

Contents

	<i>List of Figures</i>	page x
	<i>List of Tables</i>	xiii
	<i>Preface</i>	xv
	<i>Acknowledgements</i>	xvii
1	Energy Economics and Current Energy Systems	1
	1.1 What Is Energy Economics?	1
	1.2 The Role of Energy in an Economic System	3
	1.3 Energy Systems and CO ₂ Emissions	4
	1.3.1 Total Energy Consumption	4
	1.3.2 Energy Consumption by Sector	6
	1.3.3 Energy Demand in the Future	7
	1.3.4 Greenhouse Gas Emissions	8
	1.3.5 The Relationship between Carbon Dioxide and Global Warming	11
	1.4 Main Problems Resulting from the Current State of Energy Systems	11
	1.4.1 Environmental and Economic Problems	11
	1.4.2 Non-renewable Energy Sources	12
	1.4.3 Geopolitics and Security of Energy Supply	13
	1.4.4 Inefficiency in the Use of Energy	13
	1.5 The Way Ahead: Energy Transition	14
	1.5.1 Energy Transition	14
2	Market Failures and Behavioural Anomalies	21
	2.1 Introduction to Market Failures	21
	2.2 Market Failures	23
	2.2.1 Externalities	23
	2.2.2 Public Goods and Common Resources	26
	2.2.3 Information and Principal–Agent Problems	29
	2.2.4 Lack of Competition – Monopoly and Collusive Oligopoly	31
	2.2.5 Behavioural Anomalies	34
	2.3 Role of Energy and Climate Policies	39
	2.3.1 Energy Policy and Climate Policy Goals	39
	2.3.2 Role of Governments in Adaptation Strategies	41
	2.3.3 Energy and Development	42

2.4	Sustainable Development	42
2.4.1	Institutional Definition	42
2.4.2	Definitions Based on Economic Theories: Weak and Strong Sustainability	43
2.5	Issues in Developing Countries	45
2.5.1	Traditional Market Failures	45
2.5.2	Role of Behavioural Anomalies	47
2.5.3	Review Questions and Problems	48
3	Energy Demand—Theory and Empirical Analysis	49
3.1	Introduction to Energy Demand Analysis	49
3.1.1	Energy Demand as a Derived Demand for Energy Services and Industrial Goods	49
3.2	Household Production Theory and Energy Demand	50
3.2.1	Key Functions of Household Production Theory	50
3.2.2	Graphical Representation of Household Choices	51
3.2.3	Analytical Representation of Household Choices	55
3.3	Empirical Analysis of the Residential Energy Demand	57
3.3.1	Steps in the Empirical Estimation of an Energy Demand Model	58
3.3.2	Model Specification	59
3.3.3	The Typical Functional Forms for Demand Analysis	60
3.3.4	Estimation of a Simple Electricity Demand Function: Example from a Developing Country	61
3.3.5	Estimation of a Capital Stock Demand Model	62
3.3.6	Estimated Residential Energy Price Elasticities	63
3.4	The Empirical Analysis of the Industrial Energy Demand	65
3.4.1	Energy Demand Function	67
3.4.2	Estimated Industrial Energy Price Elasticities	68
3.5	Issues in Developing Countries	70
3.5.1	Household Production Theory in Developing Countries	70
3.5.2	Energy-consuming Asset Ownership and the Role of Income	71
3.5.3	Review Questions and Problems	72
4	Economic Analysis of Energy Investments	73
4.1	Energy—Sector Investments and the Role of Discounting	73
4.1.1	Characteristics of Energy—Sector Investments	74
4.1.2	Investment and Net Cash Flow of a Typical Energy—Sector Project	75
4.2	Investment Criteria: Net Present Value and Internal Rate of Return	76
4.2.1	Net Present Value and Internal Rate of Return	76
4.2.2	Cost of Capital	78
4.2.3	Importance of Discount Rates in Investment Decisions	79
4.2.4	Example of Investment Analysis for a Power Plant	79

4.2.5	Types of Risks Associated with Investments in the Energy Sector	81
4.2.6	Measures of Risk	82
4.3	The Levelised Cost of Energy	85
4.3.1	Example of LCoE Calculation for Different Technologies at an International Level	87
4.4	The Learning Curve	89
4.4.1	The Learning Curve in the Energy Sector	89
4.5	Social Cost–Benefit Analysis	92
4.5.1	Steps of Doing a Social Cost–Benefit Analysis	93
4.5.2	Net Present Value Criterion	97
4.5.3	The Social Discount Rate	98
4.6	Issues in Developing Countries	99
4.6.1	Application of Investment Analysis: Growth of Decentralised Energy Systems	99
4.6.2	Levelised Cost of Energy in Developing Countries	100
4.6.3	Social Discount Rates	101
4.6.4	Review Questions and Problems	101
5	Economics of Energy Efficiency	102
5.1	Energy Efficiency	102
5.1.1	Definition	102
5.1.2	Reasons for Inefficiencies	103
5.2	Measurement of Energy Efficiency	105
5.2.1	Partial Indicators	105
5.2.2	Econometric Approaches	108
5.3	Investment in Energy Efficiency	110
5.3.1	Investment Decisions	111
5.3.2	Lifetime Cost Calculations	112
5.3.3	Examples: Comparing Lifetime Costs of Cars and Refrigerators	113
5.4	Energy Efficiency Gap	114
5.4.1	Private and Social Perspectives	114
5.4.2	Barriers to Energy Efficiency	116
5.5	Bounded Rationality and Energy-related Financial Literacy	118
5.5.1	Decision-making Strategies	118
5.6	Rebound Effect	120
5.7	Issues in Developing Countries	123
5.7.1	Market Failures	123
5.7.2	Poor Power Quality	124
5.7.3	Revenue Losses and Investments in Efficient Electricity Networks	125
5.7.4	Review Questions and Problems	126
6	Energy-related Market Forms	127
6.1	Introduction	127

6.2	Economies of Scale and Scope	129
6.2.1	Economies of Scale	129
6.2.2	Economies of Scope and Economies of Vertical Integration	133
6.3	Monopoly	135
6.3.1	Monopolies in the Energy Sector	135
6.3.2	Application: Resource Rent in the Hydropower Sector	136
6.3.3	Application: Natural Monopoly	137
6.3.4	Regulation Methods	138
6.4	Perfect Competition	142
6.4.1	Application: The Electricity Market	143
6.4.2	Goals and Trade-offs of the Reforms	149
6.5	Monopolistic Competition	150
6.6	Oligopoly	152
6.6.1	Cartel Model	152
6.6.2	Application: OPEC	154
6.6.3	Dominant Firm Model and the Oil Market	155
6.7	Issues in Developing Countries	158
6.7.1	Electricity Market Reform: A Comparison of Industrialised and Developing Countries	159
6.7.2	The Resource Curse	160
6.7.3	Review Questions and Problems	161
7	Market-based Economic Instruments	162
7.1	Energy and Climate Policy: Goals and Instruments	162
7.1.1	The Purpose of Energy and Climate Policy	162
7.1.2	Types of Energy and Climate Policy Instruments	165
7.1.3	Market Failures and Policy Instruments	167
7.2	Monetary Market-based Instruments	169
7.2.1	Pollution Taxes, Product Taxes, and Energy Taxes	169
7.2.2	Subsidies	181
7.2.3	Pollution Permit Trading Systems	187
7.2.4	Behavioural Anomalies and Monetary Market-based Instruments	191
7.3	Non-monetary Market-based Instruments	194
7.3.1	Information and Educational Programmes	194
7.3.2	Nudges	195
7.4	Issues in Developing Countries	199
7.4.1	A Comparison of Product Taxes and Pollution Taxes in Developing Countries	199
7.4.2	A Comparison of Carbon Taxes and Permit Trading Systems in Developing Countries	199
7.4.3	Inefficiency of Fossil Fuel Subsidies	200
7.4.4	Unintended Effects of Market-based Instruments in Developing Countries	201
7.4.5	Review Questions and Problems	202

8	Non-market-based Instruments	203
8.1	Standards	203
8.1.1	Pollution Standards	206
8.1.2	Energy Standards	211
8.2	Direct Control Measures	214
8.3	Non-market-oriented Instruments and Behavioural Anomalies	216
8.4	Voluntary Agreements	218
8.5	Issues in Developing Countries	218
8.5.1	Enforcement of Standards	219
8.5.2	Role of Information Provision in Facilitating the Effectiveness of Standards	220
8.5.3	License Plate-based Driving Restrictions	220
8.5.4	Review Questions and Problems	221
9	Policy Choice and Evaluation	222
9.1	Policy Evaluation Criteria	222
9.2	Distributional Issues and Acceptance of Policy Instruments	225
9.3	Policy Evaluation Methods	227
9.3.1	Modelling the Economic Effects	228
9.3.2	Modelling the Impact of Policies	232
9.3.3	Review Questions and Problems	242
	<i>Special Terms</i>	243
	<i>References</i>	245
	<i>Index</i>	254