

Contents

1	Introduction	1
	References	6
2	Green and Smart Building Trends	9
2.1	Business Case for Going Green	9
2.2	Smart Buildings Solutions on the Rise	10
2.3	Green and Smart Buildings Standards and Regulations	11
2.4	Financing Green and Smart Buildings	12
2.5	Zero Energy Buildings	12
2.6	Buildings Enabled by IoT	12
2.7	People Centric Focus in Buildings	13
2.8	Green Buildings at the Paris Climate Conference 2015	13
	References	14
3	Integrated Design Concepts and Tools	15
3.1	Integrated Design Process	15
3.2	Building Information Modeling	19
3.3	Energy Modeling and Simulation	20
3.4	Advance Optimization Tools	23
3.5	Airflow Modeling	24
	References	24
4	Passive Design Technologies	25
4.1	Introduction	25
4.2	Building Location and Orientation	26
4.3	Building Layout and Massing	27
4.4	Building Envelope	28
4.4.1	Insulation	29
4.4.2	Solar Heat Gain Coefficient (SHGC)	30
4.4.3	Infiltration or Air Leakage	30
4.4.4	Visible Light Transmittance (VLT)	31

4.5	Building Envelope Technologies	31
4.5.1	Shading	31
4.5.2	Cool Roofs and Coatings.	33
4.5.3	High Performance Insulation	34
4.5.4	High Performance Glazing	36
4.6	Passive Heating Technologies.	41
4.6.1	Massing and Orientation for Heating.	41
4.6.2	Thermal Mass and Phase Change Materials.	41
4.6.3	Trombe Walls for Passive Heating	42
4.7	Passive Cooling Technologies	43
4.7.1	Natural Ventilation and Cooling	43
4.7.2	Air Cooling in Dry Climates	48
4.7.3	Double-Skin Facades	48
4.8	Passive Lighting or Day Lighting	49
4.8.1	Daylight Apertures or Fenestration	49
4.8.2	Light Shelves.	51
4.8.3	Daylight Redirecting Glazing/Window Films	53
4.8.4	Light Pipes and Mirror Ducts	54
4.8.5	Transparent Insulation	55
4.8.6	Measuring Daylight Effectiveness	56
4.8.7	Integration with Electric Lighting Controls	56
	References.	57
5	Active Design Technologies.	59
5.1	Heating, Cooling and Ventilation	59
5.1.1	Air Heating and Cooling Technologies	60
5.1.2	District Heating and Cooling	67
5.1.3	Heat Pumps	68
5.1.4	Evaporative Cooling	70
5.1.5	Dehumidification Technologies	70
5.1.6	Radiant/Heating and Cooling	72
5.1.7	Passive Displacement Ventilation	73
5.1.8	Demand Controlled Ventilation	74
5.1.9	Duct Sealing Technologies	74
5.1.10	Fabric Ducts	75
5.1.11	Ductless Jet Fans	76
5.1.12	High Volume Low Speed (HVLS) Ceiling Fans	76
5.1.13	Liquid Immersion Cooling for Data Centers	77
5.2	Lighting	78
5.2.1	Lighting Performance Metrics	79
5.2.2	Light Source Technologies	79
5.2.3	Task Lighting	84
5.2.4	Lighting Controls	85

5.3	Energy Efficient Elevators.	85
5.3.1	Gearless Traction Elevators	86
5.3.2	Flat Steel Belts	86
5.3.3	Machine-Room-Less (MRL) Elevators	87
5.3.4	Regenerative Drives.	87
5.3.5	Permanent Magnet Motors.	88
5.3.6	Double-Deck Elevators and Twin Elevators	88
5.3.7	Elevator Controls.	88
5.4	Plug and Process Load Management	89
5.4.1	Use of Energy Efficient Equipment	89
5.4.2	Timer Controlled Plugs	90
5.4.3	Smart/Advanced Plug Strips	91
5.4.4	Software Power Management Settings.	93
	References.	93
6	Building Management and Automation Technologies.	95
6.1	Sensors and Meters.	95
6.1.1	Smart Sensors and Networks	96
6.1.2	Wireless Sensors Networks	97
6.1.3	Integrated Communication Technologies	97
6.2	Controllers	99
6.2.1	Mode Selection Controls	99
6.2.2	Pneumatic Controls	99
6.2.3	DDC Control Mode.	99
6.2.4	Advanced Intelligent Controls	100
6.2.5	Model Predictive Controls.	100
6.3	Actuators	100
6.4	BMS Communication and Protocols.	102
6.5	Monitoring and Diagnostics	103
6.5.1	Dashboard and Data Analytics	103
6.5.2	Alarm Management.	104
6.5.3	Automated Fault Detection and Diagnostic	104
6.6	Application and Control Strategies	105
6.7	Internet of Thing (IoT) Enabled Building Management Systems	106
	References.	107
7	Renewable Energy Integration in Buildings	109
7.1	Solar PhotoVoltaic (PV) Energy.	110
7.1.1	Rooftop Solar PV	111
7.1.2	Building Integrated PhotoVoltaic (BIPV)	113
7.2	Solar Thermal Collectors	114
7.2.1	Flat Plate Collectors	114
7.2.2	Unglazed Collectors	115

7.2.3	Evacuated Tube Collectors	115
7.2.4	Solar Thermal Based Cooling and Air-Conditioning.	116
7.3	Wind Energy	116
7.4	Geothermal Energy.	117
7.5	Energy Storage	118
7.5.1	Thermal Energy Storage	119
7.5.2	Battery Storage	119
7.6	Smart Energy Management Systems.	121
	References.	122
8	Water and Waste Management Technologies	123
8.1	Water Consumption, Monitoring and Leak Detection.	123
8.1.1	Identifying the Different Water Types in Buildings.	124
8.1.2	Water Sub-metering and Leak Detection	125
8.2	Water Efficient Fittings.	125
8.2.1	Water Efficient Faucets and Tap Adaptors.	126
8.2.2	Water Efficient Shower Heads.	126
8.2.3	High Pressure or Trigger Spray Nozzles	126
8.2.4	Automatic Water Shut-off Showers and Faucets	127
8.2.5	Water On-Demand Sensors	127
8.2.6	Instant Water Heaters	128
8.2.7	Low Volume and Dual-Flush Cisterns for Toilets	128
8.2.8	Water-Less Urinals	128
8.2.9	Composting Toilets	129
8.2.10	Water Efficient Equipment Labels	129
8.3	Greywater Recycling	130
8.4	Rainwater Harvesting	132
8.5	Water Efficient Landscaping	132
8.5.1	Drip Irrigation	132
8.5.2	Rain Sensors to Control Irrigation.	133
8.5.3	Xeriscaping	133
8.6	Water Reduction in Cooling Towers.	134
8.6.1	Improving Cycles of Concentration.	134
8.7	Reducing Construction Waste.	135
8.7.1	Reuse and Recovery of Construction Materials.	137
8.7.2	Optimising Material Usage During Construction and Deconstruction	138
8.7.3	Pre-fabricated and Pre-finished Volumetric Construction (PPVC).	139
8.8	Waste Reduction, Reuse and Recycling	139
8.8.1	Recycling Bins	139
8.8.2	Dual or Multiple Waste Chutes	140

8.8.3	Paper-Less Office.	141
8.8.4	Eliminating Plastic Water Bottles	142
8.8.5	Food Waste	142
	References.	144
9	Engaging Occupants in Green and Smart Buildings.	147
9.1	Increasing Occupant Awareness	147
9.2	Using the Utility Bill to Engage Occupants	149
9.3	Interactive Applications and Gamification to Engage Occupants	150
9.4	Green Lease	153
	References.	154
10	Green Building Performance Assessment and Rating.	155
10.1	Performance Metrics for Green and Smart Buildings	155
10.1.1	Energy Use Intensity (EUI)	156
10.1.2	Passive Design Performance Metrics	157
10.1.3	Active Design Performance Metrics	160
10.1.4	Lighting Power Density.	161
10.1.5	Renewable Energy Performance Metrics	162
10.1.6	Water-Use Performance Metrics	162
10.1.7	Waste Collection and Recycling Rate	163
10.1.8	Occupant Satisfaction Metrics	163
10.1.9	Life Cycle Costing Analysis	164
10.2	Green Building Standards, Certification and Rating Systems	165
10.2.1	Green Building Standards and Codes	165
10.2.2	Green Building Certification and Rating	166
	References.	170
11	Conclusion	171
	References.	179



<http://www.springer.com/978-981-10-1000-2>

Green and Smart Buildings

Advanced Technology Options

Jadhav, N.Y.

2016, XIII, 179 p. 86 illus., 79 illus. in color., Hardcover

ISBN: 978-981-10-1000-2