

ELECTRICITY MARKETS

**Investment
Performance
and Analysis**

Barrie Murray

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MARKETS**

**INVESTMENT,
PERFORMANCE AND
ANALYSIS**

BARRIE MURRAY

**ELECTRICITY MARKET SERVICES LIMITED,
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ELECTRICITY MARKETS

To my grandchildren Ella and Harris

PREFACE

The introduction of market disciplines into the operation and structure of utilities represents a very bold experiment in a key part of the infrastructure of developed countries. The change has not been without its opponents and some countries are choosing not to follow the UK example. Some see the need to maintain strategic control as overriding the benefits of full competition. They see a degree of central coordination as essential while others believe the market will solve all. Those countries that are actively pursuing the introduction of competition are not all choosing the same model and there is a wide spectrum of opinion on the best approach. At the time of drafting this text the market in England and Wales is some eight years into operation and it is considered timely to review what the experiment has delivered and what will lie ahead.

I am fortunate in having worked in the area of power system economics both with a state utility and in a deregulated environment and am therefore able to make a detailed comparison of the two approaches. I have also closely followed developments in other countries to draw out the differences and their significance. I have tried to take a neutral position and be as objective and factual as possible with, hopefully, not too much rhetoric and I apologise if this does not appear the case.

The book is intended to be of value to all those associated with the industry, including investors, facility and service suppliers, the new market players and academics involved in teaching and research. It focuses on the analysis of markets and their mechanisms to help develop understanding and in particular on the approach to investment appraisal as being a key determinant of future prices.

The industry has in the past always maintained a public service culture with the focus of keeping the lights on albeit sometimes at the expense of what might be considered economic. In the new environment shareholders are a dominant force and it remains to be seen how well this serves the general public interest. For my part I would like to see the industry succeed and hope this book helps.

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SYMBOLS

Avail	availability
β	LOLP lagrangian multiplier
C	capital cost
CCOS	accumulated energy output of generator
CST	generator cold start
D	demand
DNC	declared net capability
FLX	state variable indicating whether generator is flexible or not
Exp	transmission export limit
FC	fixed cost
g	generator
G_{inc}	generator incremental price
h	hours
HST	generator hot start
I	interest rate
Imp	transmission import limit
In	income
INCU	unconstrained incremental price
L	generator lower output limit
λ	demand lagrangian multiplier
LOLP	loss of load probability
MGEN	minimum stable generation
MOC	generator merit order cost
MOFLT	generator minimum off time
MONLT	generator minimum on time
MW	load
M_t	maximum allowable charge in year t
ON	variable indicating generating unit is on
OP	genset metered payments
P	price
P_o	per unit availability
PPP	pool purchase price
PRP	pool reserve price
P_t	price/kw in year t

Q	consumer consumption
RPI	retail price index
SD	variable indicating generating unit is shut down
SDD	settlement day duration
SMP	system marginal price
SPD	settlement period duration
STC	startup cost
TAU	table 'A' uplift
TCA	total actual cost of metered energy
TCW	total scheduled unconstrained energy
TGD	total gross consumer demand
TGRP	total generation reserve payments
u	utilisation
U	uplift
UL	generator upper output limit
VARCOST	average cost of production based on heat rates and fuel prices
VC	variable cost
VLL	value of lost load

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PART ONE

A REVIEW OF MARKET STRUCTURES AND MECHANISMS

Part 1 describes alternative market structures and their benefits and shortcomings in promoting an optimal generation margin and mix and in reducing prices through competition. It discusses how the choice of structure will be influenced by the inherent topology of the network and the state of evolution of the system. The development of a suite of models to appraise investments is described and the essential features of production costing models are highlighted. These are used to simulate hour by hour operation of the market and analyse some of its features. Market mechanisms are discussed and a relationship is established between the System Marginal Price (SMP) and generation plant mix to illustrate SMP volatility. The theory behind the Loss of Load Probability (LOLP) payment is introduced and it is shown how a theoretical optimum can be derived when the combined consumer LOLP payments and the capital costs of additional generation reach a minimum. This is used to illustrate the arrangements necessary to realise the optimum generation margin in practice. Basic tariff theory is introduced and a comparison is made of actual prices against an idealised bulk supply tariff to show how energy prices in England and Wales may have risen in excess of what might have occurred under the previous cost based regime. This part concludes with proposals for improving the market and in particular advocates a new approach to encourage optimal capacity planning using Lagrangian techniques to indicate market needs without loss of data confidentiality.