UKERC

UK ENERGY RESEARCH CENTRE

UKERC response to the Internal Market Sub-Committee (Sub-Committee B) of the House of Lords Select Committee on the European Union inquiry into the EU's 20% renewable energy target

April 2008

Dr Jeff Hardy
UK Energy Research Centre
58 Prince's Gate
Exhibition Road
London
SW7 2PG

Tel: +44 (0) 207 594 1572
Email: jeff.hardy@ukerc.ac.uk
www.ukerc.ac.uk

Professor David Infield
Institute of Energy and Environment
University of Strathclyde

THE UK ENERGY RESEARCH CENTRE

The UK Energy Research Centre (UKERC) was established in 2004 following a recommendation from the 2002 review of energy initiated by Sir David King, the UK Government's Chief Scientific Advisor.

The UK Energy Research Centre's mission is to be the UK's pre-eminent centre of research, and source of authoritative information and leadership, on sustainable energy systems.

UKERC undertakes world-class research addressing the whole-systems aspects of energy supply and use while developing and maintaining the means to enable cohesive research in energy.

To achieve this we are establishing a comprehensive database of energy research, development and demonstration competences in the UK. We will also act as the portal for the UK energy research community to and from both UK stakeholders and the international energy research community.

We are funded by three research councils: the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC) and the Economic and Social Research Council (ESRC).

For more detail, go to www.ukerc.ac.uk

Summary

To meet the EU 15% renewable energy target will be a significant challenge for the UK. It is important to understand that reductions in the UK's total energy demand will produce proportional reductions in the renewable contribution required. Although self-evident, this simple fact is often overlooked. Indeed the UK has to date failed to achieve any reductions in energy use, in fact the reverse is true: energy consumption in the key sectors of electricity and energy for transport continues to rise steadily.

In addition to reducing the demand for energy, there will need to be a massive increase in the contribution of renewables to transport fuel (predominately biofuels), heat and electricity. This submission concentrates on renewable electricity because UKERC has core competency this area. In Table 1, below, UKERC presents an illustrative scenario for the contribution of renewable electricity technologies towards the 2020 target. In this scenario 41% of UK electricity will need to be generated by renewables, most likely dominated by wind power (28%) and biomass (7%). This will be extremely challenging both in terms of renewable energy generation plant installation rates and the world capacity to build and deliver the technology, and also in terms of integration issues. Immediate and wide scale mobilisation of resources (human and otherwise) is required.

Table 1: An illustrative 2020 scenario for the contribution of various renewable technologies towards UK electricity generation[1]

Technology	2006				2020			
	MW	GWh	LF %	% Elec	MW	GWh	LF %	% Elec
Onshore wind	1,651	3,574	25%	0.9%	20,000	52,560	30%	13.1%
Offshore wind	304	651	24%	0.2%	20,000	61,320	35%	15.3%
Wave[2]	1	-	0%	0.0%	1,000	2,978	34%	0.7%
Tidal	-	-	0%	0.0%	1,000	3,679	42%	0.9%
PV[3]	10	7	8%	0.0%	571	1,000	20%	0.2%
Hydro[4]	1,522	4,605	35%	1.1%	1,522	4,606	35%	1.1%
Biomass[5]	1,837	9,946	62%	2.5%	5,350	28,120	60%	7.0%
Severn[6]	-	-	0%	0.0%	5,000	10,950	25%	2.7%
TOTAL	**5,324**	**18,783**	**40%**	**4.7%**	**54,443**	**165,214**	**35%**	**41.1%**

[1] Following assumptions used to calculate contributions. Energy consumption based on BERR 2006 figures. 2020 energy consumption scenario assumes that electricity and transport consumption remain flat and that heat is reduced by 20% because of demand reduction measures. This scenario is for example only and should not be construed as UKERC policy.
[2] UKERC Ocean Energy roadmap - http://ukerc.rl.ac.uk/ERR0303.html
[3] UKERC Solar Energy roadmap - http://ukerc.rl.ac.uk/ERR0301.html
[4] Assume 2020 hydro energy remains same as 2006
[5] Defra UK Biomass Strategy - http://www.defra.gov.uk/environment/climatechange/uk/energy/renewablefuel/index.htm
[6] 2020 figure based on estimate – not to be taken as UKERC policy

UKERC response

The UK Energy Research Centre welcomes this opportunity to provide input to the Internal Market Sub-Committee (Sub-Committee B) of the House of Lords Select Committee on the European Union inquiry into the EU's 20% renewable energy target. This response from UKERC focuses mainly on addressing question (i) in the inquiry with a focus on the UK's national 15% renewable energy target and in particular with a focus on the contribution of renewable electricity. There are additional comments on infrastructure and demand reduction that may be of interest to the Committee.

It should also be noted that in addition to this submission several UKERC representatives have been invited to provide oral evidence to the Committee. Robert Gross, Head of the UKERC's Technology and Policy assessment function, is acting as special advisor to the Committee.

Introduction

The focus of this inquiry is on 2020, but it is important to place the illustrative scenario presented in this submission in the context of longer term developments in the UK energy sector. Beyond 2020 it is possible that electricity will play a greater role in the transport sector (for example through plug-in hybrid electric and electric vehicles) and for heating (through heat pumps, ventilation heat recovery and electric heating). This would have knock-on effects on energy demand and as a consequence it is important that the mix of electricity generation technologies in terms of carbon emissions, cost and security remains effective in the long-term to meet these targets.

It is clear that the brunt of contribution to the UK's 2020 target of 15% of primary energy will fall to renewable electricity generation.

If it is assumed that 10% of the UK's transport fuels will be of renewable origin in line with the draft directive, then the proportion that needs to come from electricity will depend on the renewable heat contribution. It is important here to also recognise the potential for demand reduction measures. Heat demand, in particular, has the potential to be significantly reduced through a number of measures and an aggressive policy framework. In the scenario summarised in Table 1 we have assumed, perhaps optimistically, that heat demand in 2020 will be reduced by 20% compared to 2006.

In theory a substantial proportion of UK heat could come from a combination of domestic solar water heating, sustainable wood heating and other energy crops, plus the allowable contribution from heat pumps.

To give a feel for possible renewable heat consider an extreme case where 20 million households (the majority of the UK housing stock) are fitted with solar water heating. Each system would contribute around 2000kWh per year or 50% of domestic hot water, thereby contributing about 5% of national heat requirements. In this context and with policies to deliver such change, a 10% target for renewable heat is feasible.

Table 1 presents an illustrative scenario demonstrating the contribution of electricity towards the 2020 EU renewables target. In this scenario it is optimistically assumed that in 2020 demand for electricity and transport fuel remains flat at 2006 levels and that demand for heat is reduced by 20% based on 2006 levels. Assuming that 10% of the supply of transport fuels and heat is derived from renewable resources by 2020, the proportion of electricity required to meet the overall UK target for renewable energy of 15% can be estimated (assuming no significant changes to conventional plant efficiency). The result is that 41.1%[7] of electricity must come from renewable sources. For comparison currently just over 4% of the UK electricity (and 1.3% of total energy) is derived from renewable resources. Let us now consider the different renewable electricity technologies and their potential to contribute to the UK 2020 target.

Wind energy is the most developed of the technologies. Given the excellent UK wind resource, installation rates have been disappointing with only 2 GW currently installed (including 0.3 GW offshore) – accounting for around 2% of UK electricity[8]. On a positive note there is currently around 8 GW of wind capacity in the planning system. Although unlikely, if all of this was consented, and built, it would be able to

---

[7] If the contribution of renewable heat towards total heat is increased by 5% (e.g. to 15%) then the contribution of renewable electricity towards total electricity is decreased by approximately 10% and vice versa for a decrease in the contribution of renewable heat.
[8] http://stats.berr.gov.uk/energystats/dukes7_4.xls

generate an additional 7% of UK electricity bringing the total to 9%, and in principle this could be achieved within a few years. This leaves around a decade to install an additional 30 GW, assuming that there is sufficient space and wind resource to do so, which is enough to generate, in total, 28.4% of UK electricity. We understand that UK policy anticipates that the majority of this capacity will be sited off-shore (up to 20 GW in 2020), with presumably the remainder on-shore. At around 3 GW per annum this represents an order of magnitude increase on current UK installation rates (0.24 GW per year averaged over the last five years). Germany has achieved an installation rate of 2.5 GW per year averaged over 5 years between 2000 and 2005[9] (IEA data). Globally, over the same period around 7 GW of wind power was installed per year on average, possibly indicating global wind turbine production capacity. Since the UK is not the only country with ambitious plans for wind energy deployment meeting its ambitions are contingent upon the capability of world companies to expand their wind turbine manufacturing capacity to meet this demand.

Wave energy The UK has the best wave energy resource in the EU, with 50TWh/year offshore (equivalent to 15% of UK electricity demand), 7.8TWh/year in nearshore waters and 0.2TWh/year on the shoreline. However, currently LIMPET, a shoreline device on Islay (operating since 2000), is the only UK device supplying electricity to the grid.

The European Marine Energy Centre (EMEC) opened in 2004, provides test facilities for offshore testing. The Pelamis device was the first to be tested at EMEC, and Pelamis Wave Power (PWP)[10] are currently installing 3 devices (2.25MW) off the coast of Portugal - the first offshore wave farm. PWP also have consents and funding for a farm off the coast of Orkney (3MW), and are planning a 5MW farm at in the South West of England in the WAVEHUB project[11]. Wavegen[12], the developers of LIMPET, are currently installing a harbour wall device at Mutriku in Spain. In addition there are a number of other developers with funding for sea trials in the next 12-18 months: Aquamarine[13], AWS Ocean[14], Ocean Power Technologies[15], &

[9] IEA data from Economic and Social data service
[10] http://www.pelamiswave.com/
[11] http://www.wavehub.co.uk/
[12] http://www.wavegen.co.uk/
[13] http://www.aquamarinepower.com/
[14] http://www.awsocean.com/technology.html
[15] http://www.oceanpowertechnologies.com/index.htm

Wavedragon[16]. Wave energy is very much an emerging technology, with deployment at the MW level. Its development pathway is approximately 15 years behind that of wind power.

It is estimated that 1GW of both wave and tidal current energy could be installed by 2020 in UK waters (see UKERC's Marine Technology Roadmap[17]). This would require a rapid increase in deployment from 2012 onwards. A deployment of 1GW of wave energy by 2020 in the UK would translate to 0.8% of the UK's total electricity. The Carbon Trust predicts that there could be between 1-2.5GW of wave energy in European waters by 2020. There is a lot of activity and planned deployments in the UK, but it will be challenging to meet the Carbon Trust/UKERC 2020 predictions.

Tidal current The Carbon Trust estimate that the UK tidal current resource is 18TWh/year, equivalent to 5% of UK's electricity demand and about 10-15% of the total world tidal current resource. The technologies for tidal current generation show less variation than for wave energy generation, in which every device operates on very different principles. Hence, it could be argued that the technology is nearer to market. Marine Current Turbines (MCT)[18] is the only UK developer to have successfully demonstrated tidal current turbine technology and have been operating a 300kW device off the north coast of Devon since 2003. They have also recently installed the first commercial device (the Seagen project) in Northern Ireland which is rated at 1.2MW. MCT also plan a 10.5MW tidal current farm at the Skerries between the Welsh mainland and Anglesey, which could be installed as early as 2011. A full scale tidal current test site has been established at EMEC, with Open Hydro, an Irish developer, testing a 300kW grid connected device.

Like wave energy, tidal current energy is an emerging technology, with deployments at the MW level, but has the potential to make a significant contribution to the UK's renewable energy targets. It is estimated that 1GW of tidal current energy could be installed by 2020 in UK waters (see UKERC's Marine Technology Roadmap[19]). A deployment of 1GW of wave energy by 2020 in the UK would translate to 0.9% of

---

[16] http://www.wavedragon.net/
[17] http://ukerc.rl.ac.uk/ERR0303.html
[18] http://www.marineturbines.com/
[19] http://ukerc.rl.ac.uk/ERR0303.html

the UK's total electricity. The Carbon Trust has predicted that between 1-2.5GW of tidal current could be deployed in European waters by 2020.

Photovoltaics remain expensive but policies in both Japan and Germany have demonstrated that with appropriate market support significant capacity can be installed relatively quickly. Analysis by the PV EU Platform estimates that 3% of EU electricity can be met in this way by 2030, which is considerably less than Germany has already achieved (see UKERC's Solar Energy Road map[20]). In the UKERC scenario a 0.2% contribution (representing a 57 fold increase on current installed capacity) to UK electricity by 2020 has been estimated.

Hydro electricity currently accounts for 1.1% of UK electricity through large (1%) and small scale (0.1%) schemes. The scope for new hydro schemes in the UK is limited because the majority of the resource has already been successfully exploited. For example, the potential for new hydro electricity in Scotland has been estimated to be a maximum of 200MW[21]. In the UKERC scenario it has been assumed that there is no increase in the contribution of hydro electricity from current levels.

Biomass electricity currently accounts for approximately 2%[22] of total UK electricity through a mixture of biomass co-firing at large coal power plants, combined heat and power plants and anaerobic digestion plants. Professor Gail Taylor (UKERC) has estimated that that biomass electricity could account for between 7% of UK electricity demand by 2020[23].

The Severn estuary barrage is currently undergoing a two year feasibility study to assess the cost and environmental impact of the proposed scheme. It is uncertain whether the barrage will be completed by 2020 and what contribution it will make to UK electricity generation. In this response we have optimistically assumed that an 8 GW barrage will be partly completed by 2020 and at time able to generate up to 5GW, and thereby providing 2.8% of the UK's total electricity. Of course if the Severn barrage is not contributing, for whatever reason, then the onus will be on an alternative renewable technology to take up the slack.

---

[20] http://ukerc.rl.ac.uk/ERR0301.html

[21] Forum for Renewable Energy Development in Scotland: Scotland's Renewable Energy Potential: Realising the 2020 Target - Future Generation Group Report - http://www.scotland.gov.uk/Publications/2005/09/09144010/40120#15

[22] http://stats.berr.gov.uk/energystats/dukes7_4.xls

[23] Professor Gail Taylor, Bioenergy for heat and electricity in the UK - a paper for the Office of Science and Innovation (in preparation)

Integration issues will become significant as renewable energy electricity penetration levels in the UK move beyond 20% of electrical energy. There are a number of key issues associated with integration of 40% renewable electricity, including:

- Connection charges and transmission charges;
- Planning permission;
- New distribution lines and reinforcing existing lines;
- Integrating renewable resources that produce heat and electricity – for example biomass CHP – so that both outputs are used effectively and efficiently; and
- System management and stability.

Research into these issues is underway but has not yet progressed to a sufficient level to give confidence as to the technical and commercial consequences of very high levels of penetration. It is likely that 30-40% of electrical energy from renewables will require major investment in transmission and, possibly, distribution infrastructure, and changes to operational practice.

Energy demand reduction is a mechanism through which the overall size of the EU 15% renewable energy target can be reduced in absolute terms (i.e. you would simply need to install less renewable energy capacity to meet the target). The University of Oxford Environmental Change Institute[24] (ECI) in their report[25] to the Royal Commission on Environmental Pollution (The Urban Environment report) examined the potential for demand reduction from the UK housing sector in 2020 comparing the difference between a business as usual and aggressive policy scenarios with a focus on major carbon emissions reductions.

The findings of this report indicated that an aggressive policy scenario of demand reduction from the UK housing sector could reduce overall UK energy demand by approximately 5%[26]. In the context of the 15% renewable energy target this would

[24] UKERC Demand Reduction theme is based at ECI - http://www.ukerc.ac.uk/ResearchProgrammes/DemandReduction/DemandReductionHomepage.aspx
[25] http://www.rcep.org.uk/urbanenvironment.htm#studies
[26] The difference in 2020 is 93 TWh (about 17%), with 20 TWh of electricity saved in appliances and 73 TWh saved in heat (mainly gas).

reduce the absolute number by the equivalent of about 1%. The potential for demand reduction in the business and transport sectors is approximately the same. Therefore, if aggressive demand reduction policies were applied in the UK housing, business and transport sectors then approximately one fifth of the 15% target might be delivered through energy efficiency.

Concluding remarks

Even with optimistic targets for the installation of renewable energy generation technologies, meeting the UK 2020 15% renewable energy target will be extremely challenging. Demand reduction could potentially reduce the size of the overall effort required, but even with aggressive policies there is a large renewables gap that must be filled. This will be extremely challenging both in terms of renewable energy generation plant installation rates and the world capacity to build and deliver the technology, and also in terms of integration issues. Immediate and wide scale mobilisation of resources (human and otherwise) is required.