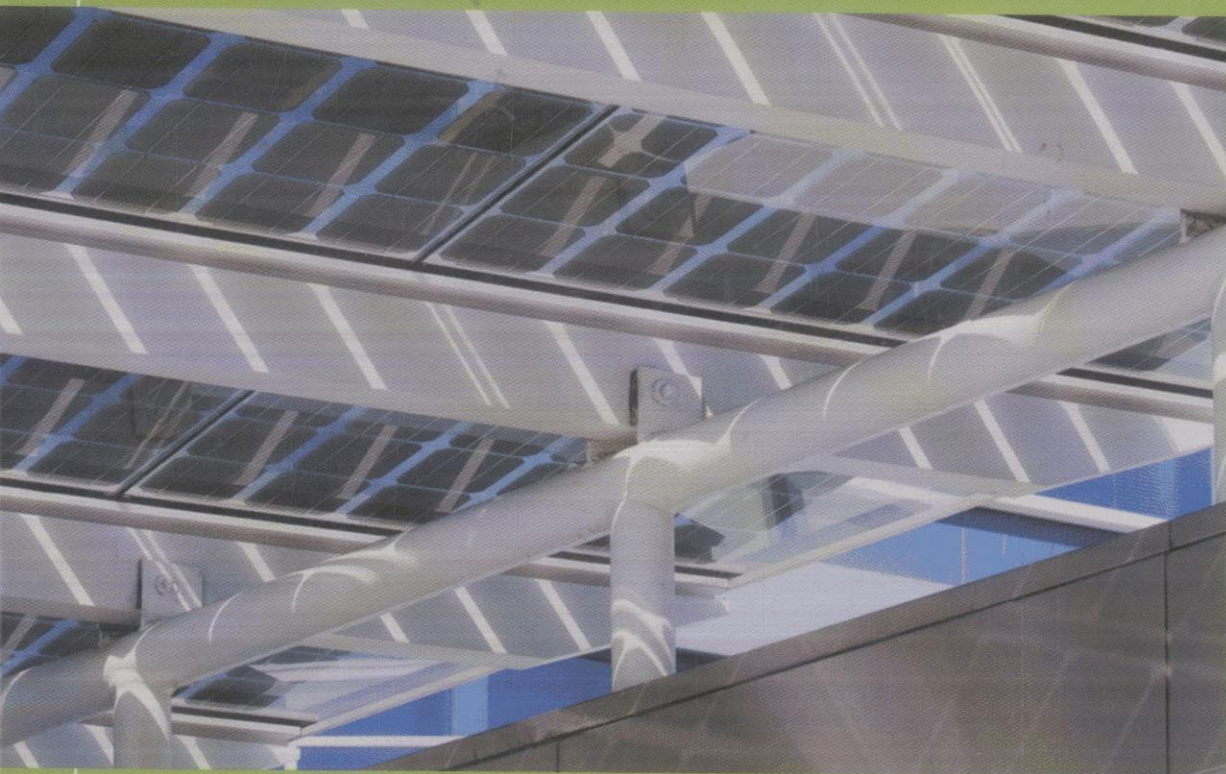


A GreenSource BOOK

# Solar Power IN BUILDING DESIGN

THE ENGINEER'S COMPLETE DESIGN RESOURCE



PETER GEVORKIAN

# CONTENTS

<b>Foreword</b>	<b>xv</b>
<b>Introduction</b>	<b>xvii</b>
<b>Acknowledgments</b>	<b>xxv</b>
<b>Disclaimer Note</b>	<b>xxvii</b>
<b>Chapter 1 Solar Power System Physics</b>	<b>1</b>
Introduction	1
A Brief History of the Photoelectric Phenomenon	1
Solar Cell Physics	5
Solar Cell Electronics	7
Types of Solar Cells Technologies	8
Other Technologies	12
Concentrators	13
Solar Panel Arrays	13
Solar Power System Components	15
<b>Chapter 2 Solar Power Technologies</b>	<b>21</b>
Introduction	21
Crystalline Solar Photovoltaic Module Production	21
Amonix Megaconcentrators	28
Film Technologies	33
Solar Photovoltaic System Power Research and Development in the United States	42
<b>Chapter 3 Solar Power System Design Considerations</b>	<b>47</b>
Introduction	47
Solar Power System Components and Materials	48
Solar Power System Configuration and Classifications	48
Storage Battery Technologies	55
Solar Power System Wiring	66
Entrance Service Considerations for Grid-Connected Solar Power Systems	71
Lightning Protection	72
Central Monitoring and Logging System Requirements	75
Ground-Mount Photovoltaic Module Installation and Support Hardware	79
Roof-Mount Installations	81
Electric Shock Hazard and Safety Considerations	90
Maintenance	92
Photovoltaic Design Guidelines	93

<b>Chapter 4 Introduction to Solar Power System Design</b>	<b>95</b>
Insolation	95
Shading Analysis and Solar Energy Performance Multiplier	99
Site Evaluation	103
Solar Power Design	111
<b>Chapter 5 Solar Power Generation Project Implementation</b>	<b>117</b>
Introduction	117
Designing a Typical Residential Solar Power System	117
Example of Typical Solar Power System Design and Installation Plans for a Single Residential Unit	119
Commercial Applications	124
Small-Scale Solar Power Pumping Systems	131
Large-Capacity Solar Power Pumping Systems	133
Pump Operation Characteristics	135
Semitropic Open Field Single-Axis Tracking System PV Array—Technical Specifications	137
<b>Chapter 6 Energy Conservation</b>	<b>143</b>
Introduction	143
General Energy-Saving Measures	143
Power Factor Correction	147
A Few Words about Power Generation and Distribution Efficiency	148
Computerized Lighting Control	150
California Title 24 Electric Energy Compliance	156
Indoor Lighting Compliance	156
Outdoor Lighting and Signs	164
Performance—Occupancy and Daylight Sensors	170
Web-Based Display Monitoring System	171
Solar Power Facts	171
<b>Chapter 7 LEED—Leadership in Energy and Environmental Design</b>	<b>173</b>
Energy Use and the Environment	173
State of California Green Building Action Plan	174
LEED	176
Los Angeles Audubon Nature Center—A LEED-Certified Platinum Project	186
TriCom Office Building	190
Warehouse, Rochester, New York	192
Water and Life Museum, Hemet, California	196
Hearst Tower	208
Statement by Cal/EPA Secretary Regarding Assembly Bill 32	212
Conclusion	212
<b>Chapter 8 California Solar Initiative Program</b>	<b>213</b>
CSI Fund Distribution	214
CSI Power Generation Targets	214
Incentive Payment Structure	215
Expected Performance-Based Buydown (EPBB)	216
Performance-Based Incentive (PBI)	217

Host Customer	217	
Solar Power Contractors and Equipment Sellers	221	
PV System Sizing Requirement	222	
Energy Efficiency Audit	223	
Warranty and Performance Permanency Requirements	223	
Insurance	223	
Grid Interconnection and Metering Requirements	224	
Inspection	224	
CSI Incentive Limitations	224	
CSI Reservation Steps	225	
Incentive Payments	229	
An Example of the Procedure for Calculating the California Solar Incentive Rebate	229	
Equipment Distributors	234	
Special Funding for Affordable Housing Projects	234	
Special Funding for Public and Charter Schools	236	
Principal Types of Municipal Lease	236	
Electric Energy Cost Increase	239	
California Assembly Bill 32	240	
Example of Energy Cost Increase in Solar Power Financial Analysis	243	
<b>Chapter 9 Economics of Solar Power Systems</b>		<b>249</b>
Introduction	249	
Preliminary Engineering Design	249	
Meteorological Data	253	
Energy Cost Factor	254	
Project Cost Analysis	255	
Feasibility Study Report	258	
Valley-Wide Recreation and Park District	258	
<b>Chapter 10 Passive Solar Heating Technologies</b>		<b>267</b>
Introduction	267	
Passive Solar Water Heating	267	
Pool Heating	268	
Concentrator Solar Technologies	278	
Solar Cooling and Air Conditioning	280	
Direct Solar Power Generation	285	
Innovations in Passive Solar Power Technology	286	
<b>Appendix A Unit Conversion and Design Reference Tables</b>		<b>289</b>
<b>Appendix B Photovoltaic System Support Hardware and Photo Gallery</b>		<b>331</b>
<b>Appendix C California Energy Commission Certified Equipment</b>		<b>353</b>

<b>Appendix D</b>	<b>Historical Time Line of Solar Energy</b>	<b>411</b>
<b>Appendix E</b>	<b>List of Sustainable Energy Equipment Suppliers and Consultants</b>	<b>419</b>
<b>Appendix F</b>	<b>Glossary of Renewable Energy Power Systems</b>	<b>457</b>
<b>Index</b>		<b>467</b>