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THE EU'S RENEWABLES POLICY: OFFICIAL COST ESTIMATES TO BRITAIN

By Ruth Lea,
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Across the political spectrum, politicians have realised that reducing costs to business and putting money back in the hands of consumers is vitally important to help them through the economic crisis. One way of doing this is to reduce the burden of regulations that push up costs for businesses and families. This paper will show that scrapping the expensive and ineffective EU renewables policy would provide a significant and welcome break for British taxpayers.

Key points

EU renewables targets are expected to impose a substantial burden on British families and businesses between now and 2030:

- A study by the energy consultancy Pöyry has estimated that in 2020 the annual cost of meeting EU renewables targets would be around £150 to over £200 per household.
- BERR's Impact Assessments have estimated that the average annual cost of meeting EU renewables targets could range from £55 to £120 per household, for the 20 years up to 2030.

Britain is facing a much harder target than many other European Union member states:

- With the exception of Malta and Luxembourg, the UK is faced with by far the greatest challenge in reaching its 2020 target. Because the share of renewables was only 1.3 per cent in 2005 (the lowest with the exception of Malta and Luxembourg) it will have to increase its renewables share eleven-fold by 2020.

Other countries are signalling that they will not accept new regulations that will harm business. German Chancellor, Angela Merkel, has said we "must not take decisions that would endanger jobs or investments in Germany." Italian Prime Minister, Silvio Berlusconi, has said: "We do not think that now is the time to be playing the role of Don Quixote". Other countries are protecting their economic interests, we should do the same and the EU's renewables policies are particularly costly to Britain.

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Introduction

The EU's renewables policy, involving a significant replacement of the use of fossil fuels by renewable energy sources, is one of the EU's primary mechanisms for achieving its target of a 20 per cent reduction in carbon dioxide emissions by 2020. The EU's Emissions Trading Scheme is the other main policy. This report is primarily concerned with official estimates of the costs to Britain of the EU's renewables policy. These estimates are substantial and will put British industry at considerable cost disadvantages to overseas competitors and undermine people's living standards. They are also almost certainly under-estimates.¹

Given the increasing doubts about many EU countries' commitment to the costly carbon reduction targets - several "new EU" members and Italy expressed major reservations at the mid October 2008 EU Summit² - and the refusal of major developing countries to curb their carbon emissions, Britain's efforts to "decarbonise" its economy at substantial cost look increasingly misguided. It should also be emphasised that the UK accounts for less than 2 per cent of all global anthropogenic carbon emissions and this figure is falling.

The UK's climate change bill

The UK's climate change bill is being introduced partly to achieve Britain's compliance with the EU's carbon reduction targets, intended to "control climate change",³ and partly for domestic political objectives. The bill was overwhelmingly endorsed by the House of Commons on 28 October 2008. Due to receive the Royal Assent very soon, the bill includes two legally binding targets:

- 80 per cent reduction (recently raised from 60 per cent) in anthropogenic CO₂ emissions by 2050, compared with 1990.
- 26 to 32 per cent reduction by 2020, compared with 1990. This is tougher than the EU's 20 per cent target.

Green policies are already adding to electricity costs in Britain. The climate change bill will increase these costs. According to official BERR estimates, climate change policies already account for 21 per cent of the average business electricity bill.⁴ But by 2020, the burden of green regulations is expected to rise to 55 per cent of the average business electricity bill. The equivalent estimates for domestic fuel bills are 14 per cent and 18 per cent.

¹ See, for example, Renewable Energy Foundation, Response to the Renewable Energy Strategy Consultation 2008, September 2008, available from www.ref.org.uk.

² Charter, D. and Watson, R. "Black clouds hang over green targets as EU states say we can't afford them", *Times*, 17 October 2008; Italian Prime Minister Silvio Berlusconi said "our businesses are in absolutely no position at the moment to absorb the costs of the regulations that have been proposed."

³ The policy of mitigating climate change by attempting to reduce manmade carbon emissions is controversial - but will not be discussed further in this paper.

⁴ The energy division of BERR was transferred to the new Department of Energy and Climate Change (DECC) on 3 October 2008; Available from BERR's website, www.berr.gov.uk

The EU's Renewables Directives

Even though the main driver behind the EU's policy on renewable energy is to reduce the use of fossil fuels, cut anthropogenic carbon emissions and "combat" climate change, there are other reasons. These include security and diversification of energy supply, environmental protection and social and economic development. Renewables are defined to include biomass, solar power, wind, wave and tide and hydroelectricity. Nuclear power is excluded on the grounds it is not strictly "renewable", even though nuclear electricity generation does not produce man-made carbon emissions and could be a major contributor to meeting carbon emission reduction targets.

The exclusion of nuclear power as a renewable, even though it is "clean", means that there could be direct conflicts between the priorities required to, firstly, meet supply, security and cost targets, secondly, meet CO2 targets and thirdly, meet the "renewables" targets. In complying with the EU's renewables targets, a future British government would be constrained from giving nuclear power a higher priority than wind-power even though it may score more highly in terms of cost, reliability or ability to deliver carbon reduction targets.⁵

The 2001 Renewables Directive required each member state to commit to specific targets for renewable energy.⁶ Under the Directive, Member States were required to adopt national targets for renewables that were consistent with reaching the Commission's target of 22 per cent of electricity from renewables by 2010. The indicative target set for the UK was for 10 per cent of electricity generated from renewable sources by that date.

The Directive also required that Member States ensured that a "Guarantee of Origin" (GoO) was issued on request in respect of the electricity generated from eligible renewable energy sources, as defined by the Directive. In the UK this part of the Directive has been implemented through the Electricity Regulations 2003 in which GoOs were designated as Renewable Energy Guarantees of Origin (REGOs).

In March 2007 the European Council made commitments to specific targets for renewables by 2020. They were:

- To deliver 20 per cent of EU primary energy consumption from renewable sources by 2020.
- To deliver a specific 10 per cent transport biofuels obligation.

⁵ This issue is discussed in the House of Lords Economic Affairs Committee's inquiry into the economics of renewable energy (2008).

⁶ "Directive on the Promotion of Electricity from Renewable Energy Sources in the Internal Electricity Market" (2001/77/EC) is the full title of the 2001 Renewables Directive; Information obtained from BERR's website, www.berr.gov.uk.

Following on from the March 2007 Summit the draft of the new Renewables Directive was released in January 2008.⁷ The main features of the Directive are:

- The share of renewable energy in the EU final energy consumption should reach at least 20 per cent by 2020.⁸
- It established national overall targets for each member state. A path of compliance was also set with interim targets every 2 years.
- The share of renewable energy in the final energy consumption of transport should reach at least 10 per cent by 2020 in each Member State.
- Trading of Guarantees of Origin (GoO) would be allowed between Member States, with the EU27 governments acting as the trading partners. A Member State would be allowed to trade its "surplus" GoOs with other Member States but would have no obligation to do so.

It should be emphasised at this point that the draft Renewables Directive is still a "draft". It was expected that it would become legally binding in December 2008. But, given the afore-mentioned October 2008 Summit and other frictions, there are now major doubts whether the draft Directive will ultimately be agreed in its current form.

2008 Renewables Directive: the UK's targets

The 2008 draft Renewables Directive contains a table of the national targets for all EU27 countries for 2020. Under the "burden sharing" agreements these national targets are required to be achieved for the EU to meet its overall 20 per cent renewables target.

⁷ Commission of the European Communities 'Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources', January 2008

⁸ The 2008 draft Renewables Directive states: " 'final consumption of energy' means the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry & fisheries, including the consumption of electricity & heat by the energy branch for electricity & heat production and including losses of electricity & heat in distribution." This is not the same as the definition used by BERR statisticians (see glossary).

Table 1: National overall targets for the share of energy from renewable sources in final consumption of energy in 2020, %⁹

	Share of energy from renewable sources in final consumption of energy, 2005	Target for share of energy from renewable sources in final consumption of energy, 2020	Arithmetic increase in share required	Ratio of 2020 target share over 2005 share
Austria	23.3%	34%	10.7%	1.46
Belgium	2.25%	13%	10.8%	5.78
Bulgaria	9.4%	16%	6.6%	1.70
Cyprus	2.9%	13%	10.1%	4.48
Czech Republic	6.1%	13%	6.9%	2.13
Denmark	17.0%	30%	13%	1.76
Estonia	18.0%	25%	7%	1.39
Finland	28.5%	38%	9.5%	1.33
France	10.3%	23%	12.7%	2.23
Germany	5.8%	18%	12.2%	3.10
Greece	6.9%	18%	11.1%	2.61
Hungary	4.3%	13%	8.7%	3.02
Ireland	3.1%	16%	12.9%	5.16
Italy	5.2%	17%	11.8%	3.27
Latvia	34.9%	42%	7.1%	1.20
Lithuania	15.0%	23%	8%	1.53
Luxembourg	0.9%	11%	10.1%	12.22
Malta	0%	10%	10%	Infinite
Netherlands	2.4%	14%	11.6%	5.83
Poland	7.2%	15%	7.8%	2.08
Portugal	20.5%	31%	10.5%	1.51
Romania	17.8%	24%	6.2%	1.35
Slovakia	6.7%	14%	7.3%	2.09
Slovenia	16.0%	25%	9%	1.56
Spain	8.7%	20%	11.3%	2.30
Sweden	39.8%	49%	9.2%	1.23
UK	1.3%	15%	13.7%	11.54

⁹ Commission of the European Communities, 'Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources', January 2008, annex 1.

It can be seen from Table 1 that with the exception of Malta and Luxembourg, the UK is faced with by far the greatest challenge in reaching its 2020 target. Because the share of renewables was only 1.3 per cent in 2005 (the lowest with the exception of Malta and Luxembourg) it will have to increase its renewables share by over eleven-fold by 2020. By contrast several EU countries are already well-placed, including Austria, Finland, Sweden and many of the central and eastern European countries.

The UK faces an insuperable task in hitting its targets.¹⁰ But, nevertheless, the Government is making an effort, and in doing so, placing a very large part of the burden of adjustment on the electricity sector because it is an easy regulatory target. BERR has estimated that in order to meet the EU renewables target 32 per cent of the electricity supplied (approximately 110 TWh) will have to come from renewables. The UK currently has about 4.5 per cent.¹¹ There is, therefore, a need for a dramatic increase in renewables electricity generating capacity. The Severn Barrage could provide about 17 TWh which, provided it started before 2020, would count towards meeting the 2020 target.¹² But even if the Severn Barrage went ahead, most (over 90 TWh) of renewables-sourced electricity would have to be generated by other means – mainly by wind.

It should be noted that electricity generated by both the Severn barrage and wind are (would be) intermittent sources of supply, requiring conventional power stations in order to provide the back-up.¹³ If this is not done, the country would be particularly vulnerable to power failures. The costs of, firstly, installing the renewables capacity and, secondly, maintaining full back-up conventional capacity will inevitably be very substantial indeed.

BERR launched the consultation exercise on the UK's renewable energy strategy in June 2008,¹⁴ the results of which will inform a policy document due in spring 2009. Prime Minister Gordon Brown announced, also in June 2008, that an estimated £100bn would be spent up to 2020 converting to a low carbon economy involving a 10-fold increase in power generation from renewable sources. It would mean 7,000 more wind turbines being built by 2020 across the countryside and around the coastline.¹⁵ It is widely accepted that this number of turbines cannot be built in time, given the construction capacity restrictions and tight timetable.¹⁶ But, even if the turbines were to be built, they would not provide sufficient electricity to enable Britain to meet its 2020 renewables target.

¹⁰ See, for example, Renewable Energy Foundation, 'Response to the Renewable Energy Strategy Consultation 2008', September 2008, available from www.ref.org.uk.

¹¹ Source: www.berr.gov.uk.

¹² See, for example, the Sustainable Development Commission's website, www.sd-commission.org.uk.

¹³ Paul Golby, Chief Executive of E.ON UK, has said that this back-up capacity would have to amount to 90% of the capacity of the wind turbines, if supplies were to be reliable.

¹⁴ BERR 'Renewable Energy Strategy Consultation', June 2008, available from www.berr.gov.uk. The closing date was 26 September 2008

¹⁵ Fiona Harvey, 'Brown unveils £100bn green vision', *Financial Times*, 27 June 2008

¹⁶ John Vidal, 'UK wind farm plans on brink of failure', *Observer*, 19 October 2008

The Pöyry study: introduction

In March 2008, Pöyry Energy Consulting completed a report for BERR on the compliance costs of meeting the 20 per cent renewable energy target in 2020.¹⁷ They developed two scenarios for the EU as a whole:

- The central case least-cost trading scenario. This assumes that a market for trading renewable certificates will develop (using the Guarantees of Origin (GoOs) as permits), enabling the most efficient deployment of renewable resources to be achieved throughout the EU.
- A domestic-constrained scenario. This assumes that no market for trading permits has developed and, therefore, Member States will have to meet their targets solely through domestic resources.

The study was necessarily constrained by the time the consultants were given to complete the study. Some key assumptions and limitations should be noted:

- Key additional costs likely to be incurred by major investment in renewable energy projects were not estimated. These included for example additional network investment, possible reinforcement costs for heat and electricity grids and any hidden costs affecting demand-side take-up.
- In addition, the total “balancing costs”, associated with the mechanism for balancing supply and demand of electricity, were probably underestimated.
- The “lifetime costs” estimates did not account for any additional costs needed for maintaining the EU’s 20 per cent target position after 2020.

For the UK, Pöyry assumed that renewables would be around 5 per cent of final energy consumption by 2020 from the current 2 per cent (under) on BAU (business as usual) projections, i.e. if there were no major change in policy.

¹⁷ Pöyry Energy Consulting, *Compliance costs for meeting the 20% renewable energy target in 2020: a report to the Department for Business, Enterprise and Regulatory Reform (BERR)*, March 2008, available from www.berr.gov.uk; The Pöyry study, using best information at the time, used “final energy demand (fed)” data in their calculations rather than “final energy consumption (fec)”. The difference being “fed” excludes energy branch consumption whilst the EU’s definition of “fec” includes energy branch consumption.

The Pöyry study: results

The main cost estimates are shown in the table below.

Table 2: Compliance costs* of meeting the 2020 renewables target

	Annual cost in 2020		Lifetime costs, up to 2020	
	Least-cost**	Domestic-constrained	Least-cost**	Domestic-constrained
EU, total (€bn)	18.8	25.6	259.0	351.7
EU, total (£bn)	14.5	19.7	199.2	270.5
UK, total (€bn)	5.0	6.7	59.0	93.1
UK, total (£bn)	3.8	5.2	45.4	71.6
UK, cost per household (£)	152	208	1,816	2,864
Breakdown of UK total costs:				
(i) extra renewables resources	2.6	6.7	23.1	93.1
(i/a) for electricity & heating	0.9	5.0	12.1	69.3
(i/b) for transport	1.7	1.7	23.9	23.9
(ii) permits	2.5	0	36.0	0

* Costs are discounted back to 2006.

** Under the least-cost scenario, the UK would meet its 15% compliance target for 2020 by 2 means: (i) by increasing renewables capacity (which would account for 10.4% of the 15%) and (ii) by buying permits (which would account for the remaining 4.6% of the 15%).

(i) Least-cost solution

For the least-cost scenario, Pöyry estimated that the annual cost for the whole of the EU of meeting the 20% target in 2020 would be €18.8bn and the “lifetime costs” up to 2020 would be €259bn.

The equivalent costs borne by the UK were €5.0bn (£3.8bn at €1.3 per £) and €59bn (£4.5bn). Pöyry calculated that under the least-cost option the UK, in order to meet its 15% target, would aim for a combination of investing in domestic renewable sources (costing €2.6bn) and supplementing domestic production through trading permits with countries that would be better positioned (costing a further €2.5bn). Other countries that would need to purchase permits included Germany, the Netherlands, Belgium, France and Romania, whilst Pöyry’s modelling suggests there will be a concentration of surplus permits among a few countries – namely, Italy, Spain, Finland, Austria and Poland.

Under this scenario the UK would face around 20-25% of the total EU costs. The cost to the UK would be relatively high, because of the lack of access to

cheap biomass resource in the electricity and heat sectors and greater reliance on higher cost, expensive electricity technologies such as wind and wave/tidal. (See table 1, in annex 1 for the EU's and the UK's possible mix of renewables.)

In 2020 the annual cost would be around £150 per UK household and the lifetime costs up to 2020 would be over £1,800 per UK household – half of which would be for permits purchased from other EU Member States.

(ii) Domestic-constrained scenario

In the domestic-constrained scenario, where there would be no trading in renewable certificates, the costs rise for the EU as a whole, and especially for the UK. For this scenario Pöyry estimated that the annual cost in 2020 for the whole EU would be €25.6bn and the "lifetime costs" up to 2020 would be €351.7bn. For the UK the equivalent data would be €6.7bn (£5.15bn, 34% higher than in the least-cost case) and €93.1bn (£71.6bn, nearly 58% higher).

Even though the notion of paying other EU Member States for permits may prove unpalatable to the British people, this alternative, domestically-constrained, scenario would be even worse for the UK. If no market in renewable certificate trading developed, then the UK would be required to comply through domestic action. In these circumstances, the UK would have to meet the target through the use of more expensive domestic technologies, which would be more costly for the UK and less efficient for the EU as a whole. The UK would be especially vulnerable as it has no cheap biomass resource, with adverse implications for the balance of payments, and would be relying on vulnerable and expensive wind technology.

In 2020 the annual cost would be over £200 per UK household, and the lifetime costs up to 2020 would be over £2,800 for each UK household.

The Pöyry study: implications for the UK

There are major social and economic implications of these higher costs and all the more so because they may be far too conservative.

Firstly, the costs to the domestic sector will inevitably rise as producers pass on the higher costs to the consumers (as indeed they do already with the Renewables Obligation). It is quite clear that the recent rapid increases in utility prices have undermined people's living standards and increased fuel poverty.¹⁸ The EU's renewables policy and the British Government's reliance on wind-power can only exacerbate the situation further. Moreover, the increased costs are socially regressive.

¹⁸ The common definition of a fuel poor household is one needing to spend in excess of 10% of household income to achieve a satisfactory heating regime (21° in the living room and 18° in the other occupied rooms).

Secondly, as already touched on in the introduction, industry, especially industries such as the chemicals industry which are large consumers of electricity, will become increasingly uncompetitive and businesses will simply continue to relocate to cheaper, less regulated countries such as China and India. If the Government is considering reversing some of the decline in Britain's manufacturing base, as it is apparently, then increasing energy costs will be particularly unhelpful. In addition, Britain's balance of payments is already heavily in deficit. With the prospect of importing biomass (or electricity directly from France if faced with a chronic lack of electricity supply), they can only worsen.

On a connected point, the Government's reliance on heavy investment in subsidised wind-power can only distort investment decisions away from the less costly to the more costly sources of electricity generation. These sub-optimal investment decisions are undermining the country's competitiveness even further.

BERR'S Impact Assessments (June 2008)

BERR published the Impact Assessments (including estimates of the likely costs and benefits) of the UK's Renewable Energy Strategy on 1 June 2008.¹⁹ BERR calculated the costs and benefits for 3 overall scenarios:

- Scenario A: burden share of target 15 per cent renewable energy in 2020 through domestic deployment: 32 per cent in electricity, 14 per cent in heat, 10 per cent in transport.
- Scenario B: 14.5 per cent renewable energy in 2020 through domestic deployment: 32 per cent electricity, 14 per cent heat, 8 per cent transport and 0.5 per cent trading.
- Scenario C: 11 per cent renewable energy in 2020 through domestic deployment: 28 per cent electricity, 11 per cent heat, 5 per cent transport and 4 per cent trading.

Total costs and benefits on 3 scenarios, cumulative to 2030 (over 20 years), 2008 prices, net present value (NPV) basis

	Total cost	Total benefit	Net benefit range	Net benefit (best estimate)
Scenario A	£67 billion	£5.6 billion	-£56bn to -£66bn	-£61 billion
Scenario B	£65 billion	£6.3 billion	-£54bn to -£64bn	-£59 billion
Scenario C	£37 billion	£8.9 billion	-£28bn to -£29bn	-£28 billion

¹⁹ Available from BERR: <http://www.berr.gov.uk/consultations/page46797.html>; BERR's key monetized costs were the resource costs (net of cost of carbon in the traded sector), including grid reinforcement and transmission and distribution costs and cost of overcoming barriers to renewable heat. The key monetized benefits were the monetized carbon benefits from the replacement of fossil fuels in electricity generation, heating and transport; BERR also calculated Impact Assessments for electricity, heat and transport separately. The data are shown in table 5 in annex 1.

It is clear even from these BERR data that the costs of the UK's Renewable Energy Strategy are going to be considerable and the benefits nugatory. *Scenario A suggests average net costs of £3bn a year at 2008 prices – or £120 per household. Even Scenario C, the least costly, would still cost nearly £55 per household each year.*

House of Lords Report: BERR estimates of costs

The recent House of Lords Report, 'The EU's Target for Renewable Energy: 20% by 2020',²⁰ included some estimates of the costs to both domestic and industrial users of the costs of meeting the 2020 renewables target. The estimates, which were provided by BERR, included the following data.

Table 3: Impact on annual electricity prices and bills resulting from measures to achieve 32% renewable energy

32% renewable electricity: central fossil fuel prices	Domestic prices (annual bills)	Industrial prices (annual bills, £000s)
2010-2014	-1 to 4% (-£3 to £13)	-1 to 4% (-£4 to £19)
2015-2019	1 to 5% (£3 to £19)	1 to 6% (£4 to £28)
2020-2024	9 to 15% (£32 to £53)	10 to 16% (£46 to £78)
2025-2029	10 to 14% (£33 to £48)	11 to 16% (£48 to £70)
2010-2030	6 to 9% (£20 to £33)	6 to 11% (£29 to £48)

Source: House of Lords Report, Appendix 7. Note "central fossil fuel prices" are in line with \$70pb.

These data provide yet further confirmation, if such is required, that policies to increase renewable energy development will add to energy prices and bills. By the 10-year period 2020-2029, electricity prices will be up to 14-15% higher for domestic users and up to 16% higher for industrial users. These increases would be regressive for domestic users and increase "carbon leakage", i.e. the migration of industries overseas to economies which do not bear these "green" costs, thus undermining the country's industrial base.

Open Europe's study

So far in this paper only official studies, or officially authorised studies, have been discussed. There are, however, other analyses. Open Europe recently released a study on the estimated costs of "the Climate Action and Renewable Energy Package" (CAREP).²¹ The initiatives in the package covered not just the Renewable targets, but also the proposed centrally controlled version of the Emissions Trading Scheme (ETS), under which the EU will set a central target for emissions reductions. The study concluded that the UK would be bearing 16 per cent of total EU costs, equivalent to about €11 billion a year. *At the current exchange rate (£/€1.25), this amounts to costs of nearly £9 billion a year – or £360 per household.*

²⁰ House of Lords, Select Committee on the European Union 'The EU's Target for Renewable Energy: 20% by 2020', 27th Report, October 2008

²¹ Open Europe 'The EU Climate Action and Renewable Energy Package: Are we about to be locked into the wrong policy?', October 2008, available from Open Europe's website: www.openeurope.org.uk.

Conclusion

The UK's response to the EU's renewables policy, the Renewable Energy Strategy, is a draconian, costly and futile folly. It will not make one jot of difference to the climate. But it will damage British industry and hurt British households – especially the poorest.

Officially authorised estimates of the costs, which are almost certainly under-estimates comprise:

- The Pöyry study estimated that in 2020 the annual cost would be around £150 to over £200 per UK household. And it estimated that the lifetime costs up to 2020 would be over £1,800 to over £2,800 for each UK household.
- BERR's Impact Assessments estimated that the average annual cost per household could range from £55 to £120, for the 20 years up to 2030.

Annex 1 Data

Table 4: Total renewable energy mix in 2020: EU and the UK: least-cost scenario²²

	EU27, %	UK, %
Electricity:		
Onshore wind	8.5	12.9
Offshore wind	2.1	5.1
Biomass	8.7	9.2
Biowaste	1.2	2.8
Biogas	3.5	7.3
Solar PV	0.1	0
Solar Thermal	0	0
Large hydro	11.6	2.3
Small hydro	2.1	0.3
Geothermal	0.5	0
Wave	0.1	0.1
Tidal Stream	0	0
Heating & cooling:		
Biomass heat non grid	16.3	11.2
Biomass heat grid connected	22.4	10.3
Solar heat	2.9	0.3
Geothermal heat	1.3	0.1
Ground source heat pumps	5.8	13.5
Transport:		
Bioethanol	7.1	11.1
Biodiesel	5.8	13.4

Table 5: Energy consumption: 2006, million tonnes of oil equivalent (Mtoe)²³

	Total, Mtoe
Conversion losses (transformation)	55.2
Distribution losses & energy industry use	19.1
Final energy consumption:	
Industry	32.6
Domestic sector	45.6
Transport	59.8
Services (& agriculture)	19.9
Total final energy consumption	157.8
Total inland primary energy consumption	232.1
Memorandum item:	
Non-energy use	11.8

²² Pöyry Energy Consulting, 'Compliance costs for meeting the 20% renewable energy target in 2020: a report to the Department for Business, Enterprise and Regulatory Reform (BERR)', March 2008, available from www.berr.gov.uk

²³ Table 1.1, BERR and ONS, 'Digest of UK energy statistics (DUKES) 2007', available from www.berr.gov.uk

Table 6: Final energy consumption: 2006, by type of fuel (Mtoe), % of total in brackets²⁴

	Total, Mtoe	As % of total	Total, TWh*
Coal & manufactured fuels	2.6	1.6%	30
Gas	52.8	33.5%	614
Petroleum products	71.0	45.0%	826
Electricity	29.5	18.7%	343
Renewable & waste	1.9	1.2%	22
Total FEC	157.8	100%	1,835

* Calculated by the author, using the conversion factor 1 Mtoe = 11.63TWh

Table 7: Final energy consumption: 2006, conversions to other units of energy

	Kilocalories	Therms	Gigajoules	Watt hours (Wh)
Total UK: 157.8 Mtoes	1,578 trillion kilocalories	62.6 billion therms	6.6 billion GJ	1,835 billion (1.835 trillion (10 ⁹)) KWh
				=1,835 million (1.835 billion) MWh
				=1,835,000 (1.835 million) GWh
				=1,835 terawatt hours TWh
Domestic: 45.6 Mtoes	456 trillion [10 ¹²] kilocalories	18.1 billion [10 ⁹] therms	1.9 billion [10 ⁹] GJ	530 billion KWh
				= 530 million MWh
				= 530,000 GWh
				=530 terawatt hours TWh

Notes: (1) Trillion = 10¹²; Billion = 10⁹

²⁴ BERR, 'UK energy in brief', July 2007, available from www.berr.gov.uk

(2) The following conversions were used for a million tonnes of oil equivalent (Mtoe):

= 10⁷x10⁶ kilocalories =10¹³ kilocalories
= 396.83x10 ⁶ therms
= 41.868 x10 ⁶ gigajoules (GJ)
= 11.63x10 ⁹ kilowatt hours (KWh)
=11.63 x10 ⁶ megawatt hours (MWh)
=11.63x x10 ³ gigawatt hours (GWh)
=11.63 terawatt hours (TWh)

(3) Note also the following conversions:

One tonne of oil equivalent	11,630 kilowatt hours, KWh
One tonne of oil equivalent	41,868,000 kilojoules (KJ)
Watt hours	Joules
1 watt hour (Wh)	3,600 joules (J)
1 kilowatt hour (KWh)	3,600 kilojoules (KJ)
1 megawatt hour (MWh)	3,600 megajoules (MJ)
1 gigawatt hour (GWh)	3,600 gigajoules (GJ)
1 terawatt hour (TWh)	3,600 terajoules (TJ)

Table 8: BERR Impact Assessments: costs and benefits by energy sector, cumulative to 2030 (over 20 years), 2008 prices, net present value (NPV) basis²⁵

	Total cost	Total benefit	Net benefit range	Net benefit (best estimate)
Renewable electricity:				
Package 1: measures to achieve 28% renewable electricity	£25bn	n/a	-£23bn to -£27bn	-£25bn
Package 2: measures to achieve 32% renewable electricity	£36bn	n/a	-£33bn to -£39bn	-£36bn
Package 3: measures to achieve 37% renewable electricity	£44bn	n/a	-£42bn to -£46bn	-£44bn
Package 4: 40p/kwh feed in tariff "deemed" for micro-electricity	£2.3bn	n/a	-£2.3bn	-£2.3bn
Renewable heat:				
Policy option 1: measures to achieve 14% renewable heat	£28bn	£4.8bn	-£17.9bn to -£23.1bn	-£20.5bn
Policy option 2: measures to achieve 11% renewable heat	£10.8bn	£3.3bn	-£5.1bn to -£7.5bn	-£6.3bn
Transport:				
Policy option 1: meeting the target by blending biofuels, so that fuels sold are 10% biofuels by energy content	£11,247m to £6m (sic)	£857m to £1,616m	-£10,390m to +£1,610m	-£10,390 to +£1,610m
Policy option 2: meeting the target through a mix of blending fuel to 10% biofuels by volume & making the difference through sales of E85*	£12,756m to £86m	£943m to £2,005m	-£11,814m to +£1,919m	-£11,814m to +£1,919m
Policy option 1a: blending biofuels, so that fuels sold are 8% biofuels by energy content	£8,009m to £4m (sic)	£610m to £1,136m	-£7,398m to +£1,131m	-£7,398m to +£1,131m
Policy option 1b: blending biofuels, so that fuels sold are 5% biofuels by energy content	£1,199m to £0m (sic)	£91m to £180m	-£1,107m to +£180m	-£1,107m to +£180m

* E85 is an alcohol fuel mixture that typically contains a mixture of up to 85% denatured fuel ethanol and gasoline or other hydrocarbon by volume.

²⁵ BERR, June 2008: <http://www.berr.gov.uk/consultations/page46797.html>.

Annex 2: Timeline: EU and UK policies on climate change and renewables

1997	The EU15 signed up to the Kyoto Protocol on the UN Framework Convention on Climate Change (UNFCCC). It agreed to cut Greenhouse Gas (GHG) emissions, of which carbon dioxide emissions are one of the most significant, by 8% by the 5-year commitment period 2008-2012 (taking annual average emissions over this period) compared with the base year 1990.
1997	EU White Paper, "Energy for the Future: Renewable Sources of Energy 1997", which discussed the importance of promoting electricity from renewable sources of energy for several reasons in addition to combating climate change. These included security and diversification of energy supply, environmental protection, and social and economic development.
2001	The EU Directive on the "Promotion of Electricity from Renewable Energy Sources in the Internal Electricity Market" (2001/77/EC), also known as the "Renewables Directive", included: <ul style="list-style-type: none"> • Member states were required to adopt national targets for renewables that are consistent with reaching the Commission's target of 22% of electricity from renewables by 2010. • The indicative target that the proposal sets for the UK was 10% of electricity by that date. • The directive also required that Member States ensure that a "guarantee of origin" (GoO) was issued on request in respect of electricity generated from eligible renewable energy sources, as defined by the directive.
2002	The Renewables Obligation (RO) introduced in GB.
2003	The Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations 2003 set out the requirements for the issue, transfer and revocation of REGOs in Great Britain. Under the regulations, Ofgem is responsible for issuing GB REGOs.
March 2006	The Government published the Microgeneration Strategy.
March 2007	The EU European Council made commitments: <ul style="list-style-type: none"> • To deliver 20% of EU [primary] energy consumption from renewable sources by 2020. • To deliver a specific 10% transport biofuels obligation.
March 2007	UK Government released the Climate Change Bill, which included: <ul style="list-style-type: none"> • a series of clear targets for reducing carbon dioxide emissions - including making the UK's targets for a 60% reduction by 2050 and a 26 to 32% reduction by 2020 legally binding. • a new system of legally binding five year "carbon budgets", set at least 15 years ahead, to provide clarity on the UK's pathway towards its key targets and increase the certainty that businesses and individuals need to invest in low-carbon technologies.
May 2007	DTI, <i>Meeting the energy challenge: A White Paper on energy</i> , May 2007, TSO.
January 2008	"Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources", also known as a "Renewables Directive", followed on from the March 2007 agreement and included: <ul style="list-style-type: none"> • The share of renewable energy in the EU final energy consumption (fec) reaches at least 20% by 2020. Establishes national overall targets for each member state. A path of compliance is also set with interim targets every 2 years. • The share of energy from renewable sources in transport in 2020 is at least 10% of final energy consumption (fec) in

	<p>transport.</p> <ul style="list-style-type: none"> • Trading of Guarantees of Origin (GoO) is allowed between member states, the trading partners will be the EU27 governments. A country is only allowed to trade its GoOs additional to its interim target, without obligation.
June 2008	BERR launches the consultation on "UK renewable energy strategy", with a closing date of 26 September 2008. It will inform the "UK Renewable Energy Strategy", which is due to be published in spring 2009.
October 2008	EU Summit meeting, at which several of the "new EU" member states and Italy expressed their doubts about the EU's renewables policy.

Annex 3: Glossary

Alternative energy: a term used for some energy source that is an alternative to using fossil fuels. Generally, it indicates energies that are non-traditional (non conventional) and have low environmental impact. The term *alternative* is used to contrast with fossil fuels according to some sources, and some sources may use it interchangeably with renewable energy.

Balancing mechanism: the mechanism the National Grid Company uses to balance the supply and demand of electricity.

Biofuels: liquid or gaseous fuel for transport produced from biomass. They include:

- Biodiesel: produced from vegetable oils or animal fats by mixing them with ethanol or methanol to break the down.
- Bioethanol: created from crops rich in starch or sugar by fermentation, distillation & finally dehydration.

Biomass: products derived from plant or animal matter and includes agricultural, forestry wastes/residues and energy crops. It can be used for fuel directly by burning or extraction of combustible oils.

British Electricity & Transmission Arrangements (BETTA): arrangements agreed to create a single wholesale electricity market for Great Britain.

Business as usual (BAU): term used in scenario building to denote broadly unchanged policy.

Capacity credit: the capacity credit of wind power expresses how much "conventional" power can be avoided or replaced by wind power.

Climate change levy (CCL): A levy applied to the energy use of all non-domestic sectors, subject to certain exemptions and reductions to encourage energy efficiency.

Climate Change Bill: was released in March 2007. The aims include:

- A series of clear targets for reducing carbon dioxide emissions - including making the UK's targets for a 60 per cent reduction by 2050 and a 26 to 32 per cent reduction by 2020 legally binding.
- A new system of legally binding five year "carbon budgets", set at least 15 years ahead, to provide clarity on the UK's pathway towards its key targets and increase the certainty that businesses and individuals need to invest in low-carbon technologies.

Combined Heat and Power (CHP): is the simultaneous generation of usable heat and power (usually electricity) in a single process.

Conventional (traditional) energy sources: other than renewable energy (RE) sources.

Department of Business, Enterprise and Regulatory Reform (BERR): the former DTI.

Emissions Trading Scheme (EU ETS): this EU scheme began in 2005 and involves the trading of emissions allowances as means of reducing emissions by a fixed amount.

EU Renewables Directive (2001): see timeline.

EU Renewables Directive (draft 2008): see timeline.

Final Energy Consumption (FEC): the BERR defines as energy consumption by final users: industry, domestic, transport and services & agriculture. It excludes non-energy uses of energy sources. However, the 2008 draft Renewables Directive states: " 'final consumption of energy' means the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry & fisheries, including the consumption of electricity & heat by the energy branch for electricity & heat production and including losses of electricity & heat in distribution."

Fossil fuels: Coal, natural gas & fuels derived from crude oil (for example petrol and diesel) are called fossil fuels because they have been formed over long periods of time from ancient organic matter.

Fuel cells: produce electricity from hydrogen and air, with water as the only emission. Potential applications include stationary power generation, transport (replacing the internal combustion engine (ICE)) and portable power (replacing batteries in mobile phones).

Fuel poverty: the common definition of a fuel poor household is one needing to spend in excess of 10 per cent of household income to achieve a satisfactory heating regime (21° in the living room and 18° in the other occupied rooms)

Gigajoule: see joule.

Gigawatt and gigawatt hour: see watt and watt hour.

Guarantee of origin (GoO): an electronic document which has the function of providing proof that a given quantity of energy was produced from renewable sources, introduced under the 2001 EU Renewables Directive. They are known as Renewable Energy Guarantees of Origin (REGOs) in GB. Under the 2008 draft Directive on renewables, trading of Guarantees of Origin (GoO) will be allowed between member states and the trading partners will be the EU27 governments.

Joule: a generic unit of energy, equal to the energy dissipated by an electrical current of 1 ampere driven by 1 volt for 1 second.

- Kilojoule (KJ) = 10^3 joules
- Megajoule (MJ) = 10^6 joules
- Gigajoule (GJ) = 10^9 joules
- Terajoule (TJ) = 10^{12} joules

Kilojoule: see joule.

Kilowatt and kilowatt hour: see watt and watt hour.

Load factor: is the actual amount of, say, kilowatt hours (KWh) delivered on a system in a designated period of time as opposed to the total possible kilowatt hours that could be delivered on a system in a designated period of time.

Megajoule: see joule.

Megawatt and megawatt hour: see also watt and watt hour. A 1 MW (megawatt) power-generating unit running for 1 hour produces 1 megawatt hour (MWh) of electrical energy. MWe is used to emphasise when electricity is being measured and MWt is used when heat ("thermal") is being measured.

Microgeneration: is the generation of zero or low-carbon heat and power by individuals, small businesses and communities to meet their own needs. The Government published the Microgeneration Strategy in March 2006. The aim was to create conditions under which microgenerators become a realistic alternative or supplementary energy source.

Million tonnes of oil equivalent (Mtoe): see tonnes of oil equivalent (toe).

New Electricity Trading Arrangements (NETA): replaced the "pool" in England and Wales in 2001. The arrangements are based on bilateral trading

between generators, suppliers, traders and customers and are designed to be more efficient, and to provide greater choice for market participants.

Non-energy use (of energy sources): includes fuel used for chemical feedstock, solvents, lubricants and road making material.

Non-Fossil Fuel Obligation (NFFO): before the introduction of the Renewables Obligation (RO), the NFFO was the Government's major instrument for encouraging growth within the renewable energy industry. The NFFO applied in England and Wales. In Scotland and Northern Ireland, the Renewables Obligation (Scotland) (ROS) or the Northern Ireland NFFO (NI-NFFO) applied. The NFFO assisted the industry by providing premium payments for renewables-generated electricity over a fixed period, with contracts being awarded to individual generators.

Photovoltaics (PV): the direct conversion of solar radiation into electricity by the interaction of light with the electrons in a semiconductor device or cell.

Plant capacity: the maximum power available from a power station at a point in time.

Plant loads, demands and efficiency: measures of how intensively and efficiently power stations are being used. The plant load factor is the average hourly quantity of electricity supplied during the year, expressed as a percentage of the average output capability at the beginning and the end of the year.

Primary energy consumption (PEC): equals final energy consumption (BERR definition) plus conversion and distribution losses and energy industry use. Non-energy use of energy sources is excluded – though they are included in primary demand (BERR).

Primary fuels: fuels obtained directly from natural sources of energy. For example, coal, oil and natural gas.

Renewable energy (RE): is the term used to describe energy flows that occur naturally and continuously in the environment, such as energy from the wind, waves or tides. The origin of the majority of these sources can be traced back to either the sun (energy from the sun helps to drive the earth's weather patterns) or the gravitational effects of the sun and the moon. This means that these sources are essentially inexhaustible.

Renewable energy (RE) sources: includes solar power, wind, wave and tide, and hydroelectricity. Solid renewable energy sources consist of wood, straw, short rotation coppice, other biomass and biodegradable fraction of wastes. Gaseous renewables consist of landfill gas and sewage gas. Non-biodegradable wastes are not counted as a renewables source. They can be classified under three types of resources:

- Electricity.

- Heat (thermal).
- Transport.

Renewable Energy Guarantees of Origin (REGOs): introduced in 2003 in GB in response to the 2001 EU Renewables Directive, they are electronic certificates attaching to electricity produced from renewable sources.

Renewable energy obligation: a national support scheme requiring energy producers to include a given proportion of energy from renewable sources in their production, requiring energy suppliers to include a given proportion of energy from renewable sources in their supply or requiring energy consumers to include a given proportion of energy from renewable sources in their consumption.

The Renewables Obligation (RO): is the obligation placed on licensed electricity suppliers to deliver a specified amount of their electricity from eligible renewable sources. It is designed to incentivise the generation of electricity from eligible renewable sources in the United Kingdom. It was introduced in England & Wales and in a different form (the Renewables Obligation (Scotland)) in Scotland in April 2002 and in Northern Ireland in April 2005. The RO places an obligation on licensed electricity suppliers in the United Kingdom to source an increasing proportion of electricity from renewable sources. This figure was initially set at 3 per cent for the period 2002/03 and under current political commitments will rise to 10.4 per cent by the period 2011-12, then by 1 per cent annually for the five years following. Suppliers meet their obligations by presenting Renewables Obligation Certificates (ROCs).

Renewable Obligation Certificates (ROCs): eligible renewable generators receive ROCs for each MWh of electricity generated. These certificates can then be sold to suppliers. In order to fulfil their obligation, suppliers can either present enough certificates to cover the required percentage of their output, or they can pay a "buy-out" price for any shortfall. The cost of ROCs is effectively paid by all electricity consumers, since electricity suppliers pass this cost on as an increase in the tariff for the electricity they sell.

Reserves: with oil and gas these relate to the quantities identified as being present in underground cavities. The actual amounts that can be recovered, and considered economically worthwhile to recover, depend on the level of technology available and existing economic situations. These continually change - hence the level of the UK's reserves can change quite independently of whether or not new reserves have been identified.

Secondary fuels: fuels derived from natural sources of energy. For example, electricity generated from burning coal, gas or oil is a secondary fuel, as are coke and coke oven gas.

Terajoule: see joule.

Terawatt and terawatt hour: see watt and watt hour.

Therm: common unit of measurement of energy.

Thermal efficiency: of a power station is the efficiency with which heat energy contained in fuel is converted into electrical energy.

Thermal sources of electricity: these include coal, oil, natural gas, nuclear, landfill gas, sewage gas, municipal solid waste, farm waste, tyres, poultry litter, short rotation coppice, straw, coke oven gas, blast furnace gas, waste products from chemical processes.

Tonne of oil equivalent (toe): common unit of measurement for energy. Million tonnes of oil equivalent (Mtoe) measure is frequently used.

Transport biofuels obligation: the 2008 draft Renewables Directive also contains a specific 10 per cent target for transport biofuels obligation in addition to a 20 per cent for total renewables.

Watt (W): a unit of electrical power, the conventional unit to measure a rate of flow of energy. One watt amounts to 1 joule per second.

- Kilowatt (KW) = 10^3 watts
- Megawatt (MW) = 10^6 watts
- Gigawatt (GW) = 10^9 watts
- Terawatt (TW) = 10^{12} watts

Watt hour (Wh): The watt hour is a measure of work, the watt is a measure of power. The amount of wattage times the amount of time is the amount of work done. It is not used in the International System of Units (SI). The SI unit of energy is the joule (J), equal to one watt second. The kilowatt hour is commonly used, though, especially for measuring electric energy. One watt hour is equivalent to 3,600 joules (there being 3,600 seconds in an hour).

- Kilowatt hour (KWh) = 10^3 watt hours
- Megawatt hour (MWh) = 10^6 watt hours
- Gigawatt hour (GWh) = 10^9 watt hours
- Terawatt hour (TWh) = 10^{12} watt hours