

Index

This index serves also as a Glossary. Pages shown in **boldface** contain also a definition of the item.

A

Abdou, M.A., 346
Ablator, 397, 402
Actinides, 162, 167
Advanced fuel cycles, 313, 365–368
Advanced tokamak, 257, 267, 270, 344, 348, 351, 352, 357, 368
Aerosols, 8, 12, 14
AGR, **160**
Air-core transformer, 252, 377
Albedo, **8**, 9, 19, 125
Alcator, 290, 346
Alcator-C, 290
Alfvén wave, 255, 273, 312, 343
Alfvén wave instabilities, 342–343
Algae, 70–71, 139, 155
Alpha particle, **182**
Altamont Pass, 76, 77
Altitude change, 12
Amasa Bishop, 276
Amorphous silicon, 98, 120, 122, 128
Anchor coil, 384
An Inconvenient Truth, 5, 41
Anomalous diffusion, 229, 235, 262, 267
Anomalous transport, 236
Antarctica, 9, 12, 19, 189
Anthropogenic, **3**, 5, 8, 9, 14, 20, 23, 25, 32–34
Aphelion, **10**
Apollo program, 311, 418–420, 422
Arctic drilling, 66–67
Argus, 396
ARIES, 351–354, 356, 374, 378
ARIES-AT, 351–354
ARIES-CS, 374
ARIES reactor designs, 352
ARIES-ST, 351, 378, 379
ARPA, **40**

Artificial photosynthesis, 139, 170–171
Artsimovich, L., 219, 279
ASDEX, 249, 250, 263, 268, 282
Ash, 59, 68, 249, 263, 287, 289, 335
Aspect ratio A, **225**, 226, 258, 308, 349, 373, 375, 376
Astron, 412
Atmospheres (atm), 62, 69, 206, 324
Atmospheric density, 206
Atom, **184**
Atomic number, 113, **156**, 179, 180, 258, 302, 308, 313, 367, 402
Atomic weight, 39, **156**, 321
Aurora Australis, 189
Aurora Borealis, 188, 189
Availability, 349
Average-minimum-B, **247**
Axisymmetric mirrors, 386, 413

B

Backbone power, **43–44**, 58, 79, 94, 107, 133, 203, 417
Bad curvature, **247–249**, 375, 376, 386, 391
Balance-of-plant, 350, **356**
Balance-of-system (BOS), 121, **123**, 124
Ballooning mode, **247–248**, 273
Banana diffusion, 225, 226, 238, 241
Banana orbits, 222–225
Bananas, 222–238, 259, 288
Banana theory, 222, 257
Bandgap, **110**, 112, 113, 115–117, 121, 127, 129, 130
Barrels of oil equivalent (BOE), 45, **67**, **68**, 183
Baseball coils, 382–384
Basic Energy Sciences, 33, 146, 419
Bas Pease, 278

- Batteries, 33, 92, 100, 107–109, 134, 143, 146–152, 155
- Bay of Fundy, 170
- Beam emission spectroscopy (BES), **244**
- Bean-shape, 248
- Bernoulli's Law, 29
- BES. *See* Beam emission spectroscopy
- Beta (β), **295**
- Beta-decay, 157, 173, 329
- B-field, **209**, 215, 237, 238, 257, 284, 295, 343, 377, 378, 380, 382, 384, 390, 391, 393, 408, 414
- Binding energy, 179–182
- Biofuels, 58, 152–155, 170
- Biomass, 46, 71, 124, 154, 155, 170–171
- Birds, 17, 21, 23–24, 73, 76, 77, 82, 101, 124, 164, 171
- Blanket designs, 321–328
- Blankets, 320–328
- Blobs, 235, 236
- Blumlein, 408, 409
- Bohm diffusion, 158, **227**–229, 235, 238, 258, 279
- Boiling water reactor, **159**, 165
- Bootstrap current, 253, 255–257
- B_p , **225**–**226**
- Brayton cycle, 352, 353
- Breakeven, 205, 282, 397
- Breeding reaction, 322
- British Petroleum (BP), 53–57, 64, 66, 169
- Bruno Coppi, 346
- Bryan Taylor, 279, 388
- B_r , **225**, 226
- Bubble fusion, 410
- Buckyballs, **128**
- Bulk heterojunction, 127, 128
- Burning plasma, 283, 289, 294, 300, 339, 342, 346
- C**
- Cadmium telluride (CdTe), 115, **121**–124, 127, 128
- CAES. *See* Compressed air energy storage
- Canadian deuterium uranium (CANDU), **159**, 165
- Cap and trade, **59**–**60**
- Carbon capture and storage (CCS), **60**
- Carbon dioxide (CO₂) lasers, 401
- Carbon fiber composites (CFCs), 8, 40, 135, **313**, 317, 318
- Carbon footprint, 39, 91, **104**, 145
- Carbon sequestration, 60–64
- Carnot efficiency, 141
- Carnot's theorem, **52**, 61
- Catalytic fast pyrolysis, 154
- Catastrophes, 17–31, 317
- CdTe. *See* Cadmium telluride
- Cellulose, 154, 155
- Cellulosics, 153, 154
- Centralized solar thermal, **98**
- Central solar, **96**, 105, 106
- Central solenoid (CS), 320, 333, 334, 337
- Central station solar power, 101–133
- CERN, 307
- CFCs. *See* Carbon fiber composites
- CH₄. *See* Methane
- Chain reaction, 157, 158, 160, 161, 163, 164, 167, 180, 182, 367
- Change of elevation, 14
- Chaos, 188, 198–201, 389
- Chaos theory, 188, 200
- Chernobyl, 79, 163–165
- Chiyoë Yamanaka, 400
- Chlorophyll, 170–171
- Christofilos, Nick, 412
- CIGS. *See* Copper indium gallium diselenide
- Circularizer coil, 384
- Classical confinement time, 216, 227
- Classical diffusion, **216**, 225, 227–229, 238, 280, 287
- Coal and carbon management, 58–64
- Coal gasification, 60
- CO₂ concentration, 4, 7, 9, 33, 41
- COE. *See* Cost of electricity
- Co-injection, **254**
- CO₂ lasers
- Cold fusion, 409–410
- Collision, 185, 205, 207, 208, 215, 224–226, 238, 257, 291, 413
- Collision at a distance, **208**
- Collisionless plasma, **208**
- Commercial feasibility, 349–351
- Compact helical system, 262
- Compact stellarators, 373–374
- Compagnie Européenne des Technologies de l'Hydrogène (CETH), **139**
- Compressed air energy storage (CAES), 93, **108**, 125, 126
- Compressed air storage, 92, 109
- Computer modeling, 5, 11–12, 18
- Computer models, 7, 20, 25, 286, 326
- Computer simulation, 24, 48, 57, 235, 262, 283–286, 292, 389, 398
- Concentrator PV, 119
- Confinement scaling, 297–298
- Conn, R.W., 283, 351

Connection length, 235, 273
 Control rods, 161, 163, 164, 168
 Convective cells, 260–262
 Conversion of energy units, 45–46
 Copper indium diselenide (CIS), **123**
 Copper indium gallium diselenide (CIGS),
 122, 123
 Coriolis force, 29–31, **41**
 Corn, 153–155
 Cost breakdown, 356
 Cost levelization, 358–359
 Cost of developing fusion, 418–421
 Cost of electricity (COE), **356–361**
 Cost of fusion energy, 359–361
 Coulomb barrier, 185, 204, 410, 411
 Covalent bonds, 113, 114
 Critical mass, 159, 166
 Crossed electric and magnetic fields, 209, 259
 Cryo pumps, **331, 335**
 Cryostat, 320, 321, 332, 335
 Crystal, 111, 113, 115, 120
 Cs₁₃₇, **157, 164**
 Current profiles, 241, 243, 257, 266–268, 293,
 336, 339, 344, 389
 Cyclotron orbit, 192, 202, 229

D

D_n, **227**
 Dark matter, 188, 307
 Dawson, J., 159, 284
 3D calculations, 285eDCLL. *See* Dual-cooled
 lithium lead
 DCX, 277
 DD reaction, 366, 367
 deBroglie wavelength, 411
 Deep drilling, 65–66
 Deepwater horizon, 66, 164
 DEMO, 280, 301, 302, 307, 311–314, 317,
 329, 335, 336, 339, 340, 345, 347,
 349, 372, 419
 Demoiselle cranes, 184
 Dense plasma focus (DPF), **394, 395**
 Density gradient, 233–235, 256, 257
 Deuterium, **182, 184**
 Deuterons, 158, 185, 192, 345, 366, 390, 412
 D-He₃, 366, 367, 413
 Diagnostics, 243–245, 270, 289, 316, 393, 395
 Diamagnetic, 233, 295, 390
 (Dick) Post, R.F., 277, 381, 384
 Diffraction grating, 398
 DIII-D, 251, 268, 270, 275–277, 282, 283,
 288, 340, 349
 Direct conversion, 367, 381, 387, 390, 391

Direct drive, 403–407
 Direct-drive reactors, 407
 Disasters, 5, 12, 17–32, 164, 342
 Discharge-cleaning, 343
 Discounting, **358, 359**
 Discount rate, 357–361
 Displacements per atom (dpa), 167, 168,
 315, 345
 Disruptions, 290–295, 312, 317, 341–343,
 351, 368, 372
 Divertors, 250
 Divertor technology, 318
 Dmitri Ryutov, 381
 Doped semiconductor, **114**
 Doubly-connected, 194, 200, 375
 dpa. *See* Displacements per atom
 DPF. *See* Dense plasma focus
 Drag coefficient, 143, 172
 Drift instability, 231–236
 Drift wave, 231, 232, **234, 235, 259,**
 260, 262
 Drought, 17, 21–26
 D-shape, **248–255, 299**
 Dual-cooled lithium lead (DCLL),
 325–327, 352
 Dye-sensitized solar cell, 129, 139

E

E10, **152, 153**
 E85, **152, 153**
 ExB drift, 211, 217, 227, 233, 259–261,
 264, 265, 267
E. coli, 155
 Edge-localized modes (ELMs), 266, **286–288,**
 312, 317, 340–341, 372, 376
 Edge physics, 266
 E-field, **209, 211, 212, 215, 240, 241, 260**
 Electra laser, 401
 Electric cars, 140–152, 155
 Electric shear, 265
 Electrochemical potentials, 410
 Electrode, 106, 122, 128–130, 139, 147–151,
 171, **172**
 Electromagnets, 190, 191, 195, 205, 222,
 244, 293, 312
 Electron cyclotron heating (ECRH), 254,
 255, 337–339
 Electron drag, **253**
 Electron-hole pairs, 111–113, 128–130
 Electron temperature (T_e), 208
 Electron-volt (eV), 158, 183, **203–204, 206**
 Electrostatic confinement, 412–413
 ELM coils, 340, 341, 372

- ELMO Bumpy Torus, 277, 343
 ELMs. *See* Edge-localized modes
 ELMy H-mode, 288
 El Niño, 22, 29
 El Niño Southern Oscillation (ENSO), 22
 Elongation, 249, 293, 308, **375**
 $E = mc^2$, 110, 181
 Empirical scaling law, 298
 Enercon, 82, 83
 Energy, 6, 43–73, 75–174, 179–203, 219, 246, 273, 311, 366, 417
 Energy consumption, 46–48, 95, 168
 Energy forecasts, 48
 Energy for transportation, 134–155
 Energy payback time, 91, 99, 104, 105, 109, 123, 124, 133
 Energy principle, 278
 Energy reserves, 53–58, 68
 Energy storage, 33, 92–94, 104, 125, 146, 149, 150, 152
 Enrico Fermi, 223
 E.ON Netz, 79–81
 Ethanol, 58, 70, 152–155
 Eurofer, 319, 320, 326
 Eutectic, **324**
 EWR, **159**
 Experimental Advanced Superconducting Tokamak (EAST), 282, 332
 Exponent, 45, **183**
 External costs, 361
- F**
 Farads, **151**
 Farrokh Najmabadi, 351
 Fast Alfvén wave, 255
 Fast ignition, 403, 405
 Favorable curvature, 386
 FDF. *See* Fusion development facility
 Feedback stabilization, 389
 Field-reversed configuration (FRC), **390–393**, 412
 Filling factor, **422**, 28
 Finite-Larmor-radius (FLR) effect, **230**, 391
 First solar, 105, 106, 121
 First wall (FW), **313–320**
 Fishbones, 288–289
 Fission-fusion hybrids, 166–168, 385
 Flaking of carbon, 343
 Flash lamps, 400
 FLiBe, **323**, 325, 406, 407
 FLR. *See* Finite-Larmor-radius (FLR) effect
 Fluence, **345**, 348, 358
 Fluorescent tube, 214
 Flux conserver, 390, 391
- Forcings, 7–10, 14, 19, 33, 212
 Fossil footprint, **75**, 90–91, 98, 102, 123–126
 Fourth state of matter, 188
 FPP. *See* Fusion power plant
 Fractals, 200, 284
 Fractional burnup, 328, 329
 FRC. *See* Field-reversed configuration
 Fresnel lens, 102, 104, 119
 Fthenakis, V.M., 124
 Fuel cell, 134–**137**, 138–140, 152, 410
 Fueling, 300, 331, 349, 372
 Fuel reprocessing, 161
 Fullerene, **128**
 Fusion development facility (FDF), 302, 345, **347–349**
 Fusion Energy Sciences, 283, 396, 419
 Fusion Ignition Research Experiment (FIRE), **346**
 Fusion ignition tokamaks, 346
 Fusion power plant (FPP), 134, 139, 155, 301, 311, **349–355**, 367, 396
 FutureGen Alliance, 61
- G**
 Gallium arsenide (GaAs), **114**, 116, 117
 Gamma 10, 381, 384
 Gas centrifuge, 158, 163
 Gas diffusion, 158, 162, 163
 Gas Dynamic Trap, 386
 Gas-electric hybrids, 32, 57, 142–143
 Gas hydrates, **71–73**
 Gas turbine, 61, 92, 93, 125, 126
 Gauss (G), 206
 Gaussian, **186**, 188, 204
 1958 Geneva Conference, 219
 Geo-engineering, 132–133
 Geothermal, 108, 169
 Germanium, 113, 114, 116
 Gigatons, **36**, **39**
 Glaciers, 3, 12, 14, 18, 19
 Glass lasers, 397, 399–401, 407
 Global temperature rise, 12–17, 33, 36
 Good curvature, **247**, 248, 375, 391, 413
 Gore, Al, 5, 6
 Grassy ELMs, 288
 Grätzel cells, **129**
 Gravitational field, 171, 188
 Gravitational interchange instability, 388
 Great ocean conveyor belt, 20
 Great Red Spot, 260
 Greenhouse gases (GHGs), **5–8**, 16, 17, 22, 32–36, 124, 132, 138, 141, 142, 144, 152, 153, 155, 156, 158, 169, 417
 Greenland, 12, 14, 19–21

Green power, **43**, 59, 156
 Greenwald density, 291, 294
 Greenwald limit, 167, **294–295**, 357,
 372, 389
 Grid parity, 105–106
 Gross domestic product (GDP), 33, 35, **49–51**
 Guiding centers, **193**
 Gulf stream, 20–21
 Gyration orbit, 192, 193, 226
 Gyres, **20**
 Gyro-Bohm, 258
 Gyrotrons, 132, 255, 337–339

H

Half-life, 41, **157**, 161, 164, 216, 330
 Harold Furth, 222
 HCCB. *See* Helium cooled ceramic breeder
 HCLL. *See* Helium-cooled lithium-lead
 Heavy hydrogen, 180, **182**, 329
 Heavy ion beam probes (HIBP), **244–245**, 262
 Heavy water, **158**, 159, 165, 182, 409
 He3-He3 reaction, 367
 Helical field, 198, 199, 213, 219, 220, 223,
 224, 291, 296, 369, 388, 391
 Helium-3 (He₃), 182, 330, 337, **366–368**, 413
 Helium ash, 263
 Helium cooled ceramic breeder (HCCB), **323**,
 324, 328
 Helium-cooled lithium-lead (HCLL), **324**, 325
 Helium Subscriptply, 335
 Helix, 195, 332, 389
 High-confinement mode, 255, 263–270, 286
 High energy physics, 419
 High-temperature Superconductors,
 335–336, 352
 High volume neutron source, 346–347
 High-Z, **313**, 315, 342
 History of fusion, 276
 H-mode, 255, **263–268**, 282, 286–288,
 340, 376
 H-mode pedestal, 264, 267, 340
 Hockey stick, 3
 Hohlraum, **403–405**, 407, 409
 Holdren, J.P., 283
 Hole, **193–195**
 Horsepower, 58, **140**
 Horseshoe magnet, 190
 Hubbert's Peak, **54**, 55
 Hurricane Katrina, 26
 Hurricanes, 17, 26, 29–31
 Hydrodynamics, 211, 228, 266
 Hydroelectricity, 53, 75, 124, 140, 145,
 168–169
 Hydrogen bomb, 72, 188, 277, 368, 396, 419

Hydrogen cars, 134–140
 Hydrogen economy, 134–135
 Hydrolysis, **139**

I

I₁₃₁, 157
 Icebergs, 18, 67, 85
 Ice cores, 3, 5, 9, 10
 Ice sheets, 12, 14, 18, 19
 ICF, 420
 ICRH. *See* Ion Cyclotron Resonance Heating
 IGCC, **60**, 61
 Ignition, **296**
 Ignitor, 346
 II–VI compound, **115**, 121
 III–V semiconductors, **113–115**
 Indirect bandgap, 121
 Indirect drive, 403–406
 Inductive drive, 377
 Inertial confinement fusion, 395–409
 InGaN, 116
 Insolation, 96
 Inspectability, 349
 Instabilities, **207**
 Institute for Laser Engineering, 400
 Interchange instability, **212–214**, 219, 382, 388
 Interglacial, 7, 9, 10
 Intergovernmental Panel on Climate Change
 (IPCC), 4, **5**, 8, 17, 19–22, 26, 32, 33,
 35, 36, 41
 Interior of the sun, 183, 185, 203
 Internal transport barriers (ITBs), **267–270**,
 344, 348
 International Atomic Energy Agency (IAEA),
 265, **278**, 279
 International fusion materials irradiation
 facility (IFMIF), **345–346**, 361
 Inverter, **100**
 Ioffe bars, 279, 382–384
 Ioffe, M.S., 279, 382
 Ion cyclotron heating, 229, 254, 337
 Ion Cyclotron Resonance Heating (ICRH),
229, 254
 Ion diamagnetic drift, **233**
 Ion mean free path, 206
 Ion temperature (T_i), **204**, 205, 208, 244, 269,
 281, 282, 285, 366, 372, 389
 Ion-temperature-gradient instability, 235
 Ion temperature gradient mode, 285
 IPCC. *See* Intergovernmental Panel on Climate
 Change
 IPCC-AR4, 5
 Iraq and Afghanistan wars, 418
 Isobutanol, 155

Isotope, 156
 Isotope effect, 257–258
 Isotope separation, 158–159, 161, 163, 182, 331
 ITBs. *See* Internal transport barriers
 ITER, 40, 64, 132, 282, 298–307, 311, 332–335, 370, 419
 ITER timeline, 305, 306

J

$J(r)$, 241, 242
 Janus, 396
 Japan Torus (JT)–60U, 268, 276, 332
 Taylor, J.B., 380
 JET. *See* Joint European Torus
 Joint European Torus (JET), 268, 270, **275**, 282, 292, 297, 300, 301, 313, 345, 348
 Joule, 44, 45, **183**
 JT–60, 267, 282
 JT–60SA, 332
 JT–60U, 268, 276, 332
 Jupiter, 10, 260, 261

K

Keeling, Charles D., 3
 KeV, 185, **204**–206, 208, 214, 216, 226, 250, 253, 270, 274, 281, 282, 288, 307, 330, 336, 366, 372, 385, 386, 389, 390, 397, 410, 413
 Kilowatt-hour (kW-hr), 38, 45, 91, **105**, 126, 143, 183, 352, 354, 357
 Kinetically stabilized tandem mirror, 386, 387
 Kinetic energy, 142, 181, 338
 Kink instability, **220**–**222**, 239, 259, 277, 289, 388, 393
 Kink-unstable, 222
 Klystrons, 339
 Kolmogoroff, 228
 Kruskal Limit, 220–222
 Kruskal-Shafranov limit, **221**, 225, 230, 235, 239, 242, 266, 268
 Krypton-fluoride, 401
 KSTAR, 282, 332
 Kyoto Protocol, 6, 39

L

Laboratory for Laser Energetics, 400, 403
 Landau damping, 230, 232, 234
 Large Hadron collider (LHC), 307, 328
 Large helical device (LHD), 282, 304, 332, 369, 371–372

Larmor orbit, **192**, 193, 203, 207, 209, 230, 246, 254
 Larmor radius, **192**, 224, 227
 Laser fusion, 351, 391, 395, 396, 402, 406, 409
 Laser Mégajoule, 401
 Lasers, 122, 158, 159, 244, 279, 351, 391, 395–404, 406, 407, 409
 Lattice, 111, 113, 114, 120, 128
 Lattice-matching, 115
 Lawson criterion, **204**, 205, 207, 216, 273, 397
 Lawson diagram, 297
 Lead-acid batteries, 100, 146, 147
 Learning factor (L), **357**
 Lev Artsimovich, 219, 279, 280
 LHD. *See* Large helical device
 LHH. *See* Lower hybrid heating
 Life-cycle analyses, 90, 98, 102, 123
 Lightning, 29, 188, 215
 Light water, **158**, 159
 Light water reactor (LWR), **159**–161, 167, 168
 Lignin, 154
 Linear regime, **228**
 Lines of force, 190
 Liquefied natural gas (LNG), **64**, 66, 134
 Liquid-metal fast breeder (LMFBR), **160**, 167
 Liquid wall, 407
 Lithium, 92, 135, 140, 146–148, 182, 185, 230, 301, 315, 321–327, 345, 368
 Lithium-air batteries, 151
 Lithium hydride (LiH), 368
 Lithium-ion batteries, 92, 140, 146–148
 Livingston's law, 273
 L-mode, **264**
 LNG. *See* Liquefied natural gas
 Load leveling, 94
 Local solar, **96**, 100, 101, 133
 Lorentz force, **191**, 192, 195, 201, 211, 237
 Loss cone, **382**, 386
 Lower hybrid heating (LHH), 254, **339**, 343
 Lower-hybrid wave, 255, 268, 339, 340
 Lyman Spitzer, Jr., 196, 227, 277, 278

M

Magnetic bottle, 189–198, 203–217
 Magnetic errors, 372
 Magnetic field lines, 190, 193, 197, 203, 213, 215, 219, 236, 246, 255, 266, 285, 316, 325, 340, 342, 344, 390
 Magnetic fields, 189–194, 380
 Magnetic islands, 200, 239–242, 262, 263, 266, 273, 288, 342, 369
 Magnetic mirrors, 222–224, 246, 277, 381–387

- Magnetic pinches, 388–395
 Magnetic pressure, 210, 211, 220, 237, 259, 295
 Magnetic resonance imaging (MRI), **206**, 332
 Magnetic shear, 213, 214, 246, 265
 Magnetic wells, 246–248, 279, 280
 Magneto-hydrodynamic flow, 325
 Magneto-hydrodynamics (MHD), **229**, 230, 278, 291, 295
 Magpie Project, 394
 Maintainability, 349
 Maintenance and operation, 326
 Major radius R , 225, 226, 237, 282, 299, 308, 347, 349, 352, 373, 391
 Manhattan Project, 227, 418, 422
 Mann, M., 3
 Mapping, 198–201
 Marx bank, 407, 408
 Mass defect, 181
 Maxwell, J.C., 190
 Maxwellian distribution, 186, 188, 208
 Maxwell Laboratories, 407
 MEA, **60**, 62, 73
 Megajoule laser, 396
 Megampere (MA), **215**, 242, 332
 MegAmpere spherical tokamak (MAST), 376, 378
 Meridional overturning circulation (MOC), **20**, 21
 Metal-organic frameworks (MOFs), **73**, **136**, 137
 Methane (CH_4), 6, 8–11, 19, 21, 59, 71, 72, 138, 139, 164, 169, 170, 313
 MeV, 158, 160, **184**, 186, 255, 281, 296, 297, 300, 301, 315, 322, 336, 342, 345, 366, 368, 385, 412
 MFTF-B, 281, 384, 385
 MHD. *See* Magneto-hydrodynamics
 Microballoons, 401, 402
 Micro-crystalline silicon, 98, 120, 123
 Microinstabilities, 229–232, 235, 250, 259, 261–263, 265, 269, 273, 279, 383
 Micron, 121, 128, 137, **172**, 404
 Migma, 413
 Minimum-B, 247, 279, 382
 Mirror fusion test facility (MFTF), 281, 332, 384, 385
 Mirror machines, 75, 277, 279, 381, 384–387, 390, 391
 Mirror ratio, **382**, 386
 Mitigation, 5, 23, **32**, **33**, 35–37, 40
 Mixed oxide (MOX), **161**, 163, 165
 Mobile power, **43**, 135
 MOC. *See* Meridional overturning circulation
 Moderator, **158**–161, 165, 166, 322
 Modulational instability, 262
 Monarch butterflies, 184
 Montreal protocol, 8
 Moore's law, 273, 274
 Motional Stark Effect, 270
 MST, 389
 Multifaceted asymmetric radiation from the edge (MARFE), **372**
 Multi-junction cell, 115, 119, 126
 Multi-junction solar cells, 115, 118, 121
 Muon fusion, 410–412

N
 N_2 . *See* Nitrogen
 Nacelle, **82**–85, 89, 91, 92
 Nafion, 138
 Nanoparticles, 129, 138, 319
 Nanowires, 129–131
 NASA, 420
 National Compact Stellarator Experiment (NCSX), **373**
 National Ignition Facility (NIF), **396**
 Naval Research Laboratory, 166, 401
 Nb_3Sn . *See* Niobium-tin
 NbTi . *See* Niobium-titanium
 Nd-glass lasers, 400
 Neoclassical diffusion, **225**, 227, 238
 Neoclassical tearing mode, 291–292
 Neptunium 239 (Np_{239}), **157**
 Nested magnetic surfaces, 200, 201, 203, 207, 241, 243
 Net present value of fusion, 361
 Neutral beam injection (NBI), **253**, 288, 331, **336**, 378
 Neutron flux, 315, 345, 346, 348
 Neutron source, 346, 347, 361, 385
 Newcomb, W.A., 230, 232, 234
 Nickel-metal-hydride (NiMH), 146, 147, **172**
 NIF. *See* National Ignition Facility
 NIF laser, 399–401
 NIF target chamber, 406
 Nike krypton-fluoride laser, 401
 NIMBY, **62**, 77
 Niobium-tin (Nb_3Sn), **304**, 332, 333, 335
 Niobium-tin cable, **332**, 333
 Niobium-titanium (NbTi), **304**, 332, 335, 370
 Nitrogen (N_2), **6**
 Nitrous oxide (N_2O), 6, 8, 10, **60**, 68
 Non-axisymmetry, 372–373
 Non-inductive current drive, 268, 336
 Non-inductive drive, 377
 Nonlinearity, **228**, 235, 258, 260, 262, 285, 289
 Nonlinear regime, 228

- Normalized β ? (β_N), 167, 295, 357, 376
 Norman Rostoker, 393
 North Atlantic Oscillation (NAO), **21**, 22
 Nova, 396
 Nova laser, 400
 NRL, **401**
 N-type, **112**, 114, 130
 Nuckolls, J., 396
 Nuclear accidents, 163–165
 Nuclear power, 124, 142, 145, 156–168, 184
 Nuclear proliferation, 162–163
 Nuclear reactors, 159
 Nuclear waste, 156, 162, 348, 360, 385
 Nucleons, 173, **179**, 182, 184
- O**
 O₂. *See* Oxygen
 Oceans, 5, 11–13, 18–21, 25–26, 29, 41, 71, 72, 108, 170, 171, 321
 Ocean temperature, 12, 13
 Octopole, 280
 Octupole, 280
 Offshore wind, 79, 85–87, 170
 Ohmic heating (OH), **215**, 220, 229, 251–253, 255, 264, 268, 270
 Ohmic heating (OH) coils, 252, 268, 270
 Ohm's law, 215
 Oil crisis of 1973, 134, 280
 Oil from algae, 70–71
 Omega laser, 403
 Organic solar cells, 127–131
 Organization for Economic Cooperation and Development (OECD), **49–51**, 362
 O-type null, **194**
 Oxygen (O₂), 6, 39, 120, 138, **187**
 Ozone, 8, 34, 40
- P**
 Pacala, S., 35
 Paleoclimate, 9–11
 Palladium, 409, 410
 Palmer drought severity index, 23
 Parabolic mirror, 102
 Parametric instabilities, 398, 401, 403
 Parametrization, 12
 Parts per million (ppm), **3**, 11
 p-B₁₁, 367, 393, 395, 413
 Pb–17Li, 324
 p-B₁₁ reaction, 367, 393, 413
 Pebble bed, **165**, 324, 328
 Pebble-bed modular reactor (PBMR), **165**, 166
 Pebble-bed reactor, 165
 Pedestal, 264, 265, 267, 286, 288, 340
 Peeling-ballooning instability, 288
 Pellets, 157, 159, 161, 263, 300, 331, 342, 372, 396, 403, 406, 409
 Perhapsatron, 277
 Perihelion, **10**
 Permafrost, 19, 21
 Permanent magnets, 143, 190, 191, 201, 222, 223
 Photosynthesis, 70, 139, 155, 170
 Photovoltaic (PV), **98–100**, 104–107, 109–112, 115, 117, 118, 126, 133, 360
 Phytoplankton, 25
 Picket fence, 247
 Pinch, 43, 277, 278, 388–391, 394, 399
 Plasma, **183**
 Plasma exhaust, 249, 302, 316, 346
 Plasma facing components (PFCs), 302, **313**
 Plasma focus, 394–395
 Plasma guns, 378, 380
 Plasma physics, 188, 197, 207, 227, 243, 266, 271, 278, 286, 288, 311, 346, 373, 383, 392
 Plasma pressure, 207, 211, 216, 220, 226, 237, 256, 264, 265, 287, 292, 295, 372, 376, 393
 Plasma state, 188
 Plasma temperature, 204, 220, 231, 253, 367
 Plasma turbulence, 227, 228
 Plug-in hybrid electric vehicles (PHEVs), **144–145**
 Plug-in hybrids, 143–145
 Plutonium (P₂₃₉), **157**
 Poloidal, **194**
 Poloidal field (PF), **194**
 Poloidal magnetic field, 213, 219, 239, 259, 267, 290, 342, 368, 380
 Poloidal windings, 198
 Polycrystalline silicon (p-Si), **98**, 120, 123
 Population, 33, 35, 47, 49, 77, 93, 106, 125, 132, 161, 228, 302, 417
 Positive feedback, 7, 21, 210
 Post, Richard F., 277
 Potential energy, 181
 Pounds per square inch (psi), **135**, 136, 140
 Power, 6, 43, **44**, 75, 177, 203, 228, 251, 275, 311, 365, 417
 Power Plant Conceptual Studies (PPCS), **353–357**
 Power plant designs, 351–355
 Precession of the equinoxes, 10
 Pressure, **206**
 Pressure drift, **211**
 Pressure gradient, 231, 256, 257

Pressurized water reactor (PWR), **159**, 163
 Probability of DT fusion, 204
 Project Sherwood, 213, 278
 Protium, **331**
 Proton exchange membrane (PEM), **137–138**
 Proxies, **9**, 11, 12
 Pseudocapacitors, 149–152
 P-type, **112**, 114, 130
 Pulsed poloidal current drive, 389, 390
 Pulsed power, 396, **407–409**, 412

Q

$q(r)$, 240–242, 266, 270, 296, 344
 Q-machine, **230**, 231
 Quads, **46–48**, 50, 53, 55, 57, 71, 95
 Quality factor (q), 222, 226, 239–244, 266, 291, 295–297, 375
 Quantum dot solar cells, 129, 130
 Quasineutral, **187**, 231, 273
 Quiescent (Q), 167, 230, 231, 282, 295–297, 300, 305, 348
 Quiescent plasma, 231

R

Radioactive waste, 156, **161–162**, 166, 184, 353
 Radioactivity, 160, 162, 164, 182, 184, 313, 319, 320, 328, 330, 345, 353
 Radiofrequency (RF), 421
 Rainfall, 22, 26, 28, 41
 RAMI,
 Ramp-down, 343
 Random walk, 215, 228
 Rayleigh-Taylor instability, 210–212, 214, 219, 227, 273, 278, 291, 382, 391, 397, 398, 403
 Raymond Orbach, 283
 Reactivities, 366
 Reactor control, 161
 Recirculating power fraction, 352
 Recycling, 32, 41, 162, 328, **329**
 Reduced activation ferritic martensitic steels, 319
 Reliability, 349
 Remote handling, 305, 328, 344–345, 348, 349, 367
 REpower Systems, 79
 Resistive drift wave, **231**, 232
 Resistive wall modes (RWMs), **312**, 341, 389
 Resistivity, 120, 215, 229–232, 234, 241, 243, 251, 291, 292, 332, 342
 Revelle buffer factor, 25

Reversed-field pinch (RFP), 238, **388–390**
 Reversed shear, 266–267, 270, 282, 344, 351
 RFX, 389
 RIKEN-RAL, 412
 Conn, Robert W., 283, 351
 Robin Hood, 213
 Robinson, D., 279
 Rooftop solar, 98, 101, 107, 139
 Room temperature, 136, 137, 158, 160, 331, 332, 335, 336, 411
 Rotating magnetic field (RMF), 393
 Rotational transform, **199**, 200, 221, 222, 225, 238, 240, 253, 255, 266, 296, 372, 378
 Rotamak, 392
 Runaway electrons, 291, 293, 342
 Rutherford-Appleton Laboratory, 400, 414

S

Sagdeev, R., 299
 Sakharov, A., 219, 277
 Saline aquifers, 62, 63
 Sandia National Laboratories, 393, 394, 408
 Sawtooth oscillations, 242–243, 279, 289, 368
 SBS. *See* Stimulated Brillouin scattering
 Schlesinger, J.R., 280
 Scientific breakeven, **205**, 280, 297, 300
 Scientific notation, **45**, 95, 183
 Sea level, 17–19, 32
 Seebeck effect, 130
 Self-cooled lithium lead breeding blanket, 326
 Self-organization, 128, 245, 368, 372, 378
 Separatrix, 390, 391
 Shale oil, 67–68
 Shear, 29, 214, 219, 231, 240, 246, 261, 266–267, 270, 282, 287, 344, 351, 384
 Sheared fields, 213–214
 Shear stabilization, 213, 265, 266, 291
 Shiva, 396
 Shockley-Queisser limit, **126–127**
 SiC/SiC, **315**, 326, 356, 406
 Siemans, 83, 84
 Silane (SiH_4), **120**
 Silicon carbide (SiC), 90, 315, 316, 319, 320, 323, 326, 352, 356, 406, 421
 Silicon solar cells, 98, 112–120, 132
 Single-helicity mode, 389
 Single-null divertor, 287
 Sleipner platform, 62
 Sloshing ions, 384
 Small tight aspect ratio tokamak (START), 376, 377
 Smart grid, 108
 Snowflake, 245

Socolow, R., 35
 Sodium-sulfide (NaS) batteries, 92
 Solar cell, 38, 54, 94, 96, 98–100, 105–107, 109, 112–123, 126–133, 139, 171
 Solar concentrators, 101, 104, 130
 Solar electric, **98**, 101, 104, 125, 139
 Solar energy, 7, 32, 33, 38, 72, 76, 94–101, 108, 109, 124, 131–133, 165, 171
 Solar farm, 103, 105, 107, 108, 118, 120, 125, 130, 133
 Solar photovoltaic plants, 105–107
 Solar power tower, 102
 Solar radiation, 5, 8, 10, 41, 94, 106, 185
 Solar radiation energy, 94
 Solar spectrum, 110, 113, 115, 116, 118, 119, 123, 129, 133
 Solar swimming pool heaters, 98
 Solar thermal, **98**, 101–105, 360
 Solar thermal plants, 101–104
 Solar variability, 3, 9
 Solar wind, 189, 239
 Sonoluminescence, 410
 Spherical tokamak (ST), 349–351, 375–379, 391, 413
 Spheromaks, 378–381, 390
 Spitzer, L. Jr, 196, 227, 277, 278
 Spitzer resistivity, **215**
 Stacey, W.M., 166
 Startup, 343
 Steady-state operation, 343, 372, 393
 Steam reforming, 138, 139
 Stellarators, 197, 368–374
 Stimulated Brillouin scattering (SBS), **399**
 Stimulated Raman scattering (SRS), **399**
 Strange attractors, 200
 Structural materials, 319–320, 322, 323
 Subpolar Gyre, 20
 Sugarcane, 153, 154
 Supercapacitors, 149–152
 Superconducting magnets, 320, 321, 331–336, 338
 Superconductor, 207–208, 335–336
 Superphénix, 160
 Surface tension, 150, 210
 Switchgrass, 155
 Switch yard, 399, 404
 Syngas, 60, 61, 154

T

Tamm, I., 219, 277
 Tandem mirror, 384–387
 Target designs, 401–403
 Tar sands, 68–70

Taylor, B., 279, 388
 Taylor state, 388
 TBR. *See* Tritium breeding ratio
 Tearing mode, **230**, 292, 388
 Terajoule, **45**
 Tesla Roadster, 142, 146
 Teslas (T), 206, **332**
 Test blanket modules (TBM), **321**, 323, 326
 TF. *See* Toroidal field
 TFTR. *See* Tokamak Fusion Test Reactor
 Thermal barriers, 384
 Thermal diffusivity, 269, 270
 Thermoelectric power, 130
 Thermonuclear reaction, 188, 278
 Thin film solar cells, 98, 105, 118, 121–123
 Thonemann, P., 278
 Three Gorges Dam, 168, 288
 Three Mile Island, 163–165
 Tilt mode, 392
 Time scales, 262, 263, 290
 TMX, 384
 Tokamak, 167, 197, **219**–271, 273, 311, 365, 418
 Tokamak Fusion Test Reactor (TFTR), 268, 275, 281, 282, 292, 293, 345, 349
 Tokamak power core, 356
 Tom Stix, 224
 Tone, **45**, 63, 68
 Tore Supra, 332, 343
 Toroidal, 194, 195, 206, 219, 239, 277, 311, 368
 Toroidal beta (β_T), **376**, 377
 Toroidal coil, 238, 252, 253, 377, 390, 3378
 Toroidal field (TF), 166, **194**–196, 207, 219–221, 225, 226, 237, 238, 249, 253, 257, 269, 290, 298, 304, 332, 333, 347–349, 369, 370, 388, 389
 Toroidal-field coil, 166, 249, 253, 369, 370
 Toroidal windings, 198
 Torus, **194**, 197, 213, 219–220, 226, 276, 375–381
 Toyota Prius, 142
 Transformer, 53, 91, 215, 251–253, 263, 291, 305, 336, 343, 350, 368, 377, 389
 Transmission, 107–108
 Transmutation, 385
 Transport barrier, 263, 264, 266–270, 286, 344, 348
 Transport task force, 266
 Tree rings, 3, 9
 Tri-Alpha Energy, 393
 Triple product (Tn τ), 273, 274, **282**, 297, 329, 372
 Tritium, **182**, 184, 301, 320–331
 Tritium basics, 329–330

- Tritium breeding, 320–328, 346, 413
 Tritium breeding ratio (TBR), **328**, 329, 349
 Tritium fuel cycle, 330–331
 Tritium management, 328–331
 Tritium self-sufficiency, 328–329
 Tritons, 185, 322, 366, 411
 TRIUMPH, 412
 Troyon limit, 291, **295**, 376
 Tuck, J., 213, 277, 278
 Turbines, 52, 61, 76–93, 102, 104, 108, 125, 126, 151, 152, 159, 169, 170, 172, 350, 353, 367
 Turbulence, 87, 143, 227–231, 235, 260, 262, 263, 267, 269, 285, 286
 Turbulent eddies, 260, 268
 Turbulent state, 262, 285
 Typhoons, 29–31
- U**
 Ultimate fusion, 413–414
 Universal instabilities, **232**, 234
 Uranium 235 (U_{235}), **156**–160, 163, 180, 182
 Uranium 238 (U_{238}), **156**–160, 166, 182
 Uranium 239 (U_{239}), **157**
 Uranium hexafluoride (UF_6), **158**, 159, 163
 U.S. fusion research budget, 281
 US Geological Survey (USGS), 67, **71**, 72
- V**
 van Allen, J., 278
 Vattenfall, 60, 79
 V_{De} , 233
 V_{Df} , 233
 Velikhov, E., 164, 299
 Venus, 7
 Vertical fields, 237–238, 252, 375
 Very high temperature reactors (VHTR), **165**
- Vestas, 78–80, 85, 87, 88, 90, 93, 172
 Volcanoes, 8, 9
 Volume neutron source (VNS), **347**
- W**
 Ware pinch, 258–259
 Water leaks, 343
 Watt, 44, **45**, 105
 Wave and tide energy, 170
 Wavebreaking, 284
 Weather extremes, 26–28
 Wendelstein, 369–370
 Wendelstein 7, 282
 Wendelstein 7-X, 369, 370, 373
 Wetted wall, 407
 Wind energy, 76–94
 Wind turbines, 77–80, 82, 83, 86, 89, 92, 104, 108, 126, 151, 152, 170, 172
 Wire arrays, 393, 394
 World's Fattest Banana, 224
 WWS, 108, **109**
- X**
 X-type null, **194**
- Y**
 Yin-yang coils, 383
 Yucca Mountain, 162
- Z**
 Zeta, 278, 288, 388
 Zinc-air, 151
 Z-machine, 393, 408, 409
 Zonal flows, 259–262, 285
 Z-pinch, 393–395