

Index

a

air temperature 66, 67, 210, 212, 237,
241, 244–246, 250, 253, 262, 263

b

battery installed capacity 32
battery storage system 31, 54, 62, 64, 85
battery utilization hour 28, 37
benchmark market transaction model
303
bi-level emission quota allocation 15,
113–138, 143–171
bi-level multi-objective emission quota
allocation 15, 175–199
bi-level multi-objective model 79, 81, 92,
175–177, 185, 186, 191, 195
bi-level planning 16, 179
bi-level programming 84, 85, 113, 115,
125, 148, 154, 155
burden distribution 334

c

capacity optimization model 361
cap-and-trade 114, 302
capital investment 23
carbon dioxide emission 22, 52, 113,
135, 143, 270, 360, 374
carbon emission 22, 23, 26, 28, 30, 34,
39, 43, 44, 52, 53, 56, 58, 60, 63, 64,
66, 81, 88, 92, 97, 105, 128, 131,
132, 135, 138, 145, 194, 232,
238, 361
allocation mechanism 118, 169

allocation quota 119
allowances 123, 131, 133, 135,
175–177, 183
reduction 360
trading 359, 361
carbon intensity 179, 360
carbon neutral 2, 4, 16, 23, 359
carbon neutrality 1–3, 35, 87, 91, 270,
381
carbon price 114, 138, 316, 332
carbon tax 114, 370
carbon trading market 178
central government 30, 311, 331–334,
336–337, 339–340, 348, 354–355
climate change 2–3, 30, 51, 79–80, 115,
144, 204, 208, 359, 387
coal and sewage co-combustion 175–199
coal and sewage sludge co-combustion
176, 191, 194
coal-biomass co-combustion 9, 113–115,
117, 122–124, 126, 132–134, 138,
169
coal-fired power plants 11, 23, 56, 84,
113, 118, 175–187, 189–192,
194–199
coal-municipal solid waste co-combustion
143–171
coal-sludge blending 179
coal-waste co-combustion 144, 169
coal-waste incineration 143
co-combusted hybrid energy system 9,
11, 13, 15, 16, 116, 175, 177, 178
co-combustion 8

- co-combustion (*contd.*)
 - of coal and municipal solid waste 143, 144
 - of coal and sewage sludge 175–178
- co-located hybrid energy system 9, 11, 13, 15, 16
- co-location 8, 9
- co-operated hybrid energy system 9, 11–13, 15, 16
- co-operation 8, 9
- cogeneration, combined heat and power plant 9
- commercial and industrial power
 - consumer 304, 318, 319
- compressed air energy storage (CAES) 389, 391
- conflicting objectives 145, 177, 179, 249
- construction cost 24
- consumption standard 332
- curtailment rate 275, 277, 286, 290–293, 295

- d**
- decarbonization 15, 21–45, 359, 360
- deployment optimization 13, 15, 16
- developing countries 2, 3, 6, 22, 23, 30, 56, 60, 114, 144, 242, 359
- direct co-firing 114, 116
- dispatch flexibility 205
- distributed renewable energy 21, 22, 56
- dynamic equilibrium strategy 113, 115, 123, 132–134
- dynamic programming 113, 115, 229

- e**
- economic and environmental equilibrium 143, 301
- economic development 91, 113, 115, 123, 125, 138, 147, 150, 175, 177, 179, 180, 185–187, 204, 216, 229, 244, 251, 326
- electricity consumption 23, 26, 28, 29, 32, 39, 87, 187, 301, 306, 316, 317, 320, 331, 336, 354, 372
- electricity price 22, 26, 29, 39, 53, 57, 66, 67, 69, 70, 72, 73, 95, 104–106, 264, 303
- electricity utilization cost 29, 51, 71, 337
- emission allocation scheme 144
- emission quota allocation 13–16, 113–138, 143–171, 175–199
 - strategy 178
- emission reduction 2, 3, 11, 24, 43, 72, 73, 97, 105, 114, 119, 125, 138, 145, 149, 165, 171, 176, 181, 182, 184, 194–195, 301, 360, 361, 363, 380, 381
- emissions allowances 119–121, 123, 124, 134–137, 138, 147, 165, 169
- energy and environmental economics 302
- energy consumption 22, 23, 25, 26, 30, 35, 38, 39, 41, 81, 302, 332, 334, 336, 337, 375
- energy cost 23, 60, 169, 377
- energy demand 22, 33, 35, 79, 126, 270, 393
- energy density 122, 389
- energy economics 13
- energy efficiency 21, 22, 238, 360
- energy-intensive 33, 60, 94
- energy products 8, 9
- energy production 30, 113, 228, 229, 238, 354, 393
- energy resilience 34, 97, 101, 105, 106
- energy security 13
- energy transition 1, 3–5, 21, 23, 51, 79, 87, 359, 360
- energy transmission 26
- environmental and economic trade-off 23
- environmental impact 63, 113, 144, 180, 301, 323, 369
- environmental protection 22, 79, 84, 91, 113, 115, 119, 125, 131, 134, 138, 147, 175, 177, 179–180, 185–186, 198, 305, 363, 366, 367
- environmental risk 23

environmental sustainability 13, 53, 56,
60, 94, 145
equitable allocation 331, 336–337, 355
execution rate 334, 337–339, 341, 349
extra emissions 148, 152

f

feasible solution 22, 217
feed-in-tariff 303, 306, 307, 374
flexibility 13, 53, 60, 64, 92, 138, 146,
175, 205–207, 225, 228, 230–231,
242, 261, 270, 296, 363
flexible PV panels 24, 31, 33–34, 39
flow battery 388, 390
flywheel energy storage 389
fossil fuels 21, 37, 52, 60, 116, 204, 238,
262
depletion 176
-free 204
full load hours 25, 28, 30, 37, 39
fuzzy membership function 84, 178,
249–250, 301, 303, 311, 313, 372
fuzzy theory 147, 175, 177–178, 208–209

g

general industry and commerce 304
generation and trading plan 341, 347,
359, 361, 364, 367, 369, 372, 375,
377–379
generation and trading strategy 331,
363, 375
generation technologies 8–12, 15, 34,
169, 335–338, 344–345, 349, 354,
363, 365, 367, 377, 381
greenhouse gas emissions 2, 22, 37, 113,
116, 143, 144, 302, 359
grid-connected PV system 23

h

hard-technology 114
hybrid energy system 1, 5–13, 24, 25, 29,
30, 52, 83, 88, 106, 107, 115–118,
143–144, 146, 175, 177–178, 232,
270, 331, 359–361, 392–393

hybrid power generation 12, 210–211,
237, 239, 244, 245, 248, 251, 252,
255, 260, 262–264, 360
hybrid renewable energy system 5, 53,
54
hybrid solar–hydro power generation
system 206, 215
hybrid solar–hydro system 15, 203–232,
269, 293, 296
hybrid solar–wind–hydro system 15,
269–297
hybrid systems 8, 21, 60, 205, 231
hybrid wind-solar-storage systems 21, 33
hybrid wind-solar-storage-gas system
79–107
hybridization 1, 9, 13, 391–393

i

indirect co-firing 114
industrial decarbonization 15, 21–45
industrialisation 22, 37, 94, 314
inherent uncertainties 151, 273
initial allowances 148
initial investment cost 29, 57, 59, 95
installed capacity 29–31, 34, 35, 39, 43,
44, 52, 83, 204, 251, 278, 281, 283,
290, 343, 374, 375, 377, 393
integrated renewable energy system 53
interaction mechanism 361, 362
International Energy Agency 2, 3, 30,
52, 60, 143, 204, 270, 359, 360
International Renewable Energy Agency
3, 4, 56, 90, 175, 204, 270
investment cost 29, 57–59, 66, 86, 87, 387

k

Karush–Kuhn–Tucker (KKT) 155, 177

l

laboratory-scale studies 176
large-scale energy storage system 270
large-scale grid-connected hydro-solar
production systems 205
large-scale hybrid wind-PV-hydro system
269

large-scale industry 304, 307, 317, 318, 320
 latent heat 390
 leader-follower decision-making
 interaction 117
 leader-follower game 143, 333
 life cycle assessment 26, 144
 local government 25, 44, 157, 309, 331–334, 337–340, 354
 long-distance transmission line 269, 270, 279, 295
 low-carbon energy transition 359, 360

m

maintenance cost 26, 37, 38, 86, 87, 231
 managerial insights 143
 mixed-integer multi-objective
 optimization model 26, 34
 multi-input multi-output hybrid energy systems 9
 multi-input single-output hybrid energy systems 9, 10
 multi-objective optimization model 26, 27, 34, 228, 313, 369
 multi-objective planning 16, 179, 180
 multi-objective programming 113, 115, 207, 216, 242, 272, 305, 310, 311, 363
 municipal waste 38, 144, 157, 164

n

natural gas electricity price 244, 264
 natural limitations 203, 205–207
 natural resource 23, 25, 27, 42, 51, 54, 67, 70, 71, 107, 363, 387
 net-zero emissions 4, 22, 269, 331
 NiCd battery 388, 390
 non-dispatchable new energy 270
 non-dispatchable renewable energy 269, 289, 293, 296
 non-energy products 8, 9
 non-hydro renewable energy 301, 326, 348, 375

o

objective conflicts 16
 off-peak power 389
 on-site renewable 22
 on-site solar photovoltaic system 22
 operating cost 13, 22, 86, 87, 118, 121, 149, 180, 183, 187, 189, 239, 296
 operation and management cost 29, 57–59
 operational flexibility 205
 optimal solution 22, 42, 92, 125, 156, 216, 249–250, 255, 257, 258, 369–372, 378, 390

p

parallel co-firing 114
 policy acceptance 301, 303, 306, 311, 320
 policy impacts 81, 203, 205–207
 pollution emissions regulation 148
 power consumer 106, 272, 302, 303, 310, 316–318, 320, 323, 324, 367
 power curtailment 217, 251, 269, 271, 277, 280, 288, 290, 292, 293, 295, 370
 power density 65, 390
 power distribution strategy 303
 provincial government 303–308, 310, 311, 313, 333, 336, 337, 361–363, 367, 369, 370, 379
 pumped hydro storage (PHS) 8, 389

r

real-time air temperature 253
 regional authority 120, 143, 145, 147, 149–154, 161, 163–165, 167
 regional renewable portfolio standard goal allocation 331
 reliability 9, 12, 15, 23, 52–53, 64, 72, 81, 210–211, 216, 228–231, 237, 239–240, 242–245, 248–249, 255, 257, 260, 262–263, 269–272, 280, 361
 rate 275, 276, 279, 284, 288–290, 295
 reliable fossil fuels 237

- renewable electricity consumption ratio 320, 331, 336, 343, 354
 - renewable energy consumption ratio 336, 337, 341
 - renewable energy consumption target allocation 305
 - renewable energy integration 24
 - renewable energy resources 25, 305, 334
 - renewable energy system 5, 13, 22, 27, 44, 52–54, 60, 263
 - renewable portfolio standard 15, 30, 301, 306, 331, 359
 - renewable power consumption target 331
 - residents 167, 304, 307, 317, 320, 324, 326
 - resilience 12, 15, 24, 34, 79–107, 214, 354
 - resource complementarity 269, 271, 296
 - resource-rich region 334
 - roof PV panel 24, 33, 34, 39
- S**
- scheduling coordination 13, 15, 16
 - scheduling scenarios 203, 224, 225, 228, 229, 231, 237, 239, 255–258, 260, 273, 280
 - seasonal uncertainty 203, 209, 214, 229, 273
 - sewage sludge incineration 176, 179
 - short-term operation 203
 - short-term scheduling 30, 206, 237–264, 296
 - single-input multi-output hybrid energy systems 9
 - soft-technology 114
 - solar irradiation 86, 89, 95, 96, 203, 204, 208, 212, 237, 239, 241, 245, 250, 253, 260, 263, 273, 276
 - forecast system 204
 - uncertainty 206
 - solar panels 22, 245
 - start-and-stop operation 271
 - storage technologies 8, 9, 15, 21, 32, 296, 387–393
 - supercapacitor 388, 390, 391
 - superconducting magnetic energy storage (SMES) 388–390
 - supply and demand balance 32–33, 91, 183
- t**
- technical feasibility 23
 - technological advancement 205
 - technological innovation 114, 169, 360
 - thermal energy storage 389
 - thermochemical heat 390
 - tradable green certificate 303, 332, 359, 361, 365, 376
 - transmission capacity 24, 209, 214, 274, 279, 306, 309, 339, 341, 345, 365, 374
 - trapezoidal fuzzy number 26, 32, 89, 116, 146, 151, 181, 182, 212, 237, 241, 245, 246, 253, 263
 - trapezoidal fuzzy set 203, 229
- u**
- uncertain parameter 26, 28–29, 38, 83, 86–87, 113, 116, 118–119, 143, 147, 149, 158, 178, 181, 183, 210, 213, 220, 244, 251, 253
 - unit investment cost 86, 87
 - unit operation and management cost 57, 59
 - urbanization 22, 51, 52
 - utility-scale photovoltaic 205
 - utilization hour 28, 31, 37, 335, 338, 344, 345, 374, 375
- w**
- waste incineration power plants 144, 145, 147, 149
 - wastewater treatment 21–29, 32–39, 42–44, 176
 - water flow 206, 209, 210, 213, 215, 219, 220, 229–231, 273–275, 278, 283
 - weather-driven renewable energy source 240
 - wind-solar-storage system 9, 21–45, 51–73

- wind-solar system 23
- wind speed 30, 40, 58, 61, 66, 67,
70–72, 237, 241, 244, 246, 250, 253,
254, 260, 262, 263, 273, 275, 276,
283
- wind turbine 9, 22–34, 37–42, 44, 52,
54–55, 57–59, 61–63, 66, 80, 240,
243–246, 248, 274–276, 283, 286
- world solar PV electricity production
204

