

# **ISES Solar World Congress 2017 and IEA SHC Solar Heating and Cooling Conference for Buildings and Industry 2017**

Abu Dhabi, United Arab Emirates  
29 October – 2 November 2017

Volume 1 of 4

**Editors:**

**Manuel Romero  
Daniel Mugnier**

ISBN: 978-1-5108-6541-9

**Printed from e-media with permission by:**

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



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

Copyright© (2017) by International Solar Energy Society  
All rights reserved.

Printed by Curran Associates, Inc. (2018)

For permission requests, please contact International Solar Energy Society  
at the address below.

International Solar Energy Society  
Wiesentalstr. 50  
79115 Freiburg  
Germany

Phone: +49 761 459 06 0  
Fax: +49 761 459 06 99

[hq@ises.org](mailto:hq@ises.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## Scientific Program

### Active Demand-side Management

<b>Price-Based Demand Side Management (DSM) Coupled with Cold Thermal Energy Storage (TES) and Solar PV for Peak-Load Reduction</b> <i>Cabeza, L.F., Belusko, M., Boer, D., Fernandez, C., Saffari, M., de Gracia, A.</i> . . . . .	<b>1</b>
<b>Investigating Smart Grid Approaches for optimal integration of PV Distributed Energy Resources in Dubai</b> <i>Shahin, M., Topriska, E.</i> . . . . .	<b>12</b>

### Clean Transportation Technologies and Strategies

<b>Potential of Energy Storage and Rapid Charge System Using Electric Double Layer Capacitors for the Solar Light Rail</b> <i>Kameya, T., Ghann, W., Katsuma, H., Suzuki, G., Takami, H., Uddin, J.</i> . . . . .	<b>25</b>
--	-----------

### Community Micro Power and Hybrid Systems

<b>Integration of Autonomous Renewable Energy Generation Systems with Different Topologies in a Smart Grid Cluster to Enhance Performance in Usual Operational Situations</b> <i>Arrifano Manito, A.R., Flores Melendez, T.A., Mocelin, A.R., Novaes, K., Pinho, J.T., Zilles, R.</i> . . . . .	<b>34</b>
<b>Methodological Approach of Performance Evaluation for Using Pump as Micro Hydro-turbine</b> <i>Mdee, O.J., Kihedu, J., Kimambo, C.Z., Nielsen, T.K.</i> . . . . .	<b>46</b>

### Concentrating Solar Power Technologies

<b>Benchmarking of Energy Demand and CO2 Emissions of Domestic Residential Buildings</b> <i>Cabeza, L.F., Botargues, T., Coma, J., Gimbernat, T., Maldonado, J.M., de Gracia, A.</i> . . . . .	<b>59</b>
<b>Key Aspects of a Novel Undulated Receiver for Parabolic Trough Collectors</b> <i>Demagh, Y., Hachicha, A.A.</i> . . . . .	<b>65</b>
<b>The Novel Undulated Parabolic Trough Receiver: Performance Enhancement, Reduction in the Size and Cost of the Collector Fields</b> <i>Demagh, Y., Bitam, E.W., Kabar, Y.</i> . . . . .	<b>71</b>

<b>Long-Term Variability of Aerosol Optical Depth, Dust Episodes, and Direct Normal Irradiance Over Kuwait for CSP Applications</b> <i>Gueymard, C., Al-Rasheedi, M., Hussain, T., Ismail, A.</i>	75
<b>An Organic Rankine Cycle as Technology for Smaller Concentrated Solar Powered Systems</b> <i>Karsten, L., Dinter, F., Hoffmann, J.</i>	85
<b>Assessment of Liquid Metals as Heat Transfer Fluid for Solar Parabolic Trough Collector Applications</b> <i>Krishna Chaitanya, N.V.V., K, R.K.</i>	97
<b>Ni-Co Co-Modified Anodized Spectrally Selective Coatings with Enhanced Corrosion and Thermal Stability</b> <i>Kumar, R.</i>	109
<b>Thermal Stress Analysis of Parabolic Trough Receivers with Concentrated Solar Irradiation</b> <i>Lei, D., Fu, X., Ren, Y., Wang, Z.</i>	116
<b>Exergy Cost Decomposition and Comparison of Integrating Seawater Desalination Plant, Refrigeration Plant, Process Heat Plant in a Concentrated Solar Power Plant</b> <i>Leiva, R., Alarcón-Padilla, D., Cardemil, J., Escobar, R., Martínez, A., Uche, J.</i>	125
<b>Design of a Calorimetric Facility to Assess Volumetric Receivers Employing a 42 KW High Flux Solar Simulator</b> <i>Luque, S., González-Aguilar, J., Romero, M.</i>	136
<b>To Beam or Not to Beam Down</b> <i>Miller, S.</i>	146
<b>Experimental Validation of a Novel Light-Splitting Technique for Retrofitting CSP Plants by Hybridizing with CPV</b> <i>Orosz, M., Dale, J., Otanicar, T.</i>	158
<b>Molten Carbonates Electrolyzer Model for Hydrogen Production Coupled to Medium / Low Temperature Solar Power Plant</b> <i>Reyes, M.A., Delgado, A., Díaz, E., González-Aguilar, J., Romero, M.</i>	168
<b>Detrimental Effects of Dust Deposition in Pores of an Open Volumetric Air Receiver</b> <i>Singh, G., Chandra, L.</i>	179
<b>Concentrating Solar Collectors Integrated with Low CO<sub>2</sub> Emissions Ultra Supercritical Power Plants</b> <i>Tola, V., Cascetta, M., Cocco, D., Petrollese, M.</i>	189

## Daylighting

<b>Calculation of Energy Performance Indices of Daylight Linked Control Systems by Monitored Data</b> <i>Beccali, M., Bonomolo, M., Lo Brano, V., Zizzo, G.</i>	202
<b>Studying the Impact of Colored Glazing Systems on Visual and Non-Visual Performances in a Daylit Office</b> <i>Chen, X., Du, J., Zhang, X.</i>	214

<b>Study on the Effect of the Layout of Daytime Activity Space on the Annual Vertical Daylight Exposure on the Eye in Elderly Facilities</b>	
<i>Tang, B., Zhang, X.</i>	225
<b>The Daylighting Performance of an Integrated Skylight and Shading Dome for the Tropics</b>	
<i>Visitsak, S., Beltran, L., Sridaranon, N.</i>	237

## District Heating

<b>Validation of a District Heating System Model and Simulation-Based Investigation of Bidirectional Heat Transport by Decentralised Solar Thermal Plants</b>	
<i>Beckenbauer, D., Cheng, V., Ehrenwirth, M., Klärner, M., Zörner, W.</i>	247
<b>FLEXYNETS – a New District Heating Network Concept for Higher Solar Thermal and Waste Heat Share</b>	
<i>Ben Hassine, I., Jobard, X.</i>	259
<b>Solar District Heating in Europe: Supplying Renewable Zero-Emission Heat</b>	
<i>Berberich, M., Mangold, D.</i>	269
<b>Central Versus Semi-Decentralized Solar District Heating for Low Heat Density Housing Areas in Germany</b>	
<i>Best, I., Orozaliyev, J., Vajen, K., Yu, Y.</i>	279
<b>Thermal Performance Analysis of a Solar Heating Plant</b>	
<i>Fan, J., Furbo, S., Huang, J., Lie Andersen, O.</i>	291
<b>Extension of Germany’s Largest Solar District Heating System with Seasonal Thermal Energy Storage</b>	
<i>Gohl, N., Bestenlehner, D., Drück, H.</i>	301
<b>Potential Analysis On Solar District Heating in China</b>	
<i>Huang, J., Fan, J., Furbo, S.</i>	310
<b>Implementation of large solar thermal system into district heating network in Chemnitz (Germany)</b>	
<i>Lal Shrestha, N., Frey, H., Göschel, T., Oppelt, T., Platzer, B., Uhlig, U., Urbaneck, T.</i>	322
<b>Drake Landing Solar Community: 10 Years of Operation</b>	
<i>Mesquita, L., Carriere, J., McClenahan, D., Thornton, J., Wong, B.</i>	333
<b>IEA SHC Task 55: „Towards the Integration of Large SHC Systems Into DHC Networks“</b>	
<i>Provasnek, A.K., Putz, S.</i>	345
<b>DH Networks - Concept, Construction and Measurement Results of Decentralized Feed-In Substations</b>	
<i>Rosemann, T., Hafner, B., Heymann, M., Rühling, K.</i>	350
<b>Barriers and opportunities to maximize the share of solar thermal energy in district heating networks – approaches within the IEA SHC Task 55, Subtask A and selected preliminary results</b>	
<i>Schmidt, R., Gölles, M., Leoni, P., Provasnek, A.K., Putz, S.</i>	362
<b>Simulations of a Solar-Assisted Block Heating System</b>	
<i>Sotnikov, A., Andersen, M., Bales, C., Dalenbäck, J., Nielsen, C.K., Psimopoulos, E.</i>	373

<b>Performance and Optimization of a Novel Combined Solar Heating Plant with Flat Plate Collectors and Parabolic Trough Collectors in Series for District Heating</b>	
<i>Tian, Z.</i> .....	384
<b>Model-Based Control Strategies for an Efficient Integration of Solar Thermal Plants Into District Heating Grids</b>	
<i>Unterberger, V., Göllés, M., Muschick, D.</i> .....	387

## Domestic Solar Water Heating

<b>Theoretical and Experimental Investigation of Polymeric Solar-Thermal Flat-Plate Collectors</b>	
<i>Ehrenwirth, M., Albert-Seifried, V., Beckenbauer, D., Klärner, M., Trinkl, C., Zörner, W.</i> .....	398
<b>Simulation Study on the Optimization of Solar Water Heating System in Passive Solar House - Case Study</b>	
<i>Li, T., Li, J., Liu, Y., Wang, D., Zhou, Y.</i> .....	407

## Education and Workforce Development

<b>Example of an Innovative Initiative for Education in Thermal Energy Storage: INPATH-TES Project</b>	
<i>Cabeza, L.F., Zsembinski, G.</i> .....	417
<b>Solar Heterogeneous Photocatalysis as Rainfall Treatment: from Laboratory to Real Sanitary Use in Elementary Schools Into Economic Unfavorable Urban Areas from Mexico City</b>	
<i>Mendez-Arriaga, F., Almanza Salgado, R.</i> .....	425
<b>Clustering Methodology for Defining a Short Test Sequence for Whole System Testing of Solar and Heat Pump Systems</b>	
<i>Menegon, D., Fedrizzi, R., Soppelsa, A.</i> .....	435
<b>Solar Energy Education and Skill Development for Enhancing Quality of Life in Developing Countries</b>	
<i>Sengar, N., Gadhia, D., Halliday, D., Sansom, C.</i> .....	446
<b>Digital Media to Contribute to the Development and Dissemination of Renewable Energy Systems</b>	
<i>Zahnd, A., Groebhnel, U., Pimmer, C.</i> .....	455

## Energy Storage in Buildings

<b>Comprehensive Analysis of Thermal Utilization of Solar Wall System</b>	
<i>Kun, Q., Qingtai, J., Wenjing, Q., daojing, X., shuhuai, W.</i> .....	467

## **Experimental and Numerical Investigation of Heat Transfer Inside an Air Cavity with a Phase Change Material Side**

*Labih, A., Aitlahbib, F., Chehouani, H., Dogeanu, A., Nastase, I., Stelian Bejan, A. . . . .* 475

## **Grid Integration of Variable Renewable Energy Systems**

### **Reliability Analysis of Photovoltaic Hybrid Systems with LED-S Integrated in Lighting Applications. Case Study**

*Fara, L., Craciunescu, D., Dragan, F., Sterian, P. . . . .* 486

### **A Multi-Criteria Analysis of Bidirectional Solar District Heating Substation Architecture**

*Lamaison, N., Bavière, R., Cheze, D., Paulus, C. . . . .* 498

### **A Multicriteria Approach for the Integration of Renewable Energy Technologies and Thermal Energy Storage to Support Building Trigenation Systems**

*Pina, E., Lozano, M., Serra, L. . . . .* 509

### **Operational Analysis of a 34 KWP Grid-Connected PV System Considering Local Weather Measurements in Central Brazil**

*Pires Pimentel, S., Bousquet, M., Marra, E., Neto, A., Nogueira, W., Rezende, A. . . . .* 521

### **Inverter Testing and Evaluation According to the Brazilian Standards; Experiences Gained in the First Two Years of Operation of the First Brazilian Laboratory Equiped for This Purpose**

*de Souza Almeida Neto, J.C., Mocelin, A., Tavares Pinho, J., Zilles, R. . . . .* 530

## **Integrating Desalination with Thermal and Electrical Systems**

### **Dynamic Numerical Simulation of a Mechanical Vapour Compression (MVC) Desalination System That Use Renewable Source Energy**

*Morales-Ruiz, S., Castro, J., Oliet, C., Oliva, A., Rigola, J. . . . .* 542

## **Integrating Renewable Technologies into Buildings**

### **Architectural Morphology and Potential Use of Renewable Energy At Urban and Building Scale**

*Ajmat, R.F., Kaufman, M.J., Lombana, S., Longhini, M.V., Sandoval, J. . . . .* 555

### **Mobile HIL Test Bench for Low Cost Radiative Heating and Cooling Collectors**

*Braun, R., Dalibard, A., Erhart, T., Mitina, I., Ursula, E. . . . .* 566

### **Active Solar Chimney (ASC) - Numerical and Experimental Study of Energy Storage and Evaporative Cooling**

*Frutos Dordelly, J.C., Arce Landa, J., Coillot, M., El Mankibi, M., Enriquez Miranda, R., Jimenez, M.J. . . . .* 577

### **Study on the Energy Performance of Semi-Transparent PV Façades Under Continental Climate**

*Ioannidis, Z., Athienitis, A., Buonomano, A., Kapsis, K., Rounis, E., Stathopoulos, T. . . . .* 589

<b>Influence of Solar Radiation on Classroom Environment in High Latitude and Rich Solar-Resource Areas</b>	
<i>Jiang, J., Chen, Y., Liu, Y., Liu, J., Wang, D.</i>	601
<b>Development of Automation Models for the Intelligent Use of PV Energy and Energy Storage in Regards to Air Quality and Comfort in Buildings</b>	
<i>Köhler, A., Björnsson, B., Böttcher, A., Fischer, M.</i>	611
<b>PVT-GSHP Hybrid Tri-Generation System for Net Zero Energy Buildings</b>	
<i>Lee, E.J., Entchev, E., Ghorab, M., Kang, E.C., Lee, K.S., Yang, L.</i>	618
<b>Switchable Windows - Spectral Transmission and Switching Times</b>	
<i>Lemarchand, P., McLean, E., Norton, B.</i>	627
<b>Performance Assessment of a Solar-Assisted, Ground-Coupled Absorption Heat Pump Under Different Scenarios in Summer and Winter Operation</b>	
<i>Macia, A., Bujedo, L.A., Chamorro, C., Magraner, T.</i>	638
<b>Experimental Investigation of Thermal Enhancements for a Building Integrated Photovoltaic/Thermal Curtain Wall</b>	
<i>Rounis, E.(D., Athienitis, A., Ioannidis, Z., Kapsis, K., Kruglov, O.</i>	647
<b>Assessment of Solar and Farming Systems Integration on Tropical Building Facades</b>	
<i>Tablada, A., Chaplin, I., Huang, H., Kosoric, V., Lau, S.K., Lau, S., Yuan, C.</i>	655
<b>BRICKER Project: Power, Heating and Cooling for Non-Residential Buildings Feeding with RES</b>	
<i>Velez, F., Antolin, J., de las Cuevas, J.R.</i>	666
<b>Studies on Optimal Application of Building-Integrated Photovoltaic/Thermal Facade for Commercial Buildings in Australia</b>	
<i>Yang, S., Fiorito, F., Prasad, D., Sproul, A.</i>	672
<b>Whole System Design of an Energy Efficient Residential Pool System</b>	
<i>Zhao, J., Bilbao, J., Spooner, T., Sproul, A.</i>	682

## Low to Medium Temperature Thermal Storage

<b>Development and Testing of a Thermo-Chemical Energy Store - Results of a Five-Year Research Project</b>	
<i>Bonk, S., Drueck, H.</i>	695
<b>Performance Evaluation of a Demonstration System with PCM for Seasonal Heat Storage: Charge with Evacuated Tubular Collectors</b>	
<i>Englmair, G., Dannemand, M., Fan, J., Furbo, S., Kong, W., Wang, Z.</i>	705
<b>Experimental and Theoretic Investigations of Thermal Behavior of a Seasonal Water Pit Heat Storage</b>	
<i>Fan, J., Chatzidiakos, A., Furbo, S., Huang, J.</i>	714
<b>Radial Diffusers in Stratified Hot Water Stores: Geometry Optimization with CFD</b>	
<i>Findeisen, F., Platzer, B., Urbaneck, T.</i>	726
<b>Results from an Absorption Heat Storage Lab Scale Heat and Mass Exchanger Cycling Test</b>	
<i>Fumey, B., Badlini, L., Weber, R.</i>	735



<b>Thermal Performance Testing of Outdoor Hot Water Stores for Long-Term Thermal Energy Storage</b>	
<i>Gerschitzka, M., Bestenlehner, D., Drück, H., Marx, R., Schmidt, D.</i>	<i>742</i>
<b>Aging and Lifetime Assessment of Polyethylene Liners for Heat Storages – Effect of Liner Thickness</b>	
<i>Grabmann, M.K., Buchberger, W., Nitsche, D., Wallner, G.</i>	<i>753</i>
<b>Increasing the Photovoltaic Self-Consumption by Integration of an Ice Storage Into a Mono-Split-Air Conditioning Unit</b>	
<i>Heinrich, C., Putze, T., Richter, M., Safarik, M.</i>	<i>761</i>
<b>Study on Seasonal and Short-Term Thermal Energy Storage Using a Phase Change Material Emulsion for District Heating Applications</b>	
<i>Lazaro, A., Delgado, M., Lozano, M.A., Marin, J.M., Peñalosa, C., Rinaldi, G., Serra, L.M., Verda, V.</i>	<i>771</i>
<b>Performance of a Domestic Oil Storage Tank During Charging and Discharging Cycles</b>	
<i>Mawire, A., Shobo, A.</i>	<i>783</i>
<b>Development of Overground Hot Water Stores in Segmental Construction for Solar and District Heating Systems Within the Project OBSERW</b>	
<i>Urbanek, T., Bestenlehner, D., Beyer, R., Drück, H., Findeisen, F., Gerschitzka, M., Herrmann, T., Lang, S., Mücke, J.M., Platzer, B.</i>	<i>790</i>

## Medium/High Temperature Thermal Storage for Electricity Production with CSP Systems

<b>Moisture-triggered ambient-temperature carbonatization of main group II metal oxides under elevated CO<sub>2</sub> pressure</b>	
<i>Gravogl, G., Artner, W., Eitenberger, E., Friedbacher, G., Harasek, M., Knoll, C., Miletich, R., Müller, D., Weinberger, P., Werner, A.</i>	<i>799</i>
<b>Metal-Oxides for Thermochemical Energy Storage – from Gas-Triggered Isothermal Cycling to Low-Temperature Applications with Increased O<sub>2</sub> Pressure</b>	
<i>Knoll, C., Artner, W., Eitenberger, E., Friedbacher, G., Gravogl, G., Harasek, M., Miletich, R., Müller, D., Weinberger, P., Werner, A.</i>	<i>811</i>
<b>Thermo-Physical Properties of NaCl-Na<sub>2</sub>CO<sub>3</sub>-NaOH as High-Temperature Sensible Heat Storage Medium</b>	
<i>Mohan, G., Venkataraman, M.</i>	<i>821</i>
<b>Lab-scale demonstration of thermochemical energy storage with NH<sub>3</sub> and impregnated-loaded zeolites</b>	
<i>Müller, D., Gravogl, G., Harasek, M., Knoll, C., Miletich, R., Weinberger, P., Werner, A.</i>	<i>828</i>
<b>Experimental Investigation of Thermal Performance for Selected Oils for Solar Thermal Energy Storage and Rural Cooking Application</b>	
<i>Nyeinga, K., Okello, D., Tabu, B.</i>	<i>837</i>
<b>Test Campaign and Performance Evaluation of a Spiral Latent Storage Module with Hitec® as PCM</b>	
<i>Rodriguez-Garcia, M.M., Bayon, R., Rojas, E.</i>	<i>845</i>

## Net Zero Energy Buildings

<b>Renovation of Swedish single-family houses from the 1960s and 1970s to net-zero energy buildings – Case study</b>	
<i>Ekström, T., Bernardo, R., Blomsterberg, Å., Davidsson, H.</i>	<i>858</i>
<b>Modeling, Construction and Monitoring of a Plus-Energy Building in Dubai</b>	
<i>Franchini, G., Al Falasi, S.A., Bin Nashooq, M.Y., Brumana, G., Perdichizzi, A., Shaheen, A.M.</i>	<i>866</i>
<b>Non-Stationary Thermal Performance Evaluation of External Façade Walls Under Central European Summer Conditions</b>	
<i>Košir, M., Božiek, D., Dovjak, M., Hudobivnik, B., Iglj, N., Kuni, R., Pajek, L.</i>	<i>876</i>
<b>Design, Development and Thermal Performance Analysis of Ultra-Low Heat Loss Triple Vacuum Glazing</b>	
<i>Memon, S., Eames, P.C.</i>	<i>886</i>
<b>Study of Photovoltaics and Solar Thermal for Nearly Zero Energy Mediterranean Villas</b>	
<i>Moià-Pol, A., Canals, V., Martinez-Moll, V., Morzhukhin, A., Nazmitdinov, R.</i>	<i>894</i>
<b>Simulation and Monitoring Results of Two MFHs in PH Standard with Heat Pump, Solar Thermal and PV</b>	
<i>Ochs, F., Dermentzis, G., Ksiezzyk, A.</i>	<i>898</i>
<b>On Behavioral Action Hierarchy for Understanding Occupants' Attitudes Driving Indoor Thermal Comfort in Office Buildings</b>	
<i>Romanelli, J., Castaldo, V.L., Cotana, F., Pisello, A.L.</i>	<i>910</i>

## Off-Grid Energy Supply

<b>Solar Energy Development and Implementation in Nigeria: Drivers and Barriers</b>	
<i>Abdullahi, D., Oloke, D., Renukappa, S., Suresh, S.</i>	<i>923</i>
<b>Direct Drive Photovoltaic Milk Chilling:</b>	<i>932</i>
<b>Integration and Management of Solar Energy for Electric Vehicle Charging Station</b>	
<i>Khan, A., Memon, S., Sattar, T.</i>	<i>943</i>
<b>Improving the Utilization Factor of Islanded Renewable Energy Systems</b>	
<i>Stambaugh, M., Sturdivant, R., Yeh, J., Zahnd, A.</i>	<i>954</i>
<b>Review of Solar Energy Inclusion in Africa Using Nigeria Model</b>	
<i>Ukoba, K., Eloka-Eboka, A., Inambao, F.</i>	<i>962</i>

## Other Innovative Components and Systems

<b>Direct Vaporization of an Organic Fluid in a Parabolic Trough Solar Collector</b>	
<i>Dugaria, S., Bortolato, M., Del Col, D.</i>	<i>975</i>

<b>Water Production from the Atmosphere in Arid Climates Using Low Grade Solar Heat</b> <i>Gentile, V., Finocchiaro, P., Fracastoro, G.V., Simonetti, M.</i> . . . . .	<b>984</b>
<b>All-Weather Snow Machine Driven by Solar Energy</b> <i>Joemann, M., Besana, F., Podesta, L., Pollerberg, C., Völkel, R.</i> . . . . .	<b>996</b>
<b>Infrared Optical Properties of Doped and Pure Thermochromic Coatings for Solar Thermal Absorbers</b> <i>Krammer, A., Demiere, F.T., Schüler, A.</i> . . . . .	<b>1008</b>
<b>Parametric Analysis of a Photonic Radiative Cooling System</b> <i>Wang, W., Fernandez, N., Katipamula, S.</i> . . . . .	<b>1015</b>
<b>Development of the Sunridge ICS System</b> <i>de Geus, A., de Beijer, H.</i> . . . . .	<b>1026</b>

## PVT Systems

<b>Analytical Study on the Effect of Optical Filtration and NANOPCM on the Performance of PV/T Solar Collectors</b> <i>Abd-Elrazik, A.S., Al-Sulaiman, F.A., Ben Mansour, R., Rahman, S.</i> . . . . .	<b>1038</b>
<b>A Simulation Analysis on Thermal Performance of Air-Type PVT Collector with Diversity of Baffles</b> <i>Ahn, J.G., Kim, J.H., Yu, J.S.</i> . . . . .	<b>1048</b>
<b>Modelling Approach for Hybrid PV/T Solar Panels with Integrated Phase Change Material (PCM) Layer</b> <i>Andrés Chicote, M., Bujedo Nieto, L.Á., Esteban Matías, J.C., Samaniego Muñoz, J., Sanz Jimeno, R.</i> . . . . .	<b>1053</b>
<b>Experimental Validation of 1D Model for Photovoltaic Thermal (PV/T) Modules</b> <i>Brottier, L., Bennacer, R., Cheze, D., Mariotto, M., Medlege, F., Razongles, G.</i> . . . . .	<b>1060</b>
<b>Ray Tracing Simulations of a Novel Low Concentrator PVT Solar Collector for Low Latitudes</b> <i>Cabral, D., Dostie-Guindon, P., Gomes, J., Karlsson, B.</i> . . . . .	<b>1068</b>
<b>Characterization of Two Secondary Optics for a Fresnel Mirror</b> <i>Fontani, D., Francini, F., Jafrancesco, D., Sansoni, P.</i> . . . . .	<b>1080</b>
<b>Energy Performance of a Solar Trigenation System Based on a Novel Hybrid PVT Panel for Residential Applications</b> <i>Herrando, M., Markides, C.N., Ramos, A., Zabalza, I.</i> . . . . .	<b>1090</b>
<b>Mathematical Modeling of a Nano-Engineered Dual-Fluid Photovoltaic/Thermal System</b> <i>Hussain, M.I.</i> . . . . .	<b>1102</b>
<b>Experimental Performance of an Advanced Air-Type Photovoltaic-Thermal (PVT/a) Collector</b> <i>Kim, J., Ahn, J.G., Kim, S.</i> . . . . .	<b>1110</b>
<b>Assessing Suitable Fields of Application for PVT Collectors with the Characteristic Temperature Approach</b> <i>Lämmle, M., Hermann, M., Kramer, K.</i> . . . . .	<b>1116</b>
<b>Reverse Engineering Prototype Solar PV/Thermal Collector Properties from Empirical Data for Use in TRNSYS Type 560</b> <i>Sommerfeldt, N., Ollas, P.</i> . . . . .	<b>1121</b>

<b>PVT Wrap-Up: Energy Systems with Photovoltaic Thermal Solar Collectors</b>	
<i>Zenhäusern, D., Baggenstos, A., Bamberger, E., Häberle, A.</i>	<b>.1133</b>

## Performance Measurement, Durability and Reliability

<b>Advanced Testing and Quality Assurance Methods for Solar Thermal Systems and Components</b>	
<i>Bestenlehner, D., Drucek, H., Fischer, S.</i>	<b>.1146</b>
<b>Solar Thermal Collector's Degradation – Influence of Corrosivity Inside and Outside the Collectors</b>	
<i>Carvalho, M.J., Correia, J., Cunha Diamantino, T., Gano, A., Gonçalves, R., Mexa, N., Páscoa, S.</i>	<b>.1151</b>
<b>Test Procedure for Accelerating Aging of Solar Thermal Collectors</b>	
<i>Fischer, S.</i>	<b>.1163</b>
<b>PVT Performance Prediction</b>	
<i>Fritzsche, U.</i>	<b>.1171</b>
<b>A Flexible Software Framework for Self-Adapting Algorithm-Based Fault Detection and Diagnosis in Solar Heating Systems</b>	
<i>Georgij, M., Braas, H., Orozaliev, J., Schmelzer, C., Vajen, K.</i>	<b>.1180</b>
<b>Absorber Surface Durability Standard Testing: ISO 22975-3 vs. Measured Thermal Stress At Extreme Test Site</b>	
<i>Kaltenbach, T., Heck, M., Weiß, K.</i>	<b>.1188</b>
<b>Development of Solar Thermal Appliances Using Building Materials</b>	
<i>Mahavar, S., Dashora, P., Punia, R.</i>	<b>.1194</b>

## Photovoltaics

<b>Study on Crawler-Type Solar EV</b>	
<i>Fujisawa, T., Kawaguchi, T., Nemoto, Y.</i>	<b>.1204</b>
<b>Beam Splitting with Luminescent Solar Concentrators in a Hybrid Photovoltaic and Thermal Collector</b>	
<i>Gajic, M., Rosengarten, G.</i>	<b>.1211</b>
<b>Aerial Thermographic Inspection of Photovoltaic Plants: Analysis and Selection of the Equipment</b>	
<i>Gallardo Saavedra, S., Alfaro Mejia, E., Duque Pérez, Ó., Franco Mejia, E., Hernandez Callejo, L., Loaiza Correa, H.</i>	<b>.1223</b>
<b>Failure Rate Determination and Failure Mode, Effect and Criticality Analysis (FMECA) Based on Historical Data for Photovoltaic Plants</b>	
<i>Gallardo Saavedra, S., Duque Pérez, Ó., Hernandez Callejo, L., Pérez Moreno, J.</i>	<b>.1232</b>
<b>Decoupling Crystallinity and Size of TiO<sub>2</sub> Nanoparticles: Application in Large Area Dye-Sensitized Solar Cells</b>	
<i>Hegazy, A., Abdelalref, M., El-Shenawy, E.</i>	<b>.1240</b>

<b>Wavelength Dependent Optical Characteristics: Intensity Distribution in Flat Silicon and Silicon Nanowire Used as Absorber in Solar Cell</b>	
<i>Hossain, M.K., Mukhaimir, A.W., Salhi, B.</i>	1251
<b>Performance and Economic Optimization of Hybrid Solar Thermal and Photovoltaic Power Plants with Dynamic Simulation</b>	
<i>Orosz, M., Otanicar, T.</i>	1261
<b>The Back Contact in CDTE/CDS Thin Film Solar Cells</b>	
<i>Romeo, N., Bosio, A., Rosa, G.</i>	1268
<b>Advantages and Limitations of Thermography in Utility Scale Solar PV Plants</b>	
<i>Sethi, R., Kumar, P.</i>	1271
<b>Correlation of Leakage Current Pathways and Potential Induced Degradation of CIGS Thin Film Solar Modules</b>	
<i>Voswinkel, S., Gerstenberg, L., Münter, S., Wesselak, V.</i>	1280
<b>Structural and Optical Characterization of Polymer Based TiO<sub>2</sub> Films for Photovoltaic Applications</b>	
<i>Waita, S., Aduda, B.O.</i>	1288
<b>Enhancing Photovoltaics Through Novel Polymer Nanocomposite Structures</b>	
<i>Walshe, J., Ahmed, H., Doran, J., Mc Cormack, S.</i>	1297
<b>Performance Analysis of One-Axis Tracking Photovoltaic System with Flat Mirrors</b>	
<i>Yoshimori, R.</i>	1306

## Renewable Resource Assessment and Applications

<b>Regional Photovoltaic Power Curtailment with Forecasting and Unit Commitment Scheduling: A Study on the Kanto Region in Japan</b>	
<i>Gari da Silva Fonseca Junior, J., Nishitsuji, Y., Ogimoto, K., Oozeki, T., Udagawa, Y.</i>	1317
<b>Analysys of Daylight Availability in Italy Trough Different Louminous Efficacy Models</b>	
<i>Iatauro, D., Signoretti, P., Spinelli, F., Terrinoni, L., Zinzi, M.</i>	1328
<b>Towards a Tuning Method of PV Power Measurements to Balance Systematic Influences</b>	
<i>Killinger, S., Bright, J., Lingfors, D.</i>	1339
<b>BcChart v2.0 – A Tool for Bioclimatic Potential Evaluation</b>	
<i>Košir, M., Pajek, L.</i>	1350
<b>Clear-Sky Broadband Irradiance: First Model Assessment in Uruguay</b>	
<i>Laguarda, A., Abal, G.</i>	1360
<b>Proposal and Evaluation of Subordinate Standard Solar Irradiance Spectra with a Focus on Air Mass Effects</b>	
<i>Wilbert, S., Armstrong, P., Bian, Z., Driesse, A., Gueymard, C., Habte, A., Jessen, W., Marzo, A., Polo, J., Ramírez, L., Vignola, F.</i>	1372
<b>Survey Research of Integrating Renewable Energy into the Mining Industry</b>	
<i>Zharan, K., Bongaerts, J.C.</i>	1385

## Resource Forecasting

<b>The Local Climate Impact of Photovoltaic Solar Farms - Results from a Field Observation Campaign in Gobi Desert</b>	
<i>Gao, X., Hou, X., Hui, X., Yang, L.</i> . . . . .	1397
<b>A Wavelet Decomposition Approach to Improve Modelling Performance of Artificial Neural Networks in Solar Energy Research</b>	
<i>Hussain, S., AlAlili, A.</i> . . . . .	1409
<b>Artificial Neural Networks (ANN) for the Prediction of Local Outside Temperatures and Solar Yields</b>	
<i>Kramer, W., Bitterling, M.</i> . . . . .	1416

## Resource Measurement and Instrumentation

<b>Comparison Between Lebaron-Perez and Dal Pai-Escobedo Correction Methods for Diffuse Irradiance Measured by the Meo Shadowring Method</b>	
<i>Dal Pai, A., Dal Pai, E., Escobedo, J.F.</i> . . . . .	1423
<b>Solis Clear Sky Scheme: Extend to High Turbidity, Development and Validation</b>	
<i>Ineichen, P.</i> . . . . .	1434
<b>Evaluation of Solar Energy Losses for the Heliostat-To-Receiver Path of a Tower Solar Plant for Different Aerosol Models</b>	
<i>López, G., Bosch, J.L., Gueymard, C.A.</i> . . . . .	1445
<b>Assessment of Hydrokinetic Potential in the Umbeluzi Basin, Mozambique</b>	
<i>Nhabetse, T., Cuamba, B., Kucel, S., Mungoi, N.</i> . . . . .	1455

## Solar Cooking and Clean Cook Stoves

<b>Towards a Homogenous Drying Rate Using a Solar Fruit Dryer</b>	
<i>Davidsson, H., Bernardo, R., Olsson, J., Otte, P., Phinney, R., Tivana, L.D.</i> . . . . .	1468
<b>A Direct Solar Fryer for Injera Baking Application</b>	
<i>Hailu, M.H., Kahsay, M.B., Nydal, O.J., Tesfay, A.H.</i> . . . . .	1475
<b>Sustainability as a Characteristic of Renewable Energy Systems in Remote Himalayan Villages</b>	
<i>Sturdivant, R., Stambaugh, M., Yeh, J., Zahnd, A.</i> . . . . .	1486

## Solar Detoxification of Water

<b>Pulp and Paper Effluent Treatment and Detoxification: Photo Catalytic Degradation of Methylene Blue Using Natural Ultra-Violet Light and Titanium Oxide</b>	
<i>Orori, B., Mgendi, M.</i>	1490

## Solar Heat for Industrial and Agricultural Processes

<b>Medium Temperature Solar Thermal Installation for Industrial Thermal Storage of Bituminous Products</b>	
<i>Bunea, M., Bony, J., Citherlet, S., Duret, A., Eicher, S.</i>	1501
<b>Simulation and Optimization Study on a Solar Heating for Underground Biogas Digester System</b>	
<i>Chen, Y., Li, T., Liu, Y., Wang, D., Zhou, Y.</i>	1511
<b>A solar furnace for copper smelting in Chile: assessment of economic benefits and reductions in greenhouse gas emissions</b>	
<i>Chudinzow, D., Eltrop, L., Switon, D.</i>	1522
<b>Thermal Model Development for Solar Greenhouse Considering Climate Condition</b>	
<i>Esmaeli, H.</i>	1530
<b>Use of Hydration Heat and Solar Energy in Prefabricated Concrete Production Lines</b>	
<i>Focke, H., Krug, B., Peyerl, M.</i>	1542
<b>SAM Process Heat Model Development and Validation: Liquid-HTF Trough and Direct Steam Generation Linear Focus Systems</b>	
<i>Kurup, P., Beikircher, T., Möllenkamp, J., Parikh, A., Samoli, A., Turchi, C.</i>	1548
<b>India's Quest for Global Solar Thermal Industrial Process Leader</b>	
<i>Malaviya, J.</i>	1560
<b>A Comparative Cost Assessment of Low Carbon Process Heat Between Solar Thermal and Heat Pumps</b>	
<i>Meyers, S., Schmitt, B., Vajen, K.</i>	1566
<b>Comparison of Thermal Losses Due to Heating-Up of System Components in Two Solar Process Heat Plants with Parabolic Trough Collectors</b>	
<i>Möllenkamp, J., Beikircher, T., Häberle, A., Rittmann-Frank, M.H.</i>	1578
<b>An Automated Solar-Biomass Hybrid Dryer System for Rural Communities in Ghana</b>	
<i>Obeng-Akrofi, G., Ampong, F.K., Donkor, M.K.E., Kenig, E., Klaus, T., Krauter, S., Nkrumah, I., Olenberg, A., Opoku-Agyemang, G., Oppong Akowuah, J., Tamakloe, R.Y., Waldhoff, M.</i>	1588
<b>Eight Feasibility Studies Demonstrating the Potential of Solar Process Heat in the European Automotive Industry</b>	
<i>Pag, F., Schmitt, B., Vajen, K.</i>	1599
<b>Solar Dryer and Post Harvest Management in Ethiopia: Design and CFD Simulation</b>	
<i>Tesfay, A.H., Abrha, A.K., Aregawi, B., Nurhusein, F.F.</i>	1608

## Solar Ponds

<b>Fatigue Characterization of Potable Water Certified PA and PPA Grades for Solar-Thermal Applications</b>	
<i>Bradler, P.R., Fischer, J., Lang, R.W., Wallner, G.M.</i>	1618
<b>Field Test Results of an Innovative PV/T Collector for Indoor Swimming Pools</b>	
<i>Brottier, L., Bennacer, R.</i>	1624
<b>Solar Thermal Technologies for Domestic Hot Water Applications: an Energy and Economic Investigation Comparing Flat Plate and Evacuated Tube Type Collectors</b>	
<i>Ghani, F., O'Donovan, T., Zaglio, M.</i>	1631

## Solar Refrigeration and Solar Air Conditioning

<b>Monitoring and Energy Performance Assessment of an Advanced DEC HVAC System in Morocco</b>	
<i>Beccali, M., Finocchiaro, P., Gentile, V., Motta, M., Muscherà, M.</i>	1644
<b>Assessment of a Solar Powered Refrigerator Equipped with Thermal Storage for a Dairy Application</b>	
<i>Coca-Ortegón, A., Coronas Salcedo, A., Müller, J., Torres-Toledo, V.</i>	1655
<b>Efficient Solar Cooling by Using Variable Effect LiBr-H<sub>2</sub>O Absorption Chiller and Linear Fresnel Solar Collector with Cavity Receiver</b>	
<i>Dai, Y., Ma, J.</i>	1667
<b>Development of a Low Carbon Coupling Device for Solar Cooling (Photovoltaic + Heat Pump)</b>	
<i>Esparcieux, P., Lorenzo, N., Marvillet, C., Mugnier, D., Pomathiod, L., Weber, C.</i>	1675
<b>Control Strategy Approach Based on the Operational Results of a Small Capacity Direct Air-Cooled Libr-Water Absorption Chiller</b>	
<i>Farnós, J., Castro, J., Oliva, A., Papakokkinos, G.</i>	1687
<b>Performance analysis of a Solar-Powered Air-Conditioning System Using Absorption Refrigeration Cycle and High Efficiency Cooling Technologies</b>	
<i>Fella, C., Isaza Roldan, C.A., Silva, P.</i>	1699
<b>Testing and Simulation of a Solar Diffusion-Absorption Refrigeration System for Low-Cost Solar Cooling in India</b>	
<i>Freeman, J., Edwards, R., Hall, R., Markides, C.N., Najjaran, A., Ramos, A., Reid, M.</i>	1711
<b>Experimental Study of a Solar Collector/Regenerator for Liquid Desiccant Systems</b>	
<i>Gomez Castro, F.M., Eicker, U.</i>	1723
<b>Theoretical Analysis of Indirect and Direct Solar Regenerators for Liquid Desiccant Systems</b>	
<i>Gomez Castro, F.M., Eicker, U.</i>	1733
<b>Establishment and Theoretical Analysis of a Solar Driven NH<sub>3</sub>-H<sub>2</sub>O Resorption Heat Pump Cycle</b>	
<i>Jia, T.</i>	1745
<b>Preliminary Assessment of a Solar Absorption System for Air Conditioning Applications</b>	
<i>Jimenez Garcia, J.C., Rivera, W.</i>	1755
<b>Potential Application of Commercial Refrigerants as Adsorbate in Adsorption Refrigeration System</b>	
<i>John, M., Eikevik, T.M., Kihedu, J., Kimambo, C.Z.M., Nydal, O.J.</i>	1767



<b>Modeling and Optimization for Contribution Rates of Solar Heating and Cooling Systems in Building Energy-Saving</b>	
<i>Li, B., He, T., Inagaki, M., Shi, X., Wang, B., Yamada, Y., Zhang, X.</i>	1776
<b>Energy Storage for PV-Driven Air-Conditioning for an Off-Grid Resort – A Case Study</b>	
<i>Luerssen, C., Cheong, K.W.D., Miller, C., Reindl, T., Sekhar, C., Wahed, A.</i>	1785
<b>Sensitivity Analysis on the Technical and Economic Performance of Thermal and PV Driven Solar Heating and Cooling Systems</b>	
<i>Neyer, D., Koell, R.</i>	1796
<b>Solar-Electric Driven Heating and Cooling System with PCM-Storage for Improved Grid Connection</b>	
<i>Schex, R., Felix, L., Korth, T., Krönauer, A., Linn, J., Remy, M., Schweigler, C.</i>	1808
<b>Increase of the Ventilation Effectiveness of Solar Chimneys with Consideration of Wind-Effects Applying CFD Simulations and Measurements</b>	
<i>Schwan, L., Auer, T., Madjidi, M., Rüttschlin, H.</i>	1820
<b>Multi-Functional Façade with PV for Solar Autonomous Cooling Applications</b>	
<i>Selke, T., Heinz, A., Mach, T., Rennhofer, M., Schlager, T.</i>	1830
<b>Highest Efficiency Ice Storage for Solar Cooling Systems – Experiences with a Vacuum Ice Slurry Cold Thermal Energy Storage</b>	
<i>Steffan, C., Heinrich, C., Honke, M., Safarik, M.</i>	1842
<b>Experimental Study on Solar Driven Dehumidification System with Silica Gel Coated Heat Exchanger in Winter</b>	
<i>Yao, Z.</i>	1848

## Solar Space Heating and Hybrid Applications

<b>Performances Analysis of Combined Rankine and Absorption Refrigeration Cycles for a Small Size Solar Power Plant</b>	
<i>Alain Christian, B., Mwanza, M., Yilanci, A.</i>	1860
<b>Residential Buildings Retrofit: the Role of Solar Technologie</b>	
<i>Bellini, A., Dipasquale, C., Fedrizzi, R.</i>	1872
<b>Techno-Economical Optimization of Solar Energy Supply Concepts for Residential Buildings</b>	
<i>Duschner, T., Hamacher, T., Klärner, M., Trinkl, C., Zörner, W.</i>	1882
<b>Energetic and Economic Efficiency Evaluation of Solar Assisted Heating Systems for Multi-Family Houses</b>	
<i>Helbig, S., Adam, M., Eggert, D.</i>	1892
<b>Solar Thermal Based New and Renewable Energy Hybrid System for the District Heating and Cooling in South Korea</b>	
<i>Heo, J., Kim, M.</i>	1902
<b>High Latitude Solar Heating Using Photovoltaic Panels, Air-Source Heat Pumps and Borehole Thermal Energy Storage</b>	
<i>Hirvonen, J., Sirén, K.</i>	1907

<b>The Characteristics of Solar Thermal Collector and Storage System Including Seasonal Thermal Energy Storage in South Korea</b>	
<i>Kim, M., Heo, J., Ueli, S.</i> .....	1917
<b>Design and Comissioning of a Solar Combisystem with Seasonal Storage for a Single Detached Canadian Home</b>	
<i>Meister, C., Beausoleil-Morrison, I.</i> .....	1924
<b>Design and Optimization of a De-Centralized Community Sized Solar Heating System for Nordic Region</b>	
<i>Rehman, H.u., Hirvonen, J., Siren, K.</i> .....	1933

## Solar Supported Agriculture in Desert Regions

<b>Modelling of a Solar Dryer for Food Preservation in Developing Countries</b>	
<i>Chaignon, J., Davidsson, H.</i> .....	1945
<b>Solar Water Pumping for Productive Uses in Nepal</b>	
<i>Foster, R., Pandey, B., Piya, R., Shresta, B., Uprety, B.</i> .....	1956
<b>Accelerating Solar Water Pump Sales in Kenya: Return on Investment Case Studies</b>	
<i>Holthaus, J., Foster, R., Mbwika, J., Ngetich, B., Pandey, B., Siminyu, P., Sokolova, E.</i> .....	1966

## Solar Thermal Collectors

<b>Experimental Investigation of the Performance of a Transpired Solar Collector Acting as a Solar Wall</b>	
<i>Bejan, A.-S., Bode, F., Croitoru, C.-V., Labihi, A., Sandu, M.</i> .....	1977
<b>Effect of Aging in Hot Chlorinated Water on the Mechanical Behavior of Polypropylene for Solar-Thermal Applications</b>	
<i>Fischer, J., Bradler, P.R., Lang, R.W., Mantell, S.C., Wallner, G.M.</i> .....	1987
<b>Material Properties of Plastics for Solar-Thermal Collector Mounting Systems</b>	
<i>Fischer, J., Bradler, P.R., Lang, R.W., Leitner, S., Wallner, G.M.</i> .....	1993
<b>Development of a High Accurate Numerical Platform for the Thermal and Optical Optimization of Linear Fresnel Receivers</b>	
<i>Guadamud, E., Almers, A., Chiva, J., Colomer, G., Farnós, J., Pérez-Segarra, C.D., Rigola, J.</i> .....	2000
<b>Enhanced Performance Analysis of Solar Chimney Power Plant Aided with Reflectors</b>	
<i>Hussain, F.M., Abd-Elrazik, A.S., Al-Sulaiman, F.</i> .....	2012
<b>Experimental and Modeling Study on Nighttime Heat Loss and Anti-Freezing Analysis of FPC Group</b>	
<i>Jin, Z., Li, Y., Liang, F., Liu, Q., Long, E., Zhang, Y., Zhao, X.</i> .....	2021

<b>Development, Optimization and Test Performance of Highly Efficient Flat Plate Solar Collector with Transparent Insulation and Low-Cost Overheating Protection</b> <i>Kizildag, D., Castro, J., Kessentini, H., Oliva, A., Rigola, J.</i>	2031
<b>Experimental and CFD Optimization on Flow and Heat Transfer to a Solar Flat-Plate Glass Collector</b> <i>Leibbrandt, P., Dölz, M., Rhein, M., Schabbach, T.</i>	2043
<b>Solar Cooker Green Cooking</b> <i>Mozid, M.</i>	2053
<b>Flat Plate Collectors with Thermochromic Absorber Coating Under Dynamic System Tests</b> <i>Müller, S., Giovannetti, F., Hafner, B., Reineke-Koch, R.</i>	2062
<b>Prototype of Integrated Collector Storage Using Phase Changes Material and Thermosyphon Heat Pipes</b> <i>Pailha, M., Cloet, D., Fraise, G.</i>	2071
<b>Numerical Model for Solar Thermal Collectors and Thermal Energy Storages Based on Phase Change Slurry</b> <i>Prearo, G., Perino, M., Serale, G.</i>	2080
<b>SOLCOSI: a New on Line Software for Evaluate the Thermal Performance of Flat Plate Solar Collectors</b> <i>Pérez-Espinosa, R.</i>	2091
<b>Design of Non-Imaging Solar Collectors for Process Heat</b> <i>Reddy, K.S., Vikram, T.S.H.</i>	2097
<b>Heat Loss Prediction from Solar LFR Linear Evacuated Surface Receiver with Variable 2-STAGE Concentrated Flux</b> <i>Reddy, K.S., Balaji, S., Sundarajan, T.</i>	2109
<b>Experimental Evaluation of Evacuated Tube Collectors with Heat Pipes to Avoid Stagnation Loads in a Domestic Hot Water System</b> <i>Schiebler, B., Giovannetti, F., Weiland, F.</i>	2117
<b>Investigation on Dustfall and Rainfall to Cover Transmittance of Flat-Plate Solar Collectors in Beijing</b> <i>Wang, M., He, T., Li, B., Wang, B., Zhang, X.</i>	2127
<b>Compound Parabolic Concentrator for Pentagon Shape Absorber</b> <i>Widyolar, B., Hassanzadeh, A., Jiang, L., Winston, R.</i>	2136
<b>Development of Solar Thermal During 2011 to 2015 and Developing Anticipation for the Technology During 2016 to 2020 in China</b> <i>Zheng, R., He, T., Li, B., Wang, M., Zhang, X.</i>	2148

## Solar Thermal Desalination Technology

<b>Investigation of Optimal Design of Direct Contact Humidification-Dehumidification Desalination Cycle</b> <i>Dehghani, S., Akbarzadeh, A., Date, A., Mahmoudi, F.</i>	2156
--	------

<b>Sustainable Desalination by Permeate Gap Membrane Distillation Technology</b> <i>Mahmoudi, F., Akbarzadeh, A., Date, A., Dehghani, S., Pishbin, M.E.</i> . . . . .	<b>2166</b>
--	-------------

## Solar and Heat Pump Systems

<b>Field Tests of a Novel Solar-Assisted Dual Source Multifunctional Heat Pump</b> <i>Besagni, G., Croci, L., Molinaroli, L., Nesa, R., Quaglia, P.</i> . . . . .	<b>2178</b>
<b>Cost-Energetic Analyses of Ice Storage Heat Exchangers in Solar-Ice Systems</b> <i>Carbonell, D., Battaglia, M., Haller, M., Philippen, D.</i> . . . . .	<b>2190</b>
<b>Combined Solar Thermal and Heat Pump Systems Within the Funding Program of Large-Scale Solar Thermal Systems in Austria – Status Investigation and Progress Report</b> <i>Helminger, F., Fink, C., Knabl, S., Windholz, B.</i> . . . . .	<b>2202</b>
<b>Steaming Process for Silicon Enrichment in Zeolites for Heat Pump Applications and Solar Driven Thermal Adsorption Storage</b> <i>Herzog, T.H., Lutz, W., Weisheit, E.</i> . . . . .	<b>2211</b>
<b>Model-Based Analysis of Solar Thermal and Heat Pump Systems Using TRNSYS</b> <i>Jonas, D., Frey, G., Meiers, J., Theis, D.</i> . . . . .	<b>2216</b>
<b>Solarhybrid Heating and Cooling – an Environmental Friendly and Economic HVAC Solution</b> <i>Neyer, D., Gritzer, F., Ostheimer, M.</i> . . . . .	<b>2228</b>
<b>Smart Control Strategy for PV and Heat Pump System Utilizing Thermal and Electrical Storage and Forecast Services</b> <i>Psimopoulos, E., Bales, C., Bee, E., Luthander, R.</i> . . . . .	<b>2240</b>
<b>Modeling of Solar Assisted Heat Pumps Combined with Photovoltaic Thermal Modules</b> <i>Simonetti, R., Manzolini, G., Molinaroli, L.</i> . . . . .	<b>2252</b>

## Strategies, Policies, and Case Studies for Renewable Heat and Electricity

<b>HUYRO Smart Ecological Farm in Peru, an Approach to Sustainability</b> <i>Hadzich, M., Pérez, J.P., Vergara, S.</i> . . . . .	<b>2265</b>
<b>Sustainability Assessment of Solar Thermal Collector Systems</b> <i>Kicker, H., Lang, R.W., Wallner, G.M.</i> . . . . .	<b>2276</b>
<b>Solar Heating and Cooling in Australia's Built Environment – an Industry Roadmap</b> <i>Sheldon, M., Sethuvenkatramam, S.</i> . . . . .	<b>2284</b>
<b>On the Economics of Solar Chemical Processes - Case Study for Solar Co Production of Methanol and Power</b> <i>von Storch, H., Hoffschmidt, B., Roeb, M., Sattler, C., Stadler, H.</i> . . . . .	<b>2296</b>

## Sustainable Building Materials and Components

<b>Thermoelectric Modules Testing for Sustainable Buildings Applications</b> <i>Al Musleh, M., Jenkins, D., Topriska, E.</i> . . . . .	<b>2307</b>
<b>Towards Novel Glazing with Seasonal Dynamics Based on Micro Compound Parabolic Concentrators</b> <i>Gong, J., Kostro, A., Schueler, A.</i> . . . . .	<b>2313</b>
<b>Optimization of Coupled Building Roof Solar Reflectance and Thermal Insulation Level for Annual Energy Saving Under Different Climate Zones</b> <i>Piselli, C., Cabeza, L.F., Cotana, F., Pisello, A.L., Saffari, M., de Gracia, A.</i> . . . . .	<b>2320</b>

## Testing, Standards, and Certification for Solar Thermal Technologies

<b>Accelerated Aging Tests of Absorber Coatings Used in Unglazed Metallic Collectors</b> <i>Dudita, M., Brunold, S., Thissen, B., Zenhäusern, D.</i> . . . . .	<b>2333</b>
<b>Analysis of Test Methods for Durability and Performance of Heat-Pipes for Solar Thermal Application</b> <i>He, Z.</i> . . . . .	<b>2337</b>
<b>In-situ Testing of Large Collector Arrays – Challenges and Methodological Framework</b> <i>Tschopp, D., Hausner, R., Ohnewein, P., Rohringer, C.</i> . . . . .	<b>2343</b>

## Urban and Regional Planning to Maximize Renewable Energy

<b>Innovative and Sustainable Energy Supply Concepts for a New Quarter in Mannheim, Germany</b> <i>Bestenlehner, D., Drück, H.</i> . . . . .	<b>2354</b>
<b>Analysis of the Match of Heating Load and Wind Turbine Production – a Case Study for the Faroe Islands</b> <i>Beyer, H.G., Niclasen, B.</i> . . . . .	<b>2363</b>
<b>Renewable Energy Assessment in Italy and Brazil: An Economic and Political Comparison</b> <i>Franzitta, V., Curto, D., Viola, A.</i> . . . . .	<b>2370</b>
<b>Development and Experimental Validation of a Multi-Functional Façade Model Within an Object Oriented Platform</b> <i>Kizildag, D., Oliva, A., Rigola, J.</i> . . . . .	<b>2378</b>
<b>Sustainable Strategic Urban Planning: Methodology for Urban Renovation At District Level</b> <i>Vallejo, E., Arrizabalaga, E., Criado, C., Vasallo, A.</i> . . . . .	<b>2389</b>
<b>Urban Planning for Solar Energy - IEA SHC Task 51</b> <i>Wall, M., Dahlberg, J., Lindkvist, C., Lobaccaro, G., Lundgren, M., Munari Probst, M.C., Siems, T., Simon, K., Snow, M.</i> . . . . .	<b>2401</b>

## Wind Energy, Ocean Energy, Hydro and Other Direct Conversion Renewables

<b>Research of Natural Renewable Energy Resources of Coasts and Seas of the Far East</b>	
<i>Knyazhev, V., Loshchenkov, V.</i> .....	<b>2414</b>
<b>Offshore Wind Energy Potential Around the East Coast of the Red Sea, KSA</b>	
<i>Mahdy, M., Alghamdi, A.S., Bahaj, A.S.</i> .....	<b>2422</b>