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Nuclear Power and Deregulated Electricity Markets: Lessons from British Energy

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Abstract The privatisation in 1996 and subsequent financial crisis in 2002 of the company British Energy plc shed some light on the difficulties of running a nuclear generator in a deregulated electricity market. This paper explains the causes of the company's financial difficulties and argues that they do not amount to evidence that nuclear power cannot survive in liberalised markets. The causes of the financial crisis were complex and varied but nuclear power risks are not conceptually different from those successfully handled by markets in other sectors. In particular there is no reason in principle why new nuclear power stations should not be viable in a deregulated power market, assuming they are fundamentally cost competitive.

Keywords Keywords: Electricity markets, nuclear power, risk management, corporate strategy, financial strategy, privatisation.

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1. Introduction

The British government privatised the more modern UK nuclear power stations in the form of the company British Energy plc in 1996. The company was unusual in being a wholly nuclear merchant power generator in a deregulated power market. It was also unusual in having full financial responsibility for its back end nuclear liabilities. The company initially raised output and profits and saw its shares rise strongly. But by 2002 it had run out of cash and had to get emergency financing from the government to avoid going into administration. The subsequent financial restructuring saw shareholders lose most of their investment.

This episode, and the contrast between the company's initial success and subsequent financial collapse, offer an interesting case study in the viability of nuclear power in a deregulated market. But the facts do not support a simple conclusion that nuclear power cannot survive in such markets. A restructured British Energy Group plc was re-listed on the London Stock Exchange in 2005 and continues to trade, albeit with a lot of volatility owing to unreliable power station availability.

A detailed examination of the British Energy story suggests that the roots of the crisis were complex and historically deep (Taylor 2007). The management had to contend with a unique type of technology and with fixed price contracts for fuel reprocessing arising from government decisions taken decades before. The company distributed cash to shareholders which, with hindsight, was unwise and reflected a general misunderstanding of the riskiness of the company. The company's corporate strategy – to vertically integrate as a hedge against falling power prices – was sensible but badly executed. And the company's overall management of risk seems inadequate.

But in this author's opinion, none of this amounts to an indictment of nuclear power's ability to survive in liberalised markets. The rest of this paper argues that the events at British Energy were historically unusual and to a large extent specific. It goes further in suggesting that the various risks associated with running a privately owned nuclear power generator in a liberalised market are not unique to nuclear power and that similar risks are routinely handled in other industries and markets without state intervention.

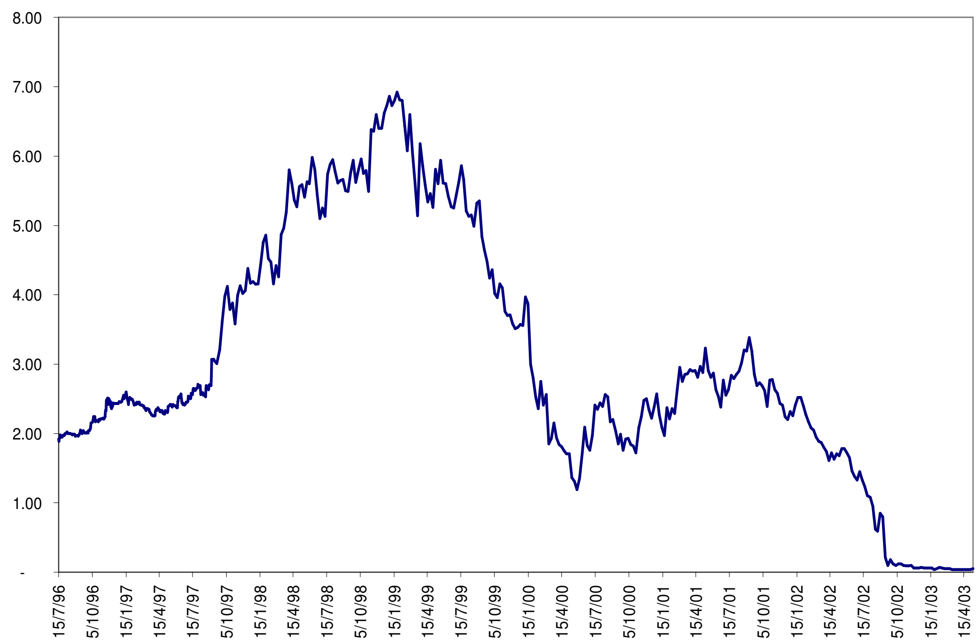
The structure of the paper is as follows. Section 2 describes the events leading up to the financial crisis in 2002 in more detail. Section 3 then examines the proximate cause of the collapse, the fall in wholesale power prices from 1999 to 2002. Section four then examine what is distinctive about nuclear power generation compared with fossil generation. Section five analyses what liberalisation means for power markets. Section six brings these points together to suggest what a nuclear power company should logically do in a liberalised market. In section seven we compare the a priori analysis with British Energy's actual decisions, to show where and why the company became vulnerable to the power price fall. Section eight looks further at the underlying risks in a privatised nuclear generator and argues that all are routinely handled in other privately owned industries. Section nine then concludes.

2. Narrative of events

After an initial failed attempt to privatise nuclear power with the rest of the British electricity industry in 1990, the government put the nuclear stations into two state owned companies, Nuclear Electric for the England and Wales stations, and Scottish Nuclear for the Scottish stations. In 1995 the more modern advanced gas cooled reactor (AGR) stations plus the new pressurised water reactor (PWR) at Sizewell were privatised in the form of a new company, British Energy plc. The older Magnox reactors were retained in a company called Magnox Electric.

Figure 1 shows the share price of the company from its initial listing in June 1996 at a price of £2.03, to a peak of £7.33 in early 1999 and then a decline to less than £1 after the company sought government financial help in September 2002.

Figure 1 British Energy Shareprice 1996-2003 (£, current prices)



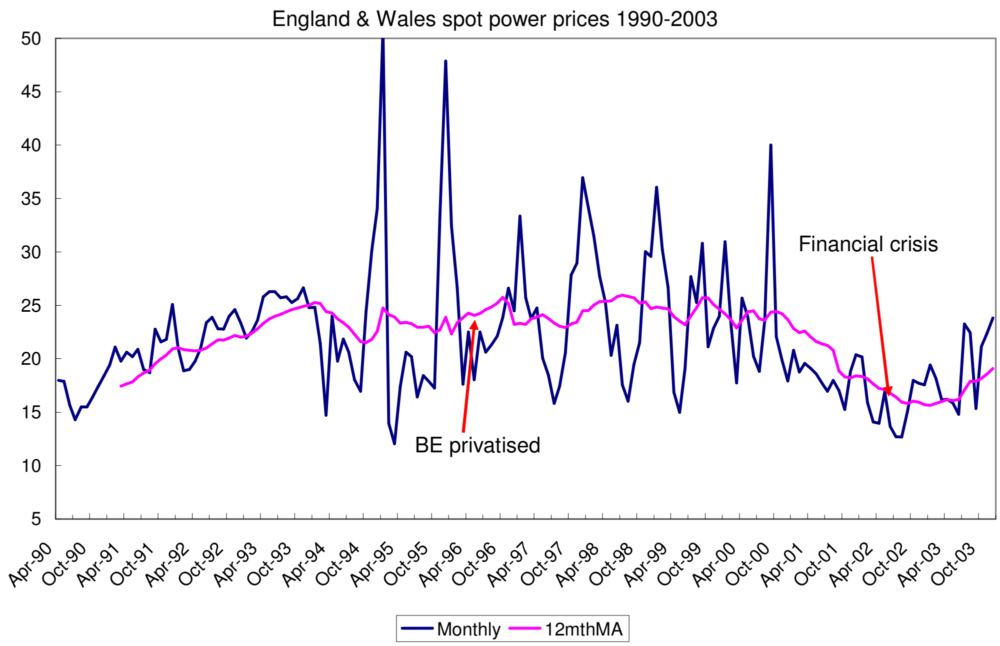
Source: Datastream

After a controversial sale and initially poor share price performance, the company became highly regarded on the back of strong cashflow generation and profit growth. By 1999 the company was able to pay £432m back to shareholders, about 10% of its market capitalisation. But then the company's profitability declined on the back of lower power prices and increasingly unreliable station operating performance. After the management failed to get a sufficient cut in reprocessing costs from the company BNFL the board concluded on 5 September 2002 that the company needed emergency financial support to keep operating. The government then provided a loan of £450m and became the senior creditor in a financial restructuring of the company, leading to a debt for equity swap. The new company was listed on the London Stock Exchange in January 2005.

3. The proximate cause: power prices

The “obvious” cause of British Energy’s financial crisis was the fall in wholesale electricity prices which began in 2000 and continued to mid-2003 (figure 2). Prices fell from around £22/MWh to about £17/MWh, or about a quarter. British Energy goal was to break even at a price of £16. By the autumn of 2002 the company was making accounting and cash losses and facing an imminent loss of investment grade credit rating. The immediate need for government funding was to allow the company to post collateral in the electricity trading market, without which it could not sell its power.

Figure 2: England and Wales Spot Power Prices 1990-2003 (£/MWh, current prices)



Source: Pool; Datastream; UKPX

Other electricity companies suffered badly from the power price collapse. The US electricity companies AES and Edison International both lost substantial amounts on coal power station investments and the company TXU Europe (a subsidiary of Texas Utilities) went into liquidation in 2002.

4. What’s distinctive about nuclear?

The key economic points about nuclear power generation compared with fossil generation are shown in table 1.

Table 1: Characteristics of Nuclear Generation

Characteristics	Implications for management	Relevance to British Energy	Relevance to other nuclear operators
High fixed, low marginal costs	High operating leverage (*) Run at baseload	Highly relevant	Highly relevant
Large deferred liability costs	High financial leverage. Financial complexity.	Highly relevant	Less relevant in US because government has responsibility for waste fuel

(*) Extent to which a change in sales causes a change in operating profits

Compared with conventional thermal generation, nuclear plants typically have much higher fixed costs and lower marginal costs. A nuclear plant requires around ten times as much capital investment as a combined cycle gas turbine plant (Roques et al, 2005). This means they have an economic incentive to run at maximum load i.e. baseload (Pouret and Nuttall, 2007). It also means that small changes in the selling price lead to magnified changes in profits, known as high operating leverage.

The other distinctive physical feature of nuclear plants is that they produce waste products with very long lives and requiring costs lasting decades or more for treatment, storage and disposal. In the UK this physical feature has important economic consequences, because nuclear companies are required to account for and pay for these waste treatment processes. In the US the federal government takes physical and economic responsibility for these costs in exchange for a fixed 0.1c/kWh levy on output, which is a normal operating cost. By contrast British Energy must provide for future waste storage and disposal costs, which lie in the future, representing a form of non-interest bearing debt. In both countries the nuclear generator is responsible for the costs of decommissioning the power stations. The combined effect of spent fuel and decommissioning liabilities is that a nuclear company like British Energy has significant financial leverage, even if it has no interest bearing debt.

High operating leverage and high financial leverage combine to make a company's net cashflows to investors more risky than average (implying a high beta in a capital asset pricing model framework). British Energy should therefore have been regarded from the start as an intrinsically high risk company, unlike the monopoly utility companies that also traded on the London Stock Exchange. British Energy was also riskier than the fossil generating companies, not only because of its greater operating and financial leverage but because power prices

5. What do liberalised power markets mean?

The UK wholesale electricity market was liberalised when the industry was privatised in 1990-1991. By abolishing barriers to entry in generation and by allowing first large customers (above 1MW demand, from 1990) and then medium customers (above 100kW demand, from 1994) freedom to choose supplier, the government allowed the electricity market to function more or less like other commodity markets. Generation ownership remained highly concentrated until the two main incumbents, National Power and PowerGen, sold much of their coal plant at the end of the 1990s so competition was initially muted. But by the time British Energy was privatised in 1996 electricity was a substantially liberalised market.

A "commodity" is something of homogeneous, well defined quality that is demanded by customers, normally for transformation into something of higher value. The traditional commodities are agricultural (soy beans, corn, orange juice) or industrial (coal, copper, zinc, oil). Gas and electricity are also commodities but this was less clear because they were typically not traded in competitive markets until relatively recently.

Commodities and commodity markets have the characteristics shown in table 2.

Table 2 Characteristics of Selected Commodities

Commodity	**Quality variation**	**Cyclicality**	**Seasonality**	**Derivative markets exist?**	**Distinctive features**
Oil	By sulphur,	Moderate	Yes (US driving season)	Extensive	Slow but cheap to move
Corn	Standard categories	Low	High	Futures	Slow but cheap to move
PVC	No	High	Low	Limited	Expensive to move
Coal	Sulphur, energy content	Moderate	Moderate	Limited	Regional rather than global markets
Natural gas	No	Low	High	Extensive	Regional rather than global market
Electricity	No	Low	Very high	Limited but growing	Non-storable, limited international trading

Electricity shares the key commodity features that it is a homogeneous, undifferentiated product of well defined quality. Demand is less cyclical (ie related to GDP fluctuations) than for industrial commodities such as metals and petrochemicals. But electricity demand is highly seasonal with very inelastic demand. When combined with the impossibility of large scale storage, this makes electricity prone to very volatile short term prices in a competitive market.

Commodity prices are typically volatile both intra-year and over several years, reflecting shifting demand and supply curves. For industrial commodities there is a traditional “cycle” of interaction between GDP-driven demand fluctuations and lags in supply which leads to pronounced boom-bust pricing variations. This is especially true in industries with a high minimum efficient scale (MES) of capacity such as oil refining and petrochemicals, where new plant may add materially to industry supply, leading to a big fall in prices.

Electricity has a relatively low MES of capacity, especially since the advent of combined cycle gas turbines which are viable at levels of 250MW (e.g. compared with total UK installed capacity of around 78,000MW (National Grid, 2007)). Annual demand variation is also much lower than for industrial commodities since a large part of demand is relatively insensitive to the state of the economy (heating, lighting, domestic use).

But the electricity market was very new in the mid-1990s and it is not at all clear that policy makers or the key market participants had adjusted to thinking of electricity as a commodity.

Commodity markets bring pricing risk for buyers and sellers. Well established commodity markets have evolved futures markets and sometimes options market too, in response to the demand for risk management. Sellers of corn or orange juice can hedge their positions efficiently using futures contracts. Similar markets have evolved for oil and some petrochemicals markets and now for natural gas. In electricity these markets have been slower to evolve, partly because of the limited physical integration of networks which has kept markets relatively small. In the UK the concentration of ownership of generation undermined the scope for derivatives markets through the 1990s, so that the nascent electricity forward agreement (EFA) market only achieved low volumes (Herguera, 2000).

6. Implications for nuclear power: indicated strategies

Nuclear power is commercially more exposed to commodity price risk because it has high fixed costs. If nuclear liabilities are regarded (as they should be) as de facto debt, then British Energy also had high financial leverage. This made the company’s profitability highly sensitive to the price of power.

Short term price volatility can be dealt with easily through contracts. Most large buyers and sellers of power in the UK in the 1990s bought on contracts of one year duration. This left the exposure to longer cycle variations in price. Since demand for power is relatively non-cyclical, that leaves supply (capacity) variation as the main cause of long term price variation.

Given the inherent commercial risk of nuclear power in a liberalised market there are a number of logical strategies for managing that risk. Risk cannot be reduced to zero and if it is costly to manage it then the optimal amount of hedging from a shareholder’s point of view is not necessarily high. The main arguments for some hedging are the costs of financial distress and convexities in the tax system (reference). Table 3 shows the options for a nuclear generator in a liberalised market.

Table 3: Risk Management Strategies for Nuclear Generation in a Liberalised Market

Activities	Comment	BE's actions
1. Corporate strategy		
Vertical integration	Questionable: downstream assets have intrinsic value; risk of over-paying	Failed
Diversified generation	Questionable: investors can diversify the risk themselves	Costly acquisition of coal station (Eggborough)
2. Commercial strategy		
Sell power on long term contracts	Depends on demand existing	Limited success: lack of demand
Sell options to raise value of commodity power	Depends on demand and/or markets existing	Limited success: lack of demand
Maximise reliability of stations, back up power sources or contractual equivalents		Under-investment; reliability fell
3. Financial strategy		
Maintain strong balance sheet		Paid out too much cash in 1999
Have variable dividend policy or share buybacks (like steel)		Wrong dividend policy
Choose long term debt to avoid liquidity crunches		Failed/bad luck: attempt to refinance bond in early 2002 hit by Enron fallout

Source: Taylor (2007)

7. British Energy's approach to these strategies

Table 3 also shows BE's actions in relation to the range of options available for a nuclear generator managing risk in a liberalised market. The overall verdict must be that the company failed to execute a vertical integration strategy, tried but failed to implement commercial risk management (owing to the lack of demand) and pursued the wrong financial strategy. The upshot was that the company was very badly positioned to cope with the fall in power prices from 1999 and therefore ran into financial crisis in September 2002.

The crisis was made more likely by the existence of the long term fuel reprocessing contracts with BNFL, which added to the company's fixed costs. But the company's corporate strategy made things worse too by adding to the company's exposure to the electricity price by: i) buying a coal power station in 1999; and ii) buying a portfolio of power offtake contracts with the acquisition of the Swalec supply business in the same year (Taylor 2007 p.110).

The fact that British Energy failed financially in 2002 reflects its financial and corporate decisions, not the inherent risks of nuclear power in a liberalised market.

8. Nuclear risks examined

The risks of a privately owned nuclear power generator are decomposed into categories in table 4, which gives examples of other industries and markets that manage very similar risks.

Table 4: Component Risks in Nuclear Power Generation

Risk type	Other industries experiencing similar risk
Commodity price volatility	Steel, petrochemicals, oil, banks
Operations risk	Manufacturing, process industries
Very long term liabilities	Extractive industries
Third party accident risk	Chemicals
Political, litigation & regulatory risk	Oil, banks, tobacco
Catastrophe risk	None

The only type of risk which is unique to nuclear power is the risk of a catastrophe such as the Chernobyl disaster of 1996. The potential third party liability of such events is so high that such risks are uninsurable in normal markets. The US introduced government insurance of nuclear plants with the Price-Anderson Act of 1957 (Rothwell 2002). In the UK nuclear operators' liability is capped under the provision of the Nuclear Installations Act 1965 and the Energy Act 1983, which implement the international convention on third party liability signed in Paris in 1960 and Brussels in 1966 (OECD, 2003).

This means that nuclear generation, even in a liberalised market, does not present any new form of risk management beyond those already used in other industries, in the private sector.

9. Conclusions

The financial collapse of the nuclear generator British Energy plc in 2002 doesn't "prove" that nuclear power is unworkable in a liberalised power market. The combination is certainly risky, mainly nuclear generation combines high operational leverage with (in the UK context at least) high financial leverage arising from the long term liabilities. Liberalised power markets behave much like other commodity markets and the price volatility is a big challenge for risk management.

But none of the risks in nuclear power is unique, except for the catastrophe risk which is automatically borne by governments under international treaty. British Energy mismanaged its risks, resulting in costly financial restructuring, but this should not be taken as evidence against nuclear power more generally. The "new" British Energy company, floated on the London Stock Exchange in 2006, has a much more appropriate financial strategy (chiefly low leverage and a variable payout policy) and is paying due attention to the operational risks of the ageing British reactors. Investors understand the company better and the shares, while volatile, trade successfully like any other power company.

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