BRIEFING NOTES ON LOW CARBON ELECTRICITY

What does the UK's electricity system look like now?

- Electricity generation is one of 3 major players in the UK's energy system, alongside transport & heating.
- Electricity generation uses roughly 30% of the total energy *entering* the system, but because over half the energy from fossil fuels or nuclear is lost as heat electricity accounts for only 20% of all energy *used*.
- Electricity supply and demand must always be balanced in order to prevent power cuts at peak times.
  - Different sources of electricity vary in whether they can respond to variable demand (see below)
- In the preliminary figures for 2012, generation of electricity in the UK broke down by source broadly as:

  Coal 40% - Gas 30% - Nuclear 20% - Renewables 10%
- The 40-30-20-10 proportions are a yearly average, and will fluctuate over timescales as little as a few hours according to factors including weather, season, demand and fuel cost.
  - E.g. 2011 had much higher rainfall and wind speeds than 2010, contributing to a 33% increase in electricity from renewables, and percentages for coal and gas swapped placed from 2011-12.

How low carbon is the UK's electricity?

- More efforts have been made so far to decarbonise electricity than transport and heating; 30% of electricity generation in the UK was not from fossil fuels in 2011, compared to 12.5% of all energy.
- Power stations accounted for just under a third of all UK CO_2 emissions in 2011, but emissions from the electricity supply sector were estimated to be around 24% lower in 2011 than they were in 1990.
  - This reflects a move from coal to gas and an increase in renewable generation.
- The percentage of electricity generation by renewable sources varies widely between countries: Sweden 55%, Denmark and Spain 32%, Italy 26%, France 17%, Germany 14% (2011 figures).

Features of the UK's current largest sources of electricity

(Percentages are rounded from 2011 figures)

Coal and Gas (70%)

Coal is the cheapest, most abundant fossil fuel but with the highest emissions. Gas power stations are the cheapest and quickest to build, and the most responsive to demand. Emissions are less than half those of coal, but still high and carbon capture and storage is not yet commercially viable (see overleaf). There is potential for developing a shale gas industry in the UK, though it is not known how much shale gas exists, and none is extracted at present.

Nuclear (20%)

Very low emissions, cheap to run, there is likely to be sufficient fuel for increased capacity up to 2050 and beyond. However, plants are very pricey to build and take a long time. Recent new nuclear builds in Europe have overrun, and the earliest a new nuclear station could come online is around 2020. Nuclear does not cope well with responding to fluctuating demand, and nor is it likely any technology will remedy this.

Wind (5.5%)

Onshore wind is the dominant, most mature renewable source and is simple and cheap to build, though cannot respond to demand. Wind farms tend to require remote locations so require long distance power lines to be built (though transmission losses are low - under 2% between Scotland and London). Offshore wind is less developed and more expensive, but can be built on a larger scale, generate more consistently than onshore, and the UK has enormous resources. Wind turbines, properly sited, have zero emissions once built and low ecological impact.

Bioenergy (2%)

Includes burning wood, waste and gas from landfill or sewage digestion. Is exchangeable with fossil fuels, and has same advantages if well managed. Emissions can be high or low depending on the fuel source.

Hydroelectric (1.5%)

Most large-scale sites have been exploited and there is limited scope for any substantial new capacity.

What will the UK's electricity system look like in the future?

Solar

Prices of solar panels are dropping while their efficiency is increasing. DECC has estimated that 25-30% of demand could be generated if every south-facing roof in the country had panels. However, it is season and weather dependent, and while there is potential for growth in solar it is unlikely to rapidly increase without significant government incentives.

Marine (wave and tidal)

The UK has good potential for marine power and the predictability of tides is a big advantage, but the technology is expensive to build and in early development. Barrages have the potential for large scale generation - the proposed Severn barrage could generate up to three times the output of a nuclear plant with costs estimated between £10-25billion.

Carbon Capture and Storage (CSS)

CCS technology aims to mitigate emissions from burning fossil fuels, but there is currently none in place in the UK's energy system. While CCS technologies have been proven to work, and the UK has strong R&D capability, they have not been demonstrated on a full scale power plant and their long term reliability is unknown. Also, they would not reduce emissions to zero (CCS installed at a gas plant could reduce CO_2 by up to 85%). All this, plus CCS being very costly to implement, means it is not currently attractive for investment.

Future of electricity consumption

Energy efficiency in homes and businesses will increase, but is likely to be offset by an increase in the use of electricity for transport and heating; most forecasts include much *more* electricity in the UK's energy system.

Smart grids: 'Smart' systems use communication between suppliers and end users to improve the efficiency of the entire system, modifying demand to take pressure off the need for supply at peak times. For example, some domestic appliances (e.g. dishwashers) could wait for a drop in demand before running, and electricity prices could differ depending on the time of day. Smart meters are being rolled out, but we are far from the implementation of a truly responsive smart grid.

Consumer costs: It is very difficult to estimate the impact on customers' bills of a push for low carbon electricity. Today, all forms cost more than existing coal and gas systems if used as slot-in replacements. A future with more nuclear and renewables would have high capital costs but lower or zero fuel costs. Overall it is likely electricity prices will increase, but any specific price claims involve so many untestable assumptions that they must be regarded with extreme caution.

What will the mix of energy sources look like?

In order to achieve the UK's legally-binding emissions targets there will have to be an increase in low carbon generation, whether renewables, nuclear or CCS. According to bodies like DECC and the International Energy Agency, all possible short/medium term scenarios include *some* fossil fuels but with a decrease in emissions.

Diversity or eggs in one basket?

There is general consensus that a diversity of electricity sources makes the system more robust. If one source fails, such as the wind not blowing or an interrupted gas supply, others can compensate. This becomes more of a concern with an increase in renewable sources with variable output.

How will infrastructure have to change?

An increasing amount of new geographical energy sources will mean the current network, centred round a few high output hubs, will become more dispersed and will require new power lines. Furthermore, increased interconnectivity with Europe may help us draw on bigger reserves for when demand outstrips supply.

Storage: There are currently no viable medium to long term options for storage of electricity in the network. One wildcard is storage by electric cars, but such ideas are not yet serious options.

Links to further information:

DECC produce an annual **'Digest of UK energy statistics' (DUKES)** which give a comprehensive picture of the UK's energy system, including chapters on electricity generation and renewables.

https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/digest-of-uk-energy-statistics-dukes

DECC's **RESTATS** website keeps statistical information on renewable energy projects, both for operational performance, and for the progress of projects from inception through to operation.

https://restats.decc.gov.uk/cms/welcome-to-the-restats-web-site/

The Committee on Climate Change, and independent body set up to advise government, produced **The Renewable Energy Review** to look at the viability of low carbon technologies up to 2030.

http://www.theccc.org.uk/publication/the-renewable-energy-review/

European energy statistics on the European Commission Eurostat website .

http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/introduction

The **UK Energy Research Centre** (UKERC) is the hub of UK research into sustainable future energy systems.

http://www.ukerc.ac.uk/

The **Tyndall Centre for Climate Change Research** is a collaboration of scientists from a number of academic institutions who research sustainable responses to climate change.

http://www.tyndall.ac.uk/

The government's **Renewable Energy Roadmap** sets out the UK's strategy for developing a low carbon energy system, including comparative figures on electricity generation and supply from 2008-11.

https://www.gov.uk/government/publications/renewable-energy-roadmap

There have been various reports on what impact potential future scenarios will have on the costs of electricity generation, such as those by Arup, Mott MacDonald and Parsons Brinckerhoff

These Briefing Notes have been written by the Science Media Centre in consultation with a number of scientists, science press officers and broadcast journalists. They are not intended as a comprehensive summary on a subject, but rather a snapshot of the basics, of points of controversy and a pointer towards sources of more detailed information. They are subject to change and will be updated as and when the science moves on.

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