

International Conference on Solar Energy and Buildings 2014 (EuroSun 2014)

Aix-Les-Bains, France
16 – 19 September 2014

Volume 1 of 2

Editors:

**Elmar Frank
Philippe Papillon**

ISBN: 978-1-5108-1045-7

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© (2014) by the International Solar Energy Society
All rights reserved.

Printed by Curran Associates, Inc. (2015)

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

International Solar Energy Society
Villa Tannheim
Wiesentalstrasse 50
D-79115 Freiburg Germany

Phone: +49-761-459-060
Fax: +49-761-459-0699

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: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

Table of Contents

Editorial

| | |
|-----------------------------------------------------------------------|----------|
| Editorial to the Proceedings of the ISES EuroSun Congress 2014 | |
| <i>E. Frank, P. Papillon</i> | 1 |

Advanced HVAC

| | |
|---------------------------------------------------------------------------------------------------------------|----------|
| Experimental and Numerical Studies of a Porous Material for a New Indirect Regenerative Cooling System | |
| <i>G. Leroux, N. Le Pierrès, L. Stephan, E. Wurtz</i> | 4 |

Building Material and Components

| | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Interaction Between Walls and Roofs in Non Air Conditioned Rooms. | |
| <i>G. Barrios, J.M. Casas</i> | 14 |
| Thermal Characterization of Different Materials for Extensive Green Roofs | |
| <i>L.F. Cabeza, J. Coma, G. Perez</i> | 19 |
| The Effect of Solar Reflectance, Infrared Emissivity, and Thermal Insulation of Roofs on the Annual Thermal Load of Single-family Households in México | |
| <i>I.R. Martín-Domínguez, M.T. Alarcón-Herrera, J. Lucero Álvarez</i> | 27 |
| Control Strategies of an Adaptive Glazing | |
| <i>V. Ritter, D. Gstöhl, C. Matschi, D. Schwarz</i> | 36 |

Concentrating PV

| | |
|-----------------------------------------------------------------|-----------|
| Ray-Tracing Modelling of an Asymmetric Concentrating PVT | |
| <i>C. Giovinazzo, L. Bonfiglio, J. Gomes, B. Karlsson</i> | 46 |

Daylighting

| | |
|-------------------------------------------------------------------------|-----------|
| Daylight in Museums: Exhibition vs Preservation | |
| <i>R. Ajmat, M. Pérez Zamora, J. Sandoval</i> | 57 |
| Assessment of Sustainability Aspects of Daylighting in Buildings | |
| <i>M. Dovjak, M. Košir, A. Krainer, Ž. Kristl</i> | 64 |

Comparative Thermal Simulation of Conventional and Daylight-deflecting Systems with BSDF-based Models in TRNSYS and EnergyPlus

M. Hauer, M. Hiller, C. Kofler, W. Streicher **72**

Daylighting And Shading of the Energy Efficiency Center

M. Reim, W. Körner, H. Weinläder **82**

Grid-integrated PV Systems

Study, Comparison and Evaluation of Model Parameters of Photovoltaic Cells

I. Farkas, D. Rusirawan **92**

Design and Benefits Analysis of Building Integrated Photovoltaic Project

C. Jia, A. Feng, Z. Li, A. Li, Z. Liu **96**

PV Performance Benchmarking in India. Results from the Project “Solar Mapping and Monitoring - SolMap”

V. Schacht, A. Häberle, A.K. Kumar, I. Mitra, A.N. Srivastava **102**

International Renewable Energy Review

Solar in West African Energy Policies - State of the Art and On-going Development

K. Mahama, R. Anne, C. Cristina, S. Ibrahim **113**

Net Zero Energy Buildings

Powerhouse – Integrating Solar in an Energy Plus Refurbishment of Office Building.

P. Bernhard, L. Bugge **123**

| | |
|------------------------------------------------------------------------------------------------|------------|
| Smart Building as Power Plant – Energyplus House with Energy Charge Management | |
| <i>F. Bockelmann, M.N. Fisch, C. Kley</i> | 131 |
| A Comparative Study of Different PV Installations for a Norwegian NZEB Concept | |
| <i>C. Good, L. Georges, A.G. Hestnes, A. Houlihan Wiberg, T. Kristjansdottir</i> | 141 |
| Development of a Smart Energy Management System Based on Plus-Energy-Houses | |
| <i>A. Köhler, M. Fischer, S. Lambeck</i> | 151 |
| Towards Low Carbon Homes – Measured Performance of Four Passivhaus Projects in Scotland | |
| <i>T. Sharpe, C. Morgan, D. Shearer</i> | 156 |
| Concept and First Energy-Balance Results of an Energy- Autonomous House | |
| <i>T. Storch, U. Gross, T. Leukefeld, C. Philipp, S. Riedel</i> | 166 |

Rational Use of Energy and Energy Storage in Buildings

| | |
|------------------------------------------------------------------------------------------------------------------------------------|------------|
| An Alternative Methodology of Light Source Spectral Distribution Selection for Use in Museums | |
| <i>F. Arana Sema, R. Ajmat, J. Pujol Ramo, J. Sandoval</i> | 175 |
| Dynamic Thermal Behaviour of Two Newly Developed PCM Cooling Ceiling Prototypes | |
| <i>F. Klinker, C. Konstantinidou, H. Weinläder</i> | 184 |
| Measurements of the Performance of the Room Integrated PCM in the New Energy Efficiency Center | |
| <i>C. Konstantinidou, H. Weinläder</i> | 194 |
| Prototype Development and First Test Results of a Facade-Integrated Solar Thermal System for Domestic Hot Water Preparation | |
| <i>S. Stark, H. Drück, N. Gohl, A. Loose</i> | 204 |

Resource Forecasting

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Forecast of Short-term Solar Irradiation in Brazil Using Numerical Models and Statistical Post-processing <i>F.J.L. Lima, F.R. Martins, E.B. Pereira</i> | 215 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|

Smart Energy Systems Based on Solar Energy and other Renewables

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| A Comparative Analysis of Room Air Temperature Modelling for Control Purposes <i>M.d.M. Castilla, R. Mena, M. Pérez, F. Rodríguez, J.D. Álvarez</i> | 226 |
| Towards Intelligent Operation of Data Centres Integrating Renewables and Smart Energy Systems <i>E. Oró, I. Dafnomilis, J. Salom</i> | 236 |

Solar Architecture and Building Integration

| | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| BAPV and BIPV Installation Trends in Sweden <i>M. Haegermark, J. Dalenbäck</i> | 248 |
| Facade Farm: Solar Mediation Through Food Production <i>A. Jenkins, N. Hall, G. Keeffe</i> | 258 |
| A Multi-Functional Ventilated Façade Model within a Parallel and Object-Oriented Numerical Platform for the Prediction of the Thermal Performance of Buildings <i>D. Kizildag, O. Lehmkuhl, A. Oliva, J. Rigola</i> | 268 |

| | |
|-----------------------------------------------------------------------------------------------------------|------------|
| Solar Potential in the Existing Slovenian Building Stock | |
| <i>M. Kosir, M. Dovjak, Z. Kristl</i> | 278 |
| Innovative Solar Products for Architectural Integration: A Joint Task 41 and Task 51 IEA Website | |
| <i>M. Munari Probst, L. Deschamps, C. Roecker</i> | 288 |
| Comparative Performance of BAPV Systems in Scotland: 4 Case Studies with Differing Energy Contexts | |
| <i>C. Porteous, J. Foster</i> | 294 |

Solar Collectors and Hybrid Collectors

| | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Evaluation of the Combination of Hybrid Photovoltaic Solar Thermal Collectors with Air to Water Heat Pumps | |
| <i>A. Abdul-Zahra, T. Faßnacht, A. Wagner</i> | 303 |
| Fabrication and Characterisation of Slim Flat Vacuum Panels Suitable for Solar Applications | |
| <i>F. Arya, P. Eames, P. Henshall, T. Hyde, R. Moss, S. Shire</i> | 313 |
| Comparative Test of Two Large Solar Collectors for Solar Field Application | |
| <i>F. Bava, S. Furbo</i> | 320 |
| Experimental Study of a Micro Combined Heat and Power System: Characterisation of the Parabolic Trough Collector Used for Direct Steam Generation | |
| <i>J. Bouvier, T. Kientz, G. Michaux, F. Nepveu, D. Rochier</i> | 329 |
| Analysis of Polymeric Solar-thermal Collectors in Drain Back Systems by Simulation | |
| <i>M. Ehrenwirth, S. Brandmayr, C. Reiter, C. Trinkl, W. Zörner</i> | 337 |
| Heat Pipe Collectors for Cost Reduction of Solar Installations | |
| <i>S. Föste, F. Giovannetti, S. Jack, G. Rockendorf, B. Schiebler</i> | 345 |
| Performance and Reliability of Insulated Glass Collector Prototypes | |
| <i>F. Giovannetti, M. Kirchner</i> | 355 |

| | |
|---------------------------------------------------------------------------------------------------------------------------------------|------------|
| Experimental Investigations of a Solar Dryer under Laboratory Condition | |
| <i>A. Halimov, J. Akhatov, E. Juraev, A. Lopez Aguera</i> | 362 |
| Market and Simulation Analysis of PVT Applications for the Determination of New PVT Test Procedures | |
| <i>F. Ille, M. Adam, R. Radosavljevic, H. Wirth</i> | 368 |
| Performance Analysis of Uncovered PV-T Collectors for Radiative Cooling and Heating Applications | |
| <i>X. Jobard, R. Braun, J. Cremers, U. Eicker, N. Palla</i> | 378 |
| Development of a Polymer-Carbon Nanotubes based Economic Solar Collector | |
| <i>S.I. Kim, C. Boyle, J. Kissick, S. Spence</i> | 388 |
| Steelabsorbers in Mass Production - Challenges, Opportunities and Produced Samples | |
| <i>L. Koch, M. Hermann, U. Horn, C. Jerg, F. Kennemann, F. Steinbach, E. Tekkaya</i> | 397 |
| Numerical Investigation on Heat Transfer, Fluid Distribution and Solid Stress to a New Type of Solar Flat Plate Collector | |
| <i>P. Leibbrandt, T. Schabbach</i> | 407 |
| Modelling Results of Covered PVT Collectors Regarding Low-E Coatings and F' | |
| <i>M. Lämmle, S. Fortuin, M. Hermann, T. Kroyer</i> | 417 |
| Use of Polysiloxane Gel as Laminate for Solar PVT Collectors | |
| <i>T. Matuska, V. Jirka, V. Poulek</i> | 427 |
| Design and Performance of Evacuated Solar Collector Microchannel Plates | |
| <i>R. Moss, S. Shire</i> | 433 |
| Comparison Between Curved-mirrors and Flat-mirrors of the Fixed Mirror Solar Concentrator Geometry | |
| <i>R. Puig-Nadal, V. Martínez-Moll, A. Moià-Pol</i> | 444 |
| Numerical and Experimental Approaches for the Characterization of Heat Transfer Mechanisms in Compound Parabolic Concentrators | |
| <i>C. Reichl, F. Hengstberger, B. Kubicek, C. Zauner</i> | 450 |
| A Novel Production Technique for Flat Plate Solar Collectors with a Fully Adhesive Edge Bond | |
| <i>H. Riess, S. Brandmayr, W. Zörner</i> | 460 |

| | |
|----------------------------------------------------------------------------------------------------------------------------------------|------------|
| Direct Tracking Error Estimation on a 1-Axis Solar Tracker | 469 |
| <i>F. Sallaberry, A. Garcia de Jalón, R. Pujol</i> | |
| Modelling of Heat Transfer in a Trapezoidal Cavity Receiver for a Linear Fresnel Solar Collector with Fixed / Narrow Reflectors | 477 |
| <i>A. Shantia, H. Kayal, W. Streicher</i> | |
| Thermal Performance Analysis of a Concentrating Beam Splitting Hybrid PVT Collector | 487 |
| <i>C. Stanley, N. Karwa, A. Mojiri, G. Rosengarten</i> | |
| Collector Efficiency Calculation Tool for the Plastic Collectors with Temperature Limitation | 497 |
| <i>A. Thür, J. Neyer, W. Streicher</i> | |
| Hydropower Generation by Solar Thermosyphon | 506 |
| <i>H. Yoshida, N. Hagino, H. Imada, N. Yada</i> | |

Solar Cooling and Air Conditioning

| | |
|---------------------------------------------------------------------------------------------------------------------------------|------------|
| Integration of Sorption Collector in Office Curtain Wall: Simulation Based Comparison of Different System Configurations | 513 |
| <i>S. Avesani, R. Fedrizzi, G. Füldner, O. Hallström</i> | |
| Demonstration of Solar Heating and Cooling System Using Sorption Integrated Solar Thermal Collectors | 523 |
| <i>C. Blackman, C. Bales, O. Hallström</i> | |
| Development and Experimental Study of a 5 kW Cooling Capacity Ammonia-Water Absorption Chiller | 533 |
| <i>S. Bonnot, F. Boudéhenn, H. Demasles, F. Lefrançois, D. Triché, J. Wytttenbach</i> | |
| Comparison of Different Modeling Methods for a Single Effect Water-Lithium Bromide Absorption Chiller | 542 |
| <i>F. Boudéhenn, S. Bonnot, H. Demasles, A. Lazrak</i> | |
| Model of H₂O/LiBr Absorption Machine Using Falling Films | 552 |
| <i>J. Cap</i> | |

| | |
|---------------------------------------------------------------------------------------------------------------------------------------|------------|
| Techno-Economic Analysis of Air-to-Water Heat Rejection Systems | |
| <i>M. D'Antoni, R. Fedrizzi, D. Romeli</i> | 560 |
| Investigation of the Performance of a Solar Driven Refrigerator for Post-Harvest Crops in Hot Arid Remote Areas | |
| <i>A.A.M. El-Bahloul, A.H.H. Ali, S. Ookawara</i> | 569 |
| Solar-Driven Refrigeration Systems for Post-Harvest Crops Reservation: The State of Art of the Systems | |
| <i>A.A.M. El-Bahloul, A.H.H. Ali, S. Ookawara</i> | 579 |
| Preliminary Results of a 7kW Single-Effect Small Capacity Pre-Industrial LiBr-H₂O Air-cooled Absorption Machine | |
| <i>J. Farnós Baulenas, J. Castro, E. Garcia-Rivera, D. Kizildag, S. Morales, A. Oliva</i> | 589 |
| Experimental Evaluation of a Novel Tube Bundle Solar Driven Liquid Desiccant Regenerator | |
| <i>U. Jordan, J. Addy, D. Fleig, M. Jaradat, K. Vajen</i> | 597 |
| New Generation Solar Cooling and Heating Systems with IEA SHC TASK 53: Overview and First Results | |
| <i>D. Mugnier, R. Fedrizzi, T. Selke, R. Thygesen</i> | 607 |
| DHW/Cooling Hybrid Strategy for Solar Cooling: One Successful Year Monitoring Results | |
| <i>D. Mugnier, L. Ramos Seleme</i> | 611 |
| Simulation Based Optimization of Dynamic Power Control for Small Capacity Chillers | |
| <i>D. Neyer, M. Brychta, J. Neyer, W. Streicher, A. Thür</i> | 616 |
| Two-stage Air-dehumidification System for the Tropics – Assessment of Conceptual System Configurations | |
| <i>M. Safi Zadeh, C. Bongs, H. Henning, J. Luther, A. Morgenstern</i> | 624 |
| First Operation Months of World's Most Powerful Solar Cooling System in the USA at Desert Mountain High School, Scottsdale, AZ | |
| <i>M. Schubert, H. Blazek, C. Holter</i> | 633 |
| Solar Cooling in High Latitudes Conditions | |
| <i>P. Shipkovs, G. Kashkarova, K. Lebedeva, L. Migla, A. Snegirjovs</i> | 636 |
| A Method to Guarantee the Performance of Solar Heating and Cooling Systems | |
| <i>A. le Denn, F. Boudehenn, E. Gautier, V. Gavan, A. Kaemmerlen, O. Marc</i> | 642 |

Solar District Heating and Cooling

Seven PHD Studies on Solar District Heat

C. Bales, F. Bava, C. Kok Nielsen, G. Lennermo, Y. Louvet, N. Peréz de la Mora, A. Shantia, A. Sotnikov **652**

Simulation Study for the Solar Retrofitting of a District Heating System

D. Beckenbauer, S. Brandmayr, W. Zörner **662**

Small Scale Solar Thermal Heat Integration in District Heating Networks

I. Ben Hassine, U. Eicker, R. Pesch **672**

Solar District Heating - Fundamental Correlations Regarding Energy and Economics

L. Deschaintre, T. Schmidt **678**

Comparison of Thermal Performance of Different Solar Collector Technologies for Solar District Heating Systems Based on Solar Keymark Certificates and SCEnOCalc

S. Fischer **686**

Modeling of Solar District Heating: A Comparison Between TRNSYS and MODELICA

L. Giraud, R. Baviere, C. Paulus **696**

Energy Services for Business Districts

B. Glumac, W. Schaefer, H. van der Zanden **707**

Analysis of a Novel Solar District Heating System

C. Nielsen, J. Dalenbäck, M. Haegermark **717**

Large-Scale Thermal Energy Stores in District Heating Systems – Simulation Based Optimization

F. Ochs **727**

Decentralized Solar District Heating Systems

A. Oliva, M. Elci, S. Herkel, W. Kramer, E. Mehmet, A. Ripka **735**

Thermal Performance of Solar District Heating Plants in Denmark

B. Perers, F. Bava, S. Furbo **743**

| | |
|------------------------------------------------------------------------------------------------------------------------------|------------|
| Software for the Analysis, Predesign and Performance Evaluation of Central Solar Heating Plants with Seasonal Storage | |
| <i>L.M. Serra, M. Guadalfajara, M.A. Lozano, J. Redriguez</i> | 753 |
| Towards District Heating with 80-100 % Solar Fraction | |
| <i>D. Trier</i> | 764 |

Solar Domestic Hot Water and Combisystems

| | |
|---------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| One Solar Heating and Hot Water Supplying Combined System for Rural Area Buildings | |
| <i>L. Aisong, F. Airong, J. Chunxia, L. Zhong, L. Zongjiang</i> | 771 |
| Energy Labelling and Testing of Hot Water Stores, Collectors and Solar Thermal Systems | |
| <i>D. Bestenlehner, S. Bachmann, H. Drueck</i> | 779 |
| Experimental Investigation of the Filling and Draining Processes of the Drainback System (Part 2) | |
| <i>R. Botpaev, K. Vajen</i> | 785 |
| Simulation of Combined Solar Thermal, Heat Pump, Ice Storage and Waste Water Heat Recovery Systems. Design Criteria and Parametric Studies | |
| <i>D. Carbonell, E. Frank, M. Granzotto, M. Haller, D. Philippen</i> | 795 |
| Carbon Nanotube Spectrally Selective Solar Absorbers | |
| <i>Z. Chen, T. Boström, Q. Nguyen</i> | 806 |
| Towards an Harmonized Whole System Test Method for Combined Renewable Heating Systems for Houses | |
| <i>D. Chèze, C. Bales, R. Haberl, M.Y. Haller, A. Leconte, P. Papillon, T. Perrson</i> | 814 |
| Long-term Performance Prediction for Domestic Solar Water Heating Systems | |
| <i>J.L. Duomarco</i> | 824 |
| PV Domestic Hot Water System | |
| <i>P. Dupeyrat, J. Doucet, R. Le Berre, A. Lindsay, J. Penneau, A. Plotton</i> | 834 |

| | |
|------------------------------------------------------------------------------------------------------------------------------|------------|
| New Control Strategy for Solar Thermal Systems with Several Heat Sinks | |
| <i>J. Glebin, C. Büttner, A. Klingenschmidt, G. Rockendorf, J. Steinweg.....</i> | 843 |
| Impact of Small Weather Data Time Steps on the Simulation of Solar and Heat Pump Systems | |
| <i>M. Granzotto, D. Chèze, M.Y. Haller.....</i> | 853 |
| Hardware in the Loop Tests on Eleven Solar and Heat Pump Heating Systems | |
| <i>R. Haberl, E. Frank, M.Y. Haller.....</i> | 861 |
| Solar Active Houses: Simulation Based Analysis of Building Concepts with High Solar Thermal Fractions | |
| <i>S. Kobelt, D. Bestenlehner, H. Drück, A. Oliva, G. Stryi-Hipp.....</i> | 871 |
| Towards a Generic Methodology to Model Solar Thermal Systems using Neural Networks Through a Short Dynamic Test | |
| <i>A. Lazrak, G. Fraisse, A. Leconte, P. Papillon, B. Souyri.....</i> | 881 |
| Extensive Validation and Possible Improvements of the FSC Method | |
| <i>A. Leconte, P. Papillon.....</i> | 892 |
| On the Use of the FSAV/FSC Characterization to Monitor and Guarantee the Solar Results of Combisystems | |
| <i>A. Leconte, P. Papillon.....</i> | 902 |
| Calculation of Solar Energy Use as a Part of Determination of the Energy Performance of Building | |
| <i>K. Lenic, D. Dikli, A. Trp.....</i> | 912 |
| Using History Based Probabilistic Irradiance Forecasts for Supporting the Predictive Control of Solar Thermal Systems | |
| <i>B. Lie, D.D. Arachchige, H.G. Beyer, C. Pfieffer.....</i> | 919 |
| Research on Solar Heating Technology for Rural Single-Family Homes in Severe Cold and Cold Zones of China | |
| <i>Z. Liu, A. Feng, C. Jia, A. Li, Z. Li.....</i> | 929 |
| Extended Laboratory Test Method for Combined Solar Thermal and Heat Pump Systems | |
| <i>A. Loose, S. Bonk, H. Drück, P. Frey.....</i> | 936 |
| Comparison of Solar Photovoltaic and Photothermal Domestic Hot Water Systems | |
| <i>T. Matuska, B. Sourek.....</i> | 946 |

| | |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Study Case of Solar Thermal and Photovoltaic Heat Pump System for Different Weather Conditions. | |
| <i>A. Moia-Pol, V. Martinez-Moll, R. Nazmitdinov, R. Pujol-Nadal</i> | 952 |
| Comparative Performane Analysis of a Solar Box Cooker and Improved Charcoal Stoves in Mozambique | |
| <i>T. Nhabetsse, B. Cuamba, I. Da Silva</i> | 962 |
| Drain Back Low Flow Solar Combi Systems. Design, Monitoring and Simulation | |
| <i>B. Perers, Z. Chen, J. Fan, S. Furbo, W. Kong</i> | 972 |
| Simulations Study of Cascade Heat Pump with Integrated Storage for Solar Combisystems | |
| <i>S. Poppi, C. Bales, V. Schubert, A. Weidinger</i> | 982 |
| Analysis of Demand and Energy Saving at Different Types of Hotels with Integration of Solar Systems and Geothermal Heat Pumps | |
| <i>M. Romero, A. Gallo, J. González-Aguilar, M. Prodanovic</i> | 992 |
| Performance of a Coupled Reinforced Learning-Fuzzy Control Approach to the Control of a Solar Domestic Hot Water System | |
| <i>A. Soppelsa, D. Bettoni, R. Fedrizzi</i> | 1002 |
| Comparative Analysis of Domestic Water Heating Thermosiphon Systems Tested According to the Standard ISO 9459-2 | |
| <i>J. Vera, I. Lillo, F. Sallaberry, M.A. Silva</i> | 1012 |
| Evaluation of Dynamic Operation Effects for a Heat Pump in a Solar Combi-plus System | |
| <i>A. Vittoriosi, R. Fedrizzi, D. Menegon</i> | 1021 |

Solar Heat for Industrial and Commercial Applications

Operational Improvements of a Large Scale Solar Thermal Plant Used for Heat Supply in the Ham Production

| | |
|----------------------------------------------------------------------|-------------|
| <i>I. Ben Hassine, M. Cotrado, D. Pietruschka, R. Söll</i> | 1032 |
|----------------------------------------------------------------------|-------------|

| | |
|-----------------------------------------------------------------------------------------------------------|-------------|
| Medium Temperature Solar Thermal Installation with Thermal Storage for Industrial Applications | |
| <i>M. Bunea, S. Citherlet, A. Duret, E. Frank, L. Péclat</i> | 1041 |
| THE BGU/CERN Solar Hydrothermal Reactor | |
| <i>Y. Garb, C. Benvenuti, S. Bertolucci, B. Bressan, F. Caspers, A. Gross</i> | 1051 |
| Numerical Modeling of Hot Air Multi-Pass Solar Dryer | |
| <i>M.W. Kareem, K. Habib, M.H. Ruslan</i> | 1061 |
| Autonomous Solar HDH Seawater Desalination | |
| <i>D. Loureiro, M. Giestas, A. Joyce</i> | 1070 |
| Solar Heat for Agro-Industrial Processes: an Analysis of its Potential Use in Southern Spain | |
| <i>M. Pérez-García, F.J. Cabrera Corral, R. Silva</i> | 1077 |
| Characterization of a Medium Temperature Concentrator for Process Heat – Tracking Error Estimation | |
| <i>F. Sallaberry, F. Alberti, L. Crema, R. Pujol Nadal, M. Roccabruna, J. Torres</i> | 1086 |
| Fast Feasibility Assessment for Solar Thermal Systems in Industry | |
| <i>B. Schmitt, C. Lauterbach, S. Meyers, D. Ritter, K. Vajen</i> | 1096 |
| Thermal Management System of Li-Ion Batteries Using Inorganic Phase-Change Materials | |
| <i>S. Ushak, L.F. Cabeza, M.M. Farid, Y. Galazutdinova, M. Grágeda, A. Gutierrez</i> | 1106 |

Solar Radiation Availability and Variability

| | |
|--------------------------------------------------------------------------------------------------------------------------|-------------|
| Solar Resource Assessment over Kuwait: Validation of Satellite-derived Data and Reanalysis Modeling | |
| <i>M. Al-Rasheedi, S. Al-Hajraf, C. Gueymard, A. Ismail</i> | 1114 |
| Solar Spectral Characterization of Three Different Locations at Alpine Latitudes Using Average Photon Energy | |
| <i>G. Belluardo, D. Baumgartner, D. Moser, M. Olefs, M. Pravettoni, M. Rennhofer, D. Strepparava, P. Weihs</i> | 1124 |

| | |
|---------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Measurements and Model Evaluation of Direct Normal Irradiance in Central Spain | |
| <i>J. Bilbao, R. Román, A. de Miguel</i> | 1133 |
| Quality Control of Solar Radiation Data within Sonda Network in Brazil: Preliminary Results | |
| <i>P.E. Dias da Silva, F. Martins, E. Pereira, S. Pereira</i> | 1141 |
| Estimating Diffuse Solar Radiation from Global Solar Radiation | |
| <i>N. Erusafe, M. Chendo, N. Obot</i> | 1150 |
| Performance of Separation Models to Predict Direct Irradiance at High Frequency: Validation over Arid Areas | |
| <i>C. Gueymard, J.A. Ruiz-Arias</i> | 1156 |
| Climate Change Impacts on Photovoltaics, Solar Thermal Energy, Transparent Insulation and Energy Demand in the Building Sector | |
| <i>A. Herrmann, C. Dorn, U. Gross</i> | 1168 |
| Satellite Based Irradiance: Long Term Global, Beam and Diffuse Validation. Irradiation Interannual Variability. | |
| <i>P. Ineichen</i> | 1175 |
| Availability and Variability of Solar Radiation Data for the Modelling of Solar Thermal Installations in Andalusia (Spain) | |
| <i>M. Pérez-García, F.J. Cabrera Corral, R. Silva</i> | 1185 |
| Enhanced Insolation and Global Irradiance in Near-tropic Region | |
| <i>Y.K. Ramgolam, K.M.S. Soyjaudah</i> | 1194 |
| Influence of Solar Altitude on Diffuse Fraction Correlations in Cyprus | |
| <i>R. Tapakis, A. Charalambides, S. Michaelides</i> | 1202 |
| Measuring the Solar Radiation Spectrum in 4 Planes for Daylight and PV Applications | |
| <i>G. Tourasse, D. Dumortier</i> | 1209 |
| Measurement of the All-Sky Spectral Radiance Distribution Using a Fisheye Camera and Principal Component Analysis | |
| <i>Y. Uetani</i> | 1217 |

Solar Thermal Electricity

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Modeling of Direct Steam Generation Linear Concentrating Solar Plants: Dynamic Studies | |
| <i>A. Aurousseau</i> | 1228 |
| Small Scale Solar-Driven CHP System Pre-Dimensioning Sensitiveness to Solar Field and ORC Power Block Components Efficiencies | |
| <i>P. Horta, G. Abdellatif, J. Brouwer, B. El Ghali, H. Frej, S. Lalami, A. Oliveira, C. Saraiva, J. Soares, J.M. Álvarez-Prieto</i> | 1239 |
| Innovative and Advanced Materials Research for High Temperature Solar Receivers | |
| <i>F. Zaversky, R. Casasola-Ríos, M.A. Mazo, D. Morris, J.A. Rodríguez-Cortés, F. Sallaberry, A. Tamayo, A. Vázquez</i> | 1246 |

Strategies and Policies

| | |
|------------------------------------------------------------------------------------------------------|-------------|
| Environmental Policies in Maritime Transport: A Case Study of Solar Ship in Galapagos Islands | |
| <i>B. Rivela, B. Criollo, J. López-Villada, A. Montero, D. Vaca</i> | 1257 |
| SHC Standards: An Integral Component of Quality Infrastructure | |
| <i>M. Thornbloom</i> | 1263 |

Thermal Storage

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Comparison of an Experimental and Numerical Investigation of a Packed-Bed Latent Heat Thermal Storage System with Encapsulated Phase Change Material | |
| <i>T. Alam, S. Bellan, J. Dhau, J. Gonzalez-Aguilar, Y. Goswami, M.M. Rahman, M. Romero</i> | 1271 |
| Thermal Storage System Development for a 1 MW CSP Pilot Plant Using an Organic Rankine Cycle | |
| <i>E.G. Bennouna, H. Frej, A. Mimet</i> | 1281 |
| Bischofite as Phase Change Material (PCM) for Thermal Energy Storage (TES) Applications | |
| <i>L.F. Cabeza, J. Gasia, A. Gutierrez, L. Miro, S. Ushak</i> | 1290 |
| Corrosion of Metal Containers for Use in PCM Energy Storage | |
| <i>L.F. Cabeza, C. Barreneche, G. Ferrer, I. Martorell, A. Sole</i> | 1299 |
| Thermal Cycling Test of PCM to Ensure Long-term Performance of Domestic Hot Water Systems | |
| <i>L.F. Cabeza, C. Barreneche, A.i. Fernández, G. Ferrer, I. Martorell, A. Sole</i> | 1306 |
| Experimental Study of Active Slab with PCM During Summer Period | |
| <i>L.F. Cabeza, A. Castell, L. Navarro, A. de Gracia, S. Álvarez</i> | 1312 |
| Economic Analysis of an Installed Single Dwelling Seasonal Thermal Energy Store with Varying Demand | |
| <i>S. Colclough, P. Griffiths, N. Hewitt, D. Redpath</i> | 1321 |
| Seasonal Thermal Energy Storage with Aqueous Sodium Hydroxide - Reaction Zone Development, Manufacturing and First Experimental Assessments | |
| <i>X. Daguenet-Frick, E. Frank, B. Fumey, P. Ganterbein, R. Weber, T. Williamson</i> | 1331 |
| Packed Bed Zeolite Experimental Setup to Study TCS Systems up to 200°C | |
| <i>P. Dolado, J. Coronas, A. Lazaro, I. Miranda, J.S. Urieta</i> | 1341 |
| Hydration / Dehydration Cycles of Salt Hydrates - Studied with NMR | |
| <i>P. Donkers, O. Adan, L. Pel</i> | 1351 |
| Predicted Charging and Discharging Efficiency of a Latent Heat Thermal Energy Storage System Linked to a Solar Thermal Collector System | |
| <i>P. Eames</i> | 1360 |
| Characterisation of a Rotating Adsorber Designed for Thermochemical Heat Storage Processes | |
| <i>G. Englmair, D. Lager, B. Zettl</i> | 1369 |

| | |
|-----------------------------------------------------------------------------------------------------------------------------|------|
| Disturbance of Stratification Caused by Direct Horizontal Inlets into a Water Storage Tank | |
| <i>M. Haller, S. Boller, E. Frank, A. Huggenberger, M. Kaufmann, L. Lötscher, B. Meier, I. Mojic, J. Podhradsky</i> | 1377 |
| SolSpaces - Development of a Segmented Sorption Store | |
| <i>H. Kerskes, H. Drück, R. Weber</i> | 1386 |
| Calorimetric Investigation of Magnesium Sulfate Hydration in Porous Glasses | |
| <i>K. Linnow, C. Kaps, M. Niermann, K. Posern, M. Steiger, T. Talreja</i> | 1394 |
| Investigations of ZnSO₄ Hydrate for Solar Heat Storage Applications | |
| <i>K. Posern, C. Kaps, K. Linnow, M. Steiger</i> | 1401 |
| Solar Thermal Energy Storage for the Typical European Dwelling; Available Resources, Storage Requirements and Demand | |
| <i>D. Redpath, S. Colclough, P. Griffiths, N. Hewitt</i> | 1407 |
| Evaluation of the Performance Criteria of Combined Thermo-Chemical Energy Storage Systems for Building Applications | |
| <i>A. Skrylnyk, M. Beeckmans, J. Bougard, E. Courbon, G. Descy, M. Frere, M. Henry, N. Heymans, P. Papillon, G. Tanguy</i> | 1416 |
| Pipe Internal Recirculation Losses in Storage Connections - An Underrated Problem | |
| <i>J. Steinweg, J. Glembin, F. Kliem, G. Rockendorf</i> | 1426 |
| Water Adsorption on Zeolites for Solar Heat Storage: Modelling and Parametric Analysis of the Reactor | |
| <i>P. TATSIDJODOUNG, J. Heintz, D. Lagre, N. Le Pierres, L. Luo</i> | 1434 |
| Design of a Thermochemical Seasonal Storage Demonstrator for a Single-Family House | |
| <i>J. Wyttensbach, L. Stephan, G. Tanguy</i> | 1444 |