

Contents

Preface *xiii*

Acknowledgments *xvii*

1	Technical Developing Pathway of Ecological Coal Mining	1
1.1	Background Introduction	1
1.2	Coal Mining Technology Development	3
1.2.1	Literature Analyses	3
1.2.1.1	Data Analysis System	4
1.2.1.2	Knowledge Diagram	5
1.2.2	Three Periods of Coal Mining Technology	7
1.2.2.1	Competition Phase	8
1.2.2.2	Diffusion Phase	8
1.2.2.3	Shift Phase	9
1.3	Discussion	11
	References	14
2	Developing Trending Toward Ecological Coal Utilization	19
2.1	Background Introduction	19
2.2	Coal Utilization Evolution	21
2.2.1	Initial Technological Competition	24
2.2.2	Fierce Innovative Diffusion	26
2.3	Coal Utilization Development Trends	28
2.3.1	Disruptive Integrated Shift	28
2.3.2	No-Coal-on-Ground Integrated Energy System	30
2.4	Discussion	32
	References	33
3	Multiple Coal Seam Coproduction-Oriented Equilibrium Approach Toward Coal-Water Conflict	37
3.1	Background Review	38
3.1.1	Multiple Coal Seam Production System	38
3.1.2	Mining Quota Allocation Scheme	38
3.1.3	Uncertain Condition	39

3.2	Modeling	40
3.2.1	Motivation for Employing Uncertain Variables	40
3.2.2	Typical Fuzzy Variables in the Proposed Method	42
3.2.3	Assumptions and Notations	43
3.2.3.1	Assumptions	43
3.2.3.2	Notations	43
3.2.4	Lower Level Decision-Making Model	43
3.2.4.1	Objective Function	43
3.2.4.2	Constraints	45
3.2.5	Upper Level Decision Making Model	47
3.2.5.1	Objective	47
3.2.5.2	Constraints	47
3.2.6	Global Optimization Model	48
3.3	Solution Approach	49
3.3.1	Parameters Defuzzification	50
3.3.2	KKT Condition Transformation	51
3.4	Case Study	52
3.4.1	Presentation of Case Problem	52
3.4.2	Data Collection	54
3.4.3	Results for Different Scenarios	55
3.4.3.1	Scenario 1: Water Quality Standards I	55
3.4.3.2	Scenario 2: Water Quality Standards II	55
3.5	Discussion	59
3.5.1	Propositions and Analysis	59
3.5.2	Management Recommendations	61
	References	62
4	Seasonal Changes-Oriented Dynamic Strategy Toward Coal-Water Conflict Resolutions	63
4.1	Background Expression	63
4.2	Methodology	65
4.2.1	Key Problem Statement	65
4.2.2	Modeling	66
4.2.2.1	Assumption	66
4.2.2.2	Notations	66
4.2.2.3	Logical Representation for the Collieries	68
4.2.2.4	Logical Representation for the Authority	71
4.2.2.5	Global Optimization Model for the EP-MQC	73
4.2.3	Model Transformation	74
4.3	Case Study	75
4.3.1	Presentation of the Case Region	76
4.3.2	Data Collection	76
4.3.3	Results Under Different Situations	77

4.4	Discussion	79
4.4.1	Propositions and Analysis	79
4.4.2	Policy Recommendations	84
	References	86
5	GIS-Oriented Equilibrium Strategy Toward Coal Gangue Contamination Mitigating	89
5.1	Review of Background	89
5.2	Key Problem Statement	92
5.3	Coal Gangue Facility Siting Method	94
5.3.1	Identifying Candidate Sites Using GIS Technique	94
5.3.2	Selecting the Optimal Site Using the Modeling Technique	96
5.3.2.1	Assumptions	96
5.3.2.2	Notations	96
5.3.2.3	Model Formulation	97
5.3.3	Model Transformation	103
5.4	Case Study	105
5.4.1	Case Region Presentation	105
5.4.2	GIS Technique	106
5.4.3	Modeling Technique	107
5.4.4	Data Collection	107
5.4.5	Computational Results and Analysis	109
5.4.5.1	Scenario 1: $\alpha = 1.0$	109
5.4.5.2	Scenario 2: $\alpha = 0.9$	109
5.4.5.3	Scenario 3: $\alpha = 0.8$	112
5.4.5.4	Scenario 4: $\alpha = 0.7$	112
5.4.5.5	Scenario 5: $\alpha = 0.6$	113
5.5	Discussion	114
5.5.1	Propositions	114
5.5.2	Management Recommendations	116
	References	117
6	Dynamic Investment Strategy Toward Emissions Reduction and Energy Conservation of Coal Mining	121
6.1	Background Review	121
6.1.1	Multi-system Consideration of Emission and Energy	122
6.1.2	Multidimensional Consideration of Economic and Ecological Benefits	123
6.1.3	Multi-stage Consideration of Environmental Investment	123
6.2	Modeling	125
6.2.1	Assumptions	125
6.2.2	Notations	125
6.2.3	Colliery Economic Benefit: Profit Objective	127

6.2.4	Colliery Ecological Benefit: Emission Reduction and Energy Conservation	128
6.2.5	Coal Production and Environmental Investment Activities	128
6.2.6	State Process Control Colliery Operations	129
6.2.7	Ecological Coal Mining Economic-Ecological Equilibrium Model	130
6.3	Economic-Ecological Equilibrium Model Solution Approach	131
6.3.1	General Parameterization	131
6.3.2	Fuzzy Goals for the Multiobjective Model	132
6.3.3	Standard and AM-Based PSO for Nonlinear Dynamic Model	133
6.4	Case Study	135
6.4.1	Case Description	135
6.4.2	Parametrization	135
6.4.3	Data Collection	136
6.4.4	Results and Different Scenarios	138
6.4.4.1	Results Analysis	138
6.4.4.2	Sensitivity Analysis	138
6.5	Discussion and Analysis	143
6.5.1	Comprehensive Discussion for Results	143
6.5.2	Management Implications	148
	References	149
7	Carbon Dioxide Emissions Reduction-Oriented Integrated Coal-Fired Power Operation Method	153
7.1	Background Review	153
7.2	Key Problem Statement	155
7.3	Modeling	157
7.3.1	Assumptions	157
7.3.2	ICPBD Strategy Intentions	157
7.3.2.1	Maximizing Economic Benefit	157
7.3.2.2	Minimizing CO ₂ Emissions	160
7.3.3	ICPBD Strategy Limitations	160
7.3.3.1	Coal Purchase Phase Restriction	160
7.3.3.2	Coal Storage Phase Restrictions	160
7.3.3.3	Coal Blending Phase Restrictions	161
7.3.3.4	Coal Distribution Phase Restrictions	163
7.3.4	Global Model	163
7.4	Case Study	165
7.4.1	Presentation of Case Region	165
7.4.2	Model Transformation	165
7.4.3	Data Collection	167
7.5	Results and Discussion	167
7.5.1	Results for Different Scenarios	167
7.5.2	Propositions and Analysis	173
7.5.3	Management Recommendations	181
	References	183

8	Equilibrium Coal Blending Method Toward Multiple Air Pollution Reduction	187
8.1	Background Presentation	187
8.1.1	Relationship Among All the Stakeholders	189
8.1.2	Decision Carrier Between All the Stakeholders	190
8.1.3	Modeling	192
8.1.3.1	Notations	192
8.1.3.2	Objectives of the Authority	193
8.1.3.3	Constrains of the Authority	195
8.1.3.4	Objectives of the CPPs	196
8.1.3.5	Constraints of the CPPs	197
8.1.3.6	Global Optimization Model	198
8.2	Case Study	199
8.2.1	Presentation of the Case Region	200
8.2.2	Model Transformation and Solution Approach	200
8.2.3	Data Collection	201
8.3	Results and Discussion	203
8.3.1	Results Under Different Scenarios	203
8.3.2	Propositions and Analysis	206
8.3.3	Management Recommendations	221
	References	221
9	Equilibrium Biomass–Coal Blending Method Toward Carbon Emissions Reduction	225
9.1	Background Review	225
9.2	Key Problem Statement	227
9.3	Modeling	228
9.3.1	Assumption	229
9.3.2	Notations	229
9.3.3	Model for the Local Authority	230
9.3.3.1	Objective 1: Maximizing Financial Revenue	230
9.3.3.2	Objective 2: Minimizing Carbon Emissions	231
9.3.3.3	Limitation on the CPPs' Operations	231
9.3.3.4	Power Supply Demand Restriction	231
9.3.3.5	Limitation on the Different Between the Quota and the Actual Emission	231
9.3.4	Model for CPPs	233
9.3.4.1	Objective: Maximizing Economic Benefits	233
9.3.4.2	Combustion Efficiency Constraint	233
9.3.4.3	Limitations on Fuel Quantities and Qualities	234
9.3.4.4	Technical Constraint	234
9.3.4.5	Social Responsibility Limitation	234
9.3.4.6	Carbon Emissions Quota Constraint	234
9.3.4.7	Fuel Resources Storage Limitation	235
9.3.5	Global Model	235

9.4	Case Study	236
9.4.1	Case Description	236
9.4.2	Model Transformation and Solution Approach	236
9.4.3	Data Collection	238
9.5	Results and Discussion	240
9.5.1	Results Under Different Scenarios	243
9.5.2	Propositions and Analyses	243
9.5.3	Policy Implications	251
	References	251
10	Carbon Emission Reduction-Oriented Equilibrium Strategy for Thermal-Hydro-Wind Generation System	255
10.1	Background Introduction	255
10.2	Modeling	259
10.2.1	Notations	259
10.2.2	Objectives	261
10.2.2.1	Carbon Emissions Reduction	261
10.2.2.2	Water Resources Wastes	261
10.2.2.3	Wind Power Utilization	262
10.2.2.4	Power Supply Balance	262
10.2.3	Constraint	263
10.2.3.1	Constraints of Wind Power	263
10.2.3.2	Constraints of Coal-Combusted Power Plants	263
10.2.3.3	Constraint of Hydropower Station	264
10.2.3.4	Constraints of Hybrid Generation System	265
10.2.3.5	Global Model	265
10.3	Case Study	267
10.3.1	Case Description	267
10.3.2	Model Transformation	267
10.4	Data Collection	269
10.5	Result and Discussion	270
10.5.1	Result Under Different Scenarios	271
10.5.2	Comprehensive Discussion of Results	271
10.5.3	Management Recommendations	280
	References	281
11	Economic-Environmental Equilibrium-Based Wind-Solar-Thermal Power Generation System	285
11.1	Background Introduction	285
11.2	Key Problem Statement	287
11.3	Modeling	290
11.3.1	Notations	290
11.3.2	Objectives	290
11.3.2.1	Economic Profits	290
11.3.2.2	Carbon Emissions	291

11.3.2.3	Renewable Energy Utilization	291
11.3.3	Constraints	293
11.3.3.1	Constraints of Hybrid System	293
11.3.3.2	Constraints of Thermal Power Plant	294
11.3.3.3	Constraints of Wind Power Plant	296
11.3.3.4	Constraints of Solar Power Plant	296
11.3.4	Global Model	296
11.4	Case Study	298
11.4.1	Case Description	298
11.4.2	Model Transformation	299
11.4.3	Data Collection	301
11.4.4	Results and Analysis	303
11.5	Discussion	315
11.5.1	Propositions and Analysis	315
11.5.2	Management Recommendations	316
	References	317
12	Carbon Emissions Reductions-Oriented Equilibrium Strategy for Municipal Solid Waste with Coal Co-combustion	321
12.1	Background Introduction	321
12.2	Key Problem Statement	323
12.2.1	Conflict and Cooperation Between the Decision-Makers	323
12.2.2	Trade-Off Between the Economy and the Environment	324
12.2.3	Problem Analysis for MSW/Coal Co-combustion	324
12.3	Modeling	326
12.3.1	Assumptions	326
12.3.2	Notations	326
12.3.3	Allocation Scheme for the Authority	326
12.3.3.1	Maximizing Financial Revenue	326
12.3.3.2	Minimizing Carbon Emissions	327
12.3.3.3	Electricity Supply Meeting Demand	327
12.3.3.4	Requirements for the MSWACPPs' Operating Rights	328
12.3.4	Production Strategy for MSWACPPs	329
12.3.4.1	Pursuing Maximum Profits	329
12.3.4.2	Coal's Inhibitory Effect on Dioxin Emissions	329
12.3.4.3	Dioxin Emissions Risk Control	330
12.3.4.4	Limited Carbon Emissions Quota	330
12.3.4.5	Social Responsibility	330
12.3.4.6	Fuel Quality Required by the Incinerators	331
12.3.4.7	Limited Fuel Quantity	331
12.3.5	Global Model	331
12.4	Case Study	333
12.4.1	Case Description	333
12.4.2	Model Transformation and Solution Approach	333
12.4.3	Data Collection	335

12.4.4	Results Under Different Scenarios	336
12.5	Discussion	344
12.5.1	Propositions and Analysis	344
12.5.2	Management Recommendations	345
	References	349
Index		353