Energy Policy 62 (2013) 431–442

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Cost estimates for nuclear power in the UK

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HIGHLIGHTS

- Nuclear power projects costs can rise substantially during the construction period.
- Pre-construction and construction time can be much longer than anticipated.
- Adjusting estimates for observed experience increases levelised costs significantly.
- Higher costs suggest that more policy support than envisaged may be required.

ARTICLE INFO

Article history:
Received 7 December 2012
Accepted 31 July 2013
Available online 22 August 2013

Keywords:
Nuclear
Cost
Electricity

ABSTRACT

Current UK Government support for nuclear power has in part been informed by cost estimates that suggest that electricity from new nuclear power stations will be competitive with alternative low carbon generation options. The evidence and analysis presented in this paper suggests that the capital cost estimates for nuclear power that are being used to inform these projections rely on costs escalating over the pre-construction and construction phase of the new build programme at a level significantly below those that have been experienced by past US and European programmes. This paper applies observed construction time and cost escalation rates to the published estimates of capital costs for new nuclear plant in the UK and calculates the potential impact on levelised cost per unit of electricity produced. The results suggest that levelised cost may turn out to be significantly higher than expected which in turn has important implications for policy, both in general terms of the potential costs to consumers and more specifically for negotiations around the level of policy support and contractual arrangements offered to individual projects through the proposed contract for difference strike price.

1. Introduction

As recently as 2002, the view of the UK Government was that the focus for its energy policy should be energy efficiency and a substantial increase in electricity generation from renewables, with the option of new nuclear power 'kept open' but with no direct support (PIU, 2002). By the mid-2000s however, the UK Government's disposition towards new nuclear power was much more positive. The 2006 Energy Review concluded that the economics of the technology had improved and that, 'new nuclear power stations would make a significant contribution to meeting our energy policy goals', albeit with the clear proviso that, 'it will be for the private sector to initiate, fund, construct and operate new nuclear plants', with the role of Government limited to, 'addressing potential barriers'(DTI, 2006). This position was informed, at least in part, by an assessment of the relative costs of the range of large-scale low-carbon electricity generating technologies available to the UK (DTI, 2006; Kennedy, 2007), and was followed by the 2008 White Paper on Nuclear Power (BERR, 2008) which confirmed the UK Government's view that, 'nuclear power has a key role to play as part of the UK's energy mix'.

The current UK Government was formed in 2010 from a coalition of the Conservative and Liberal Democrat parties and its initial position with regards to support for new nuclear power reflected the divergent positions of the coalition members, with the Conservative party supportive and the Liberal Democrats opposed (Cabinet Office, 2010). The resolution to this conflict involved an agreement that Government would support new nuclear power projects, 'provided that they receive no public subsidy' (ibid). Whilst the position of no public subsidy is still government policy, the on-going Electricity Market Reform (EMR) process appears likely to offer support for new nuclear power stations (and other low carbon generation options) through a package of measures including a Feed-in Tariff (FiT) via a Contract for Difference (CfD) and an underpinning of the price of CO_2 emissions (DECC, 2011a; HM Government, 2012).

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0301-4215/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2013.07.116

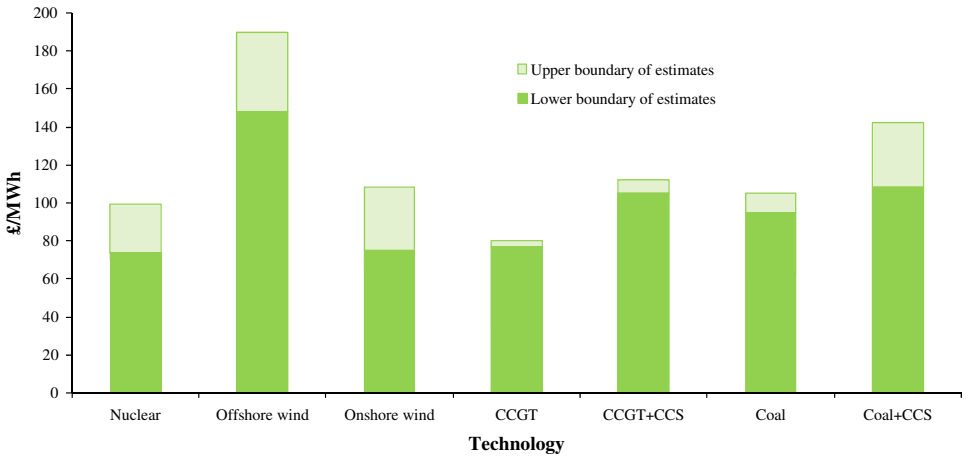

Fig. 1. Range of recent estimates for large-scale electricity generation in the UK. Note that these estimates are for projects starting around the time the sources were published (i.e. they are not forecasts for projects starting some years into the future). Carbon costs are included where applicable. *Sources*: Mott MacDonald (2010, 2011), Arup (2011), Parsons Brinckerhoff (2011).

Since the change of heart towards nuclear from the mid-2000s onwards, projected costs for new nuclear plants have risen considerably, as have costs for many other electricity generation technologies (Greenacre et al., 2010; Heptonstall et al., 2012). That notwithstanding, as Fig. 1 shows, recent cost projections for electricity from nuclear power in a UK context are up to around £100/MWh, which if realised, puts this technology towards the lower end of costs for low-carbon generation. These cost estimates helps to underpin the current UK Government's commitment to nuclear power described above.

More recent analysis suggests even lower costs for 'nth of a kind' (NOAK) plants built after the first wave of new generation plants, with the latest projections commissioned by DECC suggesting a levelised cost for electricity from nuclear plants of around £65/MWh for a notional NOAK plant with a 2017 project start date (Parsons Brinckerhoff, 2011).

Of course, cost projections for any of the technologies outlined in Fig. 1 can turn out be wrong for a range of reasons including unanticipated changes in commodity prices, currency movements, supply chain constraints, lack of technological maturity, appraisal optimism, and changes to the regulatory environment (Greenacre et al., 2010). The central contention of this paper is that recently published levelised cost estimates for nuclear new build in the UK may not be fully adjusted to reflect the following market realities that surround new build nuclear economics:

- In the US, European and the UK markets nuclear new build programmes have been effectively dormant for the past 15–20 years.
- The pre-construction and construction phases of nuclear plants last around 14 years. This time frame exposes the nuclear build process to a significant amount of exogenous pressures that impact final 'out-turn' capital costs.
- There are no reactors of any generation type that have been built in liberalised energy markets under commercial terms that the UK new build programme will operate under.

These factors all increase the uncertainty surrounding new build nuclear capital cost estimates and, in turn, there has been a wide range of levelised cost estimates for nuclear power. This paper therefore examines the potential impact on nuclear cost projections of adopting different assumptions for key time and cost variables, based on historic and current observed values. Section 2 explains the approach and methodology for the analysis, Section 3 summarises the findings from an examination of the history of nuclear power projects, Section 4 explains the results of applying these historical lessons to current estimates for nuclear power in the UK and Section 5 concludes with observations on the implications for policymakers.

The focus of this paper is on the potential implications for the levelised costs of EPR (pressurised-water) reactors because this is currently the only plant type which has received UK regulatory approval and has projects actively in the planning stage. We recognise the recent entry into the UK of Hitachi with their BWR (boiling water) reactor technology but note that such plants have yet to go through the UK regulatory approval process. Until this requirement has been met (estimated to take 2–4 years), we retain our focus on potential EPR costs.

2. Approach and methodology

In their series of 'Projected Costs of Generating Electricity' reports the International Energy Agency (IEA) define levelised cost per unit of electricity output (LCOE) as, 'the average price that would have to be paid by consumers to repay exactly the investor/operator for the capital, operation and maintenance and fuel expenses, with a rate of return equal to the discount rate' (IEA, 2005). The calculation results in a cost per unit of output (£/MWh) that has been used by policymakers to understand the relative costs of different electricity generation technologies.

The results from such cost projections, whatever the technology, depend on the set of assumptions around variables such as capital cost, construction times, the expected plant life, operational and maintenance costs, fuel costs, plant availability, load factor and discount rates (Gross et al., 2010). This paper focuses in particular on the length of the pre-construction and construction phases and how capital costs can change over these phases, drawing on evidence from US and European nuclear programmes. It then compares this experience with assumptions that feed into current UK nuclear cost estimates and goes on to substitute values based on the observed experience into a levelised cost model to examine the effect that using these alternative values may have on the projected costs of nuclear power. Finally it looks at the possible implications for UK energy policy.

The analysis that underpins this paper uses an LCOE model that calculates cash flows for each of the phases of the nuclear life-cycle on a real, pre-tax basis, based on a flexible set of inputs. The model then discounts these cash flows and divides the resultant value by the discounted energy generated by the plant throughout