**Special Section: Policymaking Benefits and Limitations from Using
Financial Methods and Modelling in Electricity Markets**

The ongoing deregulation of electricity industries worldwide has introduced market uncertainty into a sector of the economy that was traditionally state regulated. In order to make informed decisions under uncertainty and to manage associated risks, both consumers and producers find it beneficial to use financial methods. While private decision-makers have employed these techniques, such as time-series analysis, portfolio optimisation, and real options analysis, neither the impact of their use on policy goals nor their amenability to policymaking has been widely investigated. In this special section, we feature eight papers that showcase the application of financial methods and modelling in electricity markets.

We hope that they will generate a discussion among academics, industry practitioners, and policymakers about ways in which financial methods and modelling can provide insights into key challenges faced by the electric power industry. Sound policymaking has to be based on an awareness of how companies will respond to the chosen policy instruments, and this has implications for electricity market design and investment incentives, among other areas. Some readers will be able to identify areas in which contemporary financial techniques have already affected policymaking, especially in terms of how projects are launched and risk is hedged. However, we should also consider the limitations of existing methods, possibilities for their improvement, and implications of these for their interpretation and use.

The paper “Restructuring Electricity Policy and Financial Models”, by Leonard S. Hyman, is a critical essay examining the benefits of restructuring the electricity industry in the United States and the UK from a consumer perspective. He argues that in spite of some efficiency gains, the semi-competitive electric model currently prevailing in large parts of the US and in the UK has failed to deliver significant benefits to consumers as compared to the old model. The paper challenges financial modellers to perfect a simple business proposition that will help move badly needed capital to the electricity industry while providing electricity service at a price that will make electricity consumers happy.

We include three papers studying aspects of electricity pricing, and in particular ways of hedging power prices. In their paper “Volatility Transmission and Volatility Impulse Response Functions in European Electricity Forward Markets”, Yannick Le Pen and Benoît Sévi study the propagation of return and volatility shocks among the German, Dutch and British Forward Electricity Markets. Their analysis of forward price data from these markets from March 2001 to June 2005 show positive impact of return and volatility shocks on adjacent markets which they quantify in terms of volatility impulse response functions (VIRF). These impacts are significant, however only when shocks are relatively large and they decay rapidly. Understanding such interactions among these markets may prove valuable to traders who can improve forward price forecasts in the various markets and arbitrage price differences.

Electricity market design in the United States is increasingly dominated by locational marginal pricing (LMP) of energy. Financial Transmission Rights (FTRs) play a key role in such markets as instruments for trading property rights to the transmission grid

and as hedges against congestion charges. (An FTR pays the holder the difference in locational prices between two nodes, for a pre-determined volume of power.) In their paper “Efficiency of Financial Transmission Rights Markets in Centrally Coordinated Periodic Auctions” Seabron Adamson, Thomas Noe and Geoffrey Parker examine the efficiency of FTR markets by means of an empirical study using data from the New York Independent System Operator (NYISO) market containing detailed FTR auction clearing prices and corresponding congestion rents over a six year period. Their analysis confirm earlier more limited studies showing that while market efficiency has improved over time there are still significant gaps between the FTR auction prices and their realized value as hedges against congestion rents.

The paper by Shi-Jie Deng, Shmuel Oren and A.P. Meliopoulos, “The Inherent Inefficiency of Simultaneously Feasible Financial Transmission Rights Auctions”, shows that this lack of efficiency could be an inevitable implication of the algorithm used to clear the FTR auction. Even if generation and demand bids are known with certainty, the actual power flows and nodal prices will depend on the state of the network, and in particular on whether any of the contingencies that reduce its capacity may apply. Bidders in the auction may limit the quantity of FTRs that they seek to acquire, in order to avoid holding FTRs that are not matched by their actual power flows, which would thus increase their exposure to the difference between nodal prices. If these limits are binding and the volume of FTRs bought is less than the expected volume of power flows, the prices in the FTR auction will diverge from the expected nodal price differences. In particular, FTR prices will be based on a vector of nodal prices which has higher prices at generation nodes, and lower prices at demand nodes – to the extent that power flows from generation to demand nodes, the

FTRs will be under-priced. The authors suggest that this under-pricing would be reduced if FTRs were transformed from a specialised hedging instrument to one with more speculative trading, not subject to the bid quantity limits that drive their result.

Two papers consider the shortcomings of traditional approaches to company decision-making, and the extra insights that can come from financial models. Engineering-economic models are widely used to project the effects of changes in policies. Unfortunately, such models generally assume that market actors are risk neutral, and the role of financial contracts is completely disregarded. As a result, projections of investor response to policy and market design changes may be incorrectly characterized, and policy conclusions may be biased. Bert Willems and Joris Morbee take an important step towards correcting these biases in “Risk Management in Electricity Markets: Hedging and Market Incompleteness.” Their model allows them to examine questions that pure engineering-economic models cannot address. Examples include: what is the effect of the availability of financial instruments on the amount and mix of generation investment? How does increased availability affect the welfare of market participants?

Rob Gross, Will Blyth, and Phil Heptonstall examine the short-comings of using levelised per unit costs alone to evaluate new generation technologies in their paper “Investment in Electricity Generation: Why Policy Needs to Look Beyond Cost Modelling.” Investors are also concerned with risks, not just of costs but also of revenues, which do not enter levelised cost calculations. Technologies that are often marginal in the market and set market prices are less exposed to risks in their gross margins than, for instance, baseloaded or renewable technologies. The authors

quantify these risks for several generation technologies under UK market conditions, and discuss the advantages of different government policies that could help to mitigate such risks for renewable generators.

A specific approach to the problem of investing in an uncertain world is to assume that the uncertainty can be treated as risk (in the sense used by Knight (1921)) and model the investment as a Real Option – our last two papers do this. In their paper “Gas-Fired Power Plants: Investment Timing, Operating Flexibility and CO₂ Capture”, Stein-Erik Fleten and Erkka Nasakkala employ a Real-Option approach to analyse investments in gas-fired power plants. They use a two factor price process model for the spark-spread between electricity and natural gas which is calibrated to Nordpool market data. The model captures short term mean reversion and long term uncertainty. Their analysis explicitly accounts for the value of operating flexibility and the opportunity to abandon the capital equipment in determining thresholds energy prices that should trigger investment. Sensitivity analysis suggests, however, that that operating flexibility dominates the investment timing decision whereas the abandonment option is less significant.

In the final paper, “How to Proceed with Competing Alternative Energy Technologies: a Real Options Analysis”, Afzal Siddiqui and Stein-Erik Fleten consider a more general problem, relating to the choice between two alternative investments (which may or may not be mutually exclusive). One technology is available at once with known characteristics and will be profitable for a sufficiently high level of the long-term energy price (which evolves stochastically over time). This investment can only produce a limited amount of power, however (think of a

renewable resource available at a few suitable sites). The other opportunity requires an up-front investment to start its commercialisation, following which its (initially high) cost will decline (again stochastically). It has the advantage of being available in larger quantities, however. The authors show that the value of waiting for improvements in the new technology rises if this is likely to lead to a significant reduction in the technology's costs, but decreases as the price of energy becomes more volatile. This counter-intuitive result comes about because a volatile energy price could well rise to levels where even the rudimentary version of the technology would make money.

Papers in this special section were all presented at the two-day international workshop of the same name sponsored by the UK Energy Research Centre (UKERC) at St Anne's College, Oxford, UK during 9-10 July 2008 (see <http://www.ukerc.ac.uk/support/tiki-index.php?page=0807FinancialMethods>). We are, thus, grateful to the discussants and participants of this workshop for their thoughtful contributions. Furthermore, we would like to thank the UKERC Meeting Place staff for providing excellent administrative support in arranging this timely event: Karyn John, Sarah Keay-Bright, Jennifer Otoadese, and Gabi Tait. A follow-up event that distilled some of the policymaking implications of the papers was held at the UK Department of Energy and Climate Change (DECC) on 23 March 2009 (see <http://www.ukerc.ac.uk/support/tiki-index.php?page=0903FinancialMethod>). Derek Bunn of the London Business School and Ulrike Hotopp of DECC were instrumental in organising this event along with UKERC Meeting Place staff.

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Knight, F. (1921) *Risk, Uncertainty and Profit*, Boston, Houghton Mifflin Company

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