ELECTRICITY ECONOMICS
REGULATION AND DEREGULATION

Edited by
Geoffrey Rothwell
Tomás Gómez
CONTENTS

Preface xv

Nomenclature xix

1 Electricity Regulation and Deregulation 1
   1.1. The Electricity Industry: Restructuring and Deregulation 1
   1.2. From Monopolies to Markets 2
   1.3. Why Restructuring and Deregulation Now? 3
   1.4. Regulation is Still Required 4
   1.5. What Lessons Can Be Learned from International Experiences? 6
       1.5.1. Starting Points and Motivations for Deregulation 9
       1.5.2. Structural Changes and System Operation 10
       1.5.3. Design of Wholesale Markets and Market Institutions 11
       1.5.4. Retail Competition and Customer Choice 12
   1.6. Conclusions 12

2 Electricity Economics 15
   2.1. What is a Market? 15
       2.1.1. Competitive versus Noncompetitive Markets 15
       2.1.2. The Market Mechanism 16
       2.1.3. Elasticity 18
   2.2. Cost and Supply 20
       2.2.1. Economic Cost versus Accounting Cost 20
       2.2.2. Total, Average, and Marginal Costs 21
       2.2.3. Economies and Diseconomies of Scale and Scope 24
   2.3. Profit Maximization 25
       2.3.1. What is Profit? 25
       2.3.2. What is Economic Efficiency? 29
   2.4. Social Surplus: Consumer and Producer Surplus 29
   2.5. Market Power and Monopoly 30
       2.5.1. Maximizing Profit under Monopoly 30
       2.5.2. Deadweight Loss from Monopoly Power 31

vii
2.5.3. Response to the Exercise of Monopoly Power: Regulation and Antitrust 32
Exercise 2.1. Linear and Logarithmic Demand Functions 34
Exercise 2.2. A Shift in Demand and a New Equilibrium Price 35
(a Cobweb Model)
Exercise 2.3. Returns to Scale in Production and Cost 37
Exercise 2.4. Calculating a Regulated Tariff 40
Exercise 2.5. Calculating Social Surplus under Competition and Regulation 41
Exercise 2.6. Calculating Deadweight Loss under Monopoly 42

3 The Cost of Capital 43

3.1. What is the Cost of Capital? 43
3.2. Net Present Value 45
3.2.1. Discounting to the Present 46
3.2.2. Net Present Value 48
3.2.3. Assessing Cash Flows under the Net Present Value Rule 49
3.3. Alternative Methods of Project Evaluation 51
3.3.1. Payback Analysis 51
3.3.2. Average Return on Book Value 52
3.3.3. Internal Rate of Return 52
3.4. Risk and Return 53
3.4.1. Financial Instruments 55
3.4.2. Capital Structure and the Cost of Capital 58
Exercise 3.1. Risk and Diversification 58
Exercise 3.2. Risk Aversion 62
Exercise 3.3. The Capital Asset Pricing Model 68
Exercise 3.4. Certainty Equivalent Discount Rates 70
Exercise 3.5. Calculating the Internal Rate of Return 74

4 Electricity Regulation 75

4.1. Introduction to Economic Regulation 75
4.1.1. Regulatory Policy Variables 76
4.1.2. The Regulatory Process 78
4.2. Rate-of-Return Regulation 80
4.3. Performance-Based Ratemaking 83
4.3.1. Sliding Scale 84
4.3.2. Revenue Caps 85
4.3.3. Price Caps 86
4.3.4. Some Problems with Incentive Regulation 87
4.4. Rate Structure 88
4.4.1. Introduction to Tariff Regulation 88
4.4.2. Marginal Cost Pricing, Multipart Tariffs, and Peak-Load Pricing 89
5 Competitive Electricity Markets

5.1. Overview

5.2. Wholesale Power Markets
   5.2.1. The Poolco Market
   5.2.2. Contracts for Differences
   5.2.3. Physical Bilateral Trading
   5.2.4. Transmission Ownership and System Operation
   5.2.5. Ancillary Services

5.3. Market Performance and Investment
   5.3.1. Generation Expansion and Monitoring
   5.3.2. Nodal and Zonal Transmission Pricing
   5.3.3. Transmission Planning and Investment

5.4. Customer Choice and Distribution Regulation
   5.4.1. Customer Choice and Retail Competition
   5.4.2. Real-Time Prices and Retail Services
   5.4.3. Retail Access Tariffs
   5.4.4. Distribution Company Regulation

Exercise 5.1. Determining Dispatch in a Poolco Market
Exercise 5.2. Determining Dispatch Based on Physical Bilateral Contracts
Exercise 5.3. Generator Revenues and Long-Run Capacity
Exercise 5.4. Generator Profits with and without a Contract for Differences
Exercise 5.5. The Value of Transmission Expansion between Two Zones
Exercise 5.6. Calculate Nodal Prices in a Three-Bus Transmission System

6 The Californian Power Sector

Ryan Wiser, Steven Pickle, and Afzal S. Siddiqui

6.1. General Description of the California Power System
   6.1.1. Generation
   6.1.2. Transmission and Interconnections
   6.1.3. Distribution
   6.1.4. Consumption
   6.1.5. Concentration Levels
CONTENTS

6.1.6. Plant Investment 133
6.1.7. Electricity Prices 133
6.1.8. Economic and Energy Indices 134

6.2. The New Regulatory Framework 135
  6.2.1. U.S. Federal Legislation and Regulation 135
  6.2.2. California State Regulation and Legislation 137

6.3. The Wholesale Electricity Market and Institutions in California 140
  6.3.1. The Power Exchange 140
  6.3.2. The Independent System Operator 144
  6.3.3. Bilateral Trading 145

6.4. Transmission Access, Pricing, and Investment 146
  6.4.1. Access Charges 147
  6.4.2. Transmission Congestion Charges 147
  6.4.3. Transmission Losses 149
  6.4.4. Investment and Planning 149

6.5. Distribution Network Regulation and Retail Competition 149
  6.5.1. Regulation of the Distribution Network 150
  6.5.2. Remuneration for Regulated Distribution Activities 150
  6.5.3. Retail Competition 151

  6.6.1. Stranded Costs 153
  6.6.2. Market Power 154
  6.6.3. Public Purpose Programs 155
  6.6.4. Customer Protection and Small Customer Interests 156

6.7. Market Experience and the Energy Crisis 156
  6.7.2. The Electricity Crisis 157
  6.7.3. The Causes of the Electricity Crisis 158
  6.7.4. Solutions and Conclusions 159

7 The Norwegian and Nordic Power Sectors 161
  Helle Grønnlø

7.1. General Description of the Norwegian Power System 161
  7.1.1. Generation 161
  7.1.2. Transmission 162
  7.1.3. Distribution 163
  7.1.4. Consumption 164
  7.1.5. Economic Indices 164
  7.1.6. General Economic and Energy Indices 166

7.2. The New Regulatory Framework 167
  7.2.1. The Energy Act of 1990: Objectives and Consequences 168
  7.2.2. The Energy Act of 1990: Specifics 169

7.3. The Wholesale Electricity Market 170
  7.3.1. The Energy Markets 171
8 The Spanish Power Sector

8.1. General Description of the Spanish Power System
8.1.1. Structure of the Industry
8.1.2. Generation
8.1.3. Transmission
8.1.4. Distribution
8.1.5. Consumption
8.1.6. Concentration Levels and Economic Indices
8.1.7. General Economic and Energy Indices for Spain

8.2. The New Regulatory Framework
8.2.1. Background
8.2.2. The 1997 Electricity Law
8.2.3. Further Regulations

8.3. The Wholesale Electricity Market
8.3.1. General Market Institutions
8.3.2. Structure of the Wholesale Market
8.3.3. The Daily Market
8.3.4. The Intraday Markets
8.3.5. Network Constraint Management Procedures
8.3.6. The Ancillary Service Markets
8.3.7. Capacity Payments
8.3.8. Bilateral Trading
8.3.9. International Exchanges and External Agents

8.4. Transmission Access, Pricing, and Investment
8.4.1. Remuneration of Transmission Activities
8.4.2. Transmission Network Charges
8.4.3. Transmission Losses
8.4.4. Investment and Planning

8.5. Distribution Network Regulation and Retail Competition
8.5.1. Remuneration of Regulated Distribution Activities 206
8.5.2. Distribution Losses 207
8.5.3. Distribution Network Charges 208
8.5.4. Power Quality Regulation 208

8.6. Particular Aspects of the Regulatory Process in Spain 210
8.6.1. Estimated Stranded Costs 210
8.6.2. The Stranded Costs: Methodology for Recovery 211
8.6.3. The General Settlement Procedure: Regulated Tariffs and Revenues 212

9 The Argentine Power Sector 217

9.1. General Description of the Argentine Power System 217
  9.1.2. Transmission 218
  9.1.3. Distribution 219
  9.1.4. Consumption 220
  9.1.5. Electricity Tariffs 221
  9.1.6. Economic and Energy Indices 221

9.2. The Regulatory Framework 221
  9.2.1. Background 221
  9.2.2. The New Electricity Law 222
  9.2.3. Regulatory Authorities 223
  9.2.4. The Privatization Process in Argentina 224

9.3. The Wholesale Electricity Market 224
  9.3.1. Market Participants 226
  9.3.2. Energy Market and Economic Dispatch 226
  9.3.3. Capacity Payments 227
  9.3.4. Cold Reserve and Ancillary Services 227
  9.3.5. Generator Revenues 228
  9.3.6. Scheduling, Dispatch, and Settlement 228
  9.3.7. Bilateral Contracts 228

9.4. Transmission Access, Pricing, and Investments 229
  9.4.1. Transmission Charges 229
  9.4.2. Penalties for Unavailability of the Transmission Assets 230
  9.4.3. Transmission Concessions 231
  9.4.4. Transmission Expansion 231

9.5. Distribution Regulation 232
  9.5.1. Distribution Concessions 233
  9.5.2. Evaluation of Distribution Costs 234
  9.5.3. Regulated Tariff Customer Categories 235
  9.5.4. Cost Allocation in Regulated Tariffs—An Example of a User Tariff 236

9.6. Particular Aspects of the Regulatory Process in Argentina 238
9.6.1. Regulation of Power Quality after Privatization of Distribution

Glossary

References

Author Index

Subject Index

About the Authors
Dr Biggar is Australia’s leading expert on the economics of wholesale electricity markets and the economics of public utility regulation. Since 2002 he has provided economic advice primarily to the Australian Energy Regulator and the Australian Competition and Consumer Commission. Dr Hesamzadeh is assistant professor in electric power systems division of the school of electrical engineering at KTH Royal Institute of Technology in Stockholm, Sweden. Power System Economics Notes. Electricity Economics Regulation and Deregulation - Geoffrey Rothwell, Tomás Gómez. Stoft - Power System Economics. Power Systems Control and Stability 2nd Ed by P.M. Anderson & a.a. Fouad. Computational Methods in Power System Analysis. Units Used to Measure Electricity V volt The unit of electrical pressure A amp The unit of electrical current W watt Power (Energy per hour) h hour Time Wh watt-hour Energy k kilo 1000. Used in kW, kWh and kV. M mega 1,000,000. The IEA’s Electricity Information contains time series of electricity and heat data for 35 OECD countries, from 1960 to 2017, with worldwide data up to 2016. Annual statistics are available for detailed supply/demand balances, end-use consumption, electricity trade by partner country, specific autoproducer electricity and heat consumption data, as well as electricity generation capacity by generation type. Electricity Information data service Purchase Electricity Information Download the overview.