Oxera

Agenda

Advancing economics in business

A new dawn for nuclear power? Where the risks remain

The question of the viability of nuclear power in the UK is not a new one. In fact, an *Agenda* article in 2005 examined the prospects for nuclear new build in Great Britain.[1] Since then, new government policies and developments in the various factors that influence the economics of new nuclear capacity call for a re-examination of the prospects for nuclear new build. This article presents this analysis, showing where the risks remain and asking what might need to be done to ensure that nuclear power has a future in the UK

Oxera's 2005 *Agenda* article presented financial modelling of the projected profitability of new nuclear power stations in Great Britain.[1] Based on the information available at the time, the results of this exercise showed that the return on equity of investment in new nuclear power stations in the UK was insufficient to meet a reasonable, risk-adjusted benchmark level of return. As such, this evidence suggested that, in 2005, the likelihood of a nuclear renaissance was relatively remote.

However, since then the UK government has announced a number of significant policies designed to remove obstacles to greater investment in nuclear capacity, and there have been noticeable developments in those factors that influence the economics of nuclear power. This article explores these developments, updates the modelling undertaken in 2005, and shows that, while the prospects for a nuclear renaissance have indeed improved, it is not clear that greater nuclear investment would be realised under the current market arrangements.

As a result, and depending on how much nuclear generation is considered necessary to meet policy objectives such as ensuring security of supply and mitigating climate change, it may be necessary to design policies that actively support less carbon-intensive forms of generation, such as nuclear power. While the analysis in this article focuses on the UK, the issues presented are applicable to many countries anticipating an expanded role for nuclear power.

So what has changed?

In terms of energy policy, a milestone was reached in 2008 with the publication of the Nuclear White Paper, by which time security of supply concerns were considerably more prominent than had previously been the case.[2] It was considered that the effects of declining oil and gas production on the United Kingdom Continental Shelf, and the perceived risks of an overdependence on gas, could be mitigated by actively maintaining the option of more nuclear generation capacity.

Since the 2008 White Paper, the government has published the Climate Change Act 2008, the Low Carbon Transition Plan, the Energy Act 2008 and the Planning Act 2008. The box below provides further detail on the relevant elements of these policies.

Nuclear power: key legislation

***The Climate Change Act 2008* sets out legally binding targets that put the UK on course to reduce total emissions to 80% of 2005 levels by 2050. The Low Carbon Transition Plan shows how this will be achieved, detailing the steps that need to be taken in the first three 'carbon budgets' (caps on total UK greenhouse gas emissions) to 2022.**

***The Energy Act 2008* mandates nuclear developers to submit funded decommissioning programmes setting out the technical steps of decommissioning and clean-up, the costs of these operations, and details of the financial security to be provided in relation to these costs.**

***The Planning Act 2008* establishes a new procedure for the development of nationally significant infrastructure projects, including the preparation and designation of a national policy statement and the creation of the Infrastructure Planning Commission (operational since October 2009) to review planning applications.**

Source: Oxera.

These policies have put in place targets to generate some 40% of the UK's electricity requirements from low-carbon sources by 2020. Of this, roughly 10% is expected to come from nuclear and clean coal plants.[3] Beyond 2020, the Department of Energy and Climate Change (DECC) is targeting the almost complete de-carbonisation of the electricity sector by 2030. Such ambitions require the further roll-out of low-carbon generation initiatives. To keep costs down, some commentators believe nuclear generation should make up a large proportion of this.[4]

Turning to the economics, investments in nuclear power are characterised by large fixed costs and low marginal costs of operation. As a result, the profitability of nuclear investment is highly sensitive to changes in the price of electricity. Since 2005, there has been a marked increase in the volatility of the GB electricity price. This is shown in Figure 1, which plots the electricity price together with the gas price (converted to £/MWh for comparison) over the period since 2004, and includes the price outlook up to 2012. The chart displays a number of striking electricity price movements. For example, the spikes in 2005/06 were driven predominantly by increases in the gas price, while the price rises in 2008 were largely caused by lower capacity margins.[5] Greater electricity price volatility generally makes investment in baseload generation such as nuclear power plants more difficult since it complicates the long-term projection of revenues (and therefore investment returns).

Another feature of the electricity price reflected in the chart is that its level is forecast to increase. This could be good news for nuclear generators: a high electricity price, combined with the relatively stable marginal costs of nuclear plants, increases gross margins. The forecast increases in the price of electricity are predominantly driven by anticipated increases in the gas price over the coming years, which are expected to recover from their current low levels. Oxera's modelling suggests that the price of electricity could increase from its current level of around £50/MWh to around £80/MWh on average by 2030.

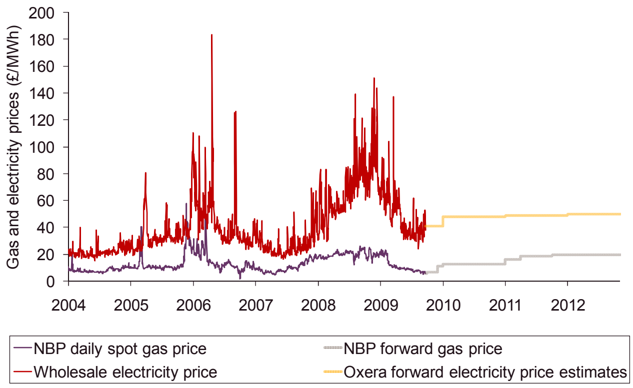
Not only have the level and volatility of the price of electricity increased, but there have also been significant increases in the forecast costs of constructing nuclear plants. In 2005, the cost of a fourth-generation reactor was estimated at £1,630/kW.[6] This value has almost doubled since then, to £2,700/kW.[7] The factors behind this increase relate to the higher prices of key commodities used in construction, such as fabricated steel metal, stainless steel castings and cement. The government's efforts to accelerate nuclear new build, and the forecast increase in the price of electricity, have certainly been recognised by the nuclear sector. Recent announcements by EDF Energy, and by E.ON UK and RWE npower (under their nuclear joint venture company) indicate the planned construction of some 13GW capacity of new plant.[8] However, the volatility of the electricity price has led some to call for the UK government to introduce a floor to the EU Emissions Trading Scheme (EU ETS) carbon price in order to reduce this volatility.[9] In spite of this, both the Conservative and Labour parties have maintained that nuclear new build in the UK will not receive any form of public subsidy. Therefore, an examination of whether the economics of nuclear new build might derail the possibility of a UK nuclear renaissance requires analysis of the profitability of merchant investments in nuclear power stations, in the absence of any government involvement.

Oxera's 2009 nuclear new build modelling: comparison of results with 2005

In addition to the changes in construction costs and the price of electricity noted above, a number of further changes between the 2005 and 2009 analyses have been made.

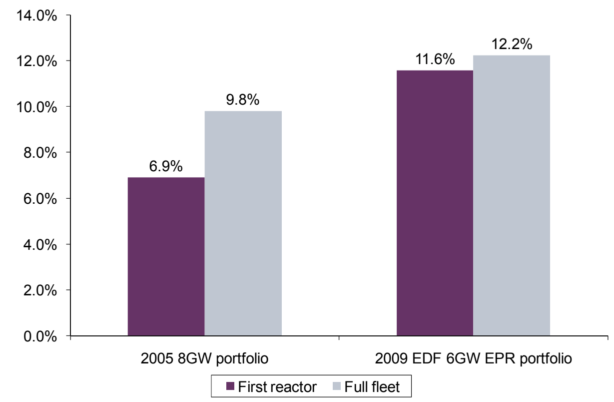
- In 2005, the size of the new nuclear investment portfolios reflected the volume necessary to replace those plants expected to close by 2020, representing total capacity of around 8GW. The volume modelled in the updated analysis now reflects the investment intentions of EDF Energy and E.ON/RWE separately, and represents planned construction of around 6.5GW of new capacity each.
- The updated modelling also uses information available on the timescales necessary for the construction of nuclear new build, and the type of new reactors likely to be built. Areva's EPR has been used in the example given in Figure 2, in line with EDF's intentions for new build in the UK.[10]

Figure 1 Electricity and gas price variation (2004 to present) including gas forward prices and electricity price estimates



Note: National Balancing Point (NBP).
Source: Bloomberg, Oxera analysis.

Figure 2 Comparison of levels of profitability on nuclear portfolios (expected returns on equity)



Note: The results from Oxera's analysis of 2005 have been transposed from nominal returns of 9% and 12% for the profitability of the first reactor and full fleet respectively, using an inflation assumption of 2%.
Source: Oxera analysis.

Figure 2 compares the expected equity returns calculated in 2005 with the profitability of the four-reactor portfolio proposed by EDF.[11] The figure indicates that the internal rates of return (IRR) of the new nuclear portfolios calculated in 2009—using updated central estimates of the electricity price and construction costs—are 11.6% for the first reactor and 12.2% for the full fleet. These results are some way above those calculated in 2005, suggesting that the increase in the forecast electricity price has had a positive net effect on the profitability of nuclear portfolios once increases in construction costs are taken into account.

In 2005, the range of risk-adjusted benchmark returns on investment in new nuclear power plants was estimated at between 14% and 16% on a post-tax, nominal basis. This range reflected the returns on UK utilities between 1990 and 2005, plus a risk premium of 200–400 basis points to account for specific risks associated with investment in nuclear plants (eg, technology risk and the cost of overruns in development and construction). This calculation is only a rough estimation of the impact of the risk profile of a nuclear portfolio on financing costs, and would warrant further research if this analysis were to be extended. Converting this range to real terms (using a 2% inflation assumption) yields a benchmark range of returns of 12% and 14%.

Comparing the updated results against this benchmark range suggests that, while there may have been an increase in the profitability of nuclear investments in the UK since 2005, the profitability estimates (ie, 11.6% and 12.2%) are still fairly low when compared to the benchmark range (ie, 12–14%).

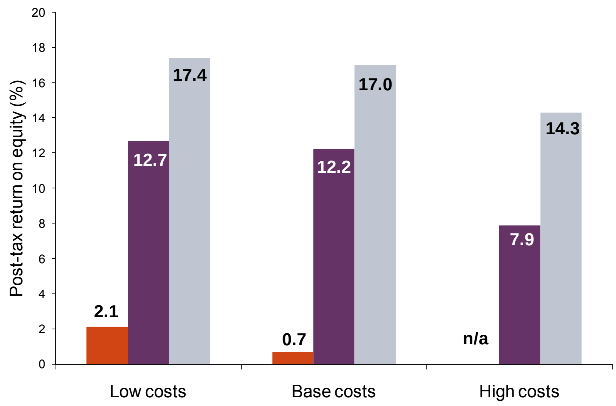
Figure 3 presents sensitivities for the updated analysis, and shows how responsive the portfolio returns are to changes in inputs. For example, using a lower range for the forecast electricity price (£31–£50/MWh for the period 2012–30) yields an almost zero return on equity. The upside, however, is that if the electricity price were to increase to within a range of £61–£107/MWh for the period 2012–30, the returns on equity would rise above 14%—the top of the range of the benchmark level of required returns.

Taken together, the 2009 analysis and the above sensitivities show that the returns available to nuclear developers are not only low with respect to reasonable assumptions on the required benchmark, but that they are also highly sensitive to changes in the electricity price and input cost assumptions. Faced with such volatile economics, it remains unclear whether new nuclear plants would be realised, at least in the current market context. This may be a problem for policy-makers tasked with meeting national targets for emissions reductions. If the government were to rely on the current market design to deliver new nuclear capacity, it is possible that an important opportunity for a GB nuclear renaissance might be lost.

So, what next?

While the benefits of new nuclear capacity for the UK economy could be significant, the real question is whether these benefits are above or below the costs of supporting additional nuclear deployment. If the UK government continues its position of not committing public funds to support new nuclear capacity, the costs

Figure 3 Comparison of levels of profitability on nuclear portfolios across electricity price and construction cost sensitivities



Note: High construction costs are assumed to be double the central case for the first reactor and 20% above the central case for subsequent reactors. The low construction cost scenario assumes no change in the cost of the first reactor and a 20% decrease in subsequent reactors. High and low electricity prices generated by Oxera using high and low DECC gas price forecasts.
Source: Oxera analysis.

of deployment that would be borne by the taxpayer might be fairly limited, although this would depend on how the liabilities associated with decommissioning and waste were managed. However, relying on the market to deliver more nuclear generation would require considerable confidence that commodity and financial market conditions do not deteriorate from their current state.

Such a strategy might suit governments indifferent to the prospects of new nuclear capacity, but, given legally binding emissions-reduction targets, this would not be expected to apply to either current or future UK governments. Evidently, the 'no support' policy option has its risks, but what are the alternatives? There are a wide range of options that could be used to support the deployment of nuclear new build.

- **Price support mechanisms**. These are mechanisms that target the value of a nuclear generator's revenues and may be direct, such as payments for emissions abatement, or indirect, such as a carbon tax on fossil-fuel generators or the establishment of a 'floor' to support the EU ETS. Price mechanisms aim to provide a more or less explicit and long-term price per unit of CO_2 emissions.

- **Financial support mechanisms**. These would target the financing costs of nuclear generators. Loan guarantees, for example, could substantially reduce nuclear developers' financing costs, given that creditors would be more likely to offer more favourable terms on debt in the knowledge that the government had guaranteed principal and interest payments.

  Another approach might involve the government taking an equity stake in new plant. The presence of governmental equity would create a 'cushion', shielding private investors from the risk of losses and, accordingly, mitigating the costs of raising finance.

- **Quantity support mechanisms**. These would target the volume of electricity sold by nuclear generation companies, rather than the price. Such mechanisms might take the form of obligations on suppliers to purchase a pre-specified proportion of their electricity from nuclear sources, on a similar basis to the Renewables Obligation for low-carbon generators.

- **Market (re)design**. Finally, the government could reform the market itself in order to bring on more nuclear generation. This could be achieved through a stronger strategic role in the planning of the generation sector, or by establishing an institution to act as a 'single buyer' whereby a central agency would act as counterparty to both supply and demand, thereby coordinating the purchase and sale of power through long-term commitments.

Any decision on the selection of such mechanisms would need to be based on an appreciation of the risk to those investors or nuclear developers that the UK government might want to target; an understanding of how well any mechanism might perform with respect to the cost per unit of nuclear delivery; and the likelihood of any mechanism receiving state aid clearance from the European Commission. In addition, an understanding of the potential distortion to the power market, and an appreciation of who might ultimately bear the associated costs of this, would be required. Mechanisms which minimise power market distortions, and under which the costs are borne by electricity consumers, would clearly be preferred.

Modelling by Oxera has shown that the costs of different support mechanisms vary widely. For example, modelling a system of loan guarantees has shown expected costs to be as low as £240m for the entire EDF Energy portfolio.[12] In contrast, the costs of direct financial support are significantly higher (at £8.4 billion in net present value terms) over the lifetime of the portfolio.[13] Both of these values represent the costs required under each support mechanism to increase the return on equity (under the central scenario shown in Figure 3) from 12.2% to 15%.

Supporting nuclear deployment will come at some cost. However, this cost might be justified by the benefits that nuclear new build could offer the UK economy. On the other hand, while pursuing an option of 'no support' might result in lower costs to the taxpayer or to consumers in the short term, the risks surrounding the deployment of new nuclear capacity would remain.

The question for the UK government is whether the short-term cost savings, achievable through a policy of no support, justify the risk that market conditions move against nuclear developers in the future—and that the dawn of the UK nuclear renaissance turns to dusk.

[1] Oxera (2005), 'Financing the Nuclear Option: Modelling the Costs of New Build', June.
[2] BERR (2008), 'Meeting the Energy Challenge: A White Paper on Nuclear Power', January.
[3] DECC (2009), 'The UK Low Carbon Transition Plan: National Strategy for Climate and Energy', July.
[4] Malcolm Wicks MP, the UK government's Special Representative on Energy Issues, advocates that the government should target nuclear generation to provide some 35–40% of the country's electricity needs. See DECC (2009), 'Energy Security: A National Challenge in a Changing World', August.
[5] Directorate-General Energy and Transport (2008), 'Market Observatory for Energy', **1**:2, July–September.
[6] Oxera (2005), op. cit.
[7] Derived from an overnight cost of $4,000/kW. Overnight costs reflect 'busbar' costs only—ie, those costs incurred in connecting the power plant to the grid, but excluding the costs of expanding the overall transmission network. Source: Yangbo, D. and Parsons, J.E. (2009), 'Update on the Cost of Nuclear Power', Center for Energy and Environmental Policy Research, May.
[8] E.ON (2009), 'E.ON and RWE Form Joint Venture to Build UK Nuclear Power Stations', press release, January 14th. A third consortium (Iberdrola, GDF SUEZ and Scottish & Southern Energy) has also expressed its interest in developing new nuclear plant in the UK, although clear indications as to the quantity of new plant have yet to be made. Source: Scottish Power (2009), 'Iberdrola and GDF SUEZ Join Forces to Participate in Construction of New Nuclear Power Stations in the UK', press release, February 4th.
[9] Vincent de Rivaz, Chief Executive of EDF Energy, called on the UK government to include in the EU ETS a floor price on carbon in order to create a 'level playing field' for nuclear generation. EDF Energy (2009), 'UK Suppliers Forum: New Nuclear Opportunities', June 30th.
[10] EDF Energy (2009), 'EDF Energy Welcomes Government Announcement on Nuclear Sites', June.
[11] Equity returns refer to real, post-tax returns on equity capital.
[12] This value is calculated by multiplying the value of the government loan guarantee required to increase equity returns to 15% by the probability of a nuclear developer defaulting on its debt.
[13] This value is equivalent to support of £150m per reactor per annum, discounted over the lifetime of the project, using a social time preference rate of between 3% and 3.5%.