Will market reform provide greater generation cost clarity?

The relative generation costs of the principal energy sources in the UK are a source of constant debate. There are numerous ways of approaching the issue. In the following feature, *David Milborrow** sets out to compare generation costs from coal, gas, onshore and offshore wind and nuclear using realistic inputs for plant, fuel and operation and maintenance costs, both for now and for 2020. It suggests there is little to choose between gas, coal and onshore wind in either case. The critical issue for nuclear is whether financing can be spread over long periods and whether the risk premium can be reduced. The critical issue for offshore wind is whether installed costs can be reduced and, again, whether the risk premium can be reduced.

The steep rises in commodity prices that were reflected in increased prices for power plant - both thermal and renewable - just before the start of the world recession in summer 2008, are now a thing of the past. A year later, commodity prices had roughly halved but they have moved up slowly since that time. Fuel prices are also more stable at present, having declined sharply from their summer 2008 peak and then, as with steel, moved up slowly. This makes the estimation of generation costs for the principal electricity generation sources easier, but there are still pitfalls.

Nuclear costs – a wide range

One of the difficulties in trying to assess nuclear new build costs is assembling a representative dataset. There is a wide range of estimates for the installed costs of nuclear plant - many emerging from the United States - but no new plants have been built there or in the United Kingdom for many years. If the first new power station in the UK is built by 2018, a level playing field really demands that fuel costs for coal and gas are based on anticipated levels at the same date. This introduces some uncertainty and so one set of the comparisons here is based on current fuel prices. A second set is based on 2020 prices – by which time some new nuclear plant may be operating.

Just over two years ago, a fairly pivotal figure in the government's Energy Review was the generation cost from nuclear power. This was estimated at £38/MWh, based on a 40-year life and a 10% discount rate. That figure has now virtually doubled. As readers of *New Power* will be aware, a speech by the non-executive chairman of RWE Npower seemed to suggest nuclear now requires an electricity price in the range £70-75/MWh to be viable.
(See *New Power 17*)

In its report for the Department of Energy and Climate Change (DECC), "UK Electricity Generation Costs Update", consultancy Mott Macdonald produced some figures in the same range, added more detail, and extended the range. With a 10% discount rate, it suggested a range from £67/MWh to £99/MWh, with the lower figure relating to 'series production' and the upper figure to 'first of a kind' costs. (See *New Power* 17) The latter estimate is linked to a construction cost of £4419/kW, but higher estimates are circulating in the United States. The 'Turkey Point 6 and 7' reactors in Florida have estimated construction costs in a range that goes up to £4934/kW. A realistic 'low' estimate is perhaps more difficult to define, but Progress Energy in the United States has quoted a figure of just under £3000/kW and that will be used here. Other capital cost estimates for nuclear plant, reported to the International Energy Agency, vary, from a low of around £1450/kW in China, to a high of £3700/kW in the Czech Republic. There is an element of uncertainty in these figures as exchange rates may have moved since the data were compiled.

Although there are differences in the fuel and operation and maintenance costs between British and American estimates, these have a relatively minor influence on the overall generation costs.

Wind energy

More data is available for the installed costs of onshore wind. Information published in *New Power* and elsewhere suggests the current UK average is around £1400/kW, with a range that encompasses most estimates of +/- £100/kW. This is consistent with the data in the 'Onshore costs/benefits study' completed by Garrad Hassan for Renewableuk. At one time, British costs appeared to be a little higher than the global average, but that difference is no longer statistically significant. As wind turbine costs - which account for about two thirds of the total installed costs - have fallen recently, there may be a consequential reduction in wind farm costs in future. For 2020, a modest 10% fall from the current average has been assumed, taking the level to £1260/kW.

At first sight there is a wide range of installed costs for offshore wind, but the Danish Energy Agency has observed that the most expensive projects are for demonstration purposes. The Agency suggested a cost range of around £1900-3200/ kW, and the

UKERC study (see notes below Table 2) suggested a current average of £3000/kW. The choice of an appropriate range is therefore a little subjective, but the majority of recent projects have been in the range £2250-3000kW. For 2020, published estimates show some scatter; UKERC suggests a 20 % reduction and so an estimate of £2400/kW has been used.

Coal and gas prices

There is reasonable consistency in the literature on the installed costs of coal and gas plant and the values used are shown in the table. 2010 fuel costs are based on estimates of the averages from mid-2009 to mid-2010, drawn from DECC's 'Energy Prices and Values'. Fuel price projections for 2020 use DECC central estimates and the carbon price for 2020 has been taken as £30/tonne of CO2, in line with what appears to be an aspirational price in the Electricity Market Reform (EMR) documentation.

Table 1 summarises the inputs to the generation cost analysis. Note that the ranges quoted do not cover all the extremes (low or high), but aim to capture the 'centre ground'.

Table 1. Generation cost analysis – inputs and sources

Technology	Item value or range	Source	Comments
Gas			
Installed cost	£600-700/kW	*New Power*/MM	
Fuel price	£13-15/MWh	DECC	Range over last 12 months (DECC central estimate)
(2020)	(£23/MWh)		
O&M cost	£25/kW	MM	
Coal			
Installed cost	£1400-1890/kW	EIA/MM	
Fuel price	£7-8/MWh	DECC	Range over last 12 months
O&M cost	£64/kW+£2/MWh	MM	Mid-range
Nuclear			
Installed cost	£3000-4160/kW	See text	Excludes interest during construction
Fuel cost	£5-9/MWh	MM/NARUC	"Busbar" cost, not delivered fuel cost
O&M cost	£78/kW+£2/MWh	MM (mid-range) NRDC	
Waste disposal and decommissioning	£2.1/MWh	MM	WNA quotes ~£1/MWh for both fuel and decomm.
Onshore Wind			
Installed cost, 2010	£1300-1500/kW	GH	UK data only
(2020)	(£1260/kW)	*New Power*	
		WPM.	
O&M costs	£40/kW	GH/MM	Average
Offshore Wind			
Installed cost, 2010	£2250-3000	MM/UKERC	
(2020)	(£2400/kW)		
O&M costs	£80/kW	MM/EY	

Abbreviations

DECC: Department of Energy and Climate Change
EIA: Energy Information Administration, US Department of Energy
EY: Ernst and Young. Impact of banding the Renewables Obligation – costs of electricity production.
GH: GL Garrad Hassan: Onshore costs/benefits study
MM: Mott Macdonald – UK Electricity Generation Costs Update
NARUC: National Association of Regulatory Utility Commissioners (US)
NRDC: National Resources Defence Council (US)
UKERC: United Kingdom Energy Research Centre. 'Great expectations: The cost of offshore wind in UK waters
WNA: World Nuclear Association, web site.
WPM: Wind Power Monthly, various issues.

Interest rates and amortisation periods

A difficulty with moving from nuclear installed costs to generating costs is that few plant have been built in Western Europe and the United States recently, so financing institutions are likely to require a 'risk premium'. This may be manifested either in a contingency on the capital cost or by way of an increased interest rate for the financial calculations. Tucked away, deep in the Impact Assessment that accompanies the EMR proposals is a table of hurdle rates likely to be used by utilities and developers for onshore and offshore wind, biomass and nuclear. This confirms that nuclear carries a risk premium, with a hurdle rate of 13.2%. Onshore wind, by comparison, has a hurdle rate of 8-9%, depending on whether it is a utility-led or developer project. If the EMR work well, then, it is suggested, these hurdle rates will come down if investors are satisfied that there will be less uncertainty in the new structure.

The rates provide a basis for estimates of comparative generation costs. The usual procedure is to base these on common interest rates -- 10% is widely used by DECC, for example. 10% is therefore used as a default value.

A common amortisation period of 20 years has been used throughout and changes in this parameter generally make little difference to the overall generation cost estimates. Although financing is unlikely to be provided for longer periods, it is generally accepted that nuclear plant are likely to have a longer life time and the OECD Nuclear Energy Agency has suggested an economic life of 40 years is appropriate. A set of estimates has been included for this period.

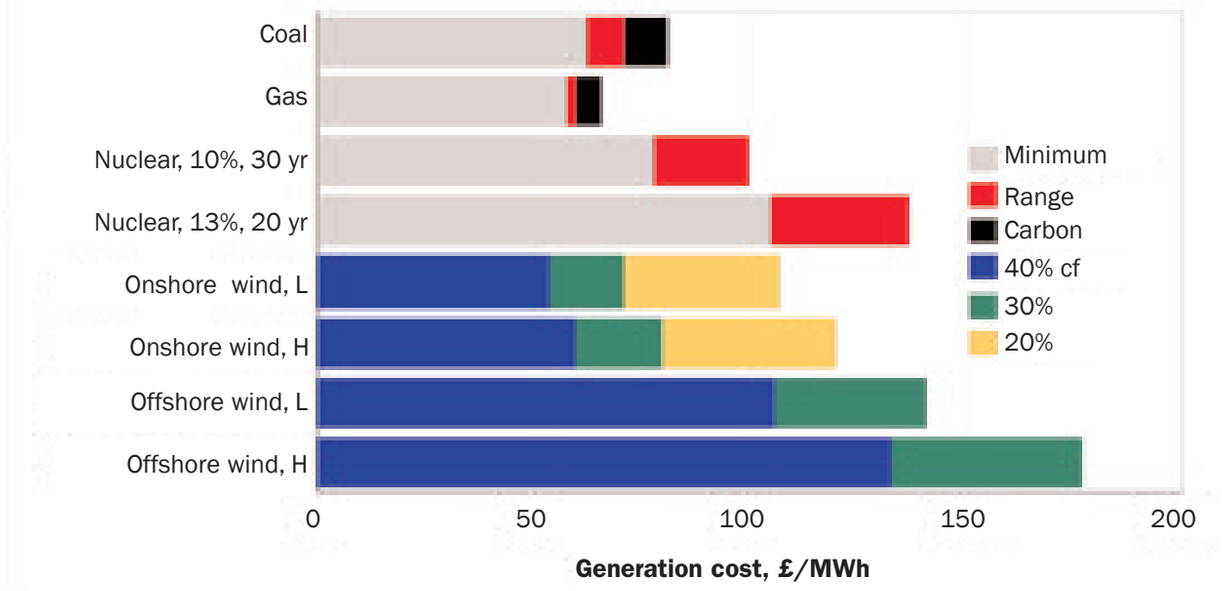
Table 2. Test discount rates (%, real) used in the analysis, based on hurdle rates in the Electricity Market Reform documentation

Technology	2010	2020
Coal	10	10
Gas	10	10
Nuclear	10/13.2	11.2
Onshore wind	9	8
Offshore wind	10	11.5

Source : DECC

Table 2 summarises the discount rates used in the analysis. The matrix of options quoted by DECC is larger; the 2010 figure for onshore wind applies to an independent developer, but the 2020 figure is a conservative average of several possible figures. The rate for offshore wind moves up by 2020, reflecting the greater uncertainties in 'Round Three'.

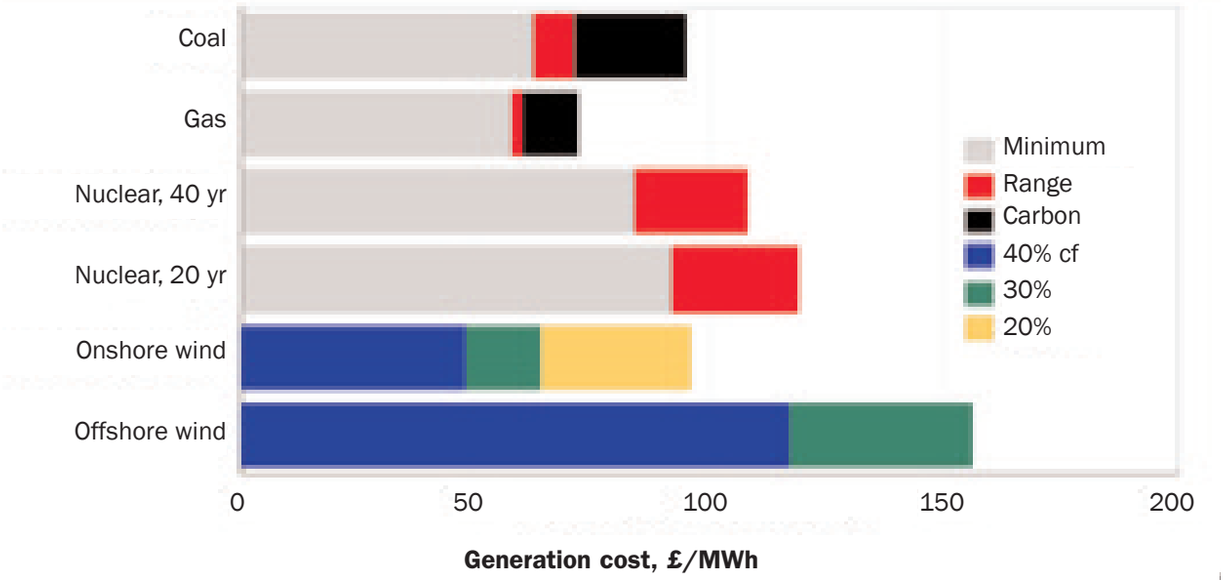
Figure 1. Generation cost estimates for 2010



N.B. Test discount rates are given in table 2 and the high (H.) and low (L) capital cost estimates for wind are shown in table 1. Wind data are shown for three capacity factors (cf). To illustrate the method of presentation the low capital cost onshore figure, with 40% capacity factor, is £54/MWh; with a 30% capacity factor, £72/MWh, and with 20% capacity factor £108/MWh.

Source: David Milborrow

Figure 2. Generation cost estimates for 2020, with the assumptions listed in tables 1 and 2



Source: David Milborrow

Comparisons

Figures 1 and 2 compare the generation cost estimates, using the inputs and assumptions that have been discussed.

At the moment, gas-fired generation and onshore wind with a low capital cost and/or a high capacity factor are the most competitive options, with generating costs around £60-65/MWh.

Coal comes next, in the range £72-81/MWh and nuclear is in a range from about £76/MWh upwards, depending on the financing arrangements.

The less productive onshore wind sites overlap with nuclear and go up to around £120/MWh. Offshore wind prices start at around £105/MWh (lower capital cost, good winds) and go up to £180/MWh (high capital costs, 30% capacity factor).

If onshore wind installed costs come down by 10% by 2020 and if the EMR result in increased investor confidence, it becomes the cheapest generating option when capacity factors are 30% or more. It delivers electricity at £64/MWh, cheaper than gas (£80/MWh) or coal (£90/MWh), approximately.

At the lower end of its cost range, and assuming 40-year financing, nuclear delivers at £84/MWh, but the upper end of its range is around £120/MWh. That is roughly the bottom end of the range for offshore wind, assuming a productive site and an installed cost of £2400/kW.

Discussion and sensitivities

Onshore wind costs are backed up by a large amount of experience and are therefore regarded as robust. Even if they do not fall by 10% by 2020, onshore wind remains attractive. Gas remains an attractive option, also, provided the price of gas does not rise to the levels seen in 2008. Coal-fired generation costs are slightly higher than those of gas (or most wind), but uncertainty over the future of carbon prices may inhibit developments.

Two other uncertainties in this analysis are the capital costs of nuclear and offshore wind. With more offshore wind in the development and construction phases, there should be greater clarity on costs by 2020 -- even if they do not fall. The timeline for greater clarity on nuclear costs is longer and it may or may not deliver cheaper generating costs than offshore wind. At the moment, the two technologies deliver roughly equal generation costs in 2020 -- assuming a productive wind site.

If offshore wind develops well between now and 2020, the risk premium may come down, which would bring down generation costs - by about £10/MWh, if a 10% discount rate is used – making it more competitive. Similar reasoning applies to nuclear, but the timescales may be longer, given longer build times, which means that 'series production' may take longer to establish.

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