IPPR, RSPB, WWF, '80% Challenge: Delivering a low-carbon UK' (2007)

1. Purpose of the activity

Aim to demonstrate feasibility of 80% target. Identify cost and technologies that will be needed. Applied additional conditions including international aviation emissions, no nuclear power and restrictions on availability of biofuels and wind.

2. Model / scenario description

a) timespan and region	2050, UK
b) scenario type	Backcasting, quantitative modelling, whole economy, normative with accompanying alternative scenarios, expert.
c) what the approach has been designed to achieve.	Scenarios explore the feasibility of increasing the emission reduction target to 80% below 1990 from 60%. Also includes international aviation with a multiplier for non-CO_2 effects, but excludes use of nuclear power and limits amount of biofuels and wind power.
d) description of modelling method	MARKAL-MACRO (used for 2007 Energy White Paper) and Anderson Model (used for the Stern Review). MARKAL-MACRO: Quantitative, least-cost optimised model. On overall cost the model accounts for growth foregone Anderson model: Quantitative, probability based modelling, with results expressed in probabilities – report uses estimates of costs and and assigns probabilites. Calculates average cost of reducing emissions. On costs,model takes difference between fossil and low carbon.
e) References, links	The report is available from http://www.ippr.org.uk/publicationsandreports/publication.asp?id=573.

3. Key Assumptions

a) carbon & energy prices	Energy and carbon prices drawn from DTI 2006 – same sources as the Gov't Energy White Paper in 2007.
b) final energy demand	Biomass limited to 1.1EJ/yr of imports in 2050 (per capita proportion of global sustainable supply – Ref WWF biofuels report 2007). Nuclear costly and issues of waste and security – therefore no new build. Used central DfT and DTI projections for energy use in domestic, industrial and surface transport. No growth in aviation emissions above 2010 levels. Anderson model: range of demand options with probabilities assigned.

c) economic conditions	Used same assumptions as government models and Stern Review. Economy increase 2%/yr to 2025 then 1.5% to 2050. Achieved entirely through domestic action – no trading of international carbon credits. Rest of economy reduces emissions by 95% below 1990 base line by 2050, to allow energy emissions to reach 80%. Uses DTI central fuel projections (DTI 2006).
d) social conditions	Not explicitly mentioned.
e) learning rates	MARKAL: learning rates taken from review by McDonald and Schrattenholzer (2002). Expected future deployment rates from European Commission World Energy Technology Outlook – 2050, although conservative estimates were used for 'central model run'.
f) technology costs	Same as government for MARKAL, Anderson – same as Stern but use UK figures rather than global. In MARKAL model: wind – limited to 25% of total grid capacity, by increasing costs to include storage/grid reinforcement to deal with intermittency and wildlife protection. Anderson model: where there is uncertainty a range of costs are identified for the technology with probabilities assigned. MARKAL: range of energy efficiency technologies. Hurdle constraint applied – NPP has to be positive at 25% discount rate (noting higher than normal 10%).
g) policies	

4. Outputs

(a) final energy demand overall	Overall figures not explicit. Transport energy demand increases. Demand for heat and industrial processes not mentioned in report.
(b) how demands were met by fuel	Both models show decarbonisation of electricity as central – declining to almost zero by 2030. Large increase in electricity demand post 2030. Anderson uses marine and hydro to provide 14% of electricity in 2050, whereas MARKAL much lower. Electricity replaces gas in household heating. Electricity demand increases from ~350TWh/yr to about 550TWh/yr. Transport decarbonises earlier in MARKAL than Anderson. Anderson: Early emphasis on engine efficiency, increasing biofuels and hydrogen. Hydrogen from fossil with CCS – leads to 20% of tansport energy demand by 2050. MARKAL: Air transport increases 30% over current, but using fossil

	kerosene. Biodiesel important in all vehicle types.
(c) power generation by technology	Nuclear excluded, although when included reduced final cost by 0.1%of GDP. Wind power and CCS dominate – MARKAL = ~75%, Anderson = 67%. Growth in wind power later in Anderson model. Anderson model: CCS 15GW (>100TWh elec) of capacity required by 2025 (100TWh, 25% of demand). MARKAL: 301TWh by 2050 (~45GW), mainly gas CCS - >50% of supply.
(d) role for bioenergy	Anderson: 1st and 2nd generation biofuels used in surface transport and aviation fuels by 2050 – in aviation they account for one third of fuel used. MARKAL: biodiesel takes off in 2010 across all vehicle types – conventional diesel phased out in 2030. First generation biodiesel and methanol reach 17% of car fuel in 2050. Fischer Tropsch biodiesel reaches 70% of car fuel by 2050.
(e) role of enabling technologies [storage, demand side management and intelligent systems operations (or 'smart' grid)where available]	Not discussed in detail.
(f) extent of decentralised energy production and role of CHP	Recognised that it may have a bigger role as both models struggle to represent it adequately.
(g) costs of achieving goals	Both models range 2-3% by 2050 = £55-80billion/yr out of GDP of £2,650-2,800billion. Various sensitivities explored – price of fossil, accelerated energy efficiency and new nuclear. Costs fall 25% if barriers to energy efficiency removed. Anderson: costs peak at 2.25%of GDP in 2025, falling to 2.1% in 2050, because of more high cost low carbon technologies. MARKAL: rise steadily to 2.8% of GDP in 2050.

5. Key messages

The cost of achieving 80% reduction in GHG emissions by 2050 (below 1990 levels), without nuclear power, are in the same order of magnitude as a 60% target (2-3% of GDP in 2050) and lower if increase measures on energy efficiency (1.5-2% of GDP in 2050).
Decarbonisation of electricity is a priority and demonstration of CCS.
Other technology choices, such as more distributed generation, may be equally valid, but not well represented in current models.