DECC, '2050 Pathways – Pathway Alpha' (2010)

1. Purpose of the activity

To explore a range of potential pathways from today to 2050 and to consider some of the difficult choices and trade-offs which will have to be made. To better manage some significant long term uncertainties, and helps avoid making long term decisions that are incompatible with meeting the 2050 emissions target.

Pathway Alpha has been described as the 'central' pathway, with balanced effort required across all sector, so its outputs are described below.

NB *Described below as released in July 2010, ahead of a Call for Evidence inviting feedback on the model and assumptions used.*

2. Model / scenario description

a) Timespan and region	2050, UK
b) Scenario type	Forecasting; Quantitative; Normative; Expert; Whole energy system
c) What the approach has been designed to achieve	A tool to help policymakers, the energy industry and the public understand choices about how to move to a secure, low carbon economy over the period to 2050. [2050PA p. 3] The approach taken to explore potential pathways to 2050 was kept simple to make the assumptions and choices transparent, and to allow the 2050 Pathways Calculator model to be as flexible as possible. [2050PA p. 7]
d) Description of modelling method	– Spreadsheet model, based on practical and physical limits not cost-optimisation. For each energy sector a range of four different future trajectories are set out, and these aim to span the full range of potential futures in that sector. A computer model combines the sectoral trajectories together in different ways to construct possible pathways to 2050. – The model delivers new supply at the rate set by the chosen trajectory for each low-carbon technology. Unmet demand is provided by coal, gas and oil (unabated gas for electricity generation), any excess supply is assumed to be exported. – Six different illustrative pathways to show the varied routes to 2050, ranging from a pathway that requires significant effort across all sectors to pathways with only a minimal contribution from particular sectors, such as renewables, bioenergy, nuclear or carbon capture and storage, and a pathway with less action on energy efficiency. None of them represents a preferred option.
e) References, links	Links to the '2050 Pathways Analysis' report and '2050 Pathways' calculator tool (online version and downloadable spreadsheet) are at: http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/2050/2050.aspx

3. Key assumptions

a) carbon & energy prices	DECC fuel cost assumptions for oil, coal and gas listed in 2050PA, Annex A. Cost of carbon has been excluded.
b) final energy demand	Scale of effort and behavioural change set by user.
c) economic conditions	2.5% growth in the UK GDP to reflect HM Treasury's assumption for long term growth, no feedback on the economy from levels of effort implied by the pathways. Rebound effect not considered.
d) social conditions	0.5% per year growth in population, based on the central scenario of the Office of National Statistics
e) learning rates	Technology growth rates set by user.
f) technology costs	Capital cost assumptions for generation technologies listed in 2050PA, Annex A. Taken from Mott MacDonald report (2010)[1] and DECC estimates.
g) policies	Analysis does not set out what policy decisions would be required to deliver a future.

4. Outputs

(a) final energy demand overall

	2050		*2010*	
	TWh/yr	*%*	*TWh/yr*	*%*
Transport	585	32	716	38
Industry	534	29	476	25
Heating and cooling	517	28	508	27
Lighting & appliances	184	10	171	9
Total Use	***1821***		***1871***	

Under Pathway Alpha:

- Modal shift of freight to rail and water, with some 'smarter choices' policies to encourage a shift from car use to other modes.
- Industrial output increases across all sectors, rising by 130% overall. However, energy intensity and process emissions reduce dramatically meaning that energy use rises only by a quarter. Emissions reduce to 56% of 2007 levels, with steeper falls after 2030 due to the deployment of CCS. [2050PA, Section C]
- Average internal home temperatures rise by 0.5° by 2050.

[1] Available online at http://www.decc.gov.uk/media/viewfile.ashx?filetype=4&filepath=Statistics/Projections/71-uk-electricity-generation-costs-update-.pdf&minwidth=true.

(b) how demands were met by fuel

Energy source	*2050*		*2010*	
	TWh/yr	*%*	*TWh/yr*	*%*
Primary electricity, solar, marine and net imports	1166	40	183	7
Environmental heat	233	8	0	0
Imports of ag, waste, biomatter	549	29	105	4
Coal	300	10	359	14
Oil and petroleum products	613	21	872	35
Natural gas	33	1	1001	40
Total Primary Supply	**2895**		**2520**	
Of which, imported	726.2		663	

By 2050 the majority of car and van distance travelled is in PHEVs (54%) with ICE vehicles still significant (35%), and a modest proportion of pure EVs (10%) and fuel cell vehicles, FCV, (1%).

(c) power generation by technology

Generation technology	*2050*		*2010*	
	TWh/yr	*%*	*TWh/yr*	*%*
Unabated thermal	0	0	309.3	81
Combustion + CCS	238.7	28	0	0
Nuclear power	274.9	32	52.6	14
Onshore wind	52.7	6	11.5	3
Offshore wind	184.3	22	4.1	1
Hydroelectric	7.0	1	5.3	1
Wave and Tidal	28.5	3	0.0	0
Geothermal	7.0	1	0	0
Distributed solar PV	59.9	7	0.0	0
Total generation	**853.0**		**382.9**	

(d) role for bioenergy

Pathway alpha would make use of 10% of UK land for energy crops. The UK would also import an amount of bioenergy equivalent to half of the UK's projected market share of global bioenergy by 2050, based on IEA figures. The majority of this would be co-fired in CCS power stations.

(e) role of enabling technologies

- For the occasional cold periods when there is little wind, back-up would be through an increase in storage, interconnection with the continent and flexible demand together with 2 GW of fossil-fuel-fired back-up generation which would be inactive for most of the year.
- The introduction of biomethane as an alternative heating fuel could allow some parts of the gas grid to remain in use.
- For very low wind conditions in the UK, it is assumed that flows to the UK would be up to 75% of available interconnection capacity, driven, for example, by diversity of generation and wind output across continental Europe and the larger hydroelectric storage capability of Norway and the Alps.
- The amount of flexible demand assumed in different 2050 analyses varies but the assumption used is generally between 20% and 30%.

[2050PA, Section P]

(f) extent of decentralised energy and role of CHP

By 2050, up to 30–60% of domestic heat demand would be met by electric technologies and most of the remainder would come from district heating connected to large power stations.

(g) costs of achieving goals	Annual capital expenditure on power generation will need to rise from around £6 billion per year today to £10–19 billion per year by 2020 in the low-carbon pathways, compared to £3 billion per year in the reference pathway. Compared with the reference pathway, annual undiscounted fuel costs are £10bn lower in the low carbon pathways by 2030, and over £20bn lower by 2050.

5. Key messages

In Pathway Alpha, all sectors would help make the transition to a low carbon economy. This would require increasing and sustained investment in low carbon electricity generation. Among other distributed generation technologies, three main low carbon generation options (renewables, nuclear and fossil fuels with CCS) would be rolled out between now and 2050.

Despite a slight reduction in overall energy demand, demand for electricity would double by 2050, as a result of electrification of much of industry, heating and transport. Decarbonisation of generation would mean that all of the UK's electricity would come from low carbon sources by the 2040s, making significant use of the UK's wind resources, onshore and offshore, while keeping wind deployment well within the estimated limits that account for land use, sea use, ecological sensitivity and proximity constraints. It also assumes that we build new nuclear plant at a rate of 1.2 GW a year, and that carbon capture and storage on fossil fuel plants is successful and rolled out at a rate of 1.5 GW a year after 2030.

An analysis of the six illustrative pathways indicates some common messages: (discussed in detail in the report)

- Ambitious per capita energy demand reduction is needed
- A substantial level of electrification of heating, transport and industry is needed
- Electricity supply needs to be decarbonised, while supply may need to double
- A growing level of variable renewable generation increases the challenge of balancing the electricity grid
- Sustainable bioenergy is a vital part of a low carbon energy system
- Reduction in emissions from agriculture, waste, industrial processes and international transport will be necessary by 2050
- Fossil fuels continue to play a role

As well as a set of common conclusions, the pathways analysis also identifies some areas of uncertainty, where it is not yet clear what developments will take place, or what the optimal choice would be: (also discussed in detail in the report)

- The shape of future energy infrastructures
- The precise 2050 electricity generation mix
- Availability of sustainable bioenergy
- International dynamics
- Technological uncertainties
- Environmental impacts

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