

CONTENTS

Foreword	xiii
Introduction	xv
My Reason for Writing This Book	xxv
Acknowledgments	xxvii
Disclaimer Note	xxix
Chapter 1 Solar Power Technology	1
Introduction	1
A Brief History of the Photoelectric Phenomenon	1
Solar Cell Physics	2
Solar Cell Electronics	4
Types of Solar Cells	6
Other Technologies	7
Concentrators	7
Solar Panel Arrays	8
Solar Power System Configurations	10
Solar Power System Applications	13
Commercial Projects Best Suited for Solar Power Installation	15
Solar Power Application in Residential Installations	15
Design Considerations for Commercial and Residential Projects	18
Advances in the Design and Development of Photovoltaic Technology	21
Evaluation of Photovoltaic Systems	23
Chapter 2 Solar Power Generation Design	25
Introduction	25
Solar Power System Components and Materials	26
Solar Power System Configuration and Classifications	26
Storage Battery Technologies	34
Solar Power System Wiring	44
Entrance Service Considerations for Grid-Connected Solar Power Systems	50
Lightning Protection	50
Central Monitoring and Logging System Requirements	54
Ground-Mount Photovoltaic Module Installation and Support Hardware	57
Roof-Mount Installations	59
Electric Shock Hazard and Safety Considerations	62
Maintenance	64
Photovoltaic Design Guideline	66
Financial Analysis	67

Chapter 3	Solar Power Generation Project Implementation	69
	Introduction	69
	Designing a Typical Residential Solar Power System	69
	Example of Typical Solar Power System Design and Installation	
	Plans for a Single Residential Unit	71
	Commercial Applications	72
	Small-Scale Solar Power Pumping	95
	Large-Capacity Solar Power Pumping Systems	96
	Pump Operation Characteristics	99
Chapter 4	Energy Conservation	101
	Introduction	101
	General Energy-Saving Measures	101
	Power Factor Correction	106
	A Few Words about Power Generation and Distribution Efficiency	106
	Computerized Lighting Control	108
	California Title 24 Electric Energy Compliance	116
	Indoor Lighting Compliance	117
	Outdoor Lighting and Signs	123
	Solar Power Facts	126
Chapter 5	LEED™—Leadership in Energy and Environmental Design	129
	Energy Use and the Environment	129
	State of California Green Building Action Plan	130
	LEED™	132
	Los Angeles Audubon Nature Center—A LEED™-Certified Platinum Project	142
	TriCom Office Building	146
	Warehouse, Rochester, New York	147
	Water and Life Museum, Hemet, California	151
	Hearst Tower	155
	Conclusion	161
Chapter 6	California Energy Commission Rebate Incentive Plans	163
	Introduction	163
	Eligibility Requirements	164
	Incentives Program	170
	Special Funding for Affordable Housing Projects	177
	Special Funding for Public and Charter Schools	177
	Principal Types of Municipal Leases	179
Chapter 7	Economics of Solar Power Systems	183
	Introduction	183
	Preliminary Engineering Design	183
	Meteorological Data	187
	Energy Cost Factor	188

Project Cost Analysis 189
 Feasibility Study Report 192
 Valley Wide Recreation and Park District 193

Chapter 8 Passive Solar Heating Technologies 211

Introduction 211
 Passive Solar Water Heating 211
 Pool Heating 212
 Concentrator Solar Technologies 222
 Solar Cooling and Air Conditioning 224
 Direct Solar Power Generation 229
 Innovations in Passive Solar Power Technology 230
 U.S. Government Annual Research Expenditure 232

Chapter 9 Fuel Cell Technologies 233

Introduction 233
 Fuel Cell Technology 233
 Short History 234
 Basic Operation Principles 235
 Fuel Reformers 235
 Types of Fuel Cells 235
 Benefits of Fuel Cell Technology 239
 Impact of Fuel Cells on the Global Economy 239
 Examples of Fuel Cell Demonstrations 239

Chapter 10 Wind Energy Technologies 241

Introduction 241
 Wind Power Energy 241
 Basics of Wind Power Turbine Operation 242
 Energy Generation Capacity of a Wind Turbine 243
 Construction of Wind Turbines 245
 Wind Turbine Energy Economics 246
 Wind Turbine Energy Supply Potential for the United States 248
 Transmission Line Access 248
 World Wind Power Production Capacity 250
 New Transmission Lines 250
 Growing Use of Wind Energy for Utility Systems 251
 Wind Farm Study Cases in the United Kingdom 252
 Wind Power Calculations 253
 Advantages and Disadvantages of Wind Power 254

Chapter 11 Ocean Energy Technologies 255

Introduction 255
 Tidal Power 255
 Barrages 257
 Types of Tidal Energy 260
 Current Tidal Generation Technologies 260
 Other Tidal Technologies 262
 Tidal Streams 265
 Marine Current Turbines 267
 Some Interesting Oceanic Technologies 270

Chapter 12	Geothermal Energy	273
	Introduction	273
	Geothermal Resources	273
	Geothermal Power Extraction Potential	275
	Types of Geothermal Power Plants	275
	Potential of Geothermal Power	277
	Cost of Geothermal Energy and Economics	278
	Environmental Impact of Geothermal Power	280
	Benefits, Uses, and Disadvantages of Geothermal Power	280
	Ocean Thermal Energy	281
Chapter 13	Biofuels and Biogas Technologies	283
	Introduction	283
	The Chemical Composition	283
	Origins of Biomass	284
	Biomass Energy Potential	285
	Benefits of Biomass Energy	286
	Impact of Biomass Energy on Climatic Conditions	287
	Biomass Technologies	288
	Economic Benefits of Using Landfill Gas	294
	Environmental Benefits of Using Landfill Gas	294
	Case Study of a Successful Application of Microgenerator Technology	294
	Cal Poly Biogas Case Study	299
	Biomass Energy	301
	Biofuels Production	302
	Some Interesting Facts about Bioenergy	306
	Biodiesel	307
	Fluidized Bed Boilers	309
Chapter 14	Hydroelectric Power	311
	Hydroelectric Power Generation	311
	Hydroelectric Power Plants	311
	Hydroelectric Power Potential	313
	Environmental Effects of Hydroelectric Power	314
	Effect of Dam Construction on Local Population	315
	Impact of Hydropower Dam Construction on Human Health	316
	Hydroelectric Power Technology	316
	Case Studies of Hydroelectric Power Plants	319
Chapter 15	Nuclear Power	333
	Introduction	333
	Properties of Uranium	333
	Nuclear Fission Power Plants	335
	Fusion Reactors	347
Chapter 16	Pollution Abatement	359
	Air Pollution Abatement	359
	Effects of Pollution on Human and Animal Life	360
	Pollution Abatement Equipment	361
	Sewage Treatment	371
	Emerging Future Technologies—Bioreactors	377

Appendix A	Unit Conversion and Design Reference Tables	379
Appendix B	Photovoltaic System Support Hardware and Structures	421
Appendix C	California Energy Commission Rebate Forms and Certified Equipment	435
Appendix D	Historical Timeline of Solar Energy	497
Appendix E	List of Sustainable Energy Equipment Suppliers and Consultants	505
Appendix F	Glossary	545
	Index	555