WJEC
CBAC

GCE A level

1204/01

GEOGRAPHY

G4 - SUSTAINABILITY

P.M. TUESDAY, 1 February 2011

1 hour 45 minutes

ADDITIONAL MATERIALS

In addition to this question paper, you will need a 12 page answer book and the Resource Folder.

INSTRUCTIONS TO CANDIDATES

Use black ink or ball-point pen.

Answer **all** questions.

Write your answers in the separate answer book provided.

Write your name, centre number and candidate number in the spaces at the top of the answer book.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication used in your answers.

You are reminded that this paper is synoptic and so will draw on your understanding of the connections between the different aspects of the subject represented in the geography specification.

SECTION A

In this section you may use information from the **Resource Folder** *and your own research.*

1. Explain why there are increasing demands for electricity and water in south-east England. [10]
(approximately 13 minutes)

2. Outline how precipitation patterns and the potential for storing water in different parts of the UK contribute to problems of water supply. [10]
(approximately 13 minutes)

3. Describe how different methods of generating electricity create environmental concerns. [10]
(approximately 13 minutes)

4. Assess the sustainability of strategies aimed at managing increasing demands for water. [25]
(approximately 33 minutes)

SECTION B

In this section you may use information from your studies for AS and A2 Geography as well as from the Resource Folder and your own research.

5. Describe differences in wealth in cities. To what extent do these disparities create problems of sustainability? [25]
(approximately 33 minutes)

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1204/01-A

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SUSTAINABILITY

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Examination copy

To be given out at the start of the examination.

The pre-release copy must not be used.

RESOURCE FOLDER

1204
01A001

ADVICE TO CANDIDATES

In this synoptic exercise you will be assessed on your ability to **synthesise knowledge and understanding and skills** derived from your A level course.

You are reminded that assessment will take into account the quality of written communication used in your answers.

The main focus of the materials in this Resource Folder is on the potential future demands for water and electricity in the south-east of England, including London. Various strategies to meet these demands, and some of the difficulties associated with these strategies, are given in a wider UK context.

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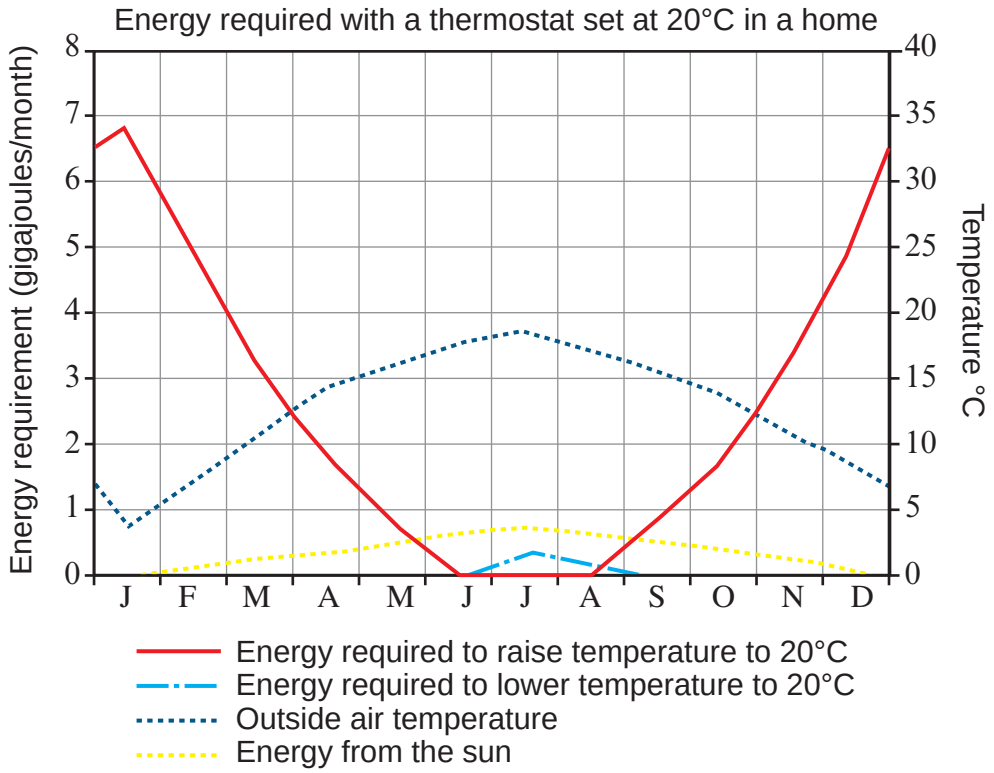
FUTURE DEMANDS FOR ENERGY AND WATER IN LONDON AND SOUTH-EAST ENGLAND

Figure 1 The demand for energy in the UK, based on London in 2005



Source: adapted from www.cbes.ucl.ac.uk

Figure 2 Future energy demands in London up to 2025

Domestic demand

London is expected to undergo a significant increase in population and a larger increase in new dwellings as the average number of people per dwelling continues to fall. An estimated additional 457,950 new dwellings will be needed by 2016, from which a figure of 659,550 homes for 2025 has been extrapolated. In addition, demolitions have been assumed at around 8,000 per annum, which equates to 160,000 over the next 20 years. This results in a net number of 499,550 new dwellings in 2025.

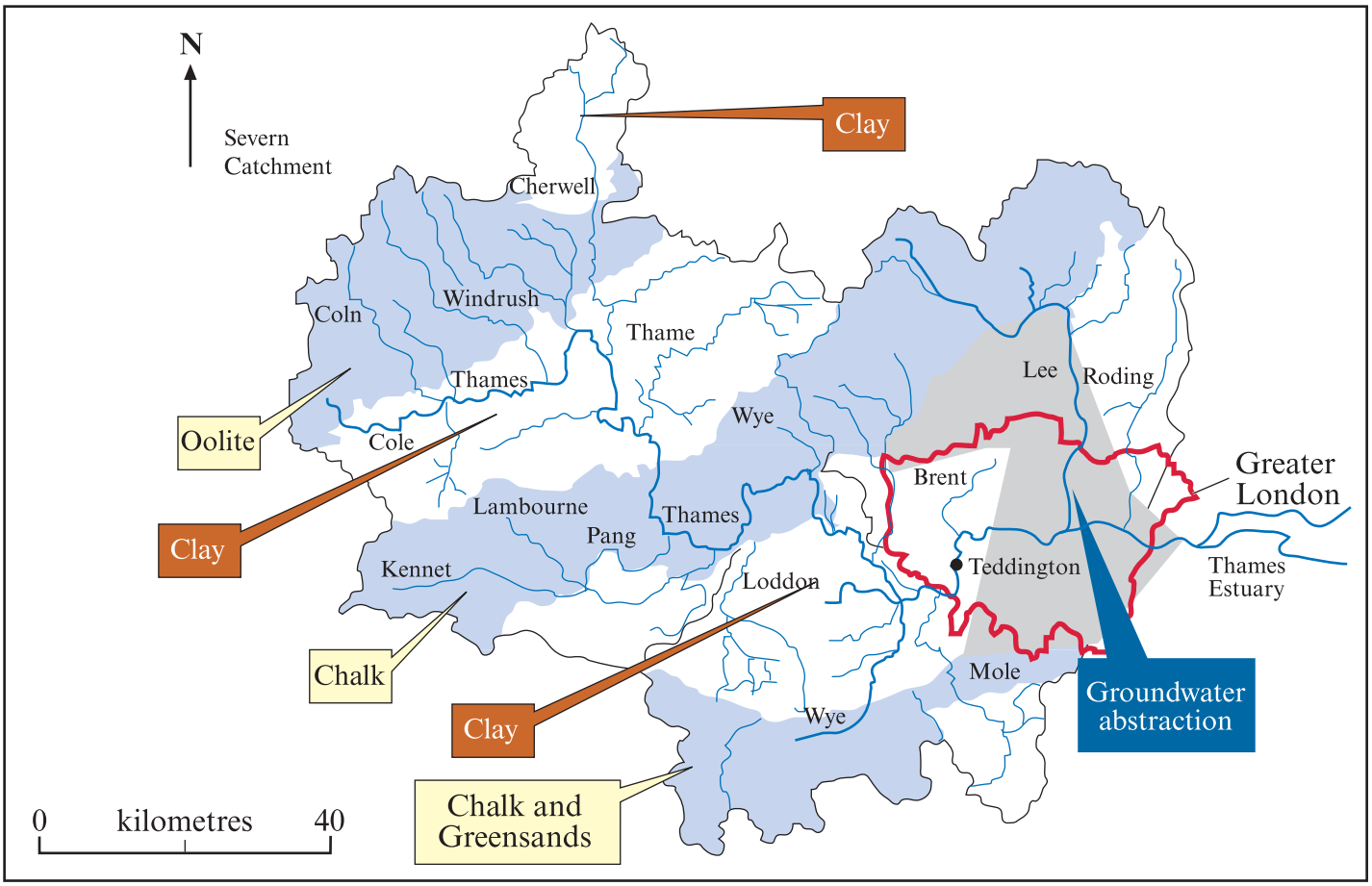
In this period it is assumed there will be a 10% reduction in heat demand due to improved insulation and that the proportion which are electrically heated will remain the same. For new homes it has been assumed that heat demand per home will be considerably lower at 3,000kWh per annum, and that electricity demand for lights and appliances will be 20% less than for existing dwellings at 2,700kWh per annum.

Non-domestic demand

An increase in employment of 845,000 and a 24% increase in non-domestic floor space together with replacement of 5% demolitions will result in nearly 16.4 million m^2 of new-build floor space. It is assumed that there will be a 25% reduction in annual heat demand compared with the current level for 'Good Practice' offices. It is also assumed that there will be a 30% reduction in electricity use compared with 'Typical Practice'. It is assumed that the proportion of electrically heated floor space will fall to 10% in new buildings and that the proportion of new air-conditioned offices will remain at 50%.

Source: www.london.gov.uk

Figure 3 Water sources and the geology of the Thames Basin



About 80 per cent of London's supply is taken from the freshwater River Thames upstream of Teddington Weir. This water resource is sourced from the Chalk, Greensand and Oolite aquifers (areas of blue) of the Thames catchment, which provide baseflow into the tributaries of the River Thames. The other source is from the tributaries of the River Thames that flow over the impervious clay outcrops (non-coloured areas). The remaining 20 per cent of London's water supply is derived from groundwater abstraction from the Chalk formation (underlying the clay formations and outcropping to north and south of the London conurbation), shown by the grey shaded area of the map.

Source: www.london.gov.uk

Figure 4 The reliability of London's water supply

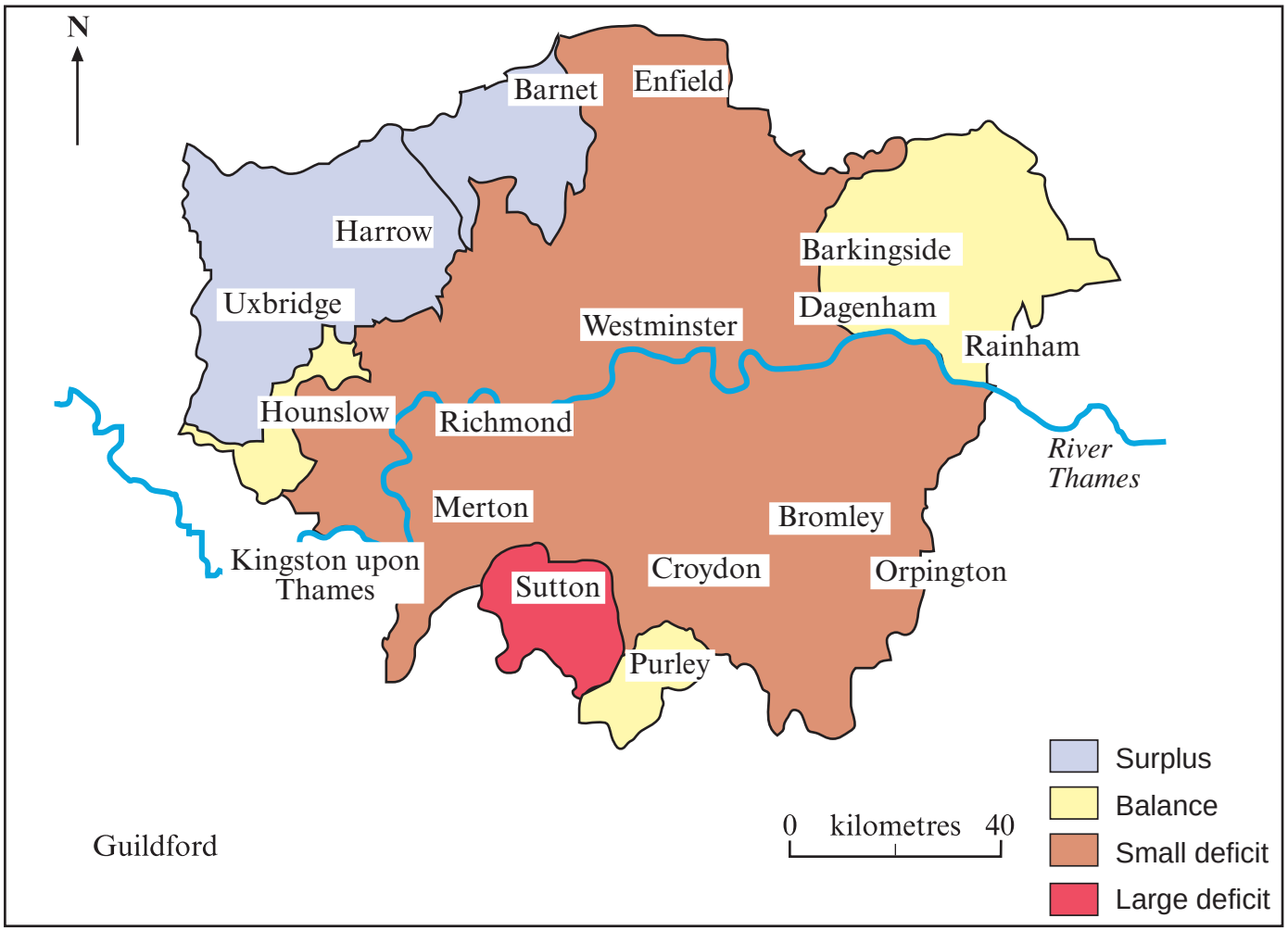
The Thames basin is the largest river basin in the south-east of England. It offers a more dependable supply of water during droughts than other catchments in the south-east of England. By the time the River Thames reaches London, the flow has increased from the many groundwater inputs. During the summer months it is these groundwater releases that largely control the flow of the River Thames and its tributaries. Rainfall in the winter months replenishes the groundwater levels as vegetation takes up most of the spring and summer rainfall.

During most summers, there is sufficient water in the rivers Thames and Lee to meet London's demand for water. It is periods of low rainfall that threaten the security of supply. Low rainfall over the winter months limits the refill of groundwater stores, which in turn leads to low river flows in the following spring and summer. Typically it takes two winters of below average rainfall to lead to drought conditions. Supply is uneven across London, with some areas experiencing a deficit.

Source: www.london.gov.uk

Turn over.

Figure 5 Areas of water surplus, balance and deficit in London



Source: www.london.gov.uk

Figure 6 London's future demand for water up to 2035

In 2008, the demand for water in London was around 2 112 million litres per day (Ml/d). Thames Water expect this to rise to 2 266 Ml/d by 2015. Looking further ahead, it may rise to 2 542 Ml/d by 2035, but this figure could be reduced if all users were to adopt a series of water conservation measures.

Whichever of the forecast demands arises, increased storage capacity will be needed in order to meet these demands and to be adequate if there are high summer temperatures after several winters of low rainfall. Three options for extra storage capacity have been considered, (1) 75 million cubic metres (Mm^3), (2) 100 Mm^3 and (3) 150 Mm^3 of water. 75 Mm^3 is now considered too risky with the possibility of supplies being cut off. 150 Mm^3 would eliminate almost all risks but would involve enormous spending that may be unnecessary. The option of 100 Mm^3 would carry only a very small risk of not meeting needs, and would be an affordable option.

The extra 100 Mm^3 could be met by the proposed new south-west Oxfordshire reservoir. If this were to be built, there would be no need for any transfer of water from the Severn catchment into the Thames basin.

Source: www.thameswater.co.uk

Figure 7 Predicted water balance (ml/d) in London and Guildford

London

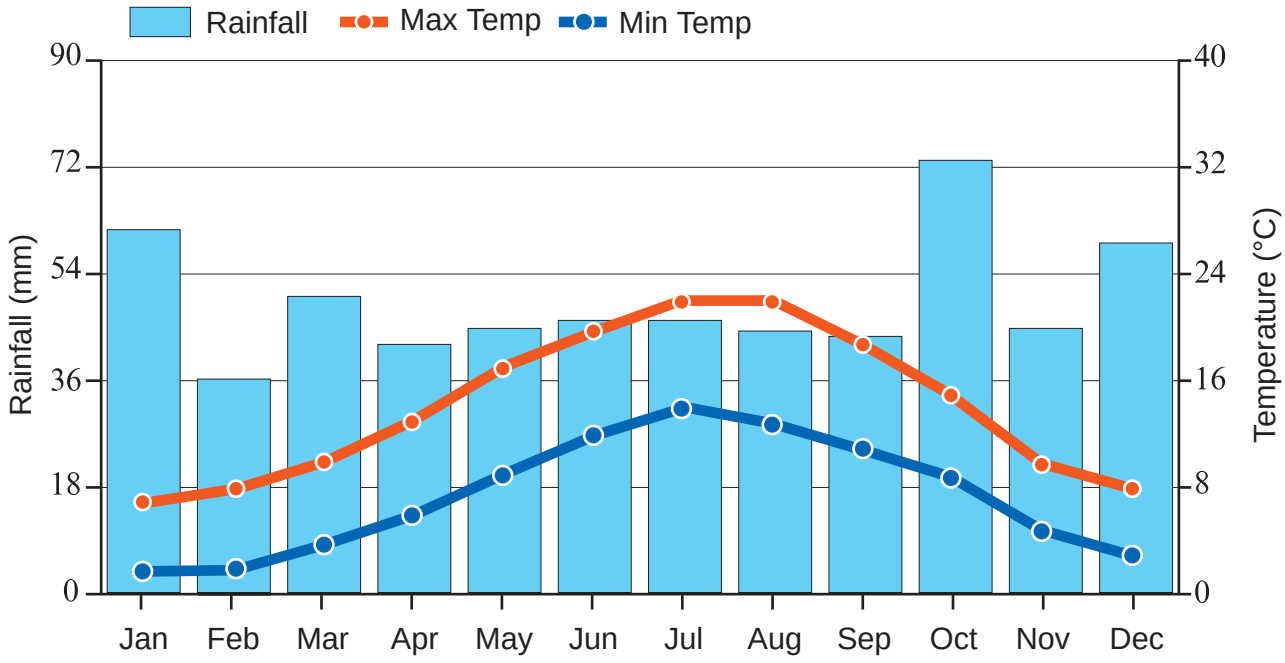
Date	2015	2020	2025	2030	2035
Demand	2 266	2 365	2 459	2 515	2 542
Supply with no additional sources	2 106	2 080	2 054	2 041	2 031
Surplus/Deficit	–160	–285	–405	–474	–511

Guildford

Demand	61	63	65	66	68
Supply with no additional sources	74	74	74	74	74
Surplus/Deficit	+13	+11	+9	+8	+6

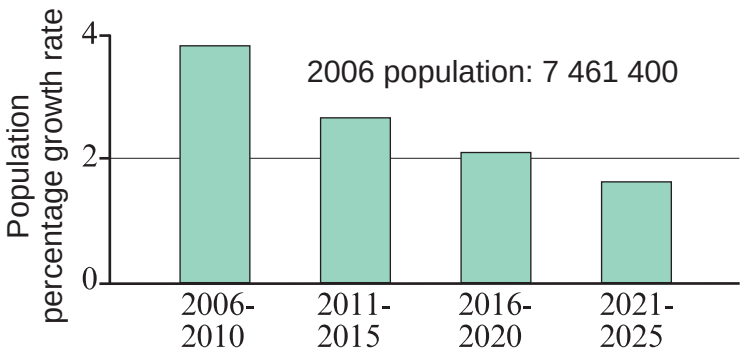
Source: www.thameswater.co.uk

Figure 8 London's average rainfall and temperature

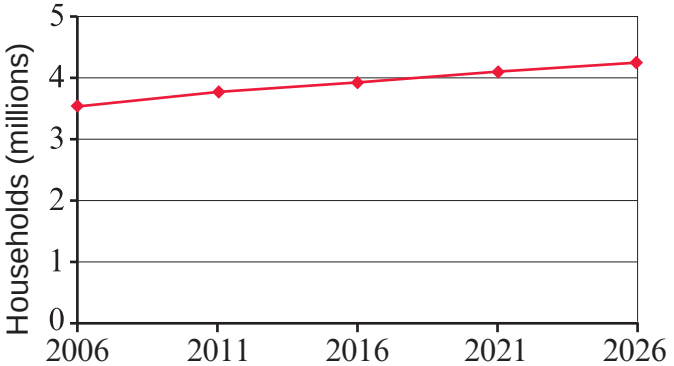


Source: www.metoffice.gov.uk

Figure 9 The predicted percentage growth of London's population and growth in the number of households in south-east England

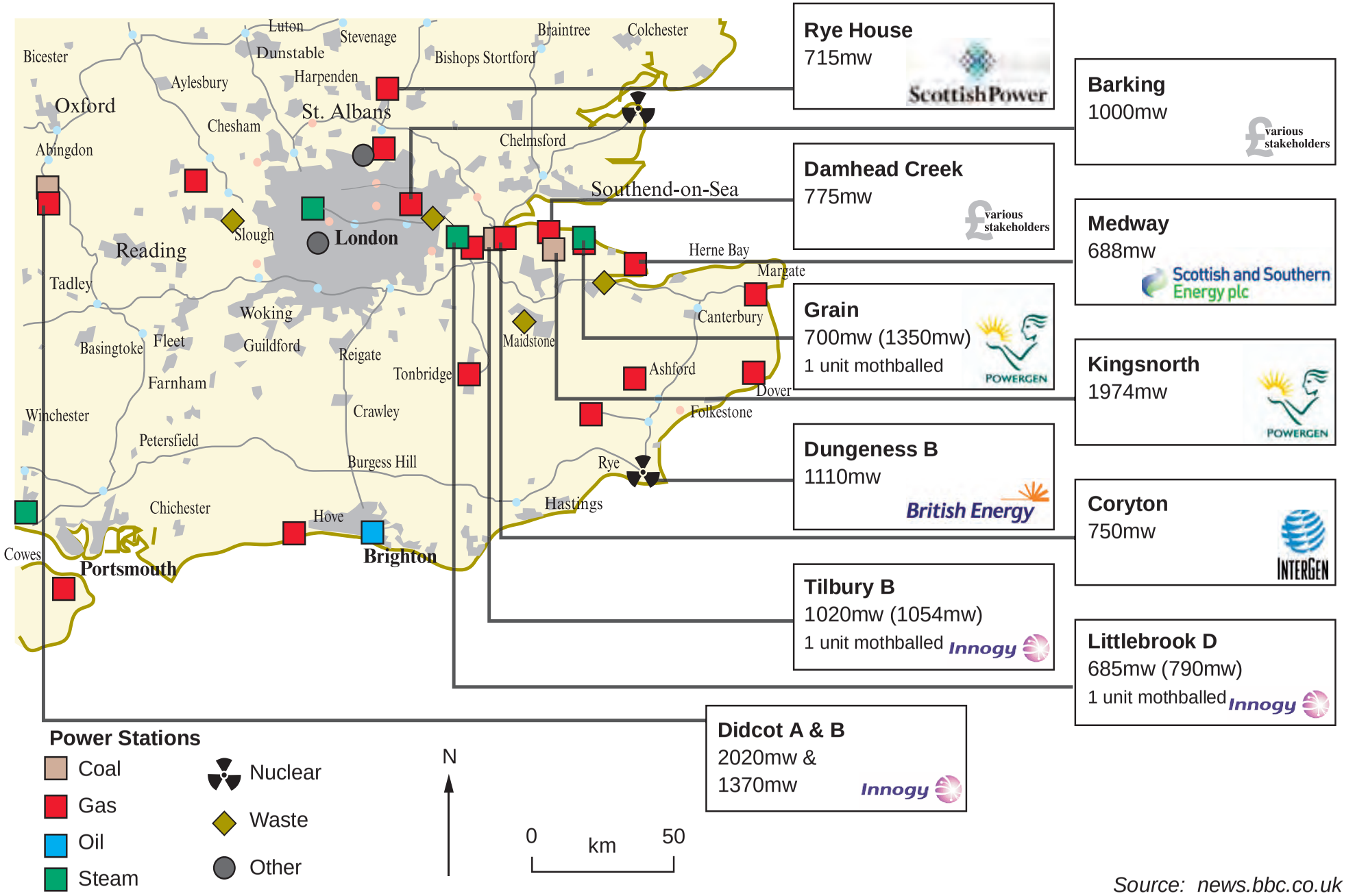


Source: www.communities.gov.uk



Source: www.statistics.gov.uk

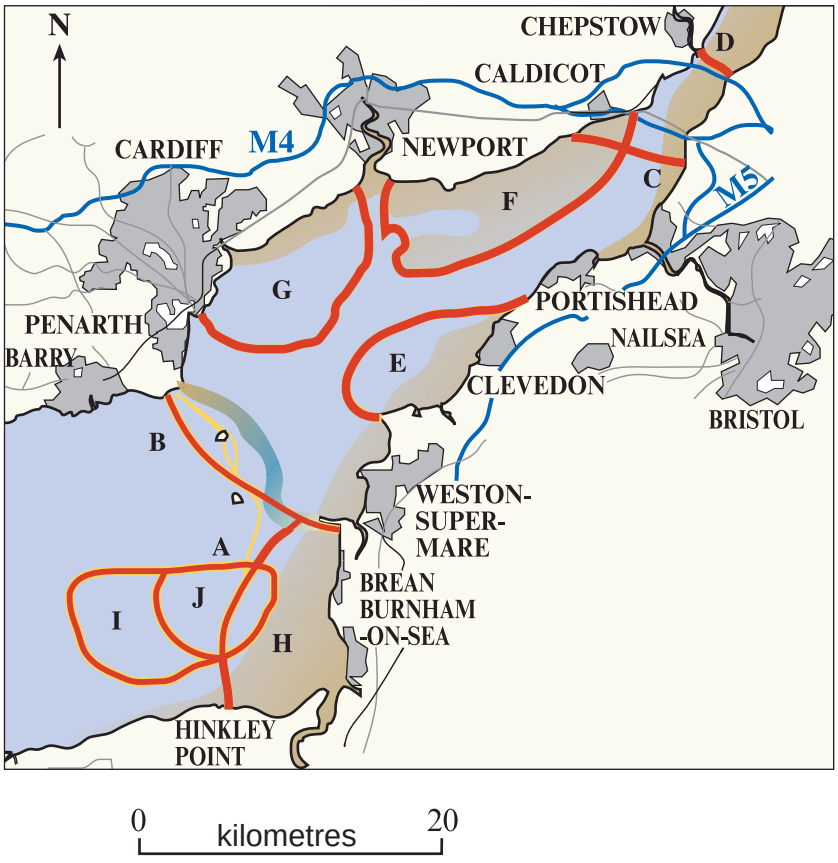
Figure 10 Power stations in London and south-east England



Source: news.bbc.co.uk

STRATEGIES FOR INCREASING SUPPLIES OF ENERGY AND WATER

Figure 11 The options being considered for Severn tidal power



OPTIONS

Barrages (A-D) Lagoons (E-J)

A	Middle Barrage (Hinkley Brean)
B	Middle Barrage (Cardiff Weston)
C	Inner Barrage
D	Beachley Barrage
E	Land Connected Tidal Lagoon (English Grounds)
F	Land Connected Tidal Lagoon (Welsh Grounds)
G	Land Connected Tidal Lagoon (Peterstone Flats)
H	Land Connected Tidal Lagoon (Bridgewater Bay)
I	Offshore Tidal Lagoon (Bridgwater Bay)
J	Offshore Tidal Lagoon (Bridgewater Bay)

Source: adapted from wales.gov.uk

Figure 12 The proposals for a Cardiff Weston barrage and tidal lagoons

The main aim of these proposals is to generate electricity. There is a large tidal range in the Severn estuary and the power of the water coming in and out can turn turbines. The current favourite is a barrage (B) between Weston-super-Mare and Cardiff, with three lagoons (E, F and G) created in the estuary on the landward side of the main barrage. Turbines would be located both on the main barrage and on the lagoons.

- The barrage would generate up to 8.64 GW (1 GW = 1 000 MW).
- It would average 2.00 GW.
- The lagoons would average a further 2.75 GW.
- Together over 12% of UK electricity could be produced by the Severn schemes.

The lagoons would save emitting 11.6 million tonnes of CO_2 per year or 2% of the UK total CO_2 emissions. This would go a long way to helping the UK meet CO_2 emission reduction obligations.

The barrage would also provide a third crossing over the Severn estuary between Wales and England. With the western end being only a few miles from the centre of Cardiff, the capital would have immediate and uninterrupted access to the motorway network.

Source: adapted from www.foe.co.uk

Figure 13 Proposed water transfers in southern Britain

KEY

Pipeline transfers

River regulation

Canal Transfer

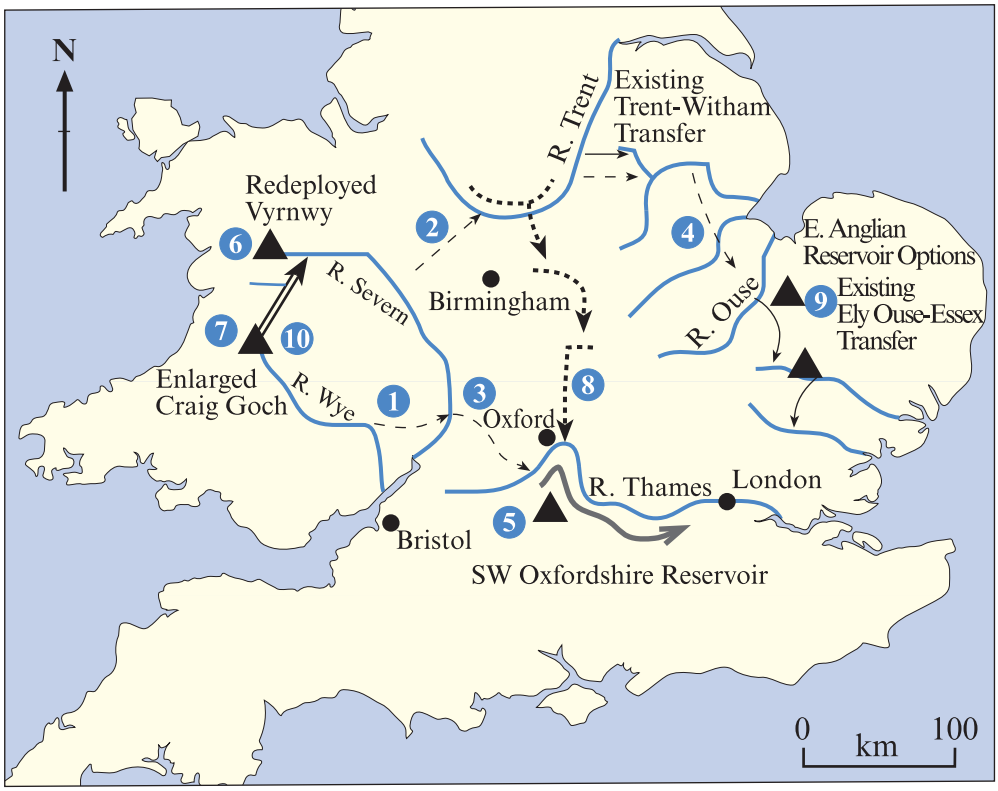
Existing Transfer

New Transfer

Tunnel

Reservoir

1. River Wye to River Severn - with regulation of the Wye from Craig Goch Reservoir
2. River Severn to River Trent transfer
3. River Severn to River Thames transfer
4. River Trent to East Anglia
5. South West Oxfordshire Reservoir
6. Redeployment of Vyrnwy Reservoir
7. Enlarged Craig Goch Reservoir - would be used to regulate either the River Severn or River Wye
8. Canal transfer to the River Thames
9. East Anglian Reservoir
10. Tunnel from Craig Goch to River Severn



Source: www.environment-agency.gov.uk

Figure 14 Proposals for boosting water supplies in south-east England

In 1994 the National Rivers Authority (NRA) considered transferring water from the River Severn (and/or possibly the River Wye) into the Thames to increase supplies of water to London and south-east England.

To ensure that the Severn had sufficient flow to support the transfer, it was proposed that extra water be fed into the Severn from Lake Vyrnwy and that Craig Goch reservoir in the Elan Valley should be enlarged.

The scheme has been shelved because of the high cost and concerns about altering the chemistry of the River Thames and disturbing its ecosystem by introducing alien micro-organisms.

In 1994 the NRA also proposed building a new reservoir in south-west Oxfordshire to supplement the flow of the Thames and to ensure water supplies for London and south-east England. This would hold 150 million cubic metres of water and cost £400 million at 2009 monetary values.

Thames Water do not think that the south-west Oxfordshire reservoir will be needed until 2026 as measures to prevent leakage, conservation measures by consumers, fully efficient recycling of water and creating smaller new sources and reservoirs are likely to meet demands until then.

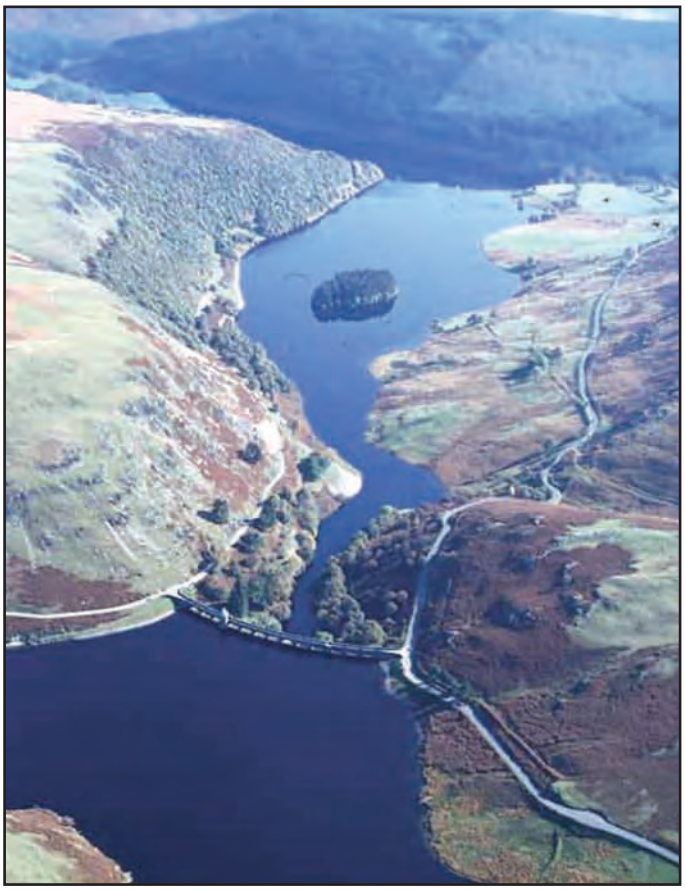
Source: www.environment-agency.gov.uk

Figure 15 Temperature and rainfall for Rhayader near Craig Goch and Lake Vyrnwy (6 and 7 on Figure 13)

	Monthly averages		
	Minimum temperature (°C)	Maximum temperature (°C)	Precipitation (mm)
January	2	6	142
February	2	6	138
March	2	9	110
April	3	11	113
May	6	14	108
June	8	16	96
July	10	18	87
August	10	19	104
September	8	16	121
October	7	12	174
November	4	9	164
December	1	5	167

Source: weather.uk.msn.com

Figure 16 Craig Goch Reservoir



Source: © crown copyright RCAHMW

Turn over.

Figure 17 Glendoe – a hydro-electric power station opened in Scotland in 2009

Figure 18 Glendoe electricity output and other potential uses

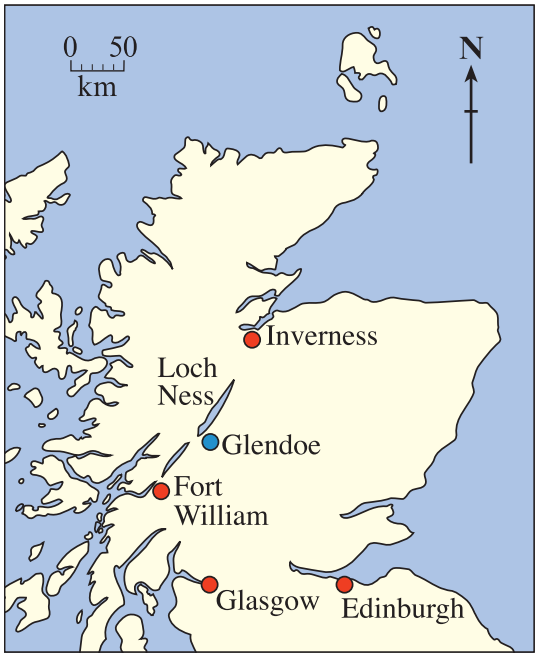
This dam, built on slopes above Loch Ness, can generate 100 MW of electricity. It can also store large amounts of water but local demand for water is met already and water is expensive to transfer over greater distances. Large cities in Scotland, such as Glasgow and Edinburgh, are just too far away.

The electricity can be used to supply Fort William and Inverness, the nearest settlements of any size. It can supply needs of these towns and still have enough to completely supply the demands of a city the size of Glasgow.

To reach Glasgow, power lines would need to be constructed crossing many mountains. There is much opposition to building power lines across these mountains which many people consider to be exceptionally beautiful. Cables can be laid underground, but they are very much more expensive.

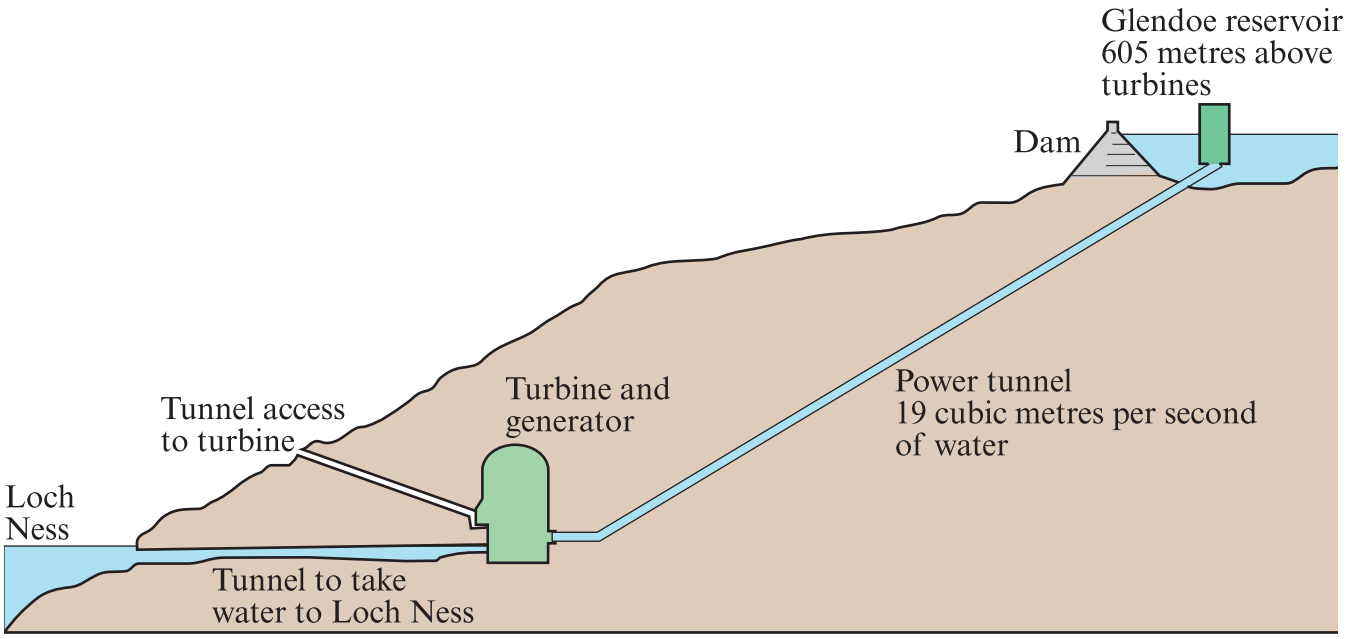
Source: www.glendoe.co.uk

Figure 19 The location of Glendoe HEP station



Source: wjec

Figure 20 Cross-section of the Glendoe HEP station



Source: www.glendoe.co.uk

Figure 21 Power loss transmitting electricity over long distances

Transmission losses are power losses in an electrical system. They are typically around 5 - 7% of the total power put into the system. In some countries, older transformers and power lines can lead to losses as high as 21%. Transmission losses represent a loss in value as every MWh of power that is generated, but cannot be sold, costs money.

They also lead to an increase in fuel burnt in thermal power stations and so increase environmental impacts. The loss becomes greater and greater as the distance of transmission increases.

Transmission losses are caused by:

- The electrical resistance of the conductor lines (accounts for 5% losses or 147 million MWh in Europe).
- Converting the power between high voltages used for long distance transmission and safe low voltages used in most industry and homes (accounts for 2% losses or 59 million MWh across Europe).

In Europe, the resistance in transmission lines alone represents the waste of around 20 million tonnes of coal, 3.1 million tonnes of gas and 1.7 million tonnes of oil. The annual loss in value is around €12 billion. The annual increase in greenhouse gas emissions is around 60 million tonnes of CO_2 per year.

Source: www.europacable.com

Turn over.

Figure 22 The UK potential for renewable energy

This windswept island nation has enormous potential for wind, wave and tidal power: more than enough to meet all of our energy needs many times over.

The total value, globally, of new wind power installed in 2006 was £12 billion – and the industry grows by an astounding 30 per cent or more a year. But the UK is only seizing a small percentage of that market, and we're being left behind. Germany, Denmark, the US, Italy, Spain, China and India all have more wind capacity than us. Canada, France and Portugal are at about the same level or slightly less but, last year, they all grew faster than us.

Source: www.greenpeace.org.uk

Figure 23 Wind power

Great Yarmouth wind farm, Norfolk

Lambrigg wind farm, Cumbria

Wind power is a large-scale, reliable source of power that's already having a major positive impact; it provides enough electricity to supply 1.2 million UK homes every year. But we've barely scratched the surface.

Despite the fact that our wind is stronger and more constant than theirs, Germany has built more than ten times our wind farm capacity. Spain has built over five times more than we have, in just a few years.

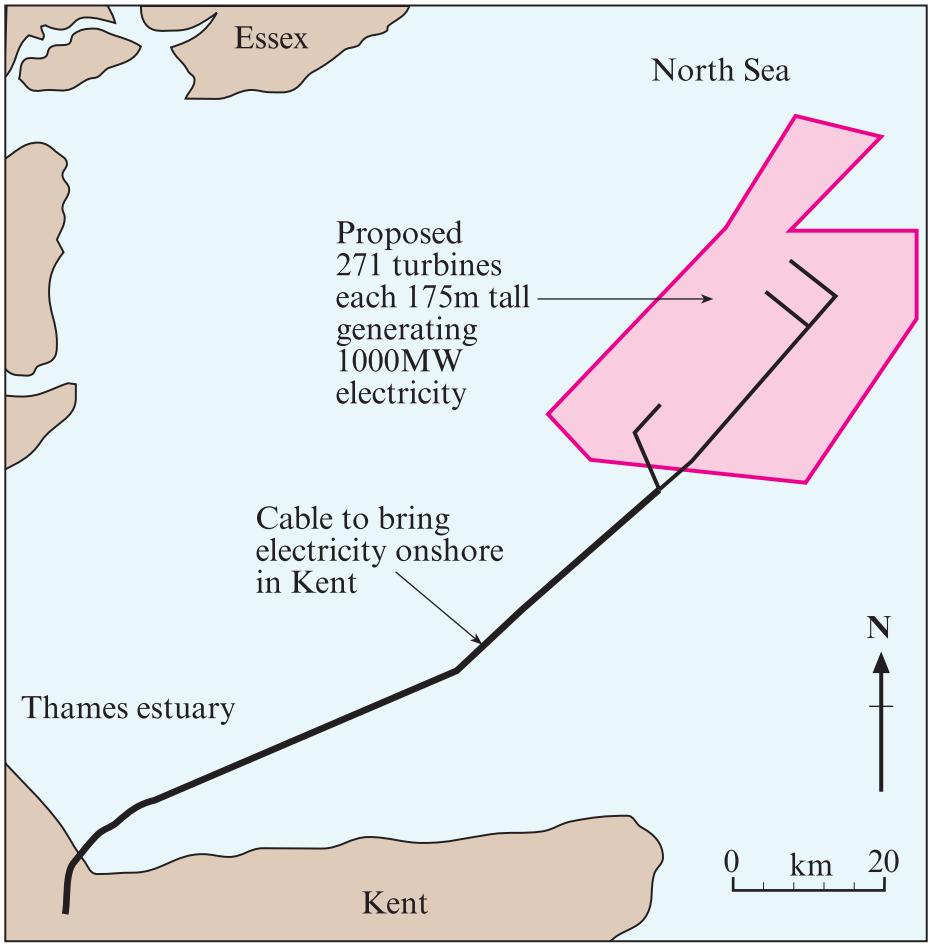
Once approved, a wind farm doesn't take long to build.

Offshore wind farms like the London Array are planned on a scale that will generate the equivalent of the electricity needs for 750,000 homes. Some more recently conceived projects are even bigger, with a predicted output from one such offshore wind farm being about the same as the output from a typical nuclear power station.

Between onshore and offshore wind, the long term potential for wind power in the UK is enormous. Government figures suggest that more than a quarter of today's electricity consumption could be provided by wind power by 2025 – and that to do it would be both economic and practical.

Source: www.greenpeace.org.uk

Figure 24 The proposed London Array wind farm



Source: http://www.londonarray.com

Figure 25 Wave and tidal power

Ocean power
The power in the seas is vast – and wave and tidal power is at an innovation stage. The world's first commercial wave power generator is on Islay, in the Western Isles of Scotland. The Orkney Isles has a hugely important test centre for wave and tidal machines.

The Bristol Channel alone has enough tidal energy potential to power the whole of Wales. (Figure 11)

Conclusion
Between them, wind, wave and tidal power could deliver more than twice as much electricity than the new fleet of nuclear reactors being debated – and the renewables would be built more quickly.

Even then, the full potential of these sources would not have been tapped – much more could be harnessed in the future. But we have to start now if we're going to end our dependence on fossil fuels and reduce emissions. Ambitious support for renewables will bring benefits – not just of clean, fuel-free energy, but the jobs and economic growth that come from pioneering new industries and technology.

Source: www.greenpeace.org.uk

Turn over.

Figure 26 The UK targets for renewable energy and CO_2 reduction

Renewable energy is an integral part of the Government's longer-term aim of reducing CO_2 emissions.

Currently, the number one target is to reduce emissions by 60% by 2050.
Therefore in 2000 the Government set a target of 10% of electricity supply from renewable energy by 2010.

In 2006 it was announced that the aspiration is to double that level by 2020.
In 2007, 5% of the UK's electricity supply came from renewable sources, with 4.9% from Renewable Obligation (RO) eligible sources.

The Government held a consultation, in summer 2008, seeking views on how to drive up the use of renewable energy in the UK, as part of the overall strategy for tackling climate change and to meet our share of the EU target to source 20% of the EU's energy from renewable sources by 2020.

Source: www.berr.gov.uk

Figure 27 Small-scale energy projects

A small generator using methane produced by an old landfill site.

Source: http://www.geograph.org.uk

ISSUES ARISING FROM SOME PROPOSALS

Figure 28 Opposition to the Severn barrage – Friends of the Earth

Local economy
We are concerned that the Cardiff-Weston barrage would impede navigation of larger ships and so significantly reduce freight trade entering the UK via the Severn ports, particularly Avonmouth and Portbury. This would have adverse knock-on effects on the economy around Bristol, and strain port capacity at, and transport links to, other UK ports.

Photo source: http://www.geograph.org.uk

Environment
We consider that there are far less environmentally damaging ways to minimise existing and forecast future climate related flood risks around Severnside. New coastal defence techniques, which include managed retreat, forward building, retractable barriers, and the construction of bunds using silt filled geo-textile bags might also actually enhance the Severn's protected biodiversity. A much smaller Inner Barrage located just downstream of the Second Severn Crossing may also be an option, and one which could carry a strategic (South Wales-London) rail link and generate tidal power.

Energy
We are concerned that the barrage would draw investment away from other renewable energy technologies in which the UK has commercial leads and export potential. We also point out that the huge twice daily pulses of barrage power to the National Grid would be costly and difficult to balance.

Source: www.foe.co.uk

Turn over.

Figure 29 Opposition to the Severn barrage – Wye and Usk Foundation

One would expect an environmental organisation such as the Wye and Usk Foundation, which was set up to restore and protect fish and fisheries, to be against any scheme that could severely reduce or extinguish runs of migratory fish. Salmon, shad and lamprey currently enjoy the protection of the EU Habitats Directive. The barrage will present massive problems for planners attempting to reconcile these important environmental considerations.

Fishing on the River Usk

Photo source: www.flickr.com

Equally, the barrage presents huge challenges to one of the most important RAMSAR sites, where birds both live and over-winter in a unique habitat. Colleagues in the RSPB, WWF, Wildfowl and Wetlands Trust (Slimbridge) and other wildlife trusts therefore have parallel concerns and together we are creating a united front.

Wildfowl at Slimbridge

Photo source: www.flickr.com

There are, however, plenty of other reasons for opposing the barrage, amongst which are ...

- It is disproportionately expensive.
- Tidal power is intermittent; power is produced at night, and in short, heavy bursts.
- It will not solve either of the problems of climate change or power generation as effectively as some other schemes.
- It is a risky 'all eggs in one basket' scheme.

Source: www.wyeuskfoundation.org

Figure 30 Climate change sceptics

Some scientists disagree with the global and UK predictions for climate change, mainly because the climate has changed naturally before. In addition, predicting changes to our climate is very complex and the use of computer models has raised some criticism.

On top of that, some experts believe it is impossible to be certain about how our climate will change as it can be very unpredictable. They also believe the climate is supposed to change, and it has done before. Many believe activities from human beings can not be to blame for changes in the climate. Some sceptics have criticised the reports of the IPCC as being based on unknown assumptions about the future and based on computer models which are not adequate for such a job.

Professor Philip Stott

Photo source: http://word.world-citizenship.org

Emeritus Professor of Biogeography at the University of London, Philip Stott, summed up his thoughts on the issue in a newspaper article in 2005.

'Climate change has to be broken down into three questions:

1. Is climate changing and in what direction?
2. Are humans influencing climate change, and to what degree?
3. Are humans able to manage climate change predictably by adjusting one or two factors out of the thousands involved?

But the most fundamental question of all is:

- Will cutting carbon dioxide emissions at the margin of its production lead to a predictable reduction of change in the climate?

The answer is 'No'.

In so complex a coupled, non-linear, chaotic system as climate, not doing something at the margins of the system is as unpredictable as doing something.

Such reasoning is cautious science; the rest of the claims by those sounding alarms about climate change is dogma.'

Source: www.bbc.co.uk

Sources of information

Figure 1	http://www.cbes.ucl.ac.uk/projects/energyreview/Bartlett%20Response%20to%20Energy%20Review%20-%20electricity.pdf
Figure 2	http://www.london.gov.uk/mayor/environment/energy/docs/powering-london-21st-century.pdf
Figure 3 & 4	http://www.london.gov.uk/mayor/environment/water/docs/la-draft-water-strategy.pdf
Figure 5	http://www.london.gov.uk/mayor/environment/water/docs/la-draft-water-strategy.pdf
Figure 6	http://www.thameswater.co.uk/cps/rde/xbcr/corp/statement-of-response.pdf
Figure 7	http://www.thameswater.co.uk/cps/rde/xbcr/corp/statement-of-response.pdf
Figure 8	http://www.metoffice.gov.uk/education/teachers/past_weather_data.html
Figure 9	http://www.communities.gov.uk/documents/statistics/pdf/1172133.pdf http://www.statistics.gov.uk/cci/nugget.asp?id=2236
Figure 10	http://news.bbc.co.uk/1/shared/bsp/hi/pdfs/14_06_06_powerstations.pdf
Figure 11	http://wales.gov.uk/docs/desh/consultation/090126stpconsultationen.pdf
Figure 12	http://www.foe.co.uk/resource/briefings/the_severn_barrage.pdf
Figures 13 & 14	http://www.environment-agency.gov.uk/static/documents/Research/grid_1464452.pdf
Figure 15	http://weather.uk.msn.com/local.aspx?wealocations=wc:7393828&q=Rhayader%2c+Wales
Figure 16	© crown copyright: Royal Commission on the Ancient and Historical Monuments of Wales
Figure 17 & 18	http://www.glendoe.co.uk/project/
Figure 19	wjec – setter, no copyright
Figure 20	http://www.glendoe.co.uk/project/
Figure 21	http://www.europacable.com/newpages/lifecycle/transmission_losses.htm
Figure 22 & 23	http://www.greenpeace.org.uk/climate/solutions/renewable-energy both photos wjec/setter – no copyright
Figure 24	http://www.londonarray.com/wp-content/pdfs/boundaries-limits.pdf
Figure 25	http://www.greenpeace.org.uk/climate/solutions/renewable-energy
Figure 26	http://www.berr.gov.uk/energy/sources/renewables/index.html
Figure 27	http://www.geograph.org.uk/
Figure 28	http://www.geograph.org.uk/photo/209029 http://www.foe.co.uk/resource/briefings/the_severn_barrage.pdf
Figure 29	http://www.flickr.com/photos/uskgrub/2637696349/ http://www.flickr.com/photos/markfennell/2806141374/ http://www.wyeuskfoundation.org/problems/severnbarrage.php
Figure 30	http://word.world-citizenship.org/wp-archive/1898 http://www.bbc.co.uk/climate/evidence/sceptics.shtml