Generating real options

Earlier this year, EDF's long-awaited acquisition of the British Energy was completed. But what was the company's rationale behind the £12.5 billion takeover of the UK nuclear generator? ***By Lawrence Haar and Laura Haar***

The resurgence of interest in nuclear energy in the UK since the new millennium has been nothing short of remarkable. At the end of the last century the prevailing orthodoxy among industry experts, policy makers and academics was that no new plants would be built and that existing ones would be retired, often in advance of their useful lives. Since then a combination of factors, including volatile and rising hydrocarbon prices, energy security, the desire to reduce greenhouse gases, and supportive government policies, have together created a business environment favourable and conducive to new investment in nuclear generation.

Today's plans differ decisively from those of previous generations because of the role to be played by the private sector capital. Historically, nuclear power plants were state-owned enterprises, but concern over public finances has led to a business model in which new power stations would be financed and built through private initiatives. Once viewed as a business in a twilight sector to be managed down, British Energy (BE), the largely privately owned enterprise operating eight of the UK's nuclear fleet, as well as a large coal-fired power station, is now the repository of hope for the country's nuclear revival. This revival, however, has only been made possible through the attraction of inward investment by the multi-national power company EDF, owner and operator of the world's largest nuclear fleet. Through competitive negotiations with both shareholders and the British government, EDF beat several competitors to cement its place in the UK's nuclear energy revival.

Below we examine the decision making of EDF from a financial perspective. Although EDF sells power across some connectors into adjacent countries such Spain and Germany and via the sub-sea interconnector to the UK, undertaking a £12.5 billion acquisition programme ($23 billion when EDF's offer was accepted in September 2008) across borders was without precedent for the group. With life spans reaching half-a-century, the evaluation of nuclear investments presents a myriad of conceptual challenges which we have found cannot be adequately assessed using traditional financial analysis. In contrast, we show that by enhancing traditional financial analysis with Real Option Theory, the value arising from flexibility of an investment, such as the right to expand, the right to delay, the choice of technology the compelling logic of the EDF takeover begins to make sense.

Figure 1: British Energy Group share price

Figure 2: British Energy Group turnover

HISTORY OF BRITISH ENERGY

To understand the logic behind the EDF decision to enter the UK nuclear generation market through the BE takeover it is helpful to remember the history. As we show below, although BE had been through some very difficult times, post restructuring it had been transformed into a viable enterprise, albeit one with a limited longevity. To recall, the United Kingdom was a global leader in the liberalisation and privatisation of energy markets, by which we mean the supply, generation, distribution and marketing of gas and electricity to consumers, business and commercial enterprises and industry. Achieving these objectives with a privatised industry which would use competition to "regulate"

the market and create sufficient incentives for investment was envisioned under the Electricity Act of 1989. Industry restructuring went hand-in-hand with privatisation and market mechanisms it was hoped would replace the heavy hand of regulation to achieve such objectives as competitive prices, adequate returns to investors, and direction of capital to new investments. The pace of deregulation and privatisation culminated in the New Electricity Trading Arrangement (NETA) of 2001. Where power had been previously sold into a central purchasing arrangement or "the pool", it was replaced with a traded market relying upon exchanges and over-the-counter activity. By the first years of the new millennium, the combination of new entrants, deregulation of prices, customer switching, and falling input prices for gas and coal, had driven power prices at times below average variable costs. These low prices for power and poor returns forced many new entrants who were purely merchant traders in the market, *ie* without established customers and contracts, to exit the market. Market consolidation ensued as distressed assets were acquired by incumbents.

How did British Energy fare under these circumstances? Not well. With competition driving prices below average variable costs made it impossible for nuclear energy, with a large capital base, to earn an adequate return or even service its debt. Moreover the creation of a traded market power with prices at peak half-hours many multiples of those at off-peak hours, lent itself to plants which could easily cycle on and off, like gas turbines, to capture the best prices. Nuclear stations are by comparison inflexible in their operating regime, ideally only shutting down for scheduled maintenance. In addition to the new pricing regime for power creating challenges, the inadvertent consequences of deregulation and privatisation made matters worse. The legacies of privatisation and deregulation are among the reasons it was believed that nuclear energy no longer suited market realities.

Deregulation and privatisation had, by the 1990s, left the UK with a vertically integrated, concentrated market structure resembling an oligopoly like much of Europe, where the bulk of generation resides in the hands of four key players. In the UK, the original and widely agreed requirements for a competitive and traded power market – the separation of generation from distribution and supply to ensure unrestricted third-party access – have all fallen away. The competitive market structure and behaviour following privatisation and deregulation drove prices below average variable cost, placing high cost operators with limited operational flexibility at a disadvantage. A deregulated and privatised market without a requirement to take nuclear power (as is in the case of so-called green energy) was not suited for nuclear energy, which relies upon sufficiently high average prices across a long timeframe to amortise capital. Three factors rendered the situation of BE acute:

- Poor reliability leading to unplanned outages and lower output and revenue.
- The failure of the negotiations with British Nuclear Fuels (BNFL), to reach agreement on the terms of fuel contracts.
- A general review by the board of British Energy on the long-term prospects of the group.

It was under such circumstances that by 2002 British Energy faced bankruptcy and requested government intervention in the form of various credit facilities, protection from creditors, which ultimately led to financial restructuring, the sale of assets, and the exchange of private equity and debt for partial public ownership.

Post restructuring and in advance of EDF involvement the fortunes of BE had improved markedly. The restructured and recapitalised BE also enjoyed a more favourable business climate. The exiting of the many merchant generators from the market, general consolidation as noted above, higher natural gas costs as marginal generators leading to higher power prices, and lastly the ratcheting of power prices through the Emissions Trading Scheme together supported higher prices for power from which the generator BE profited. The share price, as shown in Figure 1 reflected the improved circumstances. From pence a share when the company was facing bankruptcy, the share price had risen sharply reflecting the new capital structure, more favourable trading conditions, and more recently the group's value from an acquisition standpoint. As of December 2008, shares of BE were trading at a very respectable 27 times earnings and the market capitalisation had risen to nearly £7.8 billion.

Post reorganisation we also see a stabilisation of revenues. Turnover stabilised (see Figure 2), increasing by approximately 4.7% between 2006 and 2007. Altogether a dramatic shift in circumstances for a group which had once been written-off by much of the financial press as congenitally disposed to failure and unlikely to ever succeed given its poor mix of inflexible assets with a small customer base and management.

Figure 3: British Energy's projected future capacity (assuming no new reactors or plant life extensions)

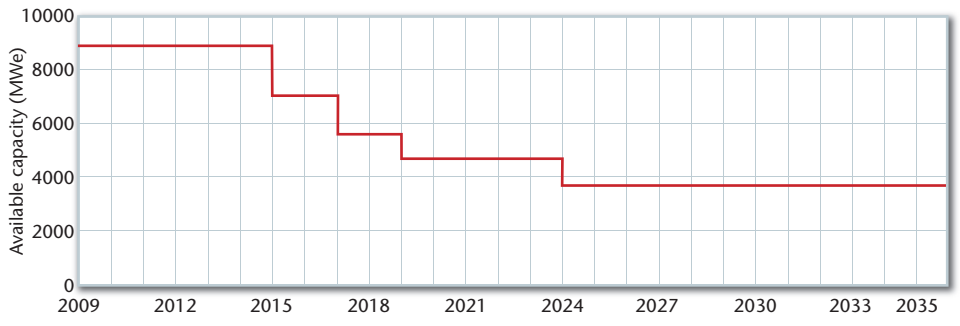


Table 1: British Energy's fleet

Name	Type	Net capacity (MWe)	Planned decommissioning date
Hartlepool	AGR	1190	2014
Heysham 1	AGR	1160	2014
Hinkley Point	AGR	860	2016
Hunterston B	AGR	840	2016
Dungeness	AGR	1090	2018
Heysham 2	AGR	1230	2023
Torness	AGR	1250	2023
Eggborough	Coal	1960	2035
Sizewell B	PWR	1188	2035

THE TAKEOVER

From a step-child of energy sector privatisation to the forced restructuring ending in 2005, the appeal of BE as an acquisition candidate and vehicle

with which to promote the revival of nuclear energy began in 2007 and gathered pace over the course of 2008 with the public policy agenda around clean, reliable, and low-carbon energy providing wind to the sails.

By the autumn of 2008 and after two rejected takeover bids, an agreement between the UK government, EDF, and the nuclear licensing authority had been reached. EDF's cash offer of 774 pence for each British Energy share had been accepted by the BE Board (see *NEI* November 2008, p5). The transaction, according to the respective Boards, would result in increased output from BE's existing nuclear power stations, higher output resulting from plant life extensions, as well as opportunities for investment in new nuclear build. The variability of power prices under liberalised markets as found in the UK and adjacent countries, not guaranteeing a return to existing and planned assets, were noted as risk factors facing existing shareholders in contemplating the EDF offer.

As part of the transaction the French group acquired a number of nuclear sites, suitable for the construction of four new reactors. This was marked as an area of concern by the European Commission when considering the proposed sale under European Union merger regulations and it imposed certain conditions on the transaction. EDF is required to unconditionally divest either the Dungeness or Heysham potential new build site, and to end one of its three grid connection agreements at Hinkley Point in order to facilitate the entry of other potential new generators into the UK nuclear industry. It is also in the process of auctioning its land next to the Wylfa nuclear site, which is being marketed simultaneously with the Nuclear Decommissioning Authority (see *NEI* December 2008, p12).

Table 2: EDF financials

Cost of equity	19%
Cost of debt	5%
Debt to equity ratio	1.02
Weighted average cost of capital	12%

Table 3: Alternative price trajectory scenarios

Rate of annual power price appreciation (%)	Net present value (€)	IRR* (%)
0	-1,465,796,839	n/a
1	-937,741,747	n/a
2	-349,266,518	n/a
3	309,363,646	12.38
4	1,049,773,811	13.34
5	1,885,887,203	14.32

* Internal Rate of Return (IRR) is the discount rate applied to future cash flows which render them equal to initial expenditure. IRR on a negative NPV is not meaningful and hence not displayed.

The restructuring of BE coupled with the general revival of nuclear as a safe, reliable, environmentally-friendly alternative to gas and coal fired power stations laid the groundwork for the EDF acquisition, thereby combining the forces, skills, and expertise of the two groups. EDF was not acquiring the heavily discounted remains of the UK nuclear sector but rather a going-concern for which it paid a premium price.

TRADITIONAL FINANCIAL LOGIC

To understand the logic behind the EDF takeover of BE we begin by considering the economic and financial logic behind this massive deal. Economic and financial gains from acquisitions typically involve the following aspects:

- Vertical & horizontal economies of scale;
- Enhancement of market power;
- Managerial improvements;
- Financing gains, *ie* reduced cost of capital.

Incorporating new assets or businesses into existing business activities, for example in an acquisition or merger, may only be value creating if somehow, the combined assets are together worth more than they were as separate entities, prior to the change in control. If the assets and business of BE are correctly priced at £12.5 billion why and how are they worth more in the hands of EDF? Remember, if none of these gains transpire, the acquisition of BE by the French group will have a net present value (NPV) of zero. Unless through such synergies, economies of scale, marketing advantages or better management, the assets are worth more, over time, to the buyer than they are in the market, no benefits will arise from the acquisition.

Existing assets

Applying the above principles we look at the economic and financial merits of the existing BE fleet and whether the sources of potential synergies noted above might apply. BE owns and operates eight nuclear power stations (14 AGR units at seven sites, and the country's only PWR at Sizewell). In addition, it owns and runs a coal-fired power station, Eggborough. The nuclear stations have a combined capacity of almost 9000MWe, whilst the coal-fired plant adds a further 1960MWe of output (see Table 1).

Putting together the combined capacity for the BE fleet we see in Figure 3 that capacity drops off sharply after 2020. Unless plant life extensions were to take place, the entire British Energy fleet of power stations ends its useful economic life by 2035.

Given the available capacity of BE and its likely power output into the future we can compare the projected revenue and income stream from these plants against the £12.5 billion EDF paid. In this way we can address if the expenditure made sense and if not, how else might have EDF justified this massive foreign direct investment (FDI) into the UK nuclear energy future.

We have created some likely net profitability scenarios as would result from BE's existing assets. Using the latest and stable published financials for EDF as assumptions, we can consider first whether present power prices for electricity would justify the takeover of this UK company, followed by the question of how high prices for power would need to make the existing assets provide adequate return to this massive FDI step. Using the published financial data for EDF (see Table 2) in order for value to be created in the BE acquisition the returns would need to beat the weighted average cost of capital (WACC) of 12%. Unless new capital is deployed at a return greater than that already deployed, value would be destroyed – unless of course other advantage or gains might arise from the transaction.

Data from the European Energy Exchange has shown that the average price for power sold in 2008 was 54.40€/MWh. Following accepted financial practices for projecting revenues beyond traded markets, EDF would have used the latest prices adjusted with an assumption for inflation escalation. Using the latest financial results for the French group for cost of sales and general administration expenses, and holding cost relationships static, we compute the performance shown in Table 3.

Escalating from a base of 2008 power prices, we see that unless the rate of price appreciation exceeds 3%

or more, the NPV is negative and the IRR is below the WACC of 12% and hence the acquisition is not value creating. Only at an unrealistic 3% annual growth rate in real prices does the internal rate of return start to beat the cost of capital, creating value. If, as most firms, EDF has a target closer to 20% return before tax on its investments this takeover would not make sense, at least in terms of the existing business and assets. As we discovered through analysis, according to the model results, power prices would need to be around €63/MWh or 17% above present prices to yield returns on the investment (see Table 4).

Interpreting these results in light of the circumstances of the acquisition, it appears that nearly €7.5 billion in additional value would need to result from such gains as noted earlier. Is this reasonable? There may be the economies of scale, there may be cost savings through having the British Energy plants managed by EDF and perhaps the French can offer better management than its British counterpart, but even so, it can be the source of €5 billion of additional value from the existing assets? How about marketing gains? Energy markets are competitive and the largest customers switch suppliers readily, together suggesting that keener pricing or lower costs are together an unlikely source of billions of euros in gains and savings to the acquirer EDF. As one commentator remarked, "For the full payout of 575 pence [per share] power prices would need to average more than £90 pounds per megawatt hour with the plants producing 65 terawatt-hours a year…" this is a gamble. Explaining this transaction is not easy but let's think of other reasons for why it may make financial sense.

REAL OPTIONALITY APPROACH

Real option theory is the application of option pricing techniques to corporate finance, in particular to capital budgeting and investment decisions made by firms. They are called real options, as they are not traded on any exchange like those in, say, oil or gold. Real option refers to the notion of flexibility, and hence the option to make new decisions or amend earlier ones in light of changing and volatile conditions. Some examples of real-optionality include whether to:

- expand current operations;
- contract out production;
- temporarily shut down;
- default on obligations or contracts;
- abandon a project.

These are all forms of real optionality implicit to managerial decision making. A modified NPV taking into account real optionality would mean accept project or undertake investment if conventional NPV + option value is greater than zero.

Thus we propose to augment the NPV analysis as performed above where we saw that justifying the EDF takeover of BE as problematic by including the value of any embedded real optionality. Critically real options help us to quantify the value of managerial flexibility. If the NPV of a project is already positive for some additional value in real optionality will not be necessary from a project justification stand-point. Flexibility in the use of assets can be a source of value because they allow the owner to respond to changing conditions and opportunities. Real optionality is useful when complex multi-phase projects are undertaken and when decisions may be made over time, as applies in this case. As we can see, ex ante looking for real options encourages managers to look for flexible value creating opportunities, especially ones which open the door to follow-on situations. Real optionality can be a key source of additional value as may arise during an acquisition. Below we explore their potential relevance to explaining decisions such as the EDF takeover of EDF

Above we have seen that the traditional economic and financial arguments are unable to make a persuasive case for why EDF launched this massive FDI into the UK nuclear sector. As an FDI advantage the ownership of the existing BE assets do not appear to make lots of sense. It has been suggested that this FDI might be justified from a location perspective but this has yet to be quantified. Below we consider what additional flexibility or real-optionality exists for EDF in the takeover of BE.

Reviewing the typology of real-optionality, the one that figures strongly in this FDI transaction is 'the option to expand.' As stated, the principle appeal of British Energy is that it affords sites and access to sites on which new nuclear plants may be constructed. This is considered in more detail below.

Option to expand

The payoff from an option to expand has one of two alternative values or outcomes. Purchasing BE gives EDF the opportunity, but not the obligation, to expand the nuclear generation fleet on its newly acquired sites (subject to regulatory approval including the EPR passing the generic design assessment).

How much might the opportunity to build four new nuclear plants be worth the EDF? According to reports, EDF plans to build four 1600MWe EPRs in the UK at an estimated cost of €6.25 billion per reactor. It aims to complete construction on the first EPR by Christmas 2017, with the other three reactors coming online in 2020, 2022 and 2025, respectively.

To quantify the option to expand – that is to build four new plants with combined generating capacity of 6400MWe on the BE sites – we have modified the previous financial-economic model. The nominal cash flows appear in Figure 4 and the performance results appear in Table 5.

Here we see that building the four new plants, unlike the existing fleet, has a positive net present value. Furthermore we see that the results

Figure 4: New plant cash flows

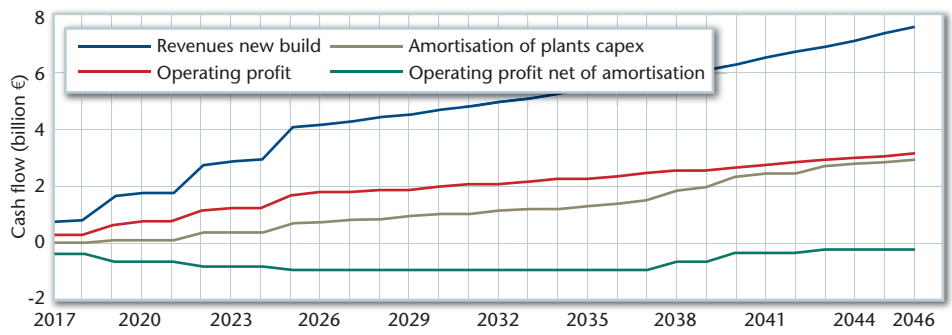


Table 4: Financial comparisons

Metrics	Results (€)
NPV at 53.40€/MWh	-346,438,487
NPV at 63.00€/MWh	7,089,257,994
Additional value	7,435,696,481

Table 5: Metrics

	Annual percentage growth real prices			
	0%	1%	2%	3%
CAPEX on 4 plants (€)	25,000,000,000	25,000,000,000	25,000,000,000	25,000,000,000
PV of CAPEX on 4 plants (€)	7,028,899,898	7,028,899,898	7,028,899,898	7,028,899,898
Payback (year)	2034	2033	2032	2031
NPV, 20 year amortisation (€)	96,049,955	551,274,122	1,112,507,986	1,808,293,955
Internal rate of return (%)	15%	36%	78%	266%

are very sensitive to the growth rate in power prices. At flat 0% growth in prices the NPV is €96 million and the IRR is 15%, while if prices grow a mere 1% annually the NPV jumps to over €500 million with an IRR of 36%. At higher rates of growth in prices returns are exceptional, though probably less realistic. The point is that prices and hence revenues are volatile and may be a source of additional option value in this expansion.

Also note that the recovery of capital, payback on a non-discounted time value basis, is less than twenty years. Other key assumptions made in this analysis were:

- Cost structure: cost of sales, general administration costs and expenses were based on BE's 2008 performance.
- Availability and reliability was based on the current operating availability of EDF's French fleet (83% average over the given year).

If EDF were to improve upon either of these key assumptions then there would be further upside to the returns presented in Table 5. Although putting faith in greater reliability or cost savings might be reasonable, hoping that greater market share can be translated into keener prices is probably the least likely.

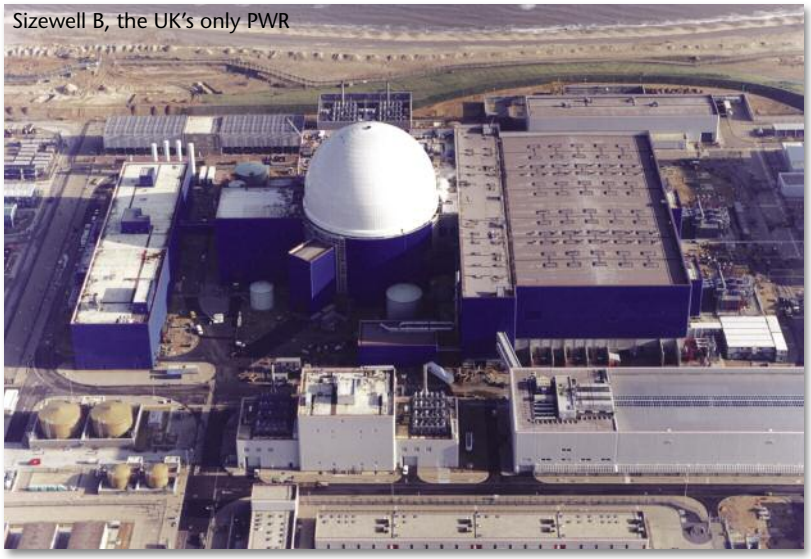
Other options

The second form of real optionality, the option to contract out relates to disposing of the Eggborough coal-fired power station. Although its sale, is stipulated in the purchase agreement with the British government, how this may be undertaken has flexibility or optionality and may be an additional source of value. EDF may even consider some form of option to contract out with regard to the Eggborough plant. Furthermore the existing plant of BE may be temporarily or even permanently shutdown, again affording yet greater value through real optionality.

Similarly, the stipulation that interests in 25% of the BE plants should be sold to a domestic entity, namely Centrica, creates lots of scope for alternative arrangements, affording additional optionality. According to reports and coverage, Centrica will take a 25% of all power generated by BE, once it is owned by EDF, and a 25% stake in new nuclear generators built by the French company. The cost to Centrica will be about £3 billion. Exactly how this will be organized between the French utility and Centrica has not yet been made public and indeed is likely under negotiation at the time of this research. Although attempting to quantify the value of such arrangements would be difficult, the right to enter into a production sharing arrangement with this smaller UK group, which has been mismatched between its customers and its supplies business since conception, does present further flexibility or real-optionality to EDF. It is easy to believe that the French group will have a strong hand in any negotiations and arrangements may favour the larger player, EDF.

LOTS OF OPTIONS

In this article we have examined the entry of EDF into the UK nuclear power industry through the acquisition of the once-troubled British Energy Group. We have shown that the economics of the existing plant, on a narrow financial basis is not very good. One would have to see very large and sustained increases in real prices for power for the economics of the existing BE fleet to generate a positive net present value, given the some £12 billion which EDF paid, or for the existing cost structures or reliability to improve dramatically, albeit unrealistically. Having shown that the economics of the existing BE could not have justified this massive cross-boarder acquisition, we turned to the concept of real-optionality to represent the flexibility which the acquisition offers to the French group. We find that presented in this manner, there is a very strong case for spending over £12 billion because the acquisition through the various sites, creates a massive option to expand. Although under traditional financial-economic cash flow analysis the merits of the transaction are challenging, finding the real-optionality provides fresh insights on how and why this massive FDI makes sense for EDF. Additional optionality as may arise through contracting out production to Centrica may yet even further value production in this multi-national transaction. Additional option value in the transaction might even result through swapping nuclear off-take with flexible gas turbine generated power. Altogether, in taking over British Energy, EDF has lots of options.



Sizewell B, the UK's only PWR

Dr Lawrence Haar is an MD for Commodity Risk with Credit Suisse International. Dr Laura N. Haar is Lecturer in International Business, Manchester Business School, University of Manchester