

Index

- African countries, 60
- agriculture, 61, 175, 234
- allocation of scarce factors, 27
- altruistic behavior, 32
- aluminium, 69, 197, 291
- ammonia, 197
- applied general equilibrium framework, 255
- Armington, 210
- ASFF. *See* Australian Stock and Flows Framework
- Asnæs fiskeindustri, 318
- Asnæsværket, 318
- Australia, 9, 165
- Australian Stocks and Flows Framework (ASFF), 9, 168, 171
- Automobiles, 57
- Avedøre Holme, 10, 314, 328
- average material intensity, 141

- backcasting scenarios, 118
- Basel Convention, 305, 368, 370
- basic industry, 197
- Baumol effect, 372
- bicycles, 57
- biomass, 18, 79
- biomass consumption, 75
- bottom-up, 10
- bottom-up and top-down modeling, 130
- bounded rationality, 374
- Brundtland Commission, 33, 34, 339
- building materials, 67
- buildings calculators, 175
- bureaucrats, 11, 345
- bulk material flows, 96
- burning, 22. *See also* Incineration
- business services, 234

- Cairncross, 58, 65, 87, 90
- calibration procedures, 177
- capital intensity, 140
- capital investment, 156

- capital turnover, 139
- capital vintage structure, 129, 135, 153, 158, 190
- carbon, 16
- carbon dioxide emissions. *See* CO₂ emissions
- carbon dioxide emissions module, 135, 137
- carrying capacity, 167
- cars, 87
- car-sharing services, 44
- cascading, 367
- cascading of materials, 23, 375
- catch levels, 367
- causes of trade and recycling, 296
- cement consumption, 86
- CES production functions, 269
- chain approach, 197
- chemical time bombs, 6, 21, 39
- chemical exergy, 61
- chemical products, 17
- chemicals industry, 144
- Chicago Board of Trade (CBOT), 293
- Chile, 60
- China, 300
- CITES, 366
- climate change policy, 126, 156, 361
- closing cycles of substances, 22
- CO₂ emissions, 21, 34, 101, 180, 187, 195, 196
- Cobb-Douglas production function, 30
- coevolution, 45
- collection, 31, 32
- collective action theory, 349
- collective approach, 337
- collective goals, 352
- combustion, 61, 367
- Commonwealth Scientific & Industrial Research Organization (CSIRO), 167
- comparative advantages, 208
- complex systems modeling, 361
- computer chips, 57, 79

- conservation of energy/mass, 19
- construction materials, 74, 88
- consumables calculator, 172
- consumers, 45
 - consumer behavior, 44
 - consumer preferences, 369
 - consumption, 29, 169
- contracts between municipalities and waste treatment, 255
- control space, 168, 178
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 366
- cooperation, 42, 348
 - cooperation culture, 313
 - cooperation in the product chain, 375
- Copenhagen area, 314
- copper, 68, 70, 87
- copper scrap, 292
- cost curves, 35
- cost of carbon, 146
- cost-benefit analysis, 368
- cost-benefit consideration, 345
- cost-effective, 345
- cost-effectiveness, 27, 28, 35, 257
- CPB (Netherlands Bureau for Economic Policy Analysis), 34, 225
- cross-price elasticity of demand, 31
- crude oil, 72

- decision support, 131
- declining ore grades, 68
- decomposability of products, 366
- decomposition
 - of final demand categories, 106
 - of output, 106
 - of value added, 106
- decoupling, 95
- delinking, 36, 95
- demand and supply functions, 259
- demand-oriented theories, 297
- dematerialization, 8, 11, 21, 24, 26, 35, 44, 57, 68, 79, 95, 100, 195, 364, 360, 366. *See also* Rematerialization
 - absolute, 104, 105
 - at the macro level, 24, 37
 - dematerializing of supply side of economy, 372
 - relative, 104, 105
 - type of, 105
 - dematerialization factors, 68–80
 - dematerialization indicator, 372
 - demography calculators, 172
 - Denmark, 314
 - deposit refund system, 256, 368
 - design, 11
 - design approach, 178
 - desulfurization, 323
 - detailed decomposition of final demand categories, 106
 - developed countries, 10, 40, 41, 294, 360
 - DIMITRI model (Dynamic Input-Output Model to Study the Impacts of Technology-Related Innovations), 9, 34, 192, 211, 223, 224
 - disembodied technical changes, 129
 - displacement, 59
 - displacement effects, 213
 - disposal, 257
 - dissipative household consumables, 89
 - downstream demand, 322
 - downstream tax, 256, 368
 - Duchin-Lange model, 230
 - Duchin-Szyld model, 230
 - dumping of waste, 21, 367
 - Dutch National Statistical Bureau (CBS), 8, 96, 233
 - Dutch Waste Management Association, 22
 - Dutch waste policy, 367
 - Dwight D. Eisenhower, 74
 - dynamic models, 125–163, 223–252, 361
 - dynamic industrial system analysis, 125
 - dynamic industry models, 140
 - dynamic input-output (DIO) modeling, 362
 - dynamic vintage approach, 129, 135, 153, 158, 204
 - dynamics, 165
 - ECCO approach (Enhancement of Capital Creation Options), 35
 - eco-efficiency, 24, 45
 - eco-industrial park (EIP), 10, 313, 337
 - ecological rucksacks, 166
 - ecology, 4
 - econometric models, 190
 - economic efficiency, 363
 - economic growth, 27, 42, 107, 199, 289, 296
 - economic life of products, 23
 - economic limits and opportunities, 14
 - economic valuation, 371
 - economic value, 65, 373
 - economics and material flow analysis, 5
 - economics perspective, 5
 - economies of scale, 44, 296
 - economy-wide feedback, 5
 - Eastern Europe, 302
 - efficiency, 30, 373
 - efficiency gap, 198
 - elasticity of substitution, 203
 - electricity production module, 135, 137
 - electronic computer, 79
 - embodied energy, 168
 - embodied energy analysis, 169
 - embodied exergy per unit of mass, 371
 - embodied technological change, 129

- empirical partial equilibrium model, 35
- end-of-pipe solutions, 313
- end-of-pipe technologies, 13
- endogenous growth mechanism, 171
- energy, 61, 96
 - energy carriers, 83
 - energy demand, 101
 - energy efficiency, 341
 - energy intensity module, 135, 136
 - energy mix module, 135, 137
 - energy models, 157
 - energy policy, 361
 - energy transformation sectors, 169
 - energy use, 236
 - energy-related emissions, 96
 - energy-rich materials, 67
- engineering and econometric analyses, 8
- entropy, 19
- environmental awareness, 296
- environmental club, 324, 327
- environmental economics, 20
- environmental Kuznets curve (ECK), 36, 42, 95
- environmental load of producing new materials, 22
- environmental policies, 291
- equilibrium, 62
- equilibrium models, 33
- erosion, 60
- essential, 30
- ethylene, 138
- ethylene industries, 126
- Europe, 9, 195, 302
- European Union (EU), 368
 - EU countries, 195
- Europoort/Botlek area, 342, 346
- evolution of cooperation, 351
- evolutionary aspects, 363
- ex post studies, 233
- exchange relationships, 352
- exergy, 19, 61–63, 62
 - exergy per capita, 79, 371
 - exergy/GDP, 79
- exports, 111, 170, 197, 228, 236
 - exports from developed to developing countries, 295
 - export level effect, 115
- external costs, 18
 - of packaging materials, 19
 - of waste, 369
- externalities, 371
- EZ (Ministry of Economic Affairs), 341
- factor 10, 90
- Factor Four, 24, 45, 90, 166, 203, 364
 - Factor Ten economy, 166
 - Factor *X*, 45
 - Factor *X* debate, 4
- fast-moving variables, 169
- FDL, 98
- FDM, 98
- final commodities, 39, 288
- final goods, 39, 65
- final products, 87
- final users, 197
- firm level, 24
- firms, 42, 259
- fisheries calculator, 175
- flat-fee pricing, 22, 255, 368
- FMS-3, 211, 212
- forecasting scenarios, 117
- forest products, 65
- forestry calculator, 175
- fossil fuel exergy, 83
- fossil fuels, 72
- free-riders, 349
- freight transport, 366
- Frosch and Gallopoulos, 339
- fuel shares, 139
- fuels, 66
- furnace production processes, 143
- Gaia, 16
- general equilibrium model, 128, 166, 256, 363
 - of the waste market, 9
- genuine collective action, 353
- geographical area, 337
- glass, 19
- glass packing, 18
- global biogeochemical cycles, 38
- global environment, 233
- global recycling market, 294
- globalization, 38
- government expenditure, 269
- Graedel and Allenby, 4
- Greenspan, 58, 65, 79, 87, 90, 185
- gross investment, 139
- group of firms, 337
- groupings of material, 371
- growth debate, 36
- growth optimists, 31
- Gyproc Nordic East, 318
- hard-wired model, 191
- hazardous waste, 305
- Heckscher-Ohlin theorem, 210, 297
- hidden material flows, 59, 166
- hierarchy of waste management, 21, 367
- highway program, 74
- history of iron and steel production, 68
- Hoover dam, 74
- Hotelling rule, 365
- household, 259
- household consumption, 113
- houses, 87

- human-made capital, 35
- hybrid-unit input-output (I/O) framework, 96
- hybrid-unit input-output (I/O) tables, 8, 96, 362
- hybrid-unit model, 102
- illegal disposal, 256
- illicit dumping, 22
- immobility of labor and capital, 41
- I-M-P chain, 40
- imperfect information, 374
- imports, 107, 109, 197
- incentives, 11
- incineration, 20, 262
- income, 199
- income elasticities of material demand, 200
- increased greenhouse effect, 21
- index approach, 107
- index decomposition analysis (IDA), 117
- indicators of dematerialization, 104
- industrial ecology, 4, 337
- industrial ecosystem, 37, 43. *See also* Eco-industrial park
- industrial metabolism, 6, 38, 226
- industrial network, 316
- industrial park, 42. *See also* Eco-industrial park
- industrial plants, 318
- Industrial Revolution, 38, 69, 166
- industrial symbiosis, 42, 313, 337
- industrial symbiotic network, 313
- industrial systems, 125
- industry dynamics, 127
- industry organizations, 136
- inert materials, 67
- INES Eco-Industrial Park, 342, 346
- information, 20
- Information Age, 38
- information and communication technology, 7
- inherent inert materials, 67
- input substitution, 203
- input-output (I/O) analysis, 32, 126, 225. *See also* Hybrid-unit input-output (I/O) framework; Structural decomposition analysis
- commodity technology assumption, 104
- commodity-by-commodity input-output (I/O) table, 104
- input-output (I/O) data and techniques, 362
- input-output (I/O) tables, 95
- input-output energy analysis (IOEA), 225
- input-output (I/O) coefficient, 97
- input-output (I/O) model, 97
- input-output (I/O) model including imports, 107
- input-output (I/O) tables), 32, 169
- institutional analysis, 363
- integrated mills, 142
- integrated modeling, 14, 29
- integrated policy, 373
- interfirm recycling linkages, 345
- integrative methods for policy analysis, 360
- intermediate products, 65
- intermediate substitution, 98
- international agreements, 374
- international flows of waste, 369
- International Institute for Applied Systems Analysis (IIASA), 168
- international material-product chain, 40, 297, 298
- international material-product chain (IMPC) model, 196
- international reuse, 370
- international trade, 10, 32, 40, 287–310
- international trade balance calculator, 176
- international trade data, 60
- Intra-Sectoral Technology Use Model (ISTUM), 130
- inverted U-curve, 199
- investments, 27, 202
 - investment goods, 113, 230
 - investment in new technology, 128
- involving stakeholders, 133
- iron and steel, 95–122, 105, 126, 138, 291
- iron and steel industry, 141
- iterative simulation process, 189
- Japan, 183
- Journal of Industrial Ecology*, 4, 339
- Kalmbach-Kurz model, 230
- Kalundborg, 10, 24, 42, 313, 338, 368
- KLEMO, 98
- Kyoto, 195
- land resources, 176
 - land regulations, 361
 - land scarcity, 296
- landfilling, 21, 262
- lead scrap, 292
- leasing, 44
- legal waste disposal, 369
- legislation, 332
- lengthening the life of products, 366
- Leontief input-output (I/O) world model, 34
- Leontief-Duchin model, 230
- levels of connectedness, 352
- life cycle
 - life cycle analysis (LCA), 27, 28, 365
 - life cycle of a product, 337
- local trust-based relationship, 326
- location, 42
- location of industrial activities, 208

- location theories, 297
 lock-in, 44, 374, 375
 low-entry energy, 24
 lumber and paper, 86
 lump-sum transfer, 259
- machine space, 168, 178
 machinery, 68
 macro level of aggregation, 35
 macroindicators, 25
 maintenance services, 44
 MARKAL, 130
 Markets, 197
 market distortions, 255
 market failures, 21
 markets for waste, 21
 mass and exergy per unit of GDP, 58, 371
 mass per capita, 371
 mass/GDP, 79
 mass-balance principle, 20, 26, 29, 60, 63
 material
 cascading, 23, 37
 typology of, 15–18, 63–68, 68–80
 material balance conditions, 33
 material cycle, 39, 40
 material entropy, 20
 material flow analysis, 183
 material policy, 202, 359
 material prices, 201
 material flows, U.S., 63–68
 material resources calculators, 175
 material-poor economy, 11
 material-product chain, 26, 27, 197, 288. *See also* International material-product chain
 materials inputs per service unit, 371
 Matter-Markal model, 211
 meat replacement, 241
 mental factors, 327
 MESEMET (Macro Economic Semi Equilibrium Model with Endogenous Technology) model, 231
 mesoeconomic model, 224
 metabolism, 169. *See also* Industrial ecosystem; Industrial metabolism
 metals, 16, 19, 67
 metals sector, 42
 methane, 21
 methanol economy, 171, 180
 methanol production scenario, 180
 micro level, 24
 mineral prices, 206
 minerals, 17, 66
 mining calculator, 176
 mining industry, 197
 Ministry of Economic Affairs, 341
 mix of policy instrument, 361
 MNP-RIVM, 224
 Modules, 135
 monetary units, 31
 monetary data, 96
 monetary economy, 189
 monetary evaluation, 28
 monetary supply and use tables, 103
 monetary valuation, 18
 monitoring, 352
 Moore's law, 79
 motor vehicles, 68
 M-P chain (MPC). *See* Material-product chain
 multilocation optimization model, 300
 multiregional input-output (I/O) model, 224
 multiregional input-output (I/O) structure, 9
 municipalities, 22
- National Energy Modeling System (NEMS), 130
 national environmental policy plan (NEPP), 223
 national stocks, 165
 natural capital, 35
 natural resource accounting, 34
 natural resource stocks, 169
 negative external effects, 367
 Negishi format, 258, 282
 Negishi weight, 282
 neoclassical production functions, 30
 neo-technology theory, 297
 Netherlands, 8, 9, 22, 105, 109, 183, 196, 209, 228, 233, 268, 341, 346
 Netherlands Bureau for Economic Policy Analysis (CPB), 35, 225
 Netherlands Energy Demand Model (NEMO), 205
 Netherlands Environmental Assessment Agency, 224
 Statistics Netherlands (CBS), 8, 96, 233
 network analysis, 347
 network externalities, 44
 New England, 42, 43
 nitrogen, 16
 nitrogen fertilizer production in the Netherlands, 208
 noise externalities, 359
 nonequilibrium approach, 134
 non-OECD countries, 236
 nonstructural materials, 87
 North-North trade, 294–296
 North-South trade, 294–296
 novel protein foods, 225, 239
 NOVEM, 344
 Novo Nordisk, 318
 NO_x permits, 217
 NO_x reduction, 215
 NPFs, 239
 N-shaped relationship, 200
 nutrient flows, 37

- OECD, 236
 OECD countries, 367
 Oostzaan, 261
 optimal growth model, 42
 optimal use of the resource, 365
 optimization of external effects, 371
 organic products, 18
Our Common Future (report), 33
 overburden, 60
 oxygen, 59
 OzEcco Embodied Energy Model, 9, 168–170
- packaging material, 18, 257
 packing material agreement, 202
 paper, 19, 197
 partial equilibrium analysis, 28, 195–223, 362
 partial equilibrium model, 9, 195, 218–222
 payoff times, 325
 per capita dematerialization, 79
 performance standard rates (PSRs), 214
 peripheral areas, 333
 personal computers, 79
 pessimists, 31
 phosphate, 197
 phosphor, 16
 photosynthesis, 62
 physical constraints, 14
 physical economy, 46, 189
 physical economy modeling, 165
 physical economy simulators, 168
 physical flow accounting, 14
 physical input-output (I/O) tables, 34
 physical imports, 171
 physical limits, 192
 physical supply and use tables, 103
 pig iron, 69
 Pigovian tax, 365
 Planning, 363
 planning-and-design perspective, 5
 plastic products, 95–122
 plastics, 17, 19, 83, 95–122, 197
 policies, 46
 policy and strategies, 21
 policy implications, 11, 359
 policy scenarios, 146, 272, 273
 pollution generation, 169
 pollution problems, 15
 population density, 296
 population-development-environment simulators, 167
 Portland cement, 67
 potassium, 197
 potentially reactive, 67
 pre-collective-action phase, 353
 President's Council on Sustainable Development, 339
 prevention of waste, 366
 prices, 258
 price-based policy instruments, 157
 price elasticities of import and export and scrap, 209
 price instrument, 32
 price mechanisms, 34, 191
 primary commodities, 39, 288
 primary materials, 197
 primary recycling, 23
 principal-agent problems, 4
 product chains, 342
 product choice, 45
 product design, 307
 product industry, 197
 product level, 24
 product life cycle, 257
 production, 153, 257
 production cycle, 373
 production functions, 29, 128, 263
 production module, 135
 of meat, 239
 products, 39
 provinces, 22
 pulp and paper, 138
 pulp and paper industry, 138
 PVC, 17
- QWERTY keyboard, 45
- R&D support, 307
 raw materials, 197
 raw agricultural products, 63
 raw material inputs, 59
 rebound effect, 45, 69, 88, 367
 reciprocity, 350
 recyclable materials, 288
 recycled material, 264
 recycling, 10, 21, 26, 31, 35, 37, 39, 202, 287.
 See also Reuse 100 percent recycling, 37
 recycling industry, 197
 recycling options, 365
 recycling rate, 289
 recycling services, 260
 refrigerators, 57
 regional aggregation, 131
 regional economic development, 320
 regional scale, 131
 regulation of resource supply, 367
 relative energy intensity (REI), 136
 remanufacturing, 44
 rematerialization, 95, 104, 105. *See also*
 Dematerialization
 repairing, 22, 23
 replacement, 30
 resilience, 165, 190
 resource-intensive industries, 316
 resource problems, 15

- resource stock management, 366
 reuse, 23, 35, 39. *See also* Recycling
 revitalization, 341
 revitalize industrial parks, 341
 RIVM (National Institute for Public Health
 and the Environment), 35
 Rotterdam, 342
 Rotterdam area, 333
 Rotterdam harbor, 346
 Royal Dutch Shell, 167
 rubber, 86
- sale, 257
 sanctioning, 352
 saving, 30
 scale effects, 41
 scarcity of land, 367
 scenario analysis, 117, 189
 scenarios, 145, 168, 198
 Schumpeterian competition, 23
 scrap, 197
 scrap prices, 206
 secondary commodities, 39, 288
 secondary materials, 197, 305
 secondary recycling, 23
 second-best policy, 372
 sector of industry, 337
 self-governance, 352
 self-organization, 10, 42, 352, 363
 self-organized interactions, 354
 sensitivity analysis, 276
 services, 29, 36, 44, 372
 service economy, 44
 service sector, 37
 shape, 20
 Silicon Valley, 316
 slow- and fast-moving variables, 166
 slow-moving variables, 169, 190
 social norm, 32
 social-accounting matrix, 34, 269, 270
 Socolow, 4
 soft model, 191
 Soilrem, 318
 South Africa, 60
 “Space for Growth” (Dutch study), 33
 spatial dimensions, 22
 species, 39
 sport utility vehicles, 57
 stakeholder, 363
 statistic optimization model, 300
 statistical-historical modeling, 360
 Statoil raffinaderiet, 318
 steady state, 5
 steel, 66, 83, 197
 stocks, 14
 strategic prospectives, 167
 STREAM. *See* Substance Throughput
 Related to Economic Activity Model
- structural decomposition analysis, 8, 32, 95–
 122, 97, 234, 362, 373
 structural materials, 87
 subsidization of virgin materials, 255
 subsidy-cum-tax scheme, 258, 260
 substance flow analysis, 28
 Substance Throughput Related to Economic
 Activity Model (STREAM), 34, 192, 195,
 196, 362
 Substances, 15
 Substitution, 20, 26, 29, 34, 45, 87, 129, 269,
 365
 direct versus indirect, 29
 between commodities, 290
 between primary and secondary materials,
 203
 of glass optical fibers, 77
 of inputs, 27
 of materials, 30
 substitution elasticities, 269, 271
 among different consumption goods, 277
 sulphur, 16
 supply security, 322
 surface mining, 60
 sustainability transition, 190
 sustainable development, 14
 sustainable food supply, 239
 sustainable harvesting, 367
 “Sustainable Economic Development
 Structures” (study), 33
 symbiosis, 10, 314
 Symbiosis Institute, 324
 system boundaries, 141, 155, 157
 system boundary for eco-industrial parks,
 348
- TC, 98
 technical and institutional limits, 289
 technical efficiency, 20
 technical progress, 203
 technological adaptations, 361
 technological changes, 129
 new technologies, 226
 in materials, 98
 technological innovation, 27
 technological progress, 198
 technological scenarios, 7, 225
 technological matrix, 226
 technology transfer, 307
 telecommunications technology, 77
 tertiary recycling, 23
 text processors, 45
 textiles, 68
 Thailand, 299
 thermodynamics, 14, 19, 30, 61
 thermo-recycling, 368
 Third Italy, 316
 throughput, 5, 365

- top-down, 10, 363
 - top-down design, 354
 - top-down project, 331
- topsoil or subsoil, 59
- total material requirement (TMR), 371
- trade, 4. *See also* International trade
 - among developed countries, 295
 - in materials, 42
 - with Germany, 208
- trade liberalization, 292
- trade relations, 210
- trade specification, 210
- trade theories, 297
- transition management, 224, 233
- transitions, 11
- translog cost function, 204
- transportation, 175
 - transportation equipment, 106
- truck tires, 302
- trust, 350
- two-region simulation model, 303

- U.K. Waste Hierarchy Policy, 367
- unilateral energy tax, 213
- unit-based pricing, 10, 256, 369
- United States, 8, 18, 31, 60, 99, 102, 109, 183, 299
 - dematerialization indicators and drivers, 57–94
 - economic system, 8, 57, 64
 - U.S. Environmental Protection Agency, 21, 125, 367
 - metals sectors, 25
 - pulp and paper, 126
 - steel exports, 208
- upstream production, 322
- upstream tax, 256, 368
- useful outputs, 63
- use of materials and energy, 16
- utility companies, 368

- value versus physical amount, 36
- vintage analysis, 29, 129, 135, 153, 158, 190, 198, 204
- virgin material, 23, 264, 288
- virgin-material-biased regulations, 255
- Vishnu group, 339

- waste, 21, 367–369
 - waste collection, 256, 264
 - waste collection services, 259
 - waste disposal industry, 197
 - waste hierarchy policy, 21, 367
 - waste management, 21, 35, 367
 - waste management hierarchy, 21, 367
 - waste market, 255, 363
 - waste mining, 6, 37, 39, 374
 - waste plastic trade, 300
 - waste policy, 11, 255, 367–369
 - waste regions, 22
 - waste tax, 256, 368
 - waste treatment, 265
 - waste treatment options, 368
- wastepaper, 291, 292
 - in India, 299
- water, 59
- water resources and air resources
 - calculators, 176
- weight of the GNP, 65
- welfare function, 262
- Western diet, 239
- Western Europe, 9, 209, 302
- whole system indicators, 169
- World Trade Organization (WTO), 293

- zero emissions, 22