American Solar Energy Society

Solar 2006

Including Proceedings from

35th ASES Annual Conference
31st ASES National Passive Solar Conference
1st ASES Policy and Marketing Conference
ASME Solar Energy Division
International Solar Energy Conference

“Renewable Energy – Key to Climate Recovery”

July 9-13, 2006
Denver, Colorado, USA

Volume 1 of 3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571
www.proceedings.com


Some format issues inherent in the e-media version may also appear in this print version.
TABLE OF CONTENTS

35th ASES Annual Conference - Volume 1
31st ASES National Passive Solar Conference - Volumes 1-2
1st ASES Policy and Marketing Conference - Volume 2
ASME Solar Energy Division International Solar Energy Conference - Volumes 2-3

VOLUME 1

35th ASES Annual Proceedings

D. Renné

Solar Irradiance Forecasting for the Management of Solar Energy Systems
D. Heinemann

Independent Validation of NDFD-Based Solar Radiation Forecasts
R. Perez

Towards Production of an Updated National Solar Radiation Data Base
S. Wilcox

The Necessity and Economics of Solar Radiation Resource Assessment
D. Myers

Digital Camera Based Site Evaluation Tool
B. Marion

A Study to Assess Solar Energy Potential Striking Existing Urban Rooftops in Honolulu, Hawaii
S. Meder, O. Pennetier

Cloudy Sky Version of Bird’s Broadband Hourly Clear Sky Model
D. Myers

Removing Systematic Errors from Rotating Shadowband Pyranometer Data
F. Vignola

Prediction and Validation of Cloudless Shortwave Irradiance Spectra for Horizontal, Tilted, or Tracking Receivers
C. Gueymard

New Renewable Energy Prototype Data Sets from NASA Satellites and Research
P. Stackhouse

The Direct Solar Radiation Analytical Model and the Solar Planar Modules’ Tilt Selection to Maximize The Annual Insolation of Their Surfaces
S. Kivalov

Inter-Comparison of Solar Resource Data Sets: NASA-SRB/SSE versus DLR-ISIS
R. Meyer, S. Lohmann
Long-Term Variability of Global and Beam Irradiance in the Pacific Northwest ......................................................... 54
L. Riihimaki, F. Vignola

Deriving Long Term High Resolution Solar Irradiances from Low Resolution Archives via Microstructure Patterning .................................................................................................................. 60
R. Perez, M. Kmiecik

Continuing Development of a High-Performance Low-Cost XCPC .............................................................................. 66
J. O’Gallagher

A Low-Cost Solar Dish Design Utilizing a Stretched Membrane Reflector ........................................................................ 72
D. Simmers

Comparative Evaluation of Effects of Alternative Covers and Movable Insulation on Thermal and Water Recovery Performance of Solar Stills .................................................................................. 77
D. James

Solar Thermal Applications in the Delmarva Poultry Industry: Economic Considerations .......................................................... 83
M. Thornbloom

Solar Roasted Coffee – An Example of Academic-Community Collaboration in Nicaragua ........................................................................ 88
S. Kinne, A. Sanchez

Study in Popularizing Solar Radiant Floor Heating and Shower System in Chinese North Rural Areas ................................................................................................................................. N/A
S. Liu

Performance Testing of a Low Cost Polymer Solar Air Heating Collector ................................................................................. 92
T. Cleveland

Development of Internal Heat Gain and Air Infiltration Identification Procedure Using Genetic Algorithms ................................................................................................................................. N/A
G. Liu, M. Liu

Comparisons of the Performance of Three Different Types of Evacuated Tubular Solar Collectors ................................................................................................................................. 98
W. Duff, J. Daosukho

Reliability and Degradation Study of the Sacramento Demonstration Novel ICPC Solar Collectors ................................................................................................................................. 105
W. Duff, J. Daosukho

Experimental Analysis of Stratified Multi-Tank Thermal Storage Configurations for Solar Heating Systems ................................................................................................................................. 112
C. Cruickshank, S. Harrison

Porous Medium Model of a Storage Tank with an Immersed Heat Exchanger .................................................................................. 118
Y. Su, J. Davidson

Are Baffles in Indirect Solar Storage Tanks Effective? ......................................................................................................................... 124
F. Kulacki

Durability of Polymeric Glazing and Absorber Materials ......................................................................................................................... N/A
G. Jorgensen

A Model of Antioxidant Loss in Polymer Tubes: Prediction of Life for SDHW ......................................................................................... 130
S. Mantell

An Apparatus for Studying Formation of Calcium Carbonate Scale on Polymer Tubes ......................................................................................... 136
Z. Wu
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Freeze Prevention for Passive Solar Water Heaters Using a Room-Air Natural Convection Loop</td>
<td>142</td>
</tr>
<tr>
<td>Northward Market Extension for Passive Solar Water Heaters by Using Pipe Freeze Protection with Freeze-Tolerant Piping</td>
<td>148</td>
</tr>
<tr>
<td>Cost, Design, and Performance of Solar Hot Water in Cold-Climate Homes</td>
<td>154</td>
</tr>
<tr>
<td>Modeling and Test-and-Rate Methods for Innovative Thermosiphon Solar Water Heaters</td>
<td>160</td>
</tr>
<tr>
<td>Effective Power Ratings for Solar Hot Water Systems</td>
<td>166</td>
</tr>
<tr>
<td>The Potential US Market for Solar Water Heaters</td>
<td>170</td>
</tr>
<tr>
<td>Simulation and Performance Evaluation of Parabolic Trough Solar Power Systems</td>
<td>176</td>
</tr>
<tr>
<td>Design and Optimization of Parabolic Trough Organic Rankine Cycle Powerplants</td>
<td>182</td>
</tr>
<tr>
<td>Quality Requirements for Parabolic Trough Receivers</td>
<td>188</td>
</tr>
<tr>
<td>Development of the Focal Point Power Trough (FPPT): An Advanced Parabolic Trough Concentrator for Electricity Generation</td>
<td>192</td>
</tr>
<tr>
<td>Ramifications of Installed NOCT Values</td>
<td>198</td>
</tr>
<tr>
<td>Development of a Digital Shade Analysis Tool for PV Siting</td>
<td>N/A</td>
</tr>
<tr>
<td>Recent Upgrades and Revisions to PVWATTS</td>
<td>N/A</td>
</tr>
<tr>
<td>A GIS-Based System for Performance Assessment of Solar Energy Systems over Large Geographical Regions</td>
<td>203</td>
</tr>
<tr>
<td>Renewable Energy Screening: Identifying and Prioritizing Solar Opportunities in Federal Facilities</td>
<td>209</td>
</tr>
<tr>
<td>A Practical Concentrating Photovoltaic Module for the Distributed Generation Market</td>
<td>217</td>
</tr>
<tr>
<td>Technical Challenges of Deploying Thin-Film Flexible Solar Arrays over Large Areas with a Retractable System</td>
<td>223</td>
</tr>
<tr>
<td>Use of Laboratory Testing to Predict Long-Term Reliability of PV Mounting Systems</td>
<td>228</td>
</tr>
</tbody>
</table>
Designing Residential PV Systems to Meet Local Wind Loads and Building Codes .............. 234
A. Rudin, E. Becerra

Redundant Industrial Grade DC Switching in a 200 kW BIPV System ........................................ 237
J. Bing

A Portable Direct-PV Thermoelectric Vaccine Refrigerator with Ice Storage through Heat Pipes .......................................................................................................................... 242
S. Jiajitsawat, J. Duffy

Building the Case for Photovoltaic Covered Parking ................................................................. 250
J. Henson

The First Application of Solar Photovoltaics to Powering a Complete Water Utility in the Event of Grid Outage .................................................................................................................. 256
C. Sherring, A. Rangarajan

AEC Photovoltaic Test Facility - First Year Test Data .................................................................. 260
J. Krumsick

Two - Years Performance of 5 kWp Amorphous Silicon GPV System ........................................... 266
N. Watjanatepin

Field Testing of CdTe PV Modules in Mexico ............................................................................. 270
R. Foster, L. Gomez Rocha

Renewable Energy Applications In Arctic Environmental Research ............................................. 276
S. Starkweather, T. Dahl

Photovoltaics Provide Potable Water in the Aftermath of Katrina .................................................. 282
C. Sherring, A. Rangarajan

Update: Effective Load Carrying Capability of Solar Photovoltaics in the U.S. .............................. 284
R. Perez

Price Responsive Electricity Demand and Wind Power Capacity Value ................................ ...... 290
S. Kennedy

Utility Solar: Keeping Distributed PV in the Climate Recovery Game with Large-Scale Competing Options .......................................................................................................................... 296
J. Cliburn, C. Robertson

Very Large Scale Deployment of Grid-Connected Solar Photovoltaics in the United States: Challenges and Opportunities ................................................................. 302
P. Denholm, R. Margolis

Effect of PV on Reducing Demand Charges: Case Study of a 26 kW PV System in MA .................................................. 307
U. Bhattacharjee, J. Duffy

Scoping Analysis of Potential Photovoltaic Contributions Towards Offsetting Transmission System Upgrades in Southern Vermont ................................................................. 314
D. Hill

Simple Solar Sanitation System (SSSS) ....................................................................................... 319
J. Cobb

Design and Development of a Continuous Flow Density-Driven Solar Water Pasteurization System ................................................................................................................................. 325
W. Duff

Design of a Distributed Wind/PV Hybrid System for Rural Electrification of an Island in the Philippines .......................................................................................................................... 330
A. Cultura, Z. Salameh
Nicaraguan Renewable Energy for Rural Zones Program Initiative ........................................... 336
  D. Ley

Utilization of Biogas from Pig Farms for Energy Production and Environmental
Amelioration ..................................................................................................................................... 343
  P. Thiengburanatham

Experimental Studies of a Photovoltaic Thermal Hybrid Collector ........................................... 349
  K. Touafek

Analysis of Geothermal Heat Pump for High-Rise Office Buildings of Tianjin,
China .................................................................................................................................................. N/A
  S. Liu

Innovative Hybrid Solar Lighting Reduces Waste Heat and Improves Lighting
Quality .............................................................................................................................................. 355
  M. Lapsa

Overcoming Technical and Market Barriers for Distributed Wind Applications:
Reaching the Mainstream ............................................................................................................... 361
  H. Rhoads-Weaver

Large Scale Deployment of Renewable Energy by Combining Wind Farms with
Solar Thermal Power Plants .......................................................................................................... 368
  B. Vick, R. Clark

The Tipping Point: Compatibility of Small Wind Systems and Solar ........................................... 374
  A. Kruse

Mass Cultivation of Photosynthetic Algae for Biodiesel Feedstock via Linear-
Peristaltic Thermal-Regulated Aseptic Photo-Bioreactors .......................................................... 376
  J. Sears

Hydrogen Generation by Hydrolysis of Zinc Powder Aerosols ......................................................... 382
  H. Funke

Hybrid Renewable Power for the Solar Decathlon’s Zero Energy Village ........................................ 385
  R. Robichaud

Independence Station Biofuel Test Facility ..................................................................................... N/A
  J. Krumsick

31st ASES National Passive Solar Conference

Data-Mining LEED® Documentation to Shape Sustainable Development Policies
& Programs ........................................................................................................................................... 401
  V. Agarwal, B. Erwine

Post Occupancy Evaluation: Understanding the Real Performance of Sustainable
Buildings ............................................................................................................................................. 407
  B. Erwine

Energy Efficient Affordable Housing: Validating HEED’s Predictions of Indoor
Comfort ............................................................................................................................................... 413
  M. Milne, J. Morton

An Evaluation of Two Residential Green Building Programs: LEED for Homes and
the Solar Decathlon ......................................................................................................................... 419
  A. Hollinger, N. Rajkovich
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy and Associated Environmental Impacts of the Draft High Performance School Rating System</td>
<td>424</td>
</tr>
<tr>
<td>S. Jamadagni</td>
<td></td>
</tr>
<tr>
<td>A Comparison of Simulations, Physical Models, and a Full-scale Prototype in Predicting Daylighting Performance of a Complex Space</td>
<td>432</td>
</tr>
<tr>
<td>G. Brown</td>
<td></td>
</tr>
<tr>
<td>Steal This Interface: Explorations In Interactive Building Simulation Software</td>
<td>439</td>
</tr>
<tr>
<td>T. Peters</td>
<td></td>
</tr>
<tr>
<td>Performance Evaluation of Natural Ventilation Strategy in a North American Climate</td>
<td>443</td>
</tr>
<tr>
<td>R. Sonal</td>
<td></td>
</tr>
<tr>
<td>Examining the Role of Full Field Solutions in Analyzing Passive Solar Architecture</td>
<td>451</td>
</tr>
<tr>
<td>V. Sami, J. Gassman</td>
<td></td>
</tr>
<tr>
<td>Integration of Photovoltaics in Building Envelope: Effect on Whole Building Energy Performance</td>
<td>458</td>
</tr>
<tr>
<td>S. Nagpal</td>
<td></td>
</tr>
<tr>
<td>Designing an Energy-Efficient Border Crossing Station for the Department of Homeland Security</td>
<td>463</td>
</tr>
<tr>
<td>A. Jackaway</td>
<td></td>
</tr>
<tr>
<td>The 2005 Cornell University Solar Decathlon House</td>
<td>471</td>
</tr>
<tr>
<td>G. Volpicelli, N. Rajkovich</td>
<td></td>
</tr>
<tr>
<td>City Hall as Symbol for Sustainability</td>
<td>476</td>
</tr>
<tr>
<td>D. Armpriest, B. Haglund</td>
<td></td>
</tr>
<tr>
<td>Renewables and Denali National Park</td>
<td>482</td>
</tr>
<tr>
<td>S. Reilly</td>
<td></td>
</tr>
<tr>
<td>Sleeping Rainbow Ranch: An Integrated Approach to Sustainable Design</td>
<td>N/A</td>
</tr>
<tr>
<td>M. Chalom</td>
<td></td>
</tr>
<tr>
<td>Combined Passive and Active Solar Space and Water Heating and More: Three Residential Case Studies</td>
<td>488</td>
</tr>
<tr>
<td>D. Arkin</td>
<td></td>
</tr>
<tr>
<td>Design and Evaluation of Passive Heating and Cooling Strategies Implemented in a New Construction House in a Desert Climate</td>
<td>493</td>
</tr>
<tr>
<td>E. Fonseca</td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain Institute-Showcase Green Office</td>
<td>N/A</td>
</tr>
<tr>
<td>C. Carmichael</td>
<td></td>
</tr>
<tr>
<td>Hawaii Gateway Energy Center-A Showcase of Cutting Edge Technologies</td>
<td>499</td>
</tr>
<tr>
<td>C. Carmichael, G. Franta</td>
<td></td>
</tr>
<tr>
<td>‘A Generation Beyond’ Office Park, Mason City, Iowa, USA</td>
<td>504</td>
</tr>
<tr>
<td>T. Hurd</td>
<td></td>
</tr>
</tbody>
</table>

**VOLUME 2**

Maximizing the Triple Bottom Line: The Potential to Green a High-End Suburban Community in Las Vegas, Nevada | N/A  |
<p>| A. Fernandez-Gonzalez, D. Overbey                                   |      |</p>
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement Natural Ventilation Scheme of an Anasazi Two-Zone Underground Kiva</td>
<td>509</td>
</tr>
<tr>
<td>A. Sharag-Eldin, J. Dalton</td>
<td></td>
</tr>
<tr>
<td>Unbuilt, Untested, Performance Unknown: Libbey-Owens-Ford and “Your Solar House”</td>
<td>515</td>
</tr>
<tr>
<td>N. Rajkovich</td>
<td></td>
</tr>
<tr>
<td>Thermal Comfort Performance Study of the Frank Lloyd Wright Freeman House</td>
<td>521</td>
</tr>
<tr>
<td>S. Brahmbhatt</td>
<td></td>
</tr>
<tr>
<td>Lessons Learned From The Pefki Solar Village In Athens, Nearly 20 Years On</td>
<td>528</td>
</tr>
<tr>
<td>B. Croxford, A. Kalogridis</td>
<td></td>
</tr>
<tr>
<td>R. Gupta</td>
<td></td>
</tr>
<tr>
<td>Quantifying the Ecological Restoration Provided by Green Machines</td>
<td>541</td>
</tr>
<tr>
<td>V. Olgyay</td>
<td></td>
</tr>
<tr>
<td>A Model for Integral Sustainable Design Explored Through Daylighting</td>
<td>547</td>
</tr>
<tr>
<td>M. DeKay</td>
<td></td>
</tr>
<tr>
<td>A Sun Clock Project</td>
<td>553</td>
</tr>
<tr>
<td>R. Bannerot</td>
<td></td>
</tr>
<tr>
<td>Heliodon: Automated &amp; Integrated</td>
<td>559</td>
</tr>
<tr>
<td>K Van Den Wymelenberg</td>
<td></td>
</tr>
<tr>
<td>Heliodons in the Classroom: A Hands-On Tool for Teaching Solar Geometry and Solar Responsive Design</td>
<td>563</td>
</tr>
<tr>
<td>J. Guggenheim</td>
<td></td>
</tr>
<tr>
<td>Daylighting Lab Operations and Management Plan</td>
<td>567</td>
</tr>
<tr>
<td>K. Van Den Wymelenberg</td>
<td></td>
</tr>
<tr>
<td>The Synergistic Benefits of Integrated Design: A Classroom Prototype for the Pacific Northwest</td>
<td>573</td>
</tr>
<tr>
<td>G. Brown</td>
<td></td>
</tr>
<tr>
<td>Solar Architecture in Minnesota: Toward Zero Energy Housing</td>
<td>579</td>
</tr>
<tr>
<td>M. Guzowski, W. Weber</td>
<td></td>
</tr>
<tr>
<td>A Cold-Climate Case Study for Affordable Zero Energy Homes</td>
<td>583</td>
</tr>
<tr>
<td>T. Givler, C. Christensen</td>
<td></td>
</tr>
<tr>
<td>Analyzing Climate-Optimized designs for Habitat for Humanity</td>
<td>591</td>
</tr>
<tr>
<td>P. Norton, C. Christensen</td>
<td></td>
</tr>
<tr>
<td>A Fully PV-Powered Home and Electric Truck for Commuting and Emergency Power</td>
<td>597</td>
</tr>
<tr>
<td>A. Compaan</td>
<td></td>
</tr>
<tr>
<td>Efficiency of Building-Integrated Photovoltaic System</td>
<td>601</td>
</tr>
<tr>
<td>M. Navvab, J. Varodompum</td>
<td></td>
</tr>
<tr>
<td>The Future of Photovoltaic Roofing Products</td>
<td>607</td>
</tr>
<tr>
<td>S. Heckeroth</td>
<td></td>
</tr>
<tr>
<td>Daylighting Performance of Toplighting Systems in the Hot and Humid Climate of Thailand</td>
<td>613</td>
</tr>
<tr>
<td>S. Harntaweewongsa, L. Beltrán</td>
<td></td>
</tr>
</tbody>
</table>
Improving Daylighting in Existing Buildings: Characterizing the Effect of Anidolic Systems
S. Kleindienst, M. Andersen .......................................................... 619

Daylight Systems For South Facing Facades – Design and Simulation in Architectural Education
M. Moek, B. Noggle ........................................................................ 628

Optical Fiber Daylighting: Sizing the Concentrating Collector
A. Fanchiotti .................................................................................. 634

A Cost-Effective Solution for Core Daylighting in Office Buildings
A. Rosemann .................................................................................. 641

Single-Axis Tracking Beam Sunlighting System
R. McCluney .................................................................................. 647

Energy Performance of a Double Skin Façade
A. Pappas, S. Reilly ....................................................................... 653

Thermal Performance of a Double Skin Façade Using Full Scale Testing, Computer Simulation and Actual Building
M. Navvab, J. Varodompum .......................................................... 658

Improving Direct Solar Radiation in Complex Building Envelopes with a Computational Genetic Algorithm
J. daVeiga ...................................................................................... 664

Dynamic Solar Heat Gain Coefficient: Experimental Evaluation of the Opaque Portion of a Curtain Wall System
V. Lerum ........................................................................................ 670

A Concise Method for Determining Optimal Glazing Specifications
V. Olgyay ....................................................................................... 676

House Comfort without Fire or Smoke, Using the Earth, Air, Sun and Roof - All Free and Renewable
D. Wright ...................................................................................... 682

Window Heat Transfer in Conventional New England Residences
F. Loxsom, N. Vivar-Orum ............................................................ 685

Green Cooling: Combining Vegetated Roofs with Night Ventilation
P. La Roche .................................................................................... 688

Passive Cooling Strategies for an Academic Building in Chicago
D. Ogoli ........................................................................................ 694

Decision-Support Framework for the Feasibility of Natural Ventilation of Non-Residential Buildings
Y. Zhao, J. Jones ........................................................................... 700

Thermal Mass and Shading Benefits with TOU Rates Structure
A. Bhargava .................................................................................. N/A

Experimental Performance of the Roofpond System in Las Vegas, Nevada, USA
A. Fernandez-Gonzalez, D. Overbey .............................................. 706

Shady Proposition: Comparing Passive Thermal Control Strategies
B. Sturlaugson ............................................................................... 712

Temperature, Humidity, Air Flow and CO2 Contents Analysis of Arcade-Type Markets
B. Kim .......................................................................................... 718
Application of “Cool Canopy” for Outdoor Thermal Comfort ............................................ 724
H. Bryan

Air Quality and Comfort Standards in a Converted Classroom ............................................ 729
S. Jensen Augustine, J. Fribley

Solar Decathlon: An Overview and Constructive Critique .................................................. 734
S. Brahmbhatt, D. Noble

Solar Decathlon Results and Strategies: A Closer Look ...................................................... 739
M. Wassmer, C. Warner

The Kirsch Center for Environmental Studies—A 17-Year Odyssey from Campus Vision to Architectural Fulfillment ................................................................. 747
D. Aitken

The Gaylord Nelson Studio - Student Work and Faculty Activism 2003-2005 ..................... 753
J. Wasley

Learning by Doing: A Post-Occupancy Building Evaluation Module for Postgraduate Architecture Students ................................................................. 759
R. Gupta

1st ASES Policy and Marketing Conference

Letting the Sun Shine on Solar Costs: An Empirical Investigation of Photovoltaic Cost Trends in California .................................................................................. 765
R. Wiser, M. Bolinger

Technical Potential for Rooftop Photovoltaics in the San Diego Region ............................ 771
S. Anders

Targeting Photovoltaic Market Transformation Efforts By Separately Considering the Residential, Commercial/Industrial, and Government Sectors .............................. 776
W. Steigelmann, H. Barnes

V. Garrett, T. Koontz

N. Blair

U.S. Solar Market Trends ....................................................................................................... 794
L. Sherwood

PV Value Chain Supply and Demand Challenges ................................................................. 800
A. Knox, C. Procaccini, R. Pinkham, T. Cooke, Booz Allen Hamilton

Annual PV Market Assessment and Supply Chain Reports ............................................... 808
T. Bradford, H. Flynn

An Assessment of Global Silicon Production Capacity and Implications for the PV Industry ................................................................. 814
H. Flynn, T. Bradford

Product Quality in Solar PV Markets: Results for Amorphous Silicon Solar Module Performance from African and North American Markets ........................................ 820
A. Jacobson
A New Perspective on Solar Financial Modeling .................................................................826
H. Tsai

PV Financing for Non Profits: A Solar Endowment ............................................................832
D. Greyber

A New Solar Financial Analysis Calculator .......................................................................837
A. Black

An Economic Assessment of Solar PV Systems .................................................................843
J. Airola

Social and Environmental Benefits of Sustainable Investments .......................................849
P. Middleton

AEC Photovoltaic Test Facility - A Financing Test Study ..................................................854
J. Krumsick

Activation of Abandoned Solar Water Heating System: A Hospital Expansion Energy Analysis .................................................................860
D. Paulus

Is Photovoltaic Power a Cost-Effective Energy Solution for Rural Peoples in Western Sudan? .................................................................866
B. Croxford, M. Rizig

Encouraging PV Adoption in New Market-Rate Residential Construction: A Critical Review of Program Experiences to Date .................................................................872
G. Barbose

Growing New Construction Markets for Photovoltaics: Recent Strategies and Activities from LIPA’s Solar Pioneer Program .................................................................878
D. Hill

Impact of Distributed Energy-Efficiency with Solar on SMUD’s Peak Load ......................883
M. Keesee

Impacts of Zero Energy Homes on Buyers and Owners ....................................................888
B. Baccei

Efficient System Design and Sustainable Finance for China’s Village Electrification Program ...............................................................................................................894
S. Ma, H. Yin

Rural Honduran PV Powered Schools and Community Centers ....................................900
D. Ley, C. Hanley

A Strategic Approach for Promoting Access to Clean Energy Development .................N/A
D. Rennê

The EMPower Program: A Strategic Market Intervention Approach for Grid-Connected Solar Energy Technologies .................................................................906
F. Morse, Cynthia Hunt Jaehne, Gunter Schramm

Potential for Renewable Energy in Nigeria .....................................................................909
I. Ufeli

Analysis of U.S. Interconnection and Net-Metering Policy ............................................915
C. Cook

Driving Renewable Energy in Colorado ........................................................................N/A
J. Gilliam
An Economic, Employment, and Environmental Analysis of the Colorado Renewable Energy Standard Ballot Initiative ................................................................. 921
  J. Deyette, S. Clemmer

Front Porch Sunshine: Extending the Benefits of Solar Water Heating to Low-Income Households ........................................................................................................ 927
  C. Kettles

Sun Power for Schools: Georgia Schools Going Solar ................................................................................................................................. 931
  L. Uhde

Clearing the Air: The Impact of Carbon Cap and Trade Regulations on Renewable Energy ............................................................................................................... 936
  R. Harmon, M. Hirschhorn

Can PV or Solar Thermal Systems be Cost Effective Ways of Reducing CO2 Emissions for Residential Buildings? ...................................................................................... 943
  B. Croxford, K. Scott

Utility-Driven Solar Energy as a Least-Cost Strategy to Meet RPS Policy Goals and Open New Markets ........................................................................................................ 949
  C. Robertson, J. Cliburn

Payback on Residential PV Systems with Performance Based Incentives and Renewable Energy Certificates ............................................................................................. 955
  A. Black

A Quarter a Kilowatt Hour: Getting Serious About Building a Solar Energy Future ................................................................. 961
  S. Letendre

Coast Economic Localization Link (CELL) – Responding at the Local Level to Peak Oil and Climate Change ....................................................................................... 967
  C. Heckeroth

Trends In Practitioner Training For The Renewable Energy Trades ................................................................................................................................. 973
  J. Weissman

Renewable Energy Technologies Diploma Series: An Interdisciplinary Approach to Renewable Energy Training ........................................................................................................ 978
  L. Rakusin

Energizing the Curriculum ................................................................................................................................................................................................. 982
  R. Welch

Educating Municipal and County Governments About Solar Energy ............................................................................................... 987
  V. Everette, J. Rees

The Eleventh Event: Public Perceptions of the Solar Decathlon ..................................................................................................................... 993
  K. Janda

Renewable Facilities for Education and Outreach ................................................................................................................................................................. N/A
  R. Carson

ASME Solar Energy Division International Solar Energy Conference

Calorimetric Measurements of the Input Power into a 500 kW High Concentration Solar Energy Volumetric Receiver ......................................................................................... 999
  G. Miron
Double-Focus Configuration at DLR Solar Furnace for Operating a Continuous Reactor .............................................................................................................. 1010
A. Neumann

CFD Modeling of Gas Particle Flow within a Solid Particle Solar Receiver .......................................................... 1018
H. Chen

Solar-Assisted Small Solar Tower Trigeneration Systems ......................................................................................... 1030
R. Buck, S. Friedmann

Some Alternative Technologies for Solar Thermal Power Generation ................................................................. 1036
M. Utamura, Y. Tamaura

Wet or Dry Cooling? .............................................................................................................................................. 1046
I. Khalil

Design and Construction of The APS 1-MWe Parabolic Trough Power Plant ...................................................... 1054
S. Canada

Performance Analysis of Thermocline Energy Storage Proposed for the 1 MW Saguaro Solar Trough Plant ....... 1062
G. Kolb

Advanced Parabolic Trough Data Collection - Real-Time Data Collection, Archiving, and Analysis for the Solargenix Advanced Parabolic Trough ........................................... 1067
R. Hurt

VOLUME 3
Field Survey of Parabolic Trough Receiver Thermal Performance .......................................................................... 1073
H. Price

Video Scanning Hartmann Optical Testing of State-of-the-Art Parabolic Trough Concentrators ......................................................................................... 1081
T. Wendelin

Practical Field Alignment of Parabolic Trough Solar Concentrators ....................................................................... 1090
R. Diver Jr., T. Moss

Preparation of CIGSS Thin Film Solar Cells by Rapid Thermal Processing .......................................................... 1100
S. Kulkarni

Preparations and Photovoltaic Properties of Thin Films Using Soluble Fulleropyrrolidine Derivatives for Organic Solar Cells .................................................................................. 1104
M. Kim

Solid-State Dye-Sensitized Solar Cells Using Conducting Polymers as Hole Transporting Materials ................. 1109
M. Kim

Prediction of Photovoltaic Power Output Considering Weather Effects .............................................................. 1114
K. Furushima, Y. Nawata

Operation and Performance of the Amonix High Concentration Photovoltaic System at the University of Nevada, Las Vegas During the Second Year of Operation ......................................................... 1116
K. Stone, V. Garboushian

Early Results from the Long-Term Testing of Inverters ......................................................................................... 1124
K. Lynn, W. Wilson

A Review of PV System Performance and Life-Cycle Cost for the Sunsmart Schools Program ......................... 1127
K. Lynn
Increasing the Productivity of Solar Photovoltaic Systems .......................................................... 1131
D. Torrey, J. Kokernak

Usage of Earth Observation for Solar Energy Market Development - Lessons Learned .................................................... 1141
M. Schroeder-Homscheidt

PV Operated HVAC for Southwest States ......................................................................................... 1151
J. McCabe

Design of Photovoltaic-Powered Refrigeration for Tropical Climates ................................................. 1155
S. Kassels, M. Brandemuehl

Preliminary Validation of Urban Building Integrated PV System Simulation Software ................................................................. 1163
K. Rapolu

Design of Grid Connected-PV System for a Hydrogen Refueling Station ............................................. 1171
S. Deshmukh

Thermodynamic Analysis of Mixed-Metal Ferrites for Hydrogen Production by Two-Step Water Splitting .............................................................................................................. 1176
M. Allendorf

Solar Thermochemical Water-Splitting Ferrite-Cycle Heat Engines .................................................. 1182
R. Diver Jr.

A Two-Step Water Splitting with Ferrite Particles and its New Reactor Concept Using an Internally Circulating Fluidized-Bed .................................................................................. 1191
N. Gokon

H2 Generation by Two-Step Water Splitting with CeO2-MOx Using Concentrated Solar Thermal Energy ............................................................................................................................. 1201
H. Kaneko

Radiative Transfer Within a Cylindrical Cavity with Diffusely/Specularly Reflecting Inner Walls Containing an Array of Tubular Absorbers ............................................................................. 1207
T. Melchior

Numerical Modeling of Solar Thermo-Chemical Water-Splitting Reactor ........................................ 1215
D. James

Efficient Solar Thermal Processes from Carbon Based to Carbon Free Hydrogen Production .................................................................................................................. 1222
C. Sattler

Hydrogen Production by Steam-Gasification of Petroleum Coke using Concentrated Solar Power - Reactor Experimentation with Slurry Feeding ........................................ 1232
A. Z’Graggen

Solar Tubular Reformer with Moten-Salt Thermal Storage - Design Modification of the Reactor Tube and Testing ............................................................................................................. 1237
T. Kodama

SOLREF: Development of an Advanced Solar High-Temperature Reformer ................................... 1245
S. Möller, S. Friedmann

Materials Development for the CR5 Solar Thermochemical Heat Engine ......................................... 1253
J. Miller

A 300 kW Solar Chemical Pilot Plant for the Carbothermic Production of Zinc .................................. 1263
C. Wieckert
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of Energy Savings by Optimization Control in Thermal Energy Storage System</td>
<td>1405</td>
</tr>
<tr>
<td>D. Seo, M. Krarti</td>
<td></td>
</tr>
<tr>
<td>Impacts on Building Return Water Temperature in District Cooling Systems</td>
<td>1413</td>
</tr>
<tr>
<td>G. Wang</td>
<td></td>
</tr>
<tr>
<td>Feasibility Study of Applications of Combined Heat and Power Systems in Tropical Locations</td>
<td>1421</td>
</tr>
<tr>
<td>L. Alva-Solari</td>
<td></td>
</tr>
<tr>
<td>Experimental Analysis of Heat Transfer from Ice Rink Floors</td>
<td>1429</td>
</tr>
<tr>
<td>J. Mun, M. Krarti</td>
<td></td>
</tr>
<tr>
<td>Economic Evaluation of a Solid Adsorption Solar Refrigerator</td>
<td>1436</td>
</tr>
<tr>
<td>E. Anyanwu, N. Ogueke</td>
<td></td>
</tr>
<tr>
<td>Airflow Distribution and Microenvironment Evaluation of CMP Task Conditioning System</td>
<td>1447</td>
</tr>
<tr>
<td>Y. Jing, G. Zheng</td>
<td></td>
</tr>
<tr>
<td>CFD-Based Parametric Analysis on the Performance of Personalized Partition Air Distribution Systems</td>
<td>1454</td>
</tr>
<tr>
<td>K. Jeong</td>
<td></td>
</tr>
<tr>
<td>Influence Factors of Energy Consumption in All Cold Outdoor Air Systems</td>
<td>1463</td>
</tr>
<tr>
<td>W. Bing</td>
<td></td>
</tr>
<tr>
<td>Genetic-Algorithm Based Controls for Daylighting</td>
<td>1469</td>
</tr>
<tr>
<td>A. Khlifi</td>
<td></td>
</tr>
<tr>
<td>J. Liu</td>
<td></td>
</tr>
<tr>
<td>Exergetic Analysis for Improving the Operation of Building Mechanical Systems: Results and Recommendations</td>
<td>1488</td>
</tr>
<tr>
<td>E. George, M. Bailey</td>
<td></td>
</tr>
<tr>
<td>Impact of Shape on Building Energy Use in Tunisia</td>
<td>1497</td>
</tr>
<tr>
<td>K. Oertani</td>
<td></td>
</tr>
<tr>
<td>Impact of Solar Model Selection on Building Energy Analysis for Kuwait</td>
<td>1505</td>
</tr>
<tr>
<td>A. Al Anzi</td>
<td></td>
</tr>
<tr>
<td>Numerical Study of Optimal Building Scales With Low Cooling Load in Both Hot and Mild Climatic Regions</td>
<td>1514</td>
</tr>
<tr>
<td>J. Zhai</td>
<td></td>
</tr>
<tr>
<td>Evaluating the Impact of Solar Radiation on Outdoor Thermal Comfort by the Development and Validation of a Simple Urban Climatic Model</td>
<td>1520</td>
</tr>
<tr>
<td>Y. Zhu</td>
<td></td>
</tr>
<tr>
<td>Comparative Thermal Analysis of Structural Insulated Panels and Wood Frame Walls for Residential Buildings</td>
<td>1527</td>
</tr>
<tr>
<td>M. Krarti</td>
<td></td>
</tr>
<tr>
<td>The Indoor Thermal Environment Simulation and Analysis of an Emporium with Atrium</td>
<td>1538</td>
</tr>
<tr>
<td>W. Bing</td>
<td></td>
</tr>
<tr>
<td>Analysis of Demand Side Management Measures for Residential Buildings</td>
<td>1545</td>
</tr>
<tr>
<td>J. Dark, M. Krarti</td>
<td></td>
</tr>
</tbody>
</table>
Implementing Solar Energy in the Colorado Production Home Market ........................................1555
J. Lyng, M. Brandemuehl

Reducing the Risk of Natural Ventilation with Flexible Design ...........................................1563
L. Greden

Cost-Benefit Analysis of Net Zero Energy Campus Residence .................................................1574
G. Raffio

Monitoring of a Zero-Energy-House .......................................................................................1583
S. Rosta

Green Development in Turkey ...............................................................................................1590
H. Sözer

Dendro: Biomass Power From, By, and For the People of Sri Lanka .......................................1595
B. Weaver

China Energy Label: A Strategy to Encourage Energy Conservation and the Challenge Ahead in Power Markets .................................................................1607
Z. Yu

Evaluating the Performance of Single Slope Passive Solar Still for Different Slope of Cover And Water Depths by Thermal Modeling: In Moderate Climatic Condition ........1611
A. Tiwari, G. Tiwari

Development of a Computational Model for a Prototype Testing Room with Integrated ABE System ........................................................1620
X. Xu, S. Van Dessel

Ray Trace Analysis for Concentrating Sunlight onto an Optical Fiber Bundle .......................1629
C. Sadasivuni

The Impacts of Climate Changes in the Renewable Energy Resources in the Caribbean Region .................................................................1635
M. Angeles, J. González

Uncertainty Calculations in Pyranometer Measurements and Applications ..........................1650
M. Kratzenberg

Interrelations of Hourly and Daily Global Illuminance .........................................................1660
P. Ravikumar

Author Index