Sustainable Construction

Green Building Design and Delivery

Fourth Edition

Charles J. Kibert

Contents

Preface	XV
Chapter 1	
Introduction and Overview	1
The Shifting Landscape for Green Buildings 1	
The Roots of Sustainable Construction 5	
Sustainable Development and Sustainable Construction 8	•
The Vocabulary of Sustainable Development and Sustainable Construction	9
Sustainable Design, Ecological Design, and Green Design 12 Rationale for High-Performance Green Buildings 14	
State and Local Guidelines for High-Performance Construction 14	
Green Building Progress and Obstacles 16	
Trends in High-Performance Green Building 18	
Book Organization 24	
Case Study: The Pertamina Energy Tower: A Primer on	
Green Skyscraper Design 25 Summary and Conclusions 34	
Notes 34	
References 35	
Part I	
Green Building Foundations	37
Chapter 2	
Background	41
The Driving Forces for Sustainable Construction 44	
Ethics and Sustainability 46	
Basic Concepts and Vocabulary 55	
Major Environmental and Resource Concerns 65	
The Green Building Movement 70	
Case Study: OWP 11, Stuttgart, Germany 78 Summary and Conclusions 81	
Notes 82	
References 83	

Chapter 3

Ecological Design
Design versus Ecological Design 88
Contemporary Ecological Design 96
Key Green Building Publications: Early 1990s 97
Key Thinking about Ecological Design 99
Evolving the Concept of Ecological Design 104
Thermodynamics: Limits on Recycling and the Dissipation of Materials 114
Case Study: Kroon Hall, Yale University, New Haven, Connecticut 118
Thought Piece: Regenerative Development and Design: Working with the Whole by Bill Reed 121
Summary and Conclusions 123
Notes 123
References 123

87

Part II

Assessing High-Performance Green Buildings 127

Chapter 4

Green Building Assessment 129 Purpose of Green Building Assessment Systems Major Green Building Assessment Systems Used in the United States International Building Assessment Systems BREEAM Case Study: AHVLA Stores Building, Weybridge, United Kingdom 138 Green Star Case Study Thought Piece: Shifting Emphasis in Green Building Performance Assessment by Raymond J. Cole 149 Summary and Conclusions Notes 152 References 152

Chapter 5

The US Green Building Council LEED Building Rating System 155

```
Brief History of LEED 156
Structure of the LEED Suite of Building Rating Systems 158
LEED Credentials 160
LEED v4 Structure and Process 161
LEED Building Design and Construction Rating System 166
```

ix

Case Study: University of Florida Research and Academic Center at Lake No Orlando, Florida 183 Summary and Conclusions 187	na in
Chapter 6	
The Green Globes Building Assessment System	189
Green Globes Building Rating Tools 190 Structure of Green Globes for New Construction 192 Green Globes Assessment and Certification Process 204 Green Globes Professional Credentials 206 Case Study: Health Sciences Building, St. Johns River State College, St. Augustine, Florida 207 Summary and Conclusions 211	
Part III	
Green Building Design	213
Chapter 7	
The Green Building Design Process	215
Conventional versus Green Building Delivery Systems 215 Executing the Green Building Project 219 Integrated Design Process 223 Role of the Charrette in the Design Process 228 Green Building Documentation Requirements 230 Case Study: Theaterhaus, Stuttgart, Germany 231 Summary and Conclusions 235 Notes 236	
Chapter 8	
The Sustainable Site and Landscape	237
Land and Landscape Approaches for Green Buildings 238 Land Use Issues 239 Sustainable Landscapes 245 Enhancing Ecosystems 252 Stormwater Management 253 Low-Impact Development 254 Heat Island Mitigation 258 Light Trespass and Pollution Reduction 259	

Assessment of Sustainable Sites: The Sustainable Sites Initiative

260

Case Study: Iowa Utilities Board/Consumer Advocate Office 261
Summary and Conclusions 266
Notes 267
References 267

Chapter 9

Low-Energy Building Strategies Building Energy Issues 270

269

325

High-Performance Building Energy Design Strategy 274

Passive Design Strategy 277

Building Envelope 285

Internal Load Reduction 291

Active Mechanical Systems 293

Water-Heating Systems 298

Electrical Power Systems 299

Innovative Energy Optimization Strategies 305

Renewable Energy Systems 308

Fuel Cells 311

Smart Buildings and Energy Management Systems 312

Ozone-Depleting Chemicals in HVAC&R Systems 313

Case Study: River Campus Building One, Oregon Health and

Science University, Portland 314

Thought Piece: Building Energy Analysis: The Present and Future

by Ravi Srinivasan 319

Summary and Conclusions 321

Notes 321 References 322

Chapter 10

Built Environment Hydrologic Cycle

Global Water Resource Depletion 326

Water Distribution and Shortages in the United States 327

Hydrologic Cycle Terminology 331

High-Performance Building Hydrologic Cycle Strategy 333

Designing the High-Performance Building Hydrologic Cycle 349

Water Budget Rules of Thumb (Heuristics) 353

Sustainable Stormwater Management 353

Landscaping Water Efficiency 361

Case Study: LOTT Clean Water Alliance, Olympia, Washington 362

Summary and Conclusions 365

Notes 365

References 366

Χİ

Chapter 11

Closing Materials Loops 367 The Challenge of Materials and Product Selection Distinguishing between Green Building Products and Green Building Materials LCA of Building Materials and Products **Environmental Product Declarations** Materials and Product Certification Systems Key and Emerging Construction Materials and Products 385 Design for Deconstruction and Disassembly Case Study: Project XX Office Building, Delft, Netherlands 393 396 Thought Piece: Closing Materials Loops by Bradley Guy Summary and Conclusions Notes 398 References 398

Chapter 12

Built Environment Carbon Footprint

401

421

Human Impacts on the Biogeochemical Carbon Cycle Climate Change and the Carbon Cycle Mitigating Climate Change Defining the Carbon Footprint of the Built Environment 411 Reducing the Carbon Footprint of the Built Environment Notes 419

References 419

Chapter 13

Indoor Environmental Quality

Indoor Environmental Quality: The Issues

Integrated IEQ Design

Addressing the Main Components of Integrated IEQ Design 433

HVAC System Design

Emissions from Building Materials 452

Particleboard and Plywood

Economic Benefits of Good IEQ

Health, Well-Being, and Productivity

Summary and Conclusions

Notes 463

References 464

Part IV	•

Green Building Implementation

465

Chapter 14

Construction Operations and Commissioning 467

Site Protection Planning 467

Managing Indoor Air Quality during Construction 471

Construction Materials Management 475

Construction and Demolition Waste Management 478

Commissioning 480

Thought Piece: The Role of Commissioning in High-Performance Green Buildings

by John Chyz 486

Summary and Conclusions 488

Notes 489 References 489

Chapter 15

Green Building Economics

491

General Approach 491

The Business Case for High-Performance Green Buildings 494

Economics of Green Building 496

Quantifying Green Building Benefits 498

Managing First Costs 505

Tunneling through the Cost Barrier 508

Summary and Conclusions 510

Notes 510

References 510

Chapter 16

The Cutting Edge of Sustainable Construction 513

Resilience 514

Cutting Edge: Case Studies 516

Case Study: The Federal Building, San Francisco, California 516
Articulating Performance Goals for Future Green Buildings 520

The Challenges 521

Revamping Ecological Design 528

Today's Cutting Edge 531

Case Study: Green Skyscrapers 534

Thought Piece: Processes, Geometries, and Principles: Design in a Sustainable Future by Kim Sorvig 543

Summary and Conclusions 545 Notes 545 References 546

Appendix A

Appelluix A	
Quick Reference for LEED 3.0	547
Appendix B	
The Sustainable Sites Initiative™ (SITES™) v2 Rating System for Sustainable Land Design and Development	551
Appendix C	
Unit Conversions	555
Appendix D	
Abbreviations and Acronyms	557
Appendix E	
WELL Building Standard® Features Matrix	563
Glossary	567
Index	579