



Energy Market Insights

The Cost of Capital for Merchant Power Generation: The Example of Drax

by Tomas Haug and Richard Hern

From the Editor

Across the world, the power generation industry requires massive new investment but questions remain about the right mix (e.g., between capital-intensive nuclear or CCS coal and cheap-to-build but expensive-to-run CCGT). At the same time, the industry continues to adapt to deregulation, with new players entering the industry and incumbents expanding out of their traditional markets, driving merger activity. With deregulation has come privatisation and increased scrutiny from antitrust watchdogs, sometimes resulting in forced restructurings and divestments. In all these settings, the cost of capital for power generation is a key parameter for decision-making, but there is little consensus across the investment community about what figures to use. In this EMI, Tomas Haug and Richard Hern review recent evidence on the cost of capital for Drax, focusing on beta risk. Drax provides a unique benchmark in that it is one of the few publicly quoted, focused merchant generation businesses in the world. The authors show how an understanding of both finance and energy markets is key to creating estimates of the cost of capital and hence reliable valuations.

Sean Gammons, Editor

Introduction

Much of the UK's power generation capacity is in need of replacement or substantial upgrades (e.g., for environmental compliance). For example, in its recently published Project Discovery report, Ofgem, the UK gas and electricity regulator, assessed the cumulative investment needs (excluding transmission and distribution) of the country to be up to £150 billion by 2020, of which the bulk would be dedicated to power generation.¹ Other European countries face similar challenges.

The cost of capital is a key input to the appraisal of any investment project, but especially for long-term capital intensive projects like power generation. Finance theory tells us that the cost of capital is primarily a function of non-diversifiable risk, which is typically measured by a beta coefficient in the Capital Asset Pricing Model (CAPM). However, there is little direct evidence available on the beta for merchant power generation, and what evidence is available is open to different interpretations.

In this issue of *Energy Market Insights* we review evidence on betas for merchant power generation in the British market using the example of Drax, a large coal-fired power station located in the north of England, and one of the few publicly quoted, pure play merchant generators anywhere in the world. Applying standard techniques, we find that the historical asset beta for Drax has varied from 0.5 to 0.8 over the last few years, which all else equal gives a range of around 10-12% for the pre-tax weighted average cost of

capital (WACC). This range is equivalent to a 20% valuation impact, as illustrated in Box 1, thus demonstrating the importance of identifying the correct beta when appraising generation investments.

Box 1 Impact of Discount Rate on Drax Valuation

In this example, we show the impact of different discount rates (pre-tax WACC) on Drax's enterprise value, using our in-house valuation model, EnergyMetrics™. Table 1 sets out our projections of Drax's free cash flows, derived using EnergyMetrics™. Table 2 shows the range of Drax's pre-tax WACC based on a range of asset betas from 0.5 to 0.8. With these assumptions, the enterprise value for Drax lies in the range of £434/kW and £528/kW, equivalent to a 20% valuation impact.

Table 1 Drax's Free Cash Flow

		2010	2011	2012	...	2029
Load Factor	%	23%	28%	25%	...	31%
Captured Clean Dark Spread	£/MWh	25.9	28.5	29.8	...	55.0
Net Revenues	£/kW	44.8	60.0	55.4	...	133.4
Fixed O&M costs	£/kW	33.2	33.8	34.5	...	48.3
EBITDA	£/kW	11.7	26.2	20.9	...	85.1
Capex	£/kW	3.1	3.7	3.3	...	5.7
Free Cash Flow - Unlevered	£/kW	8.5	22.4	17.6	...	79.3

Source: NERA illustration; **Note:** Load factor and captured clean dark spread are derived on a consistent basis using our proprietary dispatch model for the UK, EnergyMetrics™

Table 2 Drax's Pre-tax WACC Range

		Low Beta	High Beta	Difference
Risk Free Rate	%	4.4%	4.4%	
ERP	%	5.4%	5.4%	
Asset Beta	number	0.5	0.8	0.3
Tax Rate	%	28%	28%	
WACC (pre-tax) - Unlevered	%	9.8%	11.9%	2.0%

Source: Bloomberg, NERA analysis.

2000 03 29	103.29	190.0194
2000 04 29	104.29	191.2223
2000 05 31	105.31	193.213
2000 06 30	106.33	194.625
2000 07 31	107.35	196.038

By construction betas are backward-looking and sluggish in detecting structural, fundamental changes in a company's exposure to systematic risk.

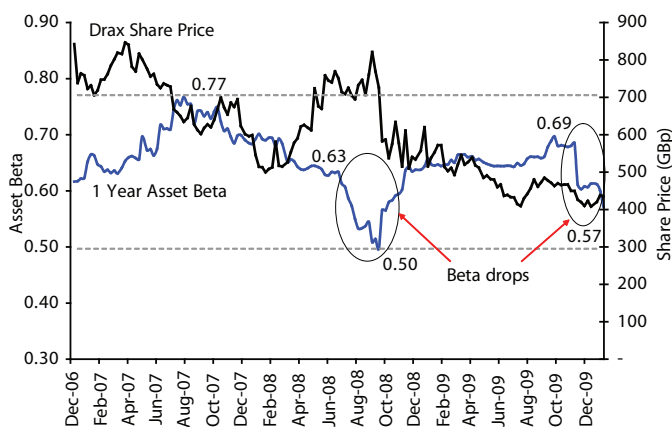
Beta Estimates

In simple terms, the beta coefficient is a measure of the portion of an asset's variance that cannot be avoided by holding a fully diversified portfolio of assets. In other words, it is a measure of the systematic risk of holding an asset.

The true beta of a stock cannot be observed. Instead, betas must be estimated through regression analysis of *historical* stock price returns against the *historical* returns of the market index.² Therefore, by construction betas are backward-looking and sluggish in detecting structural, fundamental changes in a company's exposure to systematic risk. However, from a valuation perspective it is critical that the beta reflects a forward-looking estimate of the systematic risk over the *forecast period* of cash flows and asset prices.

Figure 1 shows one-year historical rolling asset betas for Drax alongside the performance of its share price since late 2006.³ As can be seen from this figure, Drax's asset beta has been highly volatile over the period, ranging from 0.50 to 0.77.

Figure 1 Drax Asset Beta and Drax Share Price



Source: NERA analysis of Bloomberg data; betas are 'Blume' adjusted and are based on daily share price data using the FSTE All Share Index as the reference market.

One of the most striking features of this chart is the sharp drop in Drax's asset beta in the period leading up to the financial crash that followed the collapse of Lehman Brothers in mid-September 2008 (from 0.63 to 0.50), and the sharp fall again in late 2009 (from 0.69 to 0.57). These step changes are highly unusual in charts of historical betas for infrastructure assets.

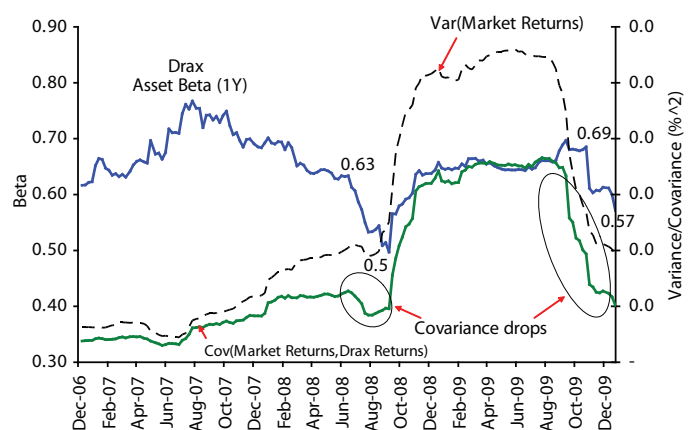
The other unusual feature of the fall in Drax's estimated beta in late 2009 is that it occurred at a time when the Drax share price was also falling: a fall in the riskiness of an asset is typically associated with a rise in its value, not a fall.

To understand why the beta of Drax fell in mid-2008 and late 2009, we need to remember that beta measures non-diversifiable, systematic risk and is defined as the covariance between returns on the asset's cash flows (R_i) and that of the aggregate market (R_M), divided by the variance of the returns on the market index, as follows:

$$\beta_i = \frac{\text{Cov}(R_i; R_M)}{\text{Var}(R_M)}$$

Decomposing Drax's asset beta into the covariance and the market variance components, as illustrated in Figure 2, shows that the sharp declines in asset beta in mid-2008 and late 2009 were primarily driven by falls in the covariance between Drax's share price and the market index, albeit the variance of the market also fell during these periods.

Figure 2 Decomposition of Drax Beta into Covariance and Variance (One-Year Rolling Basis)



Source: Bloomberg and NERA analysis.

Drivers of Beta Risk

In order to understand why the covariance of returns between Drax and the market index has changed over time, and therefore why Drax's historical beta fell in these two periods, we need to examine the fundamentals that drive Drax's share price movements relative to movements in the market portfolio as a whole.

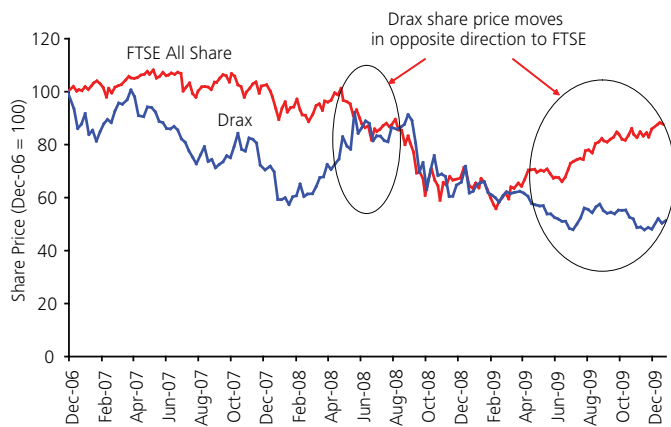


Figure 3 shows the movements in the Drax share price against the stock market index, and illustrates that the Drax share price and the FTSE index moved strongly in opposite directions over two distinct time periods:⁴

- Around mid-2008, in the run-up to the Lehman collapse (mid-September 2008): during this period, the Drax share price increased, whereas the FTSE fell; and
- March 2009 to December 2009: during this period, the Drax share price fell, whereas the FTSE increased.

These differing trends weakened the covariance of returns between the Drax share price and the FTSE and hence explain why Drax's beta fell.

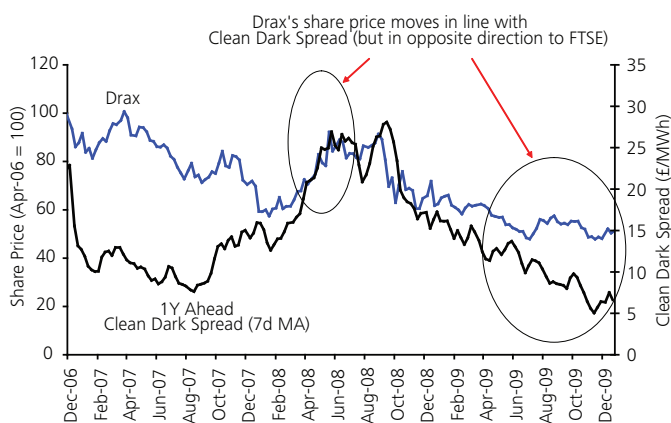
Figure 3 Drax Share Price Versus FTSE All Share Index and One-Year Ahead Clean Dark Spread



Source: Bloomberg and NERA analysis.

Drax's share price depends primarily on the outlook for earnings, which are strongly correlated with the outlook for clean dark spreads in the British wholesale power market.⁵ Figure 4 shows that the periods where Drax's beta fell coincided with periods when the forward clean dark spread reached significant highs and lows. An understanding of why the clean dark spreads were at these levels will help us to understand why the Drax beta declined sharply during these periods.

Figure 4 Drax Share Price Versus FTSE All Share Index and One-Year Ahead Clean Dark Spread

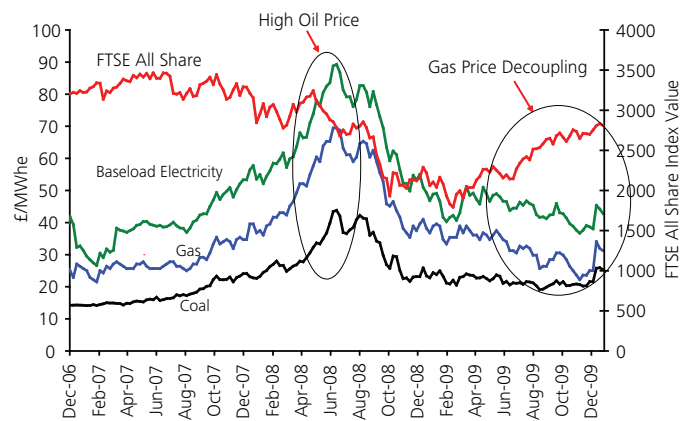


Source: Heren, Platts, Bloomberg, NERA analysis.

Oil Price Volatility

Oil prices soared to record levels in 2008, peaking at over \$140/barrel in mid-July, before falling back sharply. This spike in oil prices fed through into a spike in GB gas prices, and hence to a spike in GB power prices, which are often set by gas-fired power stations, as illustrated in Figure 5. The spike in coal prices was not as pronounced as the spike in electricity prices, however, and hence, as we have already seen, clean dark spreads increased significantly over this period.

Figure 5 One-Year Ahead Prices of Baseload Energy, Gas, and Coal Prices (£/MWh)



Source: Heren, Platts, Bloomberg, NERA analysis; Note: forward coal prices based on ARA CIF and forward gas prices based on UK NBP Gas (one-year ahead).

Figure 5 shows that over the same period as oil and gas prices soared in mid 2008, and hence so too Drax's prospective earnings,⁶ the FTSE started to decline on the back of mounting worries about write-downs of subprime-related securities by financial institutions and fears the world was heading for recession. It is this situation that caused the Drax share price and the FTSE index to move in opposite directions and which explains, at least to some extent, the fall in the covariance of returns between the two, and therefore the fall in beta.

We examine the fundamentals that drive Drax's share price movements relative to movements in the market portfolio as a whole.

2000 03 29	0.6329	190 0194
2000 04 29	0.6429	191 2223
2000 05 31	0.6531	1703 2133
2000 06 30	0.6633	1024 625
2000 07 31	0.6735	117 353038 548

Valuation models must use discount rates that are consistent with the underlying drivers of the projected cash flows in order to provide reliable estimates.

After the collapse of Lehman Brothers in mid-September 2008, oil and gas prices started to plummet as it became clear the world economy was in crisis. This period marked a turning point for Drax's asset beta: Drax's share price started to fall driven by the same underlying factors that affected the wider stock market, namely fears about the state of the world economy. Hence, Drax's beta increased sharply.

Gas Price De-Coupling

The second period when the Drax beta fell sharply was in late 2009. As Figure 5 shows, this period coincides with a sharp decline in forward gas prices during a period of stable coal prices, and hence a sharp fall in the forward dark spread. The fall in forward gas prices during this period was driven by three key factors: (i) an increase in supply, (ii) a severe fall in gas consumption, and a (iii) de-coupling of market gas prices from oil-indexed gas contract prices:

- Gas supply to the UK and Europe has increased with a surge in LNG capacity coming on line. European LNG capacity has expanded by 20% in 2009 and LNG imports have increased about 15% compared to 2008.⁷ The dramatic improvement in the prospects for unconventional gas production in North America (primarily shale gas) has further increased the supply of gas.
- Gas consumption fell in the second half of 2009 due to the recession. As a result the European gas market has experienced the largest absolute gas consumption decline for the past 25 years.
- The growing liquidity of LNG trade has led to greater integration between European, US, and Asian gas markets and hence helped undermine the traditional linkage seen between spot gas prices and oil prices in Europe, thus driving market gas prices below oil-indexed gas contract prices.

It is the combination of these factors that continued to drive down forward dark spreads and hence Drax's share price at a time when the FTSE rallied. The opposite movement of the Drax share price and the FTSE caused the covariance of returns to weaken from March 2009 onwards, which explains at least to some degree the sharp fall in beta around this time – as of January 2010, Drax's one-year historic asset beta is 0.57, down from around 0.69 shortly before its drop (see Figure 1).

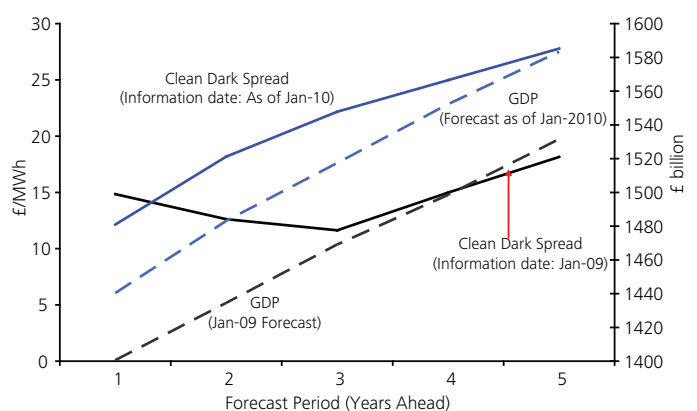
Consistency Between Beta & Cash Flows

Valuation models must use discount rates that are consistent with the underlying drivers of the projected cash flows in order to provide reliable estimates.

For example, if cash flow projections are based on the assumption that the economy will recover quickly from recession and drive up oil and gas prices, then the discount rate also needs to be consistent with these assumptions.

In the current market environment, most market analysts are expecting energy prices to move higher in the short- to medium term on the back of a global economic recovery. Most forecasts also project a re-coupling of market gas prices and oil-linked gas contract prices as the supply surplus in world gas markets is eroded by demand growth, which would put upward pressure on UK gas prices.⁸ Consistent with this view, Figure 6 shows there have been substantial upward revisions in the outlook for both GDP and UK dark spreads since early 2009. The chart also suggests a strong positive correlation is re-emerging between future dark spreads and GDP growth—by contrast, in early 2009 dark spreads were forecast to fall further in the short term while GDP was forecast to rise slowly.

Figure 6 Change in Projections of Clean Dark Spreads and Real UK GDP (January 2009 vs. January 2010)



Source: Forecast of GDP collected from Bank of England and Consensus Economics. Forecast of clean dark spreads are based on forward curves at the time of information date and our proprietary dispatch model for the UK, EnergyMetrics™.

Figure 6 is a clear example of changes in market forecasts that may not be picked up in a historical beta estimate. There is evidence that today's projections of energy prices and cash flows are substantially different from one year ago. In particular, dark spreads were forecast to fall in Jan-09 up to year 3



The required discount rate depends on the risk profile of the project, not the sponsor.

whereas levels in UK GDP were forecast to increase over the whole period. In Jan-10 both dark spreads and UK GDP were forecast to increase over the whole period. In such situations, historical betas that are based on regressions of one year's worth of data, placing equal weight on each data point, will not fully reflect the current risks associated with the investment.

Since the Jan-10 forecasts of gas prices project a re-coupling of market gas prices and oil-linked gas contracts (and the oil price is generally highly correlated with the market index), the *forward-looking* covariance between Drax and the market index at Jan-10 is therefore likely to be higher than the historical beta estimates suggest.

For this reason, the historical one-year betas that we observe in late 2009 of around 0.5 to 0.6 are likely to underestimate current forward-looking expectations of systematic risk for coal-fired merchant generation in GB.

Conclusion

Using Drax as an example, we have shown that betas estimated using historical data can produce widely varying results, with significant impacts on valuation. The asset beta for Drax has varied from 0.5 to 0.8 over the last few years, which all else equal gives a range of 9.8% to 11.9% for the pre-tax weighted average cost of capital (WACC), equivalent to a 20% valuation impact.

Faced with this variation, it is critical to understand the underlying drivers of beta risk over the estimation period, in order to determine a forward-looking beta that is consistent with the modeled projections of energy prices and cash flows, and hence gives a reliable valuation. On this basis, we conclude that valuations of Drax should use discount rates based on betas at the upper end of the recent historical range of 0.5-0.8. Our calculations therefore suggest a pre-tax discount rate of around 11-12% nominal for Drax in current market conditions. When we compare our bottom-up valuation of Drax using a 12% discount rate to current market valuations of Drax we see a very close match: we obtain £434/kW and the market currently (as of January 2010) values Drax at £430/kW.

The discount rate we have identified for Drax is the best available benchmark that should be applied to the valuation of all merchant coal-fired generation projects in GB, whether undertaken by independents or integrated utilities, since the required discount rate depends on the risk profile of the project, not the sponsor. Discount rates for other types of investment, such as gas, nuclear, or renewables, or in other geographies may be higher or lower, but the Drax discount rate still provides a useful benchmark given the lack of project-specific stock market data for other technologies and regions.

EndNotes

1. Project Discovery is Ofgem's investigation into whether or not future security of supply can be delivered by the existing market arrangements over the coming decade. Ofgem's Final Report is available at: http://www.ofgem.gov.uk/Markets/WhlMkts/Discovery/Documents1/Discovery_Scenarios_ConDoc_FINAL.pdf.
2. Beta is derived as follows:
$$R_{it} = \alpha_i + \beta_i R_{Mt} + \epsilon_{it}$$
with
$$\beta_i = \frac{\text{Cov}(R_i, R_M)}{\text{Var}(R_M)}$$
where R_{Mt} denotes the return of the market portfolio and R_i denotes the return to stock i for period $t = 1, \dots, T$. The error terms ϵ_{it} are assumed to have zero mean, constant variance and to be independently and identically distributed (IID). Following the Sharpe (1964) and Lintner (1965) version of the CAPM, all returns are in excess over a risk-free interest rate and α_i is expected to be zero.
3. Drax is a coal-fired power station with a net capacity of 3,960 MW, which has historically provided about 7% of the UK's electricity supply. It has been listed on the London Stock Exchange since December 2005.
4. Also from Aug-06 to Feb-06 the Drax share price falls whereas the FTSE increases slightly. However, this period appears not to have a material impact on beta, as the opposite movement of Drax share price and the FTSE is less pronounced than during May-08 to Oct-08 and Mar-09 to Jan-10.
5. The "clean dark spread" is the wholesale price of power less the cost of coal and the cost of EU ETS CO2 allowances (all expressed in £/MWh(e), where MWh(e) means a megawatt-hour of electricity output).
6. For instance at 11 September 2008, UBS Investment Research reported Drax's target price at 800 GBp, which was around 9% above its current share price (734 GBp). UBS retained their "neutral" rating on Drax.
7. The IEA in its Annual Energy Outlook 2009 states: "The looming glut in gas-export capacity results from factors on both the supply and demand sides. Chief among these are an ongoing surge in LNG capacity coming on line and a dramatic improvement in the prospects for unconventional production in North America, on the one hand, and the unexpected severe slump in demand in 2008-2010 caused by the recession on the other."
8. See for example Goldman Sachs, "Overview: Economic recovery followed by gas and power price rebound", 7 January 2010.

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