Committee on Climate Change, 'Building a low carbon economy' (2008)

1. Purpose of the activity

Having identified what the recommended UK greenhouse gas emission target should be for 2050, the modelling and scenario work sets out to demonstrate the feasibility of the required reduction path and at manageable economic cost.

2. Model / scenario description

a) timespan and region	UK, 2050
b) scenario type	Backcasting, quantitative based on modelling. Descriptive – explores possible futures. Mixture of expert and participatory. Addresses whole economy.
c) what the approach has been designed to achieve	Demonstrate that it is possible to envisage scenarios where reasonable actions could be taken to deliver the 80% GHG emission cuts across the whole UK economy by 2050, at a manageable economic cost. The modelling is based on the UK's contribution to achieving global emission reductions in line with a central estimate of 2^{O}C by 2100.
d) description of modelling method	AEA Energy and Environment was contracted by the Committee on Climate Change to undertake model runs using the MARKAL-MED model. Emissions reduction targets ranged from 26% - 38% in 2020, and 60% - 95% in 2050. The MARKAL model used is a modified version of a model used by several other organisations including DECC (for the 2007 Energy White Paper) and UKERC. It is least–cost optimised. Two-stage optimisation used to understand impacts of decisions post 2020. MARKAL does not include international aviation, shipping or agriculture, nor non-CO_2 emissions. Expert assumptions are used to assess these. Energy model looks at 80% and 90% CO_2 cuts to allow for emissions international aviation. MARKAL-MED (Elastic Demand allowing energy services to vary in response to cost of achieving them. Offset credits and emission allowances are also considered.
e) references, links	CCC report 'Building a low carbon economy' available at http://www.theccc.org.uk/reports/building-a-low-carbon-economy. Two reports by AEA of the model runs used by the CCC are published as 'Supporting research' to 'Chapter 2: Meeting a 2050 Target', also available from the CCC website. Documentation on MARKAL is available from http://www.ukerc.ac.uk/support/tiki-index.php?page=ES_MARKAL_Documentation_2010.

3. Key Assumptions

a) carbon & energy prices	– Fossil fuel prices from DECC central fuel price scenario May 2008 – global oil \$65-75/bbl to 2030. High-high = \$150/bbl by 2015. – EUETS Carbon price to 2020 estimated to be about £40/tCO_2 in central scenario. – Electricity costs rise by between 0 and 4 p/kWh. – Overall cost of energy will rise by a modest amount as energy price rises are greater than savings from energy efficiency. – Some reductions (~5%) achieved by buying international credits.
b) final energy demand	MARKAL-MED allows for consumer response to the price of a given energy service.
c) economic conditions	Scenario based on engineering costs and excluding changes in economic structure. Does not include impact on goods and services, nor any rebound effects. Emission credits are traded, but not expected to exceed 10%.
d) social conditions	Not specified.
e) learning rates	Wind estimate at 10% once current bottlenecks are resolved.
f) technology costs	Costs drawn from IEA ETP 2008. Report cautions about recent increases in costs requiring care when costs are used from different years. Notes importance of discount rate on some technologies such as the Severn Barrage. Nuclear power cost competitive with fossil fuels, even allowing for decommissioning. CCS could become cost effective, but needs demonstrating. Back up costs for wind are estimated to be about 1-2p/kWh for 25-30% contribution from wind.
g) policies	Baseline runs all reflect policy implemented or planned prior to the Energy White Paper 2007.

4. Outputs

(a) final energy demand overall; and broken down for (i) heat (ii) transport (iii) industry processes;	– Overall for 80% = demand falls 41% and for 90% target = 52% (below 2000 levels). – Transport: overall service demand increases, but energy demand decreases. 30-40% increase in efficiency in fossil fuel use. Rest of savings met by alternatives such as electric vehicles, biofuels and H_2. – Industry: efficiency gains but CCS will become feasible. – Residential reduction up to 19% under 90% target – mainly from heat.

(b) how demands were met by fuel	Electricity demand increase by ~50-60% by 2050, mainly post 2025 as demand increases from end-use sectors. By 2030 electricity needs to reach 70gCO_2/kWh (80% target for energy) and below 40gCO_2/kWh (90% target). 2050 falls to 35g for 80% and 20g for 90%. Coal and gas remain significant but with CCS. Hydrogen has significant uncertainties over emissions from production.
(c) power generation by technology	Amount of unabated fossil power generation is trivial beyond 2020 - energy efficiency and CCS important. Renewables supply less than 30% by 2050 (80% target) but 30% without CCS and >60% without CCS and nuclear. Marine is not expected to account for substantial amounts as it will struggle to be cost competitive.
(d) role for bioenergy	Biomass supply important. Role driven by: - economics (e.g. co-firing with CCS may become economic), - transformation efficiencies (e.g. heat better than to electricity) - availability of alternatives (e.g. in transport). Use in aviation is limited to very high reduction targets (>90%) assumed because more cost-effective for road transport.
(e) role of enabling technologies	In all the constrained cases the share of intermittent renewables does not exceed the 25% limit, above which additional energy storage must be invested in. Behavioural changes are not regarded as significant compared to improvements in energy efficiency.
(f) extent of decentralised energy and role of CHP	Decentralised generation technologies never account for more than 6% of total generation. This is because the assumptions around generation technologies mean that such technologies are not as cost-effective beyond this level.
(g) costs of achieving goals	80% and 90% target could be achieved at a cost of 1-2% of GDP in 2050. Increase to 2-3% if CCS and nuclear not available.

5. Key messages

Decarbonisation of the whole economy by 80% is technically feasible at a cost of 1-2% of GDP. A portfolio of technologies wil be required including existing and under development.

Decarbonisation of the power sector is key to achieving emission reduction targets enabling electrification of heating and transport.

Across the whole UK economy, if some sectors do not decarbonise quickly enough, such as international aviation and shipping, other parts will have to take more of the cuts.

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