# The Evolving Risk Profile of European Energy Utility Companies and the Energy Sector


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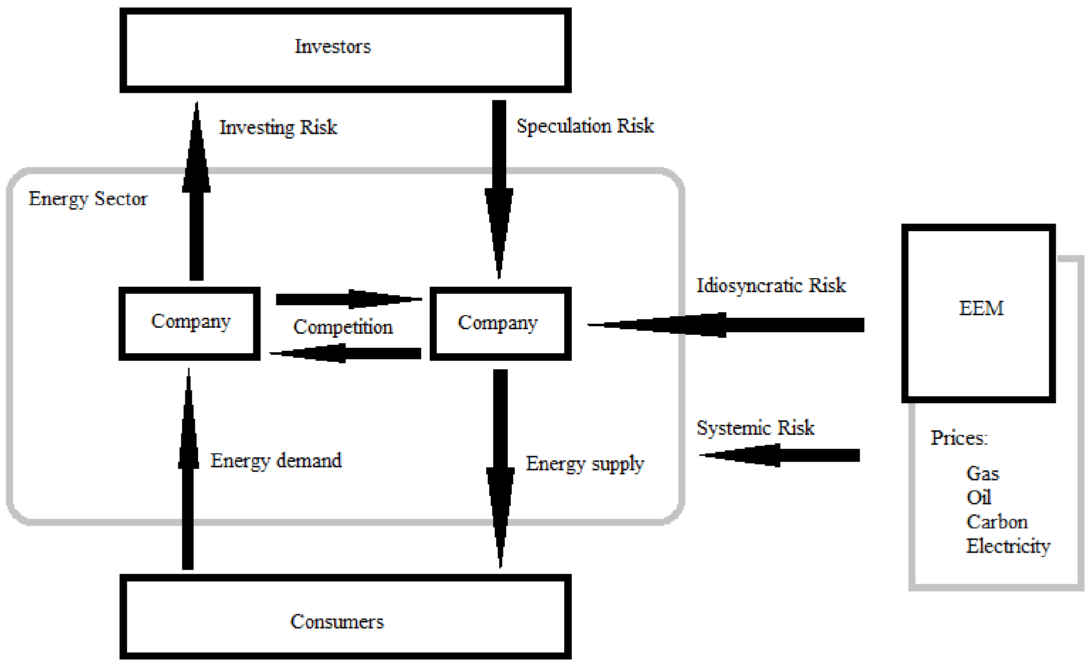
**Abstract**
This paper explores the evolving market risk profile of the European energy utility sector and companies since the liberalisation of the European energy market (EEM) started. Using established market risk metrics and total return data for individual utility companies and indexes (for the European utilities sector and the European equities market) the paper explores whether liberalisation has led to energy companies taking on more market risk (idiosyncratic risk) and whether this is also reflected in increased systemic risk for the European energy sector (EES) as a whole. The results presented suggest there have been an increase in risk for individual utility companies and the energy sector in Europe. Price return graphs covering internal market liberalisation for energy utility companies show increased volatility around liberalisation. The results show that for idiosyncratic risk, Jensen's alpha, the energy utility's stock appear to be risky for their level of return, especially at liberalisation. For systemic risk, beta appears to have little correlation with the market at liberalisation but in recent years has begun to become more correlated with market returns. There has been an increase of Value at Risk since liberalisation.


**Keywords:** Market risk; energy policy; liberalisation, financial risk


## 1. INTRODUCTION

This paper explores the evolving market risk profile of the European energy utility sector (EES) and companies since the liberalisation of the European energy market (EEM) started. The term market risk is used frequently in this paper, but it is important to clarify that in the context of this paper it specifically refers to equity and commodity price risk. Equity risk is the market risks associated with the position of an equity stock (Dowd, 2005, p.15) which can affect the ability of energy utility companies to secure capital in the future (Nwaeze, 2000, p.50). Commodity risk which refers to the market risks associated with a commodity, such as a long or short position in gas, oil or electricity (Dowd, 2005, p.15). Figure 1 depicts how different types of risk can arise from interactions within an energy system. Within the European energy system there is the EEM where energy commodities are bought and sold; competition in the energy sector between the energy companies; investor speculation; changing demand and supply of energy for consumers. The scope of this paper will primarily focus on everything within the energy sector.

**Figure 1: A Diagram of the Energy System**




*The Changing Nature of Utilities*

During the 20th century the majority of energy companies had traditional energy utility structures focusing on a single utility: taking primary energy sources such as oil, coal or natural gas to generate electricity to supply to national end users.

Alternatively, energy utility companies may refine oil and natural gas to suit the end user's needs; such as gas, heat oil, or fuel oil. In the mid 1990s the European Commission introduced Council Directives which liberalised the electricity and gas market to replace monopolies, leading to vertical and horizontal disintegration for energy utility companies. This increased competition encouraged energy utility companies to become multi-utilities, providing a number of utilities such as electricity, gas, water, telephone and internet (ECOTEC, 2001, p.v & vi). Cases such as Enron and the California electricity crisis demonstrated how liberalised multi-utility energy companies with unrestricted and unregulated market power were able to manipulate the market in an attempt to increase profits (Joskow & Kohn, 2002; Wolak, 2005). Within Europe examples of blackouts due to asset sweating have been experienced (Wolak, 2005), resulting in a lack of investment by energy companies particularly in Italy and the UK, and outside the European Union by Switzerland, the USA and Scandinavia (Helm, 2005). A completely liberalised market can make investors wary of holding stock for the aforementioned events, therefore with some regulation there will be the investment incentive of increased investor security coupled with adequate investment in the energy market, and once again, secure energy supply to end consumers at a lower cost due to the inability to sweat assets, and the reduced market risk.

*European Energy Market Liberalisation*

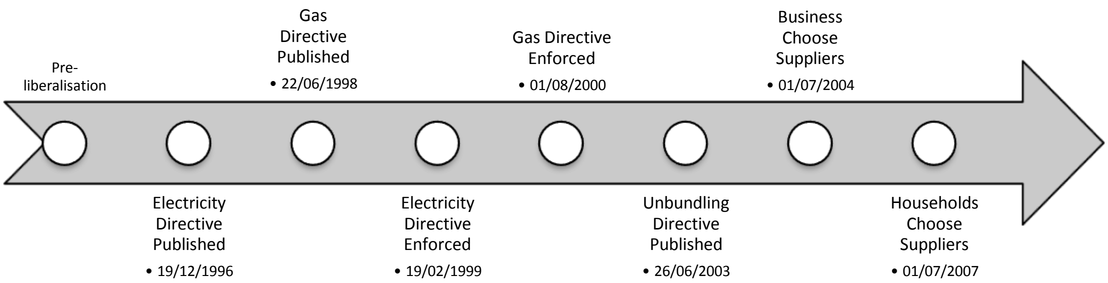
The internal market in electricity was subject to Council Directives 96/92/EC and enforced in February 1999, whilst gas was subject to Council Directive 98/30/EC and enforced on the 1st August 2000 (ECOTEC, 2001, p.1).

The both markets were liberalised with the expectation that liberalisation would result in the free movement of goods, persons, services and capital, leading to an increase in efficiency in the production, distribution, security, supply and competitiveness of the European economy (Directive 96/92/EC, 1996, p.1; Directive 98/30/EC, pp.1 & 2). In 2003, a council directive was introduced which separated distribution and transmission systems from the production systems, leading to vertical and horizontal disintegration. This ensured a level playing field in generation reducing the risk of market power dominance and predatory behaviour ensuring non-discriminatory transmission tariffs between member states and across borders to protect vulnerable customers (Directive 2003/54/EC, 2003, pp.1 & 4; Directive 2003/55/EC, 2003, p.1). A further council directive highlighted the issue of non-discriminatory network access and need for equally effective level of regulatory supervision in each member state, which at present do not exist (Directive 2009/72/EC, 2009, p.1). It was also suggested in this directive that national energy regulators, regulating both electricity and gas, need to be harmonised and strengthened (Directive 2009/72/EC, 2009, p.4; Directive 2009/73/EC, p.1 &2).

The liberalisation of the natural gas market followed similar directives with minor additions. Firstly, the interconnections and quality of gas need to be comparable between member states. In contrast to electricity, natural gas long-term contracts were prioritised so far as they did not undermine the objectives of a competitive market (Directive 2003/55/EC, 2003, p.3).

Additionally, on 1st July 2004 all non-households (businesses) could freely choose their energy suppliers, and from 1st July 2007 all customers including households could choose their energy suppliers (Ringle, 2003; Directive 2009/72/EC, 2009, p.26; Directive 2009/73/EC, 2009, p.28). Figure 2 shows a timeline which summarises all events.

**Figure 2: A Timeline of Liberalisation Events**




Important issues in the electricity and natural gas directives was that the lack of liquidity and transparency in the market. This hinders efficient resource allocation, risk hedging and new entries; therefore energy regulators and financial market regulators need to cooperate in order to enable each other to have an overview of the energy market. (Directive 2009/72/EC, 2009, p.5; Directive 2009/73/EC, 2009, p.5; Diaz-Rainey *et al.*, 2011). These liquidity and risk hedging issues can cause increased price volatility of these energy utility companies, potentially affecting the future earnings and the reliable supply of electricity and gas to end users, as demonstrated by Ewing and Malik (2010, p.1011) with oil.

*Hypotheses and Paper Structure*

To sum up, this paper attempts to enhance the academic understanding of energy market liberalisation by investigating the effects of market liberalisation on the amount of market risk being taken by energy utility companies and the energy sector. Thus there is one overarching hypothesis for the paper that market liberalisation has increased the market risk of energy utility companies and the EES. This can be broken down into two distinct hypotheses:

$H_1$ – *European energy market liberalisation resulted in an increase in idiosyncratic risk for European energy utility companies.*

$H_2$ – *European energy market liberalisation resulted in an increase in systemic risk for the European energy sector.*

*Idiosyncratic Risk* represents the portion of a stocks variance which is not attributable to overall stock market volatility (Bali *et al.*, 2005, p.910), while *Systemic Risk* is the risk from infrequent events that are highly correlated across a large number of assets which reduces gains from diversification and penalises investors for holding leveraged positions (Das & Uppal, 2004, p.2810). For this paper the systemic event is market liberalisation.

The rest of the paper will explore these two hypotheses as follows; Section 2 provides a review of relevant literature while Section 3 develops the methodology of the paper by defining the risk metrics and data used to explore the hypotheses. Section 4 reposts the results and Section 5 provides some concluding commentary.

## 2. LITERATURE REVIEW

*Financial Risk, Liberalisation and the Energy Sector*

In liberalised energy sectors, market forces are given more scope and the government adopts a less interventionist role (Cameron, 2007). It is therefore important that the sector is understood and changing trends identified to avoid unexpected market risk such as those associated with the recent financial crisis. Financial crises are associated with excessive risk taking, fraud and firm failures, and regulatory failure which could affect the energy supply in Europe (Diaz-Rainey *et al.*, 2011). The recent rise of oil, gas and other energy commodity prices has increased inflation at a macroeconomic level (Cologni & Manera, 2008, p.857). Increased energy prices would create a price pressure on the economy, increasing discount rates and reducing the present value of cash flows (Ramos & Veiga, 2010, p.1). Boyer and Filion (2007, p.433) also found that the price fluctuations of oil and gas directly affected the stock return of Canadian oil and gas companies as it affected revenues, profits, investments, and cash flows.

Vivian and Wohar (2011) imply that the cause of volatility in a market may be the result of speculative investors purchasing commodities as financial assets. As fossil fuel prices have risen it has attracted increasing investment from $6bn to $320bn from 2000-2009 (Economist, 2010). This continual speculation in energy assets can significantly affect the stock price of the energy utility companies, which affects the funds available through stock float for future investment which may significantly affect the ability of these companies to supply energy to the end users. It is near impossible to stop investors speculating in stock markets. Akerlof and Shiller (2009) iterate multiple times that the inefficiencies in stock markets and their stock pricing is the caused by human interactions in stock markets. Often investors are overconfident which causes investors to overtrade good stocks, under-trade bad stocks and effectively distort the true pricing of the stock. This compliments Nwaeze's (2000, p.65) findings where small utilities experienced larger negative return effects than large utilities suggesting a vulnerability of small utilities as a adverse effect of market inefficiencies through competition.

The shift towards open competition modified the traditional regulatory regime that protected utilities from the profit effects of cost and demand shocks, which in turn leads to increased earnings variability as inefficiencies could no longer be transferred to the consumer (Nwaeze, 2000, p.49). Nwaeze (2000, p.49 & 51) found after liberalisation large utilities experienced the largest increase in risk and the most abnormal decline in returns. Cologni and Manera (2008, p.857) suggest the most intuitive justification is that oil price shocks are indicative of the increased scarcity of energy. Diaz-Rainey *et al.* (2011) classified three categories of risk which may be applicable to an energy price shock; (1) *macroeconomic* (2) *energy systemic* and (3) *financial systemic.* Macroeconomic risk is caused by an energy speculative bubble or price spike, which through macroeconomic transmission induces inflation and is countered by high interest rates, ultimately leading to slower economic growth. Whereas energy systemic risk is described previously through market manipulation of energy to falsely inflate the energy price. Financial systemic risk is unlikely in the current context as shown by the collapse of Enron, which though it impacted equity markets did not pose any financial systemic threat.

Diaz-Rainey *et al.*'s (2011) energy systemic risk is demonstrated in an earlier paper by Nwaeze (2000, p.65) where energy market reforms caused increase earnings variability, measured from return on assets and return on equity, within energy utility companies. Nwaeze (2000) found that there were significant increases in systemic risk around reforms and negative abnormal returns around events associated with reform. Ramos and Veiga (2010, p.2) found support for global oil and gas industry returns following oil price changes, and oil price volatility being positively associated with gas and oil industry return. Firstly, this spike in industry returns could lead to a price increase for the end consumer. Secondly, this indicates that sector and market is linked; therefore there is the possibility of contagion risk.

*Hedging Risk in Energy Companies*

There are many similarities between financial assets and the assets of energy utility companies. Haushalter (2000) found several features which make gas and oil producers well suited for an analysis of risk management policies. Firstly, energy companies are exposed to common risk: the volatility of oil and gas prices can vary the cash flow of the companies. Secondly, methods are available for these energy companies to hedge their risk. Thirdly, there is a large dispersion in risk management policies among oil and gas producers: Haushalter (2000) found through surveys with chief financial officers of 100 companies that in 1993 the fraction of annual production hedged by energy companies varied from zero to 97.5 percent.

To hedge production either the selling price for production is fixed or it is insured against dropping below a fixed level (Haushalter, 2000, pp.112). The sales price of production of oil and gas producers can be locked in by using forward agreements, fixed price contracts, volumetric production, forward contracts or swaps (Haushalter, 2000, pp.112). The extent of hedging can be defined as the fraction of the firm's production for the year that is hedged against price fluctuations (Haushalter, 2000, pp.112). Haushalter (2000, pp.146) found that the fraction of hedging from oil and gas producers is positively related to the ratio of total debt to total assets, and is thought to be linked to financial contracting costs: companies with more access to public debt hedged less than those without. Hedging was also greater for companies with little financial flexibility, measured by the relative amount of debt outstanding and cash holdings.

*Measures of Market Risk; Alpha, Beta and Value at Risk*

Market risk itself can be broken down into subcategories of risk: one such category is basis risk. Basis risk is a risk generated when two indices or stock track, but do not precisely replicate each other (Figlewski, 1984; Haushalter, 2000). An example would be the correlation between the price of an asset being hedged and the price of an asset underlying the hedged instrument: the lower the correlation the greater the basis risk from hedging (Haushalter, 2000, pp.115). The most apparent cause of basis risk is the non-market return component of an asset, the idiosyncratic risk (Figlewski, 1984). This non-market return component is linked to Jensen's alpha.

Jensen's alpha is referred to as the active return on investment, and is the excess of the compensation of the risk borne. Jensen's alpha was originally developed to identify a fund manager's performance. If an investment company (or any company's alpha) is higher than 0 this indicates that the company is getting a better return for the amount of risk it has borne; if the alpha is 0 the market is efficient and the return is appropriate to the level of risk borne; an alpha below 0 indicates the company's rate of return is not sufficient for the risk borne (Jensen, 1968, p.393).

Beta measures to covariance between a stock and the market and can be a measure of systemic risk (Jensen, 1968, p.391; Mankiw and Shapiro, 1986, p.453). Beta is defined as the covariance between a stock and the market (Abdelghany, 2005). If a beta of a stock is 1 it will move in the same direction with the same magnitude as the market. Betas higher than 1 move in the same direction but higher magnitude than the market, and betas less than 1 move in the same direction but with less magnitude than the market. Negative betas move opposed to the market, and betas of 0 have no covariance with the market. Fabozzi and Francis (1979, p.1243) indicate that beta should not be measured over an entire period as it does not account for changes in risk; possibly being influenced solely by market-timing. By measuring beta over time this can identify if energy utility companies are correlated to the performance of the European TMI (Total Market Index) and to what degree EEMs and EESs are susceptible to systemic and contagion risk. Measuring beta over time for energy companies can indicate a change in market risk, either equity or commodity risk, which affects the company's ability to raise funds and supply energy; whereas measuring EESs against the European TMI can indicate whether there has been an increase of systemic risk for EESs since liberalisation, which may indicate a requirement for more regulation. If beta has increased then an infrequent systemic event which results in a price fall could (A) result in a restricted ability for energy companies to raise capital due to low share prices (Nwaeze, 2000, p.50), and (B) penalise any investor with a leverage position, resulting in less capital available for energy companies and poor investment in the energy sector.

Supporting research includes Basher and Sadorsky (2006) who found that countries that are net importers of fossil fuels found covariance between the price of oil and the development of the economy and financial markets. This need for future energy planning to reduce risk is closely linked to the work of Awerbuch (2000; 2003) who used portfolio theory and oil price volatility to construct a well diversified energy portfolio, in an attempt to reduce systemic risk to the European sector. Numerous studies have shown that Beta continues to be an appropriate measure of systemic risk (Mankiw & Shapiro, 1986; Pettengill *et al.*, 1995; Abdelghany, 2005).

Value at Risk (VaR) is an attempt to provide a single number that summarises the total risk in a portfolio (Hendricks, 1996; Hull, 2010). VaR allows the researcher to make a statement that for a given time horizon *t* and confidence level *p*, the value at risk is the loss in market value over the time horizon *t* that is exceeded with probability 1-*p* (Duffie & Pan, 1997; Linsmeier & Pearson, 2000, p.48; Cabedo & Moya, 2003, p.241; Hull, 2010). VaR indicates the likelihood that we will get an outcome no worse than the VaR from “normal” market movements and any greater losses are suffered with a specified small probability (Linsmeier & Pearson, 2000, p.48; Dowd, 2005, p.27). With a constant level of confidence it becomes possible to measure and plot the changing VaR and thus risk quantification of an energy company over time to identify if European energy utility companies have become more or less risky on an annual basis since before, and after liberalisation.

VaR has many advantages as it is flexible and can accommodate a number of assumptions previous risk measures could not, such as non-normally distributed data (Dowd, 2005, p.11). VaR also provides a common consistent measure of risk across different positions and risk factors, is holistic, takes full account of all driving risk factors and is expressed in a simple unit of measurement (Dowd, 2005, p.12). VaR has previously been used to measure the changing idiosyncratic risk of companies, such as its use by Cabedo and Moya (2003) to estimate oil price risk.

Some criticisms of VaR is that different VaR models can give different VaR estimates for the same portfolio and may be subject to implementation risk, with empirical support from Beder (1995, p.23). Beder (1995, p.23) also argues that VaR does not account for all risk factors, such as political risk, liquidity risk and regulatory risk. However, this criticism is not relevant as only market risk is being investigated and a single VaR model is being applied on all companies, over the same time horizon, and from the same market. Also, VaR will be used in conjunction with other risk measures.

# 3. METHODOLOGY: DATA AND ANALYSIS

## *3.1 Datasets*

Two datasets are employed in this research; those related to individual companies and those of related indices (for the European utilities sector and the European equities market). Dataset 1 involved identifying energy companies which had traded before and after market liberalisation to investigate the effects of market liberalisation. The universe of companies used in this paper was located using MarketLine. MarketLine allows companies to be categorised using industry, the type of energy utility company, the primary source of revenue, and type of energy production generated. The following depicts the election process for companies used in this paper:

- Energy utility companies.
- Primary revenue from power generation.
- Located within Europe.
- Sorted by revenue (US$M).
- Trading for at least 1 year prior to market liberalisation.
- Continue to trade after the markets were liberalised.

Using the selection process above and the availability of total return data on Reuters EcoWin Pro a sample of 26 companies was selected for the pilot study. However, during the pilot study Jersey Electricity plc was removed due to highly irregular data returns which skewed the dataset significantly. Also, Hafslund A and Hafslund B were found to be subsidiaries of the same company: Hafslund A was taken forward in the pilot, which left the remaining 24 companies shown in Appendix A. Historical total return data was used as it accounts for all capital appreciation, income and capital gains, and any costs such as dividends (Ritter, 1991, p.15; Brown and Goetzmann, 1995, p.680). As total return is a return on investment ratio it measures the change in stock price since the stocks were first floated.

For the analysis relating to the systemic risk of the energy sector it was identified that European utility funds which had significant operations in European member states closely followed the STOXX 600 Utilities Index. Net returns in EUR were downloaded from the STOXX website (STOXX, 2011a), delimited and the utilities index retrieved. Using historical prices return can be calculated as

$$r = \frac{(P_t - P_{t-1})}{P_t} \tag{1}$$

where $r$ denotes the return, $P_t$ denotes the current price, and $P_{t-1}$ denotes the previous price.

### *3.2. Measures of Risk*

Bali *et al.* (2005) use their model of variance as a forward looking predictive tool, and calculated the equally-weighted idiosyncratic risk from the excess return from the market to identify time series variation, defined as

$$VARIANCE_{ew,t}(\varepsilon) = \frac{1}{N_t}\sum_{i=1}^{N_t} VARIANCE_{(\varepsilon i,t)}, \tag{2}$$

where the equally-weighted monthly idiosyncratic variance of the stock $i$, $VARIANCE(_{\varepsilon i,t})$, is calculated using the within-month daily return data on $R_{i,t}$ and $R_{m,t}$: the return on stock $i$ at time $t$, and the return on the market and time $t$, respectively, and where $N_t$ is the number of stocks. Bali *et al.* (2005) also calculated the value-weighted average idiosyncratic variance using market capitalisation weights as

$$VARIANCE_{vw,t}(\varepsilon) = \sum_{i=1}^{N_t} w_{i,t} VARIANCE_{(\varepsilon i,t)}\ , \tag{3}$$

where $w_{i,t}$ denotes the weight of the stock at time $t$, and the median idiosyncratic variance, $VARIANCE_{m,t(\varepsilon)}$ is used to reduce the impact of outliers on $VARIANCE(\varepsilon_{i,t})$. As a footnote Bali *et al.* (2005, p.911) highlights that they use the standard market model

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \tag{4}$$

where $\alpha_i$ denotes the intercept of the stock return with the market return, $\beta_i$ denotes the correlation between the stock return and market return, $R_{m,t}$ denotes the market return at time $t$, and $\varepsilon_{i,t}$ denoted the random error of the stock at time $t$ which can be assumed to be 0 as historical returns are being calculated, and the model will not be used for forecasting. The alpha components of the standard market model can measure the idiosyncratic risk of the energy utility companies. One measure of a stock's alpha is Jensen's alpha, calculated as

$$\tilde{R}_{jt} - R_{Ft} = \alpha_j + \beta_j[\tilde{R}_{Mt} - R_{Ft}] + \tilde{u}_{jt} \tag{5}$$

where $\tilde{R}_{jt} - R_{Ft}$ denotes the asset premium (Jensen's alpha), $\alpha_j$ the return on the portfolio, $\beta_j$ the covariance between the portfolio and the market, $\tilde{R}_{Mt}$ the expected market return, $R_{Ft}$ the risk-free rate of return, and $\tilde{u}_{jt}$ the expected random error for forecasting. However, as this paper is not forecasting a portfolio and we want to measure the changing Jensen's alpha over time a few adjustments were made (including changing the components to fit with the other formulae) to measure the changing alpha on a single stock, becoming

$$J\alpha_{jt} = r_{jt} + \beta_{jt}[r_{mt} - r_{Ft}] \tag{6}$$

where $J\alpha_{jt}$ denotes Jensen's alpha on the individual stock at time *t*, $r_{jt}$ the return on the stock at time *t*, $\beta_{jt}$ the beta of the stock at time *t*, $r_{mt}$ the return on the market at time *t*, and $r_{Ft}$ the risk-free rate of return at time *t*.

The beta for the stock will be calculated on an annual basis as

$$\beta_{mjt} = \frac{cov(r_{jit}, r_{mt})}{VARIANCE(r_{mt})} \tag{7}$$

as an estimate of systemic risk of asset *j* at time *t* (Jensen, 1968, p.391; Mankiw and Shapiro, 1986, p.453). The beta will be calculated for the pilot using historical total return data for the European utility companies drawn from EcoWin, and the STOXX TMI will be used as the market data; drawn from STOXX's historical dataset. The STOXX Europe TMI represents West and Eastern Europe as a whole, and covers 95% of the free float market capitalisation across European member states (STOXX, 2011b). The beta will be calculated on an annual basis to measure the changing beta over the time.

As noted earlier Value at Risk (VAR) is an established metric of market risk (See Section 2). Duffie and Pan (1997) stated that when using a 99% confidence interval, and a 2 week time horizon the VaR risk is expected to be exceeded only once every 4 years, demonstrating the predicting ability of VaR. However, Hendricks (1996) suggests that a 95$^{th}$ percentile produces more accurate risk measures than the 99$^{th}$ percentile that Duffie and Pan (1997) and Cabedo and Moya (2003) used, which only covered between 98.2 and 98.5 of all outcomes. The ideal time horizon for VaR is the time it takes to ensure orderly liquidation of positions in market; in addition it can be assumed that the portfolios would not change significantly over the shorter holding period (Dowd, 2005, p.30). VaR will be calculated using the parametric approach, specifically, estimating VaR using normally distributed arithmetic returns using the formula

$$VaR = -q_p \tag{8}$$

meaning that VaR is the negative of the $p$-quantile of the Profit/Loss distribution of the total return index, expressed as

$$\alpha VaR = -(\mu_r - \sigma_r z_\alpha) \tag{9}$$

Where $z_\alpha$ is the standard normal variate corresponding to α (a confidence interval of 95%), $\mu_r$ is the mean return, $\sigma_r$ is the standard deviation of the return. Due to the higher number of observation necessary to calculate VaR with normally distributed arithmetic returns VaR will be calculated on an annual basis. Also, the use of a hypothetical investment of €1,000,000 on an annual basis should help control for size of the portfolio.

# 4. EMPIRICAL RESULTS

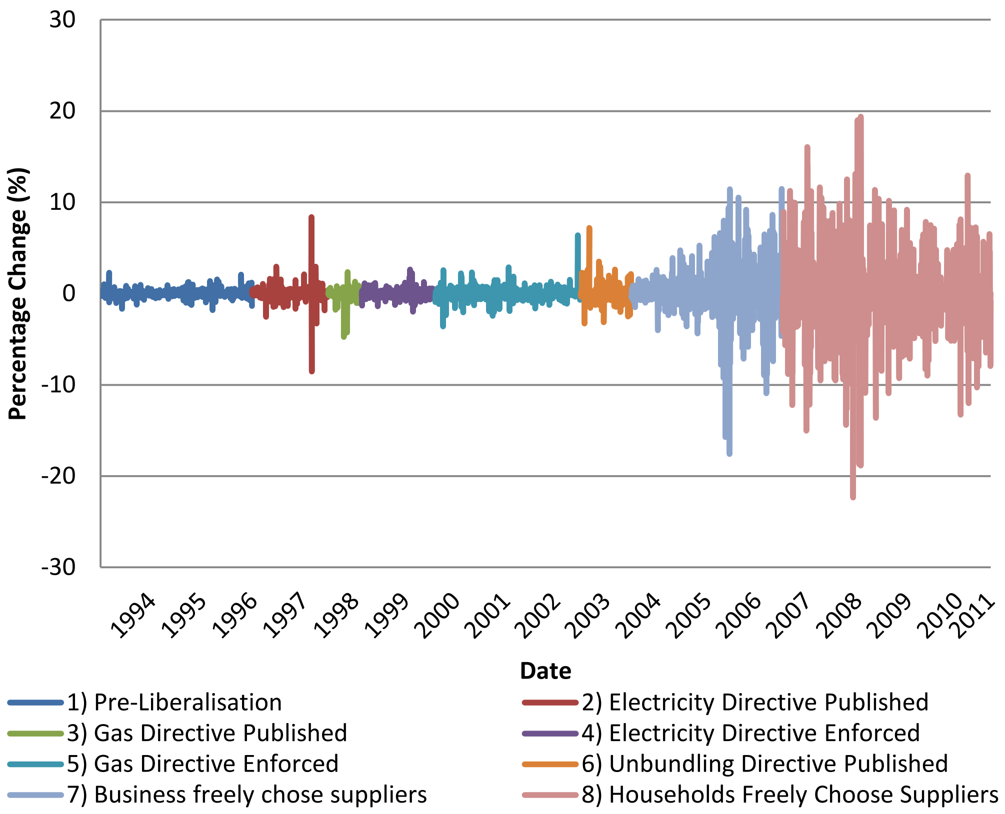
## *4.1. The Idiosyncratic Risk of Energy Utility Companies.*

The change in total return data was calculated to make the data stationary as

$$Total\ Return\ Change = \frac{TR_{jt}}{TR_{jt-1}} \tag{10}$$

where $TR_{jt}$ denotes total return value at time $t$, and $TR_{jt-1}$ denotes the total return value at time $t_{-1}$. The reason for this is to produce a visual representation of total return change, where the total return daily change appears to become more volatile around the time of electricity and gas market liberalisation, and appears to reduce in volatility when the 2003 European directive to unbundle distribution and production is imposed as shown in Figure 3.

**Figure 3: Average Daily Total Return Change for Energy Utility Companies**




Alpha and Beta was then calculated annually for each company, and as each company has $n<50$ a Shapiro-Wilk test was used to test for normality (Shapiro and Wilk, 1965) with the results shown in Table 1. The motivation for this was to identify whether outliers could be included for non-normally distributed data, or to remove outliers for normally distributed data. For the Jensen's alpha dataset 13 companies fail to reject the null hypothesis of normal distribution, whilst 11 companies reject the null hypothesis of normal distribution at ($p \leq 0.05$). For the beta dataset, 15 fail to reject the null hypothesis of normal distribution, whilst 9 reject the null hypothesis of normal distribution.

**Table 1: Test for Normality for Alpha and Beta Values**

| | *Alpha Shapiro-Wilk* | | | *Beta Shapiro-Wilk* | | |
|---|---|---|---|---|---|---|
| | *Statistic* | *df* | *Sig.* | *Statistic* | *df* | *Sig.* |
| Total | .945 | 13 | .524 | .936 | 13 | .402 |
| RWE | .943 | 13 | .493 | .985 | 13 | .995 |
| Repsol | .915 | 13 | .215 | .963 | 13 | .798 |
| Iberdrola | .980 | 13 | .979 | .920 | 13 | .248 |
| SSE | .909 | 13 | .176 | .914 | 13 | .208 |
| Areva | .716 | 13 | .001* | .851 | 13 | .030* |
| BG group | .760 | 13 | .002* | .921 | 13 | .258 |
| Alpiq | .812 | 13 | .009* | .710 | 13 | .001* |
| Atel | .814 | 13 | .010* | .729 | 13 | .001* |
| Acciona | .806 | 13 | .008* | .800 | 13 | .007* |
| International Power | .924 | 13 | .283 | .788 | 13 | .005* |
| Verbund | .915 | 13 | .215 | .797 | 13 | .006* |
| EVN | .978 | 13 | .970 | .917 | 13 | .230 |
| Ellaktor | .816 | 13 | .011* | .935 | 13 | .397 |
| repower | .818 | 13 | .011* | .936 | 13 | .410 |
| Hafslund | .794 | 13 | .006* | .826 | 13 | .014* |
| Gemina | .925 | 13 | .296 | .928 | 13 | .325 |
| Electricite de Strasbourg | .927 | 13 | .313 | .966 | 13 | .837 |
| Arendals | .850 | 13 | .028* | .920 | 13 | .249 |
| Ganger Rolf | .948 | 13 | .567 | .943 | 13 | .501 |
| Global Ecopower | .641 | 13 | .000* | .829 | 13 | .016* |
| C. Rokas | .912 | 13 | .197 | .903 | 13 | .148 |
| Viridas | .894 | 13 | .112 | .751 | 13 | .002* |
| Kinexia | .858 | 13 | .036* | .881 | 13 | .074 |

*Indicates rejection of the null hypothesis of normal distribution at $p \leq 0.05$.

Although the split between normally and non-normally distributed data was approximately even, outliers and extreme outliers were removed as the outliers appeared to have a significant effect on data averages. Most outliers for alpha calculations were founds to be preceding 2008 when the financial recession began; for beta calculations the there was also a number of outliers preceding 2008, but extreme outliers in other years were identified and removed. All graphs begin at 1994 ensuring the majority of companies which were trading during market liberalisation returns were included in the calculations.

Figure 4 shows the average Jensen's alpha values found during the pilot study. There is a noticeable drop in alpha in 1997 to 2000 when both electricity and energy markets were liberalised, indicating the stocks were bearing higher risk than their return. The second fall in alpha is during the global financial recession. Jensen's alpha value remains below 0, indicating that on average the stocks were always riskier than their historical rate of return. This may because Jensen's alpha factors in the risk free rate of return: the risk free rate of return used was the annual average for a UK treasury bill downloaded from the Bank of England's (2011) statistical database as the Euro bill only had data until 2005.

**Figure 4: Average Annual Jensen's Alpha Values for Energy Utility Companies**

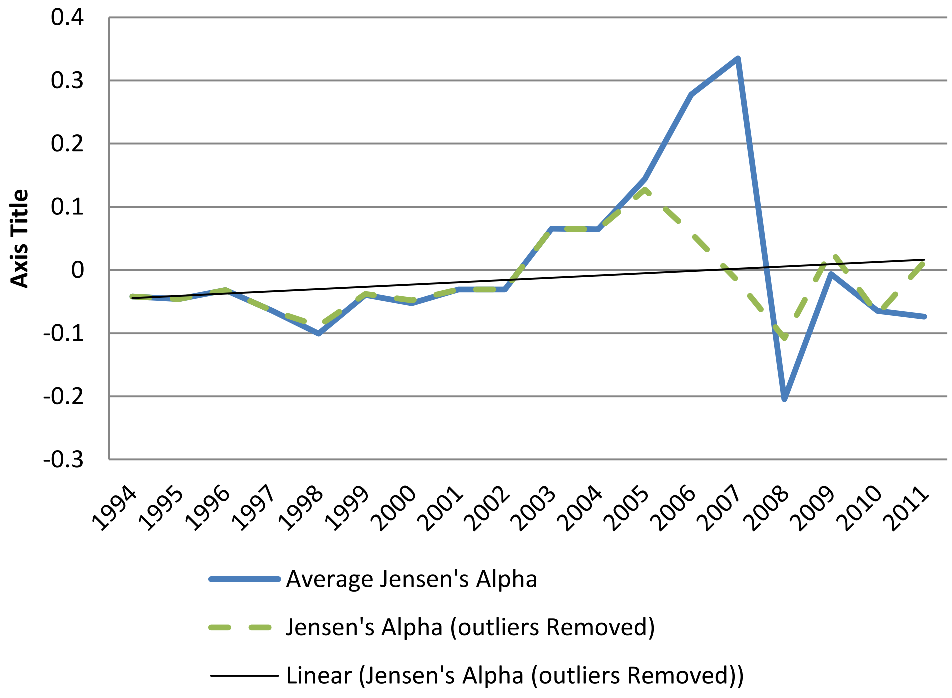
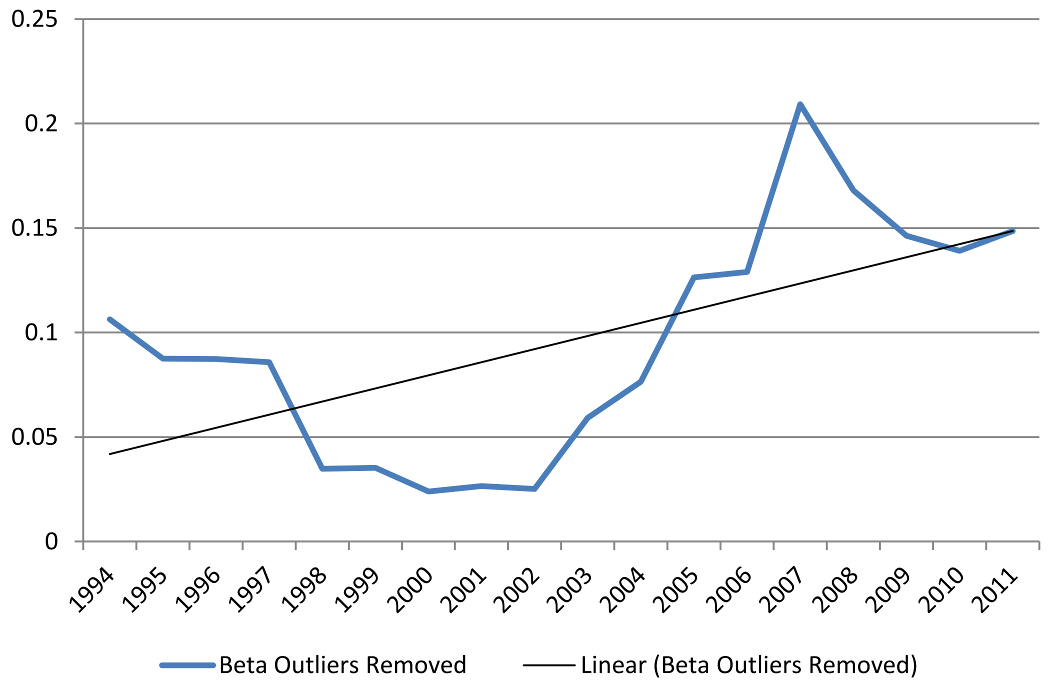



Figure 5 shows the average beta for energy utility companies against the STOXX TMI. As 0 indicates no covariance and 1 indicates covariance at the same magnitude it appears that the average energy utility company shows little covariance with the STOXX TMI, however there is an upward trend in covariance as the timeline approaches the present indicating the stocks are becoming correlated with the STOXX TMI.

**Figure 5: The Average Annual Beta of Energy Utility Companies.**




*4.2. Systemic Risk of the Energy Utilities*

Adapted from Engle (2001) the STOXX 600 Utilities time series was broken into annual time periods and used a hypothetical investment of €1,000,000. The VaR was calculated by multiplying the 5$^{th}$ percentile of the annual returns by the hypothetical investment amount: the VaR value represents the maximum annual amount at risk of being lost through "normal" market movements. Based on liberalisation we would predict a rise in VaR between 1996 and 1998, and based on the European directives there may be a reduction in VaR after 2003 due to the unbundling of distribution and production networks. The results are shown in Table 2.

**Table 2: Summary of VaR Values for STOXX 600 Utilities**

| Year | Investment | 5% Percentile | VaR |
|---|---|---|---|
| 1992 | € 1,000,000 | -0.015262 | -€ 15,262 |
| 1993 | € 1,000,000 | -0.008095 | -€ 8,095 |
| 1994 | € 1,000,000 | -0.014697 | -€ 14,697 |
| 1995 | € 1,000,000 | -0.010530 | -€ 10,530 |
| 1996 | € 1,000,000 | -0.010887 | -€ 10,887 |
| 1997 | € 1,000,000 | -0.012978 | -€ 12,978 |
| 1998 | € 1,000,000 | -0.017274 | -€ 17,274 |
| 1999 | € 1,000,000 | -0.015974 | -€ 15,974 |
| 2000 | € 1,000,000 | -0.015729 | -€ 15,729 |
| 2001 | € 1,000,000 | -0.015097 | -€ 15,097 |
| 2002 | € 1,000,000 | -0.024768 | -€ 24,768 |
| 2003 | € 1,000,000 | -0.017217 | -€ 17,217 |
| 2004 | € 1,000,000 | -0.010078 | -€ 10,078 |
| 2005 | € 1,000,000 | -0.009808 | -€ 9,808 |
| 2006 | € 1,000,000 | -0.012159 | -€ 12,159 |
| 2007 | € 1,000,000 | -0.013904 | -€ 13,904 |
| 2008 | € 1,000,000 | -0.043687 | -€ 43,687 |
| 2009 | € 1,000,000 | -0.022435 | -€ 22,435 |
| 2010 | € 1,000,000 | -0.017625 | -€ 17,625 |

It seems evident that although there is a slight decline in VaR the year preceding the liberalisation of the energy market, once the market was liberalised the VaR value increased. This pilot gives rise to the possibility of increasing the number of VaR intervals as the period following the liberalisation was longer than the period preceding liberalisation, many other market events could have happened during the post-liberalisation time period.

## 5. CONCLUSION

This paper explored the evolving market risk profile of the European energy utility sector and companies since the liberalisation of the European energy market started. Using established market risks metrics and total return data for individual utility companies and indexes (for the European utilities sector and the European equities market) the paper finds that there has in fact been an increase in risk for individual utility companies and the energy sector in Europe. Price return graphs covering internal market liberalisation for energy utility companies show increased volatility around liberalisation. The results show that for idiosyncratic risk (Jensen's alpha) the energy utility's stock appear to be risky for their level of return, especially around market liberalisation. For systemic risk, beta appears to have little correlation with the market at liberalisation but in recent years has begun to become more correlated with market returns. There has been an increase of Value at Risk since liberalisation.

The present analysis has a number of limitations most notably that one should be very careful in interpreting the increases in volatility seen in recent years as being necessarily attributable to the increases in liberalisation in this sector, since similar patterns of volatility may have been seen in other sectors.  What is needed here is a way of comparing the path of volatility seen in this sector against the benchmark of volatility in other sector. The results with respect to beta provide a rough indication in this respect that the increase in volatility in the energy sector is greater than in other sectors. However, more formal approaches are needed. This might include a GARCH analysis incorporating an index of liberalisation and a ratio of energy sector or energy company volatility relative to volatility in other sectors.

# APPENDIX A: UNIVERSE OF COMPANIES

| Company Name | Location | Generation Type | Revenue | Employees |
|---|---|---|---|---|
| TOTAL S.A. | France | Renewable | 211,491.7 | 92,855 |
| RWE AG | Germany | Nuclear | 70,803.1 | 70,856 |
| Repsol YPF, S.A. | Spain | Renewable | 63,911.7 | 41,014 |
| Iberdrola SA | Spain | Nuclear | 40,409.1 | 29,641 |
| Scottish and Southern Energy plc | United Kingdom | Fossil | 34,401.8 | 20,177 |
| AREVA SA | France | Nuclear | 19,528.6 | 79,444 |
| BG Group plc | United Kingdom | Fossil | 16,392.2 | 6,191 |
| Alpiq Holding AG | Switzerland | Renewable | 13,560.3 | 11,443 |
| Atel Group | Switzerland | Renewable | 9,229.5 | 8,461 |
| Acciona SA | Spain | Renewable | 8,316.6 | 31,687 |
| International Power PLC | United Kingdom | Renewable | 5,740.7 | 3,936 |
| Verbund AG | Austria | Renewable | 4,857.6 | 2,820 |
| EVN | Austria | Fossil | 3,668.6 | 8,536 |
| Ellaktor S.A. | Greece | Renewable | 3,163.8 | 5,168 |
| Repower AG | Switzerland | Renewable | 1,758.6 | 656 |
| Hafslund | Norway | Renewable | 1,707.1 | 987 |
| Gemina S.p.A | Italy | Renewable | 796.2 | 2,552 |
| Electricite de Strasbourg SA | France | Renewable | 766.4 | 821 |
| Arendals Fossekompani ASA | Norway | Renewable | 208.0 | 13 |
| Ganger Rolf ASA | Norway | Renewable | 1.6 | Not disclosed |
| Global EcoPower S.A. | France | Renewable | 0.7 | Not disclosed |
| C. Rokas SA | Greece | Renewable | Not disclosed | Not disclosed |
| Viridas Plc | United Kingdom | Renewable | Not disclosed | 2 |
| Kinexia SpA | Italy | Renewable | Not disclosed | Not disclosed |

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