of a small wind turbine (approximately 10m high).
 They are holding single-letter posters which together spell out the words: 'Green Community'.

Image: The Energy Saving Trust's blog

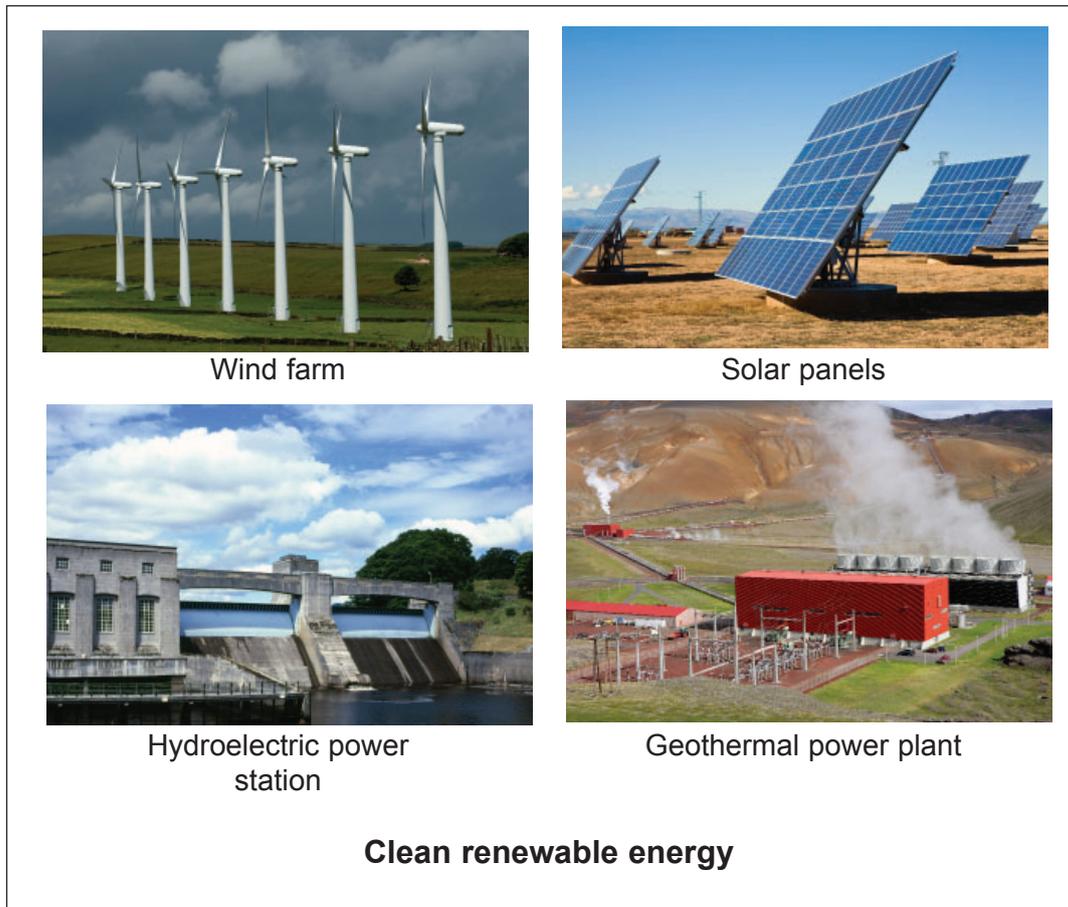
<http://energysavingtrust.wordpress.com/2011/12/08/green-dealings-a-community-kick-start/>

- The amount of electricity generated from renewable sources in 2010 was 25 734 gigawatt hours (GWh), a 2.2% increase during the year.
- Generation capacity increased by nearly 1.2 gigawatts (GW) (15%).
- Heat from renewable sources increased by 17% (to 1212 kilotonnes of oil equivalent – ktoe) during 2010; renewable biofuels for transport also increased by 17% (to 1214 ktoe).
- Renewable transport fuels accounted for 3.6% of road transport fuels in 2010. Bioethanol, as a proportion of motor fuel, increased from 1.5% to 3.1%.
- Renewable energy provisionally accounted for 3.3% of energy consumption, as measured using the 2009 Renewable Energy Directive methodology. This is an increase of 0.3 percentage points from the 2009 position of 3%.
- A number of weather factors had a major impact on renewable energy generation during 2010; rainfall was 63% lower than in 2009 and average wind speeds were at their lowest level this century.

Source: adapted from *Digest of UK Energy Statistics 2010*,
 Department of Energy and Climate Change, 2011

<http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx>

Figure 3 – UK renewable energy supplies up 23% in third quarter of 2010



- The supply of renewable energy in the UK rose 23% to 6.98 terawatt hours (TWh) in the third quarter of 2010 compared with the same period last year.
- Renewable energy now contributes 8.68% of the UK electricity supply. Wind power alone rose almost 37% due to increased capacity.
- Overall, coal and other solid fuel consumption rose 13.4%, oil by 0.5%, whereas gas consumption fell by 3.6% and primary electricity consumption fell by 18.5%.
- Total energy consumption rose 0.3%.
- Currently, the UK has 8617 megawatts (MW) of wind capacity under construction or with planning permits scheduled to go online within the next 24–36 months.
- Alex Murley, Head of Technical Affairs at RenewableUK, says:
 - “We are now within reach of 10% of electricity from renewables, having had around 2% a decade ago.”
 - “This gives us confidence that, with the right policy support, we can deliver on our 2020 targets. There are no technological barriers to having a third of our electricity from renewables in the next 10 years – it is perfectly achievable.”

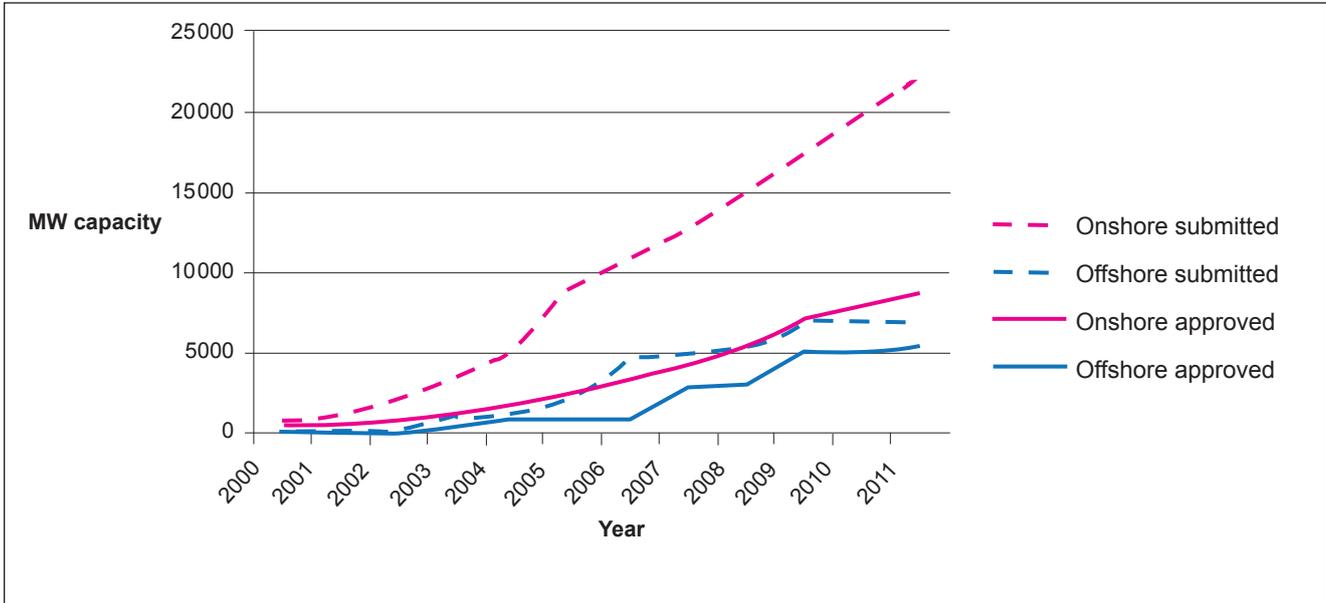
Source: adapted from Renewable Energy Focus UK, 4 January 2011
<http://www.renewableenergyfocus.com/view/14881/uk-renewable-energy-supplies-up-23-in-q3-2010/>

Images:

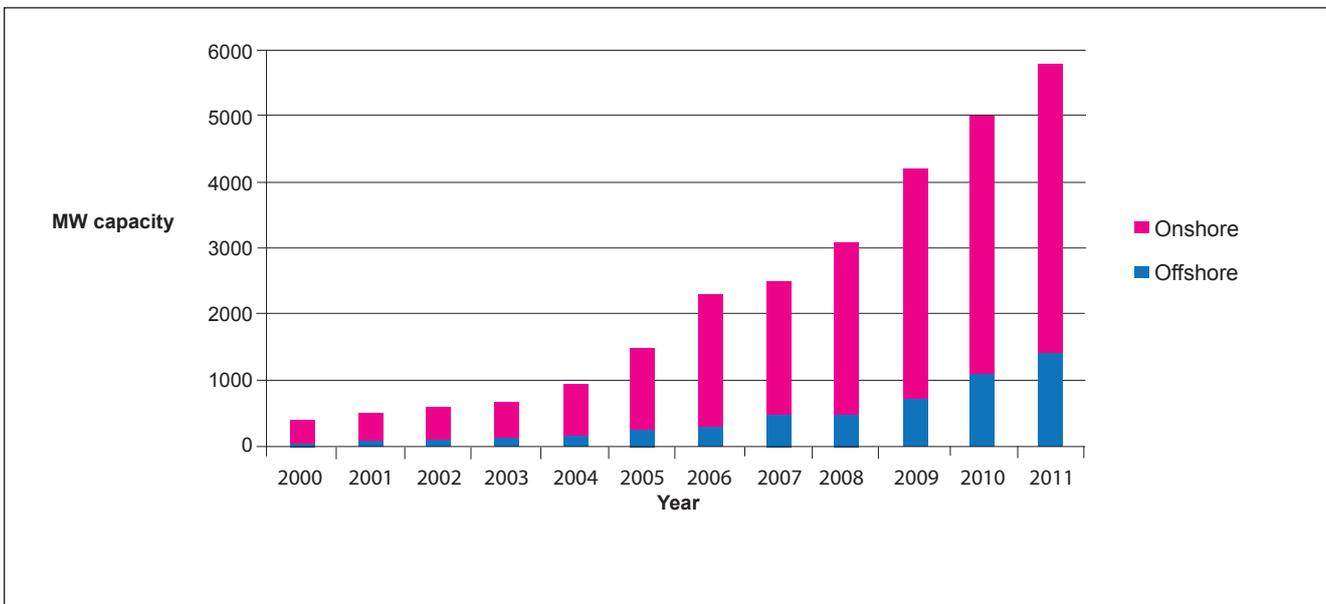
Source Wind turbines, Penistone wind farm © Terry Foster / Alamy
 Source La Calahorra, Granada, Spain; Solar Panels © Vibe Images / Alamy
 Source The Dam and Hydroelectric Power Station on The River Tummel at Pitlochry, Perth and Kinross, Scotland © Michael Walters 3 / Alamy
 Source: Krafla Geothermal Power Plant Iceland © Phil Degginger / Alamy

Figure 4 – UK wind energy mid-2000 to mid-2011

Graph 1 – UK planning applications for wind energy capacity: submitted and approved mid-2000 to mid-2011



Graph 2 – UK operating capacity mid-2000 to mid-2011



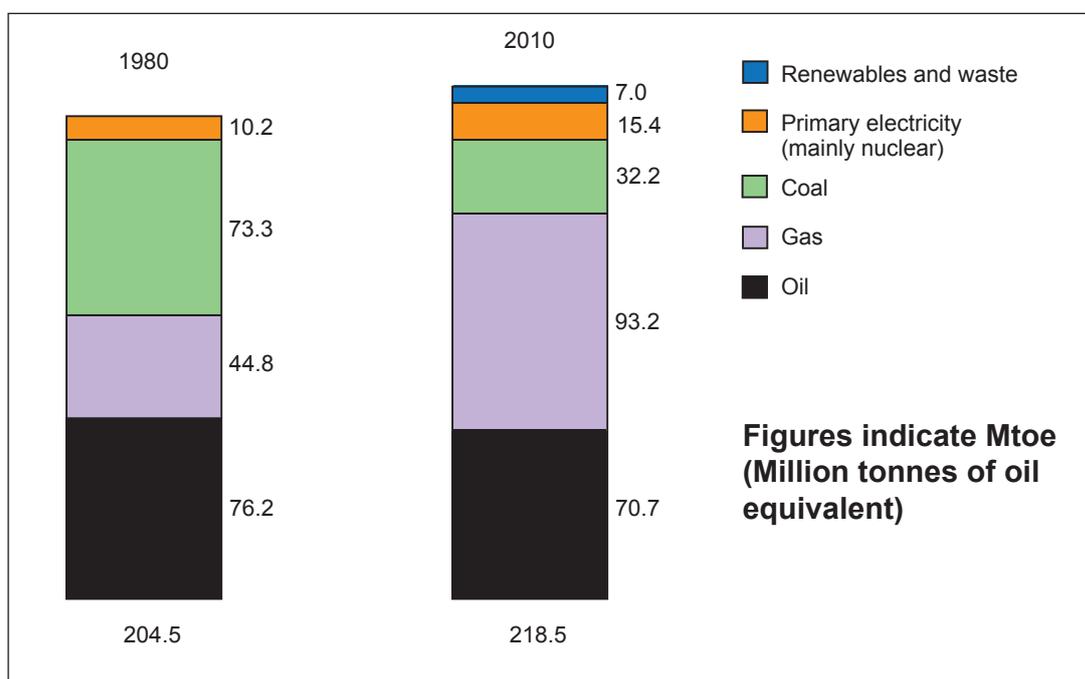
Source: *State of the Industry Report: Onshore and Offshore Wind Progress Update*, Renewable UK, 2011, www.RenewableUK.com

Figure 5 – UK production and consumption of primary fuels 1980–2010**(a) Production of primary fuels 1980–2010**

Million tonnes of oil equivalent (Mtoe)

Fuel type	1980	1990	2000	2008	2009	2010
Petroleum	86.9	100.1	138.3	78.6	74.7	69.0
Natural gas	34.8	45.5	108.4	69.7	59.7	57.2
Coal	78.5	56.4	19.6	11.3	11.0	11.5
Primary electricity	10.2	16.7	20.2	13.0	16.5	15.1
Renewables	0.0	0.7	2.3	4.5	5.0	5.3
Total	210.4	219.4	288.8	177.1	166.9	158.1

Total production of primary fuels, when expressed in terms of their energy content, fell by 5.3% in 2010 compared with 2009. Petroleum accounted for 44% of total production, natural gas for 36%, coal for 7% and primary electricity (nuclear, wind and natural flow hydro) for 10%. Renewables and waste account for 5.3 million tonnes of oil equivalent.

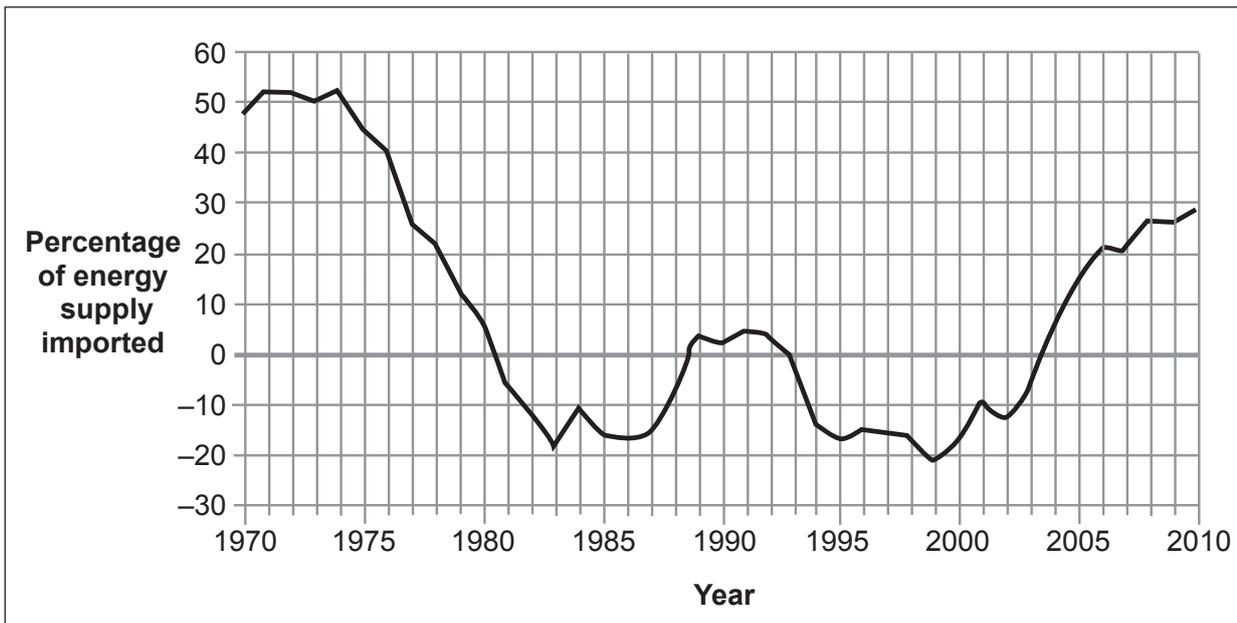
(b) UK Inland energy consumption 1980–2010

Primary energy consumption was 3.3% higher in 2010 than in 2009, though 0.4% lower on a temperature corrected basis. Since 1980, consumption of natural gas and primary electricity has risen considerably, whilst consumption of oil and coal has fallen.

Source: adapted from *UK Energy in Brief 2011*, Department of Energy and Climate Change
(a National Statistics Production) 2011

www.decc.gov.uk/en/content/cms/statistics/publications/brief/brief.aspx

Figure 6 – Overall energy UK import dependency 1970–2010



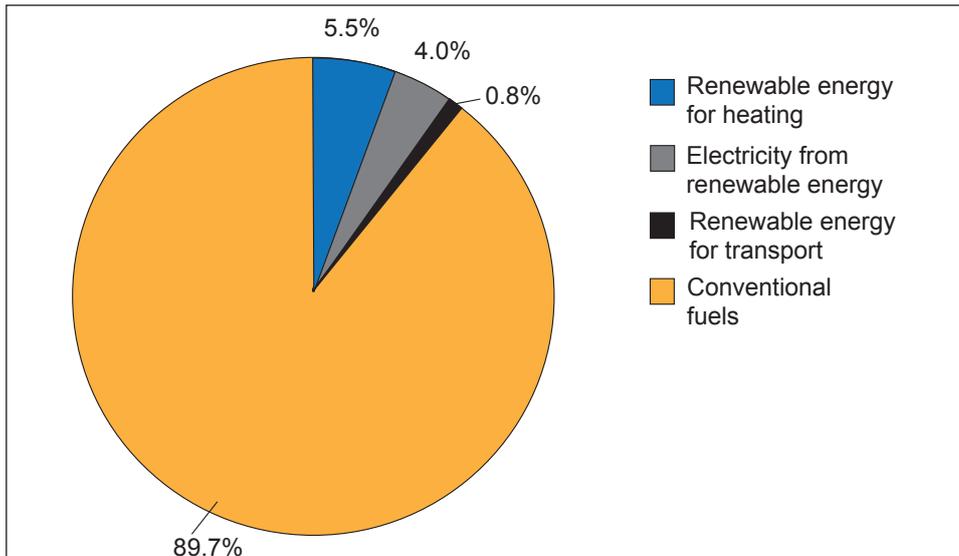
Note: Positive values indicate the percentage of the UK's energy supply imported in a particular year. Negative values indicate the percentage of the UK's energy supply exported in a particular year.

- In the 1970s, the UK was a net importer of energy.
- Following development of oil and gas production in the North Sea, the UK became a net exporter of energy in 1981.
- Output fell back in the late 1980s following the Piper Alpha disaster, with the UK regaining a position as a net exporter in the mid 1990s.
- North Sea production peaked in 1999, and the UK returned to being an energy importer of oil in 2004.
- In 2010, 28% of energy used in the UK was imported.
- Data from Eurostat, for 2009, show that the UK had the fourth lowest level of energy import dependency in the EU, behind Denmark (which remains a net exporter), Estonia and Romania.

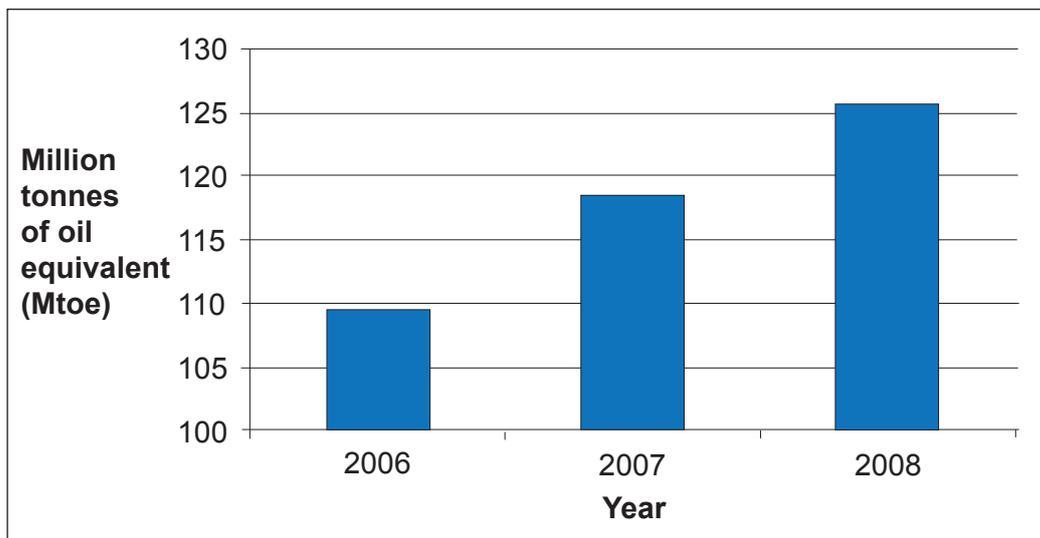
Source: adapted from *UK Energy in Brief 2011*, Department of Energy and Climate Change (a National Statistics Production) 2011
www.decc.gov.uk/en/content/cms/statistics/publications/brief/brief.aspx

Figure 7 – The European Union (EU) Dimension

a) EU breakdown of gross final energy consumption in 2008



b) EU final consumption of renewable energy



UK lags behind in EU renewable cheap energy league table

- The UK has one of the lowest shares of renewable cheap energy in Europe, a new survey has found.
- A league table of renewable energy production compiled by Eurostat, the statistical office of the European Community, revealed that the UK had a 2.2% share of renewable energy compared with its total consumption in 2008.
- Other countries where measurable consumption was low include Malta (0.2%), Luxembourg (2.1%), the Netherlands (3.2%) and Belgium (3.3%).
- Meanwhile, Sweden was found to lead the way in renewable cheap energy in Europe, with 44.4% of all its energy consumption coming from sustainable sources.
- Sweden was followed by Finland with 30.5%, Latvia (29.9%), Austria (28.5%) and Portugal (23.2%).
- The research found that almost all EU member states increased their share of renewable energy between 2006 and 2008.

Sources: NIKOLAOS ROUBANIS, CAROLA DAHLSTROM and PATRICIA NOIZETTE, *Environment and Energy*, Eurostat, 30 July 2010 © European Union, 1995–2012 and www.energyhelpline.com 15 July 2010

Source B: Onshore wind power

Wind will be a key component in meeting the UK's 2020 target for energy from renewable sources, and onshore wind could deliver around 15% of the total. The wind industry can be a key player in creating the investment, exports and jobs we need for a return to economic prosperity.

To meet our low-carbon and energy security goals, we need to move from finite, high-carbon fossil fuels to clean, secure energy. No individual technology will provide the silver bullet – our energy mix will have to become increasingly diverse. As part of that mix, onshore wind power will have an important role to play as one of the most cost-effective and proven renewable energy technologies.

Source: 'Onshore wind: helping to meet the 2020 target', Department of Energy and Climate Change, 2011 www.decc.gov.uk

Onshore wind

The UK is the windiest country in Europe, so much so that we could power our country several times over using this free fuel. A modern 2.5MW turbine at a reasonable site will generate 6.5 million units of electricity each year, enough to meet the annual needs of over 1400 households, make 230 million cups of tea or run a computer for 2250 years.

Since the first wind farm in the UK was built at Delabole in 1991, onshore wind energy has established itself as a mature, clean energy-generating technology. In 2007, wind energy overtook hydropower to become the largest renewable generation source, contributing 2.2% of the UK's electricity supply, with onshore wind comprising the bulk of this.

Wind has been the world's fastest growing renewable energy source for the past seven years, and this trend is expected to continue because of falling costs of wind energy, energy security threats and the urgent international need to tackle CO₂ emissions to prevent climate change.

The government's Renewable Energy Strategy states that the ambitious target of generating 15% of all the UK's energy from renewables by 2020 means that 35–45% of electricity will come from green sources. The lion's share of these renewables will have to be wind, some 33 GW of capacity, delivering over £60 billion of investment and creating 160 000 green-collar jobs.

The report *Building a Low Carbon Economy* (Committee on Climate Change, December 2008) stresses that onshore and offshore wind together can deliver 30% of the UK's electricity supply by 2020 and be part of a radical decarbonisation of the economy by 2030.

Source: 'Onshore wind', RenewableUK (formerly named BWEA), www.bwea.com/onshore, 2010

292 Operational Wind Farms in UK

Enough to provide electricity for more than 2.3 million homes

27 Wind Farms under construction

Enough capacity to supply 720,000 homes

222 Wind Farms have consent and are awaiting construction

These will have enough capacity to supply more than 2 million homes

2020 TARGET

15% of all energy will come from renewable sources

This means about 25% of electricity will have to be supplied by wind turbines

Source C: Half of planned wind farms blown away by local protests

Almost half of the wind farms planned for the UK countryside are rejected before they can get off the drawing board, new figures show. The failure of developers to win support for wind projects is blamed on a hardening of attitudes within local authorities towards them, the increasing influence of 'nimbys' ('not in my back yard') and anti-wind campaigners.

Figures obtained from the Department of Energy and Climate Change under Freedom of Information legislation reveal that in just five years the rejection rate for wind farm planning applications has risen from 29% in 2005 to 48% in 2010 in England and Wales. For other major developments, such as roads and supermarkets, 70% are approved.

Developers are increasingly frustrated at what they see as local issues being given priority over national needs and are worried that the Localism Bill championed by Eric Pickles, the Local Government and Communities Secretary, will worsen the situation by handing communities greater rights to reject development schemes.

Jacqueline Harris, of the legal firm McGrigors, which obtained the latest figures, said there were growing concerns that developers were being denied a fair hearing, with issues such as the visual impact of wind turbines being given special precedence even when they are only in sight of houses. "There is little willingness to consider the benefits of renewable energy generation in context – the national interest is being overridden by local concerns," she said.

Nick Medic, of RenewableUK, the industry's trade association, said the figures raised important questions about how the Government's green growth agenda could be achieved. He added: "We often find there is a vociferous minority driving the planning process. That can't be right."

High refusal rates have raised concerns about the UK's ability to meet its 2020 renewable energy and greenhouse gas targets, which require a third of electricity to be from renewable sources.

A 2010 study estimated that nimby and anti-wind campaigners will cost local communities £1.3bn in lost investment.

The rise in planning rejections comes despite a government survey showing that from 2006 to 2009 the proportion of people saying that they would be unhappy living within three miles of wind farms had fallen from 24 to 21 per cent.

Greg Clark, the Minister for Decentralisation, said: "We're putting reforms in place that will deliver an efficient planning system that still supports sustainable growth and green energy developments, but rightly gives communities a say in the planning of their local area."

Source: LEWIS SMITH and DAVID PROSSER,
'Half of planned wind farms blown away by force of local protest', *The Independent*, 11 July 2011
www.independent.co.uk

Source D: A golden opportunity for Britain to lead the world in energy production

This week, our leaders are expected to commit Britain to a civic overhaul that no other nation has had the courage – or recklessness, depending on your viewpoint – to contemplate. The cabinet is set to approve measures that will lead to a revolution in power generation, transport, house construction, planning, manufacturing and farming over the next 20 years. The aim is to mitigate the worst ravages of global warming.

The proposals form the basis of the fourth budget of the Committee on Climate Change. Initial hostility from business secretary Vince Cable and from Treasury officials, who fear funds needed for economic recovery are being wasted on projects of no immediate benefit, has been swept aside. Soon, we will be committed to the basic, radical goal of cutting carbon dioxide (CO₂) emissions to around 390m tonnes a year by 2027.

Other nations have planned no further than the end of this decade. The Committee on Climate Change's budget takes Britain 10 years further down the line. As its chief executive, David Kennedy, says: "We have moved into uncharted territory and we are going to be watched by other countries. No one else has a target like this."

But what kind of nation will Britain be once we start investing these billions, raised from taxes and increased electricity costs, in new hardware? How will we move about the country and how will we power our homes and businesses? Very differently, it is clear.

According to the committee, by 2027, we should be generating 40% of our electricity from renewable sources and 40% from nuclear plants. The remainder will come from coal, gas and oil plants, with the crucial caveat that most will be connected to carbon capture and storage (CCS) systems that will trap their CO₂ emissions and pump them underground for safe storage.

With that kind of kit, Britain can free itself from its dependence on fossil fuels and seriously cut back on harmful carbon emissions, says the committee. The obvious point is that most of the hardware does not exist yet. This is unproven technology.

Similarly, it is clear that the goal of generating 40% of our electricity from renewable sources cannot be met through our current obsession with building onshore wind farms. There is not enough land in the British Isles to provide sites for them. We will need other sources of renewable power. Relying on power sources that have still to be developed looks naive. This is something that will be pounced on by those who deny that fossil fuels are dangerous and that we need to wean ourselves off their use.

The argument is disingenuous, however. The very fact that many of these technologies are still in development offers a key advantage. Over the past four decades, Britain has amassed a great deal of marine engineering experience following the exploitation of North Sea oil. The same is true for both tidal and wave power plants and for carbon capture and storage.

The crucial point is that by acting in a timely manner in facing up to climate change, Britain has given itself a chance to take pole position in a range of renewable technologies which could then be sold around the world.

In the 20th Century, Britain was given crucial leads that we should have used to build up other types of energy generation but we squandered them. Calder Hall was the first nuclear plant to supply power to a national grid yet development of the next generation of UK nuclear stations – the advanced gas-cooler reactor – was botched. As a result, Britain's tranche of nuclear plants will be either French or American.

Turn over ►

Similarly, we could have taken a lead in wind turbine development, given the gusty meteorological conditions of these islands, but again we fluffed the chance. Consequently, the wind farms that dot the countryside consist of turbines that are made in Denmark or Germany.

The new carbon budget gives Britain a chance to cut its emissions bill, establish energy security for the nation for the next century – and develop a range of new industries. The last on this list is arguably the most important – and the most vulnerable.

Source: adapted from ROBIN MCKIE,
'A golden opportunity for Britain to lead the world in energy production', *The Observer*, 15 May 2011
© Guardian News and Media Ltd 2011

Source E: Renewable energy sources in the UK

(1) Renewable energy overview

Renewable energy refers to energy that occurs naturally in the environment, and can be replenished. This can be energy from waves, wind, the sun and geothermal heat from the ground. Renewable energy can also be produced from plant sources such as wood or crops grown specifically for fuel.

Why do we need renewable energy?

In 2003, UK emissions were over 152 million tonnes of carbon per year. The majority of the electricity and heat that we generate comes from fossil fuels. Electricity generation is responsible for over 41 million tonnes of carbon emissions per year.

This dependency on fossil fuels is driving the continued rise in the carbon emissions leading to climate change. Our huge demand for fossil fuels is depleting our indigenous supplies of oil and gas, creating the need to import more of our fuel. This is leading to concerns over security of supply. In addition, the UK is subject to increasing fuel-price volatility as we become more exposed to world market fluctuations.



Caroline Lucas, the UK's first Green Party MP



Advertisement for 2011 Green Party Conference

UK renewable targets

The UK Government supports the development of renewable energy. The Renewables Obligation was introduced in 2002 and is the Government's main mechanism for encouraging the uptake of renewable energy.

The Renewables Obligation requires licensed electricity suppliers to source a specific, and annually increasing, percentage of the electricity they supply from renewable sources. The percentage target began at 3% in 2003, rising gradually to 10% in 2010 and to 15% by 2015.

Source: adapted from '*Renewable energy sources*', The Carbon Trust
www.carbontrust.co.uk/energy

(2) UK has the world's best renewable energy resource

The UK renewable industry was given a big political vote of confidence after new Department for

Turn over ►

Energy and Climate Change (DECC) Secretary Chris Huhne promised to deliver the licensing and investment potential.

The new DECC minister said it was 'a scandal' that the UK was not fully harnessing the opportunity of renewable energy resources and described the nation as one of the worst-performing countries. Mr Huhne said that his in-tray was "heavy with two massive responsibilities – cutting dangerous carbon emissions and ensuring secure and reliable energy supplies".

According to Mr Huhne, "one of the biggest scandals is that we've got one of the best renewable energy resources anywhere in the world – and the know-how to exploit it – and yet we're one of the worst-performing countries on harnessing it. The renewable industry will come of age under this coalition Government".

Source: adapted from, "UK has world's best renewable energy resource", says new Energy Secretary',
Click Green, 20 May 2010
www.clickgreen.org.uk/news/national-news/121347

Images: Caroline Lucas, © Jeff Morgan 12/Alamy Sheffield Green Party,
<http://sheffieldgreenparty.org.uk/2011/09/08/green-party-conference-comes-to-sheffield>, 8 September 2011
Sheffield Green Party, © Sheffield and Rotherham Green Party

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