CPV-14

14th International Conference on
Concentrator Photovoltaic Systems

PROGRAM

April 16-18, 2018 Puertollano, Spain

www.cpv-14.org

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Chairmen‘s Message

Prof. Ignacio Antón and Óscar de la Rubia

On behalf of the conference committees, it is an honour to welcome you to the 14th International Conference on Concentrator Photovoltaic Systems (CPV-14) in Puertollano, Spain. In the last decades, Concentrator Photovoltaic technology has demonstrated its ability to be a „short cut“ to market for new achievements or breakthroughs in the development of high efficiency solar cells, and CPV holds the records for the highest efficiencies ever achieved by any solar technology at the cell, module, and system levels. Field experiences not only show outstanding high performance, but also that CPV technology is highly reliable and comparable to standard PV. This series of conferences started in 2002 with the objective of providing a platform for the exchange of information and experiences in the CPV field and has become the premier technical conference in the areas of high- and low-concentration PV components, modules, and tracker-based PV systems. The conference brings together students, academics, technologists, and financiers to engage in discussion of state-of-the-art CPV components, trackers, and installations.

Puertollano is one of the main industrial cities of Castilla-La Mancha, a landscape known worldwide as the backdrop for Cervante‘s Don Quixote de la Mancha. This area is an example of transition from an economy highly dependent on fossil fuels to a land of opportunities for renewable energies. The economy of Puertollano was based on coal mining and petrol refining, but it was transformed into the City of Energy in last decades. Curiously, the palace of congress La Central was an old thermoelectric plant, built in 1917 and recently reconverted for use as a conference center.

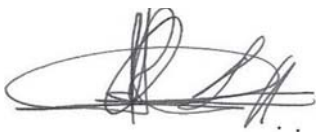
Thus, our conference topic fits well into the city‘s transformation. We recommend to reserve some time and enjoy the attractive places such as the Mining Museum or the Sour Fountain. We invite you to enjoy the Spanish cuisine in the traditional bars and taverns where you can try typical dishes like migas, gachas de harina de pitos, tiznao, among others. And of course, to taste a wonderful array of flavours in the form of tapas.

You may also consider visiting the ISFOC headquarters, laboratories and CPV power plants in operation since 2008. We offer a visit to ISFOC together with the National Center of Hydrogen, CNH2, focused on hydrogen and fuel cell technologies.

As in previous editions of the CPV Conferences, the proceedings of CPV-14 will be published open access by the American Institute of Physics (www.aip.org). The submitted papers will be reviewed and selected to be published, indexed, and are citable through the AIP website and a digital object identifier (DOI).

We wish you a profitable and successful conference and an enjoyable stay in Puertollano.

Prof. Ignacio Antón
Scientific Chair of CPV-14
Instituto de Energía Solar –
Universidad Politécnica de Madrid



Óscar de la Rubia
Conference Host of CPV-14
ISFOC – Institute for Concentration
Photovoltaics Systems

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Clement Weick, CEA, France

Monday, April 16, 2018

08:00 - 09:00 **Registration**

09:00 - 09:10 **Introduction & Welcome**

Opening CPV-14

Ignacio Antón, Instituto de Energía Solar - UPM

Welcome from Conference Host

Óscar de la Rubia, ISFOC

09:10 - 10:30 **Session 1: Introductory Session**

Chairs: Myles Steiner (NREL), Iván García (IES-UPM)

09:10 Analysis of the Performance of an On-Axis Mirror Module Design Compared to a Flatcon® Module

Maike Wiesenfarth[1], Sebastian Gamisch[1], Marc Steiner[1], Peter Jacob[1], Andreas W. Bett[1]

[1] *Fraunhofer ISE*

09:30 Long Term Power Prediction Model for CPV Plants

Mousaab Benhammane[1], Grégoire Pichenot[1], Mathieu Baudrit[1], Gilles Notton[2]

[1] *CEA - INES;* [2] *Laboratory SPE – University of Corsica*

09:50 Six-Junction Concentrator Solar Cells

John Geisz[1], Myles Steiner[1], Kevin Schulte[1], Ryan France[1], Willliam McMahon[1], Daniel Friedman[1]

[1] *National Renewable Energy Laboratory (NREL)*

10:10 Standardization of the CPV Technology in 2018 – Where are We Going to Go?

Kenji Araki[1], Carlos Algora[2], Gerald Siefer[3], Kensuke Nishioka[4], Ralf Leutz[5], Sam Carter[6], Shitao Wang[7], Stephen Askins[2], Liang Ji[8], George Kelly[9]

[1] *Toyota Technological Institute;* [2] *Instituto de Energía Solar - UPM;* [3] *Fraunhofer ISE;* [4] *University of Miyazaki;* [5] *leopil - Leutz Optics and Illumination UG;* [6] *RayGen Resources Pty Ltd;* [7] *Research Institute of Arctech Solar;* [8] *UL LLC;* [9] *Sunset Technology*

10:30 - 11:05 **Coffee Break**

11:05 - 11:40 **Welcome Session**

Chairs: Ignacio Antón (IES-UPM), Óscar de la Rubia (ISFOC)

Welcome Speeches from Representatives of Puertollano and Castilla-La Mancha

11:40 - 13:20 **Session 2: CPV Systems (I)**

Chairs: Andreas Bett (Fraunhofer ISE), Karin Hinzer (University of Ottawa)

11:40 Analysis of Ecosole HCPV System Performances During Two Operation Years

Carmine Cancro[1], Aniello Borriello[1], Gabriele Ciniglio[1], Sergio Ferlito[1], Giorgio Graditi[1], Gianni Leanza[1], Angelo Merola[1], Francesco Pascarella[1]

[1] *ENEA*

12:00 High and Low Concentration Systems at the Atacama Desert in Chile

Elias Urrejola[1], Sebastian Falkenberg[1]

[1] *ENGIE Laborelec Chile*

12:20 On-Sun Testing of a 100-Shingled-Cell Dense Receiver Array at ~50 W/cm^2 using Overlapped Single-Axis Foci

Richard Norman[1], Etienne Leveille[1], Boussairi Bouzazi[1], Brad Siskavich[2], Jean-Francois Dufault[1], Osvaldo Arenas[1], Richard Ares[1], Vincent Aimez[1], Luc Frechette[1]

[1] *University of Sherbrooke;* [2] *xVI Technologies Inc.*

12:40 REhnu Dish Based CPV: Performance and Reliability Improvements Based on Field Experience

Nicholas Didato[1], Roger Angel[1], Peter Strittmatter[1], Thomas Stalcup[1], Frank Sodari[1]

[1] *REhnu Inc.*

13:00 Long-Term Data Analysis. Feedback from ISFOC CPV Plants

María Martínez[1], Daniel Sánchez[1], Gustavo Calvo-Parra[1], Cesáreo Alamillo[1], Eduardo Gil[1], Angel Hipólito[1], Fernando de Gregorio[1], Oscar de la Rubia[1]

[1] *ISFOC*

13:20 - 14:40 **Lunch Break**

14:40 - 16:20 Session 3: Solar Cells for CPV (I)

Chairs: Matthew Lumb (Naval Research Laboratory), Rosalinda van Leest (AZUR SPACE)

14:40 On the Use of Graphene as a Transparent Electrode to Reduce the Series Resistance of High Concentrator Solar Cells

Laura Barrutia Poncela[1], Mario Ochoa[1], Iván Lombardero[1], Tomás Palacios[2], Ignacio Rey-Stolle[1], Carlos Algora[1]

[1] *Instituto de Energía Solar - UPM;* [2] *Massachusetts Institute of Technology*

15:00 Reverse Heterojunction Top Cells for High Current Density Solar Cell Operation

Myles Steiner[1], Emmett Perl[1], Ryan France[1], Kevin Schulte[1], Daniel Friedman[1], John Geisz[1]

[1] *National Renewable Energy Laboratory (NREL)*

15:20 Development of InGaAs(P) Solar Cells for 5+J Stacked Multijunction Architectures

Kenneth Schmieder[1], Matthew Lumb[2], Mitchell Bennett[3], Eric Armour[4], Ziggy Pulwin[4], Jesse Frant[1], Robert Walters[1]

[1] *US Naval Research Laboratory;* [2] *George Washington University;* [3] *Sotera Defense Solutions;* [4] *Veeco MOCVD*

15:40 MOVPE SiGeSn Development for the Next Generation 4-Junction Solar Cells

Gianluca Timo[1], Nicola Armani[1], Giovanni Abagnale[1], Marco Calicchio[1], Bernd Schineller[2]

[1] *RSE;* [2] *AIXTRON*

16:00 Dual Technological Procedure for Multijunction Solar Cells: InGaAs Subcell Epitaxial Lift-Off Combined with InP Wafer Recycling

François Chancerel[1], Philippe Regreny[2], Jean-Louis Leclercq[2], Abdelatif Jaouad[1], Maïté Volatier[1], Maxime Darnon[1], Simon Fafard[1], Michel Gendry[2], Vincent Aimez[1]

[1] *University of Sherbrooke;* [2] *Institut des Nanotechnologies de Lyon (INL - CNRS UMR-5270)*

16:20 - 17:00 Coffee Break

17:00 - 18:20 Session 4: Tracking and Reliability

Chairs: Kenji Araki (Toyota Technological Institute), Luc Fréchette (University of Sherbrooke)

17:00 **Tracking-Integrated CPV4ALL System Installation and Analysis of Mirror Tolerance Manufacturing**

Sarah Bernardis[1], Philippe Voarino[1], Jaudia Gouffa-Folliet[1], Harmen Rooms[2], Marnick Van de Zande[3], Peter Penning[3], Mathieu Baudrit[1]

[1] *CEA;* [2] *TNO, Solar Research Solliance;* [3] *SunCycle Technology BV*

17:20 **Influence of Concentration and Solar Cell Size on the Warranty Time of Concentrator Triple Junction Solar Cells**

Manuel Vazquez[1]**,** Neftali Nunez[1], Julen Tamayo-Arriola[2], Vincenzo Orlando[1], Olga Alburquerque[1], Antonio Fernandez[1], Carlos Algora[1]

[1] *Instituto de Energía Solar - UPM;* [2] *Instituto de Sistemas Optoelectrónicos y Microtecnología - UPM*

17:40 **Design and Analysis of Performance of a DC Power Optimizer for HCPV Systems within CPV Match Project**

Ricardo Alonso[1], Ainhoa Pereda[1], E. Bilbao[2], J.A. Cortajarena[2], Iñigo Vidaurrazaga[1], Eduardo Roman[1]

[1] *TECNALIA;* [2] *Engineering School of Gipuzkoa (UPV-EHU)*

18:00 **Modelling and Experimental Validation of Passive Tracking System for HCPV**

Stephen Askins[1], Jaime Caselles[2], Emmanuele Chiappori[3], Francisco Martin[4], Ignacio Antón[1]

[1] *Instituto de Energía Solar - UPM;* [2] *SolaRays Energy;* [3] *Independent Contractor;* [4] *Solar Added Value, SL*

Tuesday, April 17, 2018

09:00 - 10:40 Session 5: Solar Cells for CPV (II)

Chairs: John Geisz (NREL), Svetlana Levina (Ioffe Institute)

09:00 Lowering Perimeter Recombination Losses in Micro-Concentrator Solar Cells: A Simulation Study

Mario Ochoa[1], Iván García[1], Ignacio Rey-Stolle[1], Carlos Algora[1]

[1] *Instituto de Energía Solar - UPM*

09:20 Assessing the Suitability of Metal-Wrap-Through Solar Cells for Low-Concentration PV Systems

César Domínguez[1], Gonzalo Puertas[1], Alberto Sanchidrián[2], Rafael Cascón[2], María Martínez[3], Daniel Sánchez[3], Pablo Noriega[4], Norman Jost[1], Ignacio Antón[1]

[1] *Instituto de Energía Solar - UPM;* [2] *Escuela Técnica Superior de Ingeniería y Diseño Industrial;* [3] *ISFOC;* [4] *Abengoa Solar New Technologies S.A*

09:40 Front-Contacted Multijunction Micro Solar Cells: Fabrication and Characterization

Pierre Albert[1], Abdelatif Jaouad[1], Maxime Darnon[1], Clément Laucher[1], Christopher E. Valdivia[2], Maïté Volatier[1], Yannick Deshayes[3], Karin Hinzer[2], Laurent Bechou[1], Vincent Aimez[1]

[1] *University of Sherbrooke;* [2] *University of Ottawa;* [3] *Université de Bordeaux*

10:00 Subcell Segmentation: A Novel Method to Current Match Multi-Junction Solar Cells

Christopher Valdivia[1], Karin Hinzer[1]

[1] *University of Ottawa*

10:20 Current Localization in Heterostructures of Multijunction Solar Cells: Causes for Arising and Diagnostics Potential

Maxim Shvarts[1], Alexander Gudovskikh[2], Nikolay Kalyuzhnyy[1], Sergey Mintairov[1], Viktor Emelyanov[1]

[1] *Ioffe Institute;* [2] *St. Petersburg Academic University*

10:40 - 11:20 Coffee Break

11:20 - 11:40

Invited Talk

Chair: Carlos Algora (IES-UPM)

Operation & Maintenance - The Key for Reliable Performance in a CPV Power Plant

Johannes Wüllner, Fraunhofer ISE

Johannes Wüllner

Johannes Wüllner studied environmental engineering in Trier, Germany, and received his degree with distinction in industrial engineering from the Environmental Campus in Birkenfeld. His professional career started in 2007 at Concentrix Solar in the system engineering and covered a key role in developing the first industrial scale CPV system. He was substantially supporting the system development of Concentrix to become, under the new name of Soitec Solar, one of the global players in CPV power plants. After 9 years in the CPV business he moved to South Africa to set up his own company, focusing on operation and maintenance for renewable power plants, including a 44MWp CPV power plant. Since December 2017 he is leading the group for applied research in energy storage system at Fraunhofer ISE in Freiburg, Germany.

11:40 - 13:20

Poster Session

The poster numbers are based on topics:

A High and Low Concentration Systems - Performance, Maintenance, Field Experiences, Testing

B Concentrating Optics - Materials, Designs, Characterization

C Measurement Equipment for CPV Characterization Indoors and Outdoors

D Tracking and Control

E Concentrator Solar Cells and Solar Cell Assemblies - Low and High Concentration Cells, New Designs, Characterization

F Modeling, Performance and Energy Prediction for Modules or Systems

G Novel Concepts in CPV

H Reliability, Accelerated Testing of Components and Systems

I Codes, Standards, Markets and Policies

J Hybridization of CPV with Other Technologies

A-01 Elaboration of Affordable Luminescent Solar Concentrators

Ayaulym Alseitova
L.N. Gumilyov Eurasian National University

A-02 Design and Indoor Testing of 3D Cross Compound Parabolic Concentrator for LCPV System

Mazin AL-Shidhani
Cardiff University

A-03 Fluid-Based Spectrally Selective Filters for Building Integrated Direct Immersed PVT Concentrating Solar Systems

Daniel Chemisana[1], Eduardo F. Fernández[2], Alberto Riverola[1], Alexandre Moreno[1]
[1] *University of Lleida;* [2] *University of Jaén*

A-04 NoDustPV Project: Development and Testing of Anti-Soiling Coatings

Angel Hipólito[1], María Martínez[1], Oscar de la Rubia[1], Mónica Della Pirriera[2], Ana Milena Cruz[2], Elena Torralba-Calleja[2], Pau Bosch-Jimenez[2], Beatriz Cantos[2], Lorenzo Bautista Perez[2], Alba Álvarez[3]
[1] *ISFOC;* [2] *Leitat;* [3] *Solartys*

A-05 Energetic Simulation of a Dielectric Photovoltaic-Thermal Concentrator

Alexandre Moreno[1], Alberto Riverola[1], Daniel Chemisana[1]
[1] *University of Lleida*

A-06 Alternative Techniques for Temperature Control and Automated Dust Cleaning in CPV Installations

Tabare Pagliano
IREVO Foundation

A-07 Application of HCPV Systems in Polygenerative Systems

Filippo Paredes[1], Fabio Maria Montagnino[1]
[1] *Consorzio Arca*

B-01 A Strategy to Ensure the Correct Thickness of Optical Couplers in Concentrating Photovoltaic Systems

Intissar Benrhouma[1], Marta Victoria[2]
[1] *National Engineering School of Gabes, University of Gabes;*
[2] *Instituto de Energía Solar - UPM*

B-02 Indoor Characterisation and Comparison with Optical Modelling of Fresnel-Based High-CPV Units Equipped with Secondary Optics

Juan Pablo Ferrer
Universidad de Jaén

B-03 Optical Optimization for a Concentrated Photovoltaic Module

Ray Y. Lin[1], Sheng Hui Chen[2], Guei Shen Zeng[2], David WW Dai[1]
[1] *TaiCrystal International Technologies Co., Ltd.;* [2] *National Central University*

B-04 Design Method for Nonimaging Solar PV Concentrators Using Genetic Algorithms

Daria Freier[1], Roberto Ramirez-Iniguez[1], Carlos Gamio[1], Firdaus Muhammad-Sukki[2]
[1] *Glasgow Caledonian University;* [2] *Robert Gordon University*

B-05 Low Temperature Annealed Pd/Ge/Ti Metal Systems for Concentrator Inverted Metamorphic Solar Cells

Manuel Hinojosa[1], Ivan Garcia[1], Luis Cifuentes[1], Ivan Lombardero[1]
[1] *Instituto de Energía Solar - UPM*

B-06 Experimental Installation for Optical Characterization of Fresnel Lens Concentrators

Evgeniy Filimonov[1], Svetlana Levina[1], Maxim Shvarts[1]
Presented by Svetlana Levina[1]
[1] *Ioffe Institute*

C-01 Multijunction Solar Cells with Pronounced Optical Coupling: Single Wavelength Laser Biasing Approach at Quantum Efficiency Measurements

Svetlana Levina[1], Evgeniy Filimonov[1], Maxim Shvarts[1]
[1] *Ioffe Institute*

C-02 From Component to Multijunction Solar Cells for Spectral Monitoring

Ignacio Antón[1], Norman Jost[1], Stephen Askins[1], Rubén Núñez[1], Luis J. San José[1], Guido Vallerotto[1], Rebeca Herrero[1], Marta Victoria[1], César Domínguez[1], Gabriel Sala[1]
[1] *Instituto de Energía Solar - UPM*

C-03 Low Cost Solar Simulator for Concentrating CPV Cells Characterizations

Carmine Cancro[1], Aniello Borriello[1], Giorgio Graditi[1], Angelo Merola[1], Antonio Romano[1]
[1] *ENEA*

C-04 Evaluation of the Direct Normal Irradiance Retrieval with a Rotating Shadow Band EKO Grating Spectroradiometer

Mario Po[1], Kees Hoogendijk[1], Will Beuttell[1], Shibayama Kazunori[1], Eiji Takeushi[1]

[1] *EKO*

D-01 Analyses of the Performance of Locally Developed High Concentrator Photovoltaic System Upon Climate Conditions

Merouan Belkasmi[1], Mensah K Anaty[2], Khalid Bouziane[2], Mohamed Akherraz[3]

[1] *International University of Rabat;* [2] *UIR;* [3] *EMI*

D-02 Design Strategy for Low-Power Consumption in Solar Trackers

Diego Alonso Flores-Hernández[1], Sergio Palomino-Resendiz[2], Alberto Luviano-Juárez[2], Norma Lozada-Castillo[3], Jorge Isaac Chairez-Oria[4], Ignacio Antón[5]

Presented by Sergio Palomino-Resendiz[2]

[1] *Centro de Innovación y Desarrollo Tecnológico en Cómputo – IPN;* [2] *Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas – IPN;* [3] *Escuela Superior de Ingeniería Mecánica y Eléctrica – IPN;* [4] *Unidad Profesional Interdisciplinaria de Biotecnología – IPN;* [5] *Instituto de Energía Solar - UPM*

D-03 Comparative Analysis of Aerodynamic Properties for Different Types of Solar Trackers

Alexander Chekalin[1], Viacheslav Andreev[1], Yuri Ascheulov[1], Yuri Chumakov[2], Sergei Kognovitski[1], Viacheslav Linnas[1]

[1] *Ioffe Institute;* [2] *Peter the Great St. Petersburg Polytechnic University*

E-01 Investigation of Solar Cell Overheating under Radiation of Ultrahigh Intensity

Alexander Chekalin[1], Nikolai Davidyuk[2], Nikolai Sadchikov[1], Dmitry Malevskiy[1], Pavel Pokrovskiy[1]

[1] *Ioffe Institute;* [2] *St. Petersburg Academic University*

E-02 GaInNAsSb-Based Four Junction Solar Cells on GaAs and Ge Substrates

Arto Aho[1], Riku Isoaho[1], Marianna Raappana[1], Ville Polojärvi[1], Lauri Hytönen[1], Timo Aho[1], Antti Tukiainen[1], Mircea Guina[1]

[1] *Optoelectronics Research Centre / Tampere University of Technology*

E-03 III-V/Ge Multijunction Solar Cell with Through Cell Via Contacts Fabrication

Mathieu de Lafontaine[1], Clément Laucher[1], Maxime Darnon[1], Abdelatif Jaouad[1], Maïté Volatier[1], Erwine Pargon[2], Simon Fafard[1], Vincent Aimez[1]

[1] *University of Sherbrooke;* [2] *Laboratoire des Technologies de la Microélectronique (LTM)*

E-04 Loss Analysis for Single Junction Concentrator Solar Cells

Ned Ekins-Daukes[1], A. Pusch[2], A. Soeriyadi[2]

[1] *Imperial College London;* [2] *UNSW*

E-05 Epitaxial Ge Nanopillar Solar Cells Grown by Metalorganic Chemical Vapor Deposition

Kangho Kim[1], Youngjo Kim[2], Nguyen Dinh Lam[3], Won-Kyu Park[2]

[1] *Ajou University;* [2] *Korea Advanced Nano Fab;* [3] *Hanoi National University of Education*

E-06 Investigation of Silicon Wafers Thermal Degradation by Photoluminescence Decay Measurements

Dmitry Kudryashov

St. Petersburg Academic University

E-07 Investigation of MBE Grown III-V Phosphide Semiconductor for Multijunction Cell

Amadéo Michaud[1], Lorenzo Mancini[2], François Jomard[3], Jean-Christophe Harmand[2], Jara Fernandez Martin[1], Ahmed Ben Slimane[4], Stéphane Collin[2]

[1] *Total New Energies;* [2] *C2N;* [3] *GEMAC;* [4] *Institut Photovoltaique d' Ile de France*

E-08 Solar Cell Heating by Incident Radiation: Overheat Temperature and IV-Curve Correction

Mikhail Mintairov[1], Valery Evstropov[2], Svetlana Levina[2], Sergey Mintairov[2], Maxim Shvarts[2], Nikolay Kalyuzhnyy[2]

[1] *Submicron Heterostructures for Microelectronics, Research & Engineering Center, RAS;* [2] *Ioffe Institute*

E-09 Optical and Electrical Properties of Superlattice and Photonic Metamorphic Structures for High-Performance Solar Cells

Viktor Emelyanov[1], Nikolay Kalyuzhnyy[1], Sergey Mintairov[1], Maxim Shvarts[1]

Presented by Mikhail Mintairov[2]

[1] *Ioffe Institute;* [2] *Submicron Heterostructures for Microelectronics*

E-10 Investigation of Epitaxial Lift-Off Using the <001> Etching Directions in Inverted Three-Junction Solar Cells

Hwa Sub Oh
Korea Photonics Technology Institute

E-11 Module Interconnection for the Three-Terminal Heterojunction Bipolar Transistor Solar Cell

Marius Zehender[1], Elisa Antolín[1], Pablo García-Linares[1], Irene Artacho[1], Iñigo Ramiro[2], Juan Villa[1], Antonio Martí[1]
[1] *Universidad Politécnica de Madrid;* [2] *Instituto de Energía Solar - UPM*

E-12 High Efficiency Low Concentrator Silicon Solar Cells with Innovative Ag-Free Multi-Wire Metallization

Maxim Shvarts[1], Tatyana Kost[2], Alla Chebotareva[2]
[1] *Ioffe Institute;* [2] *Lomonosov Moscow State University, SINP*

E-13 Output Parameters of Photovoltaic Cells at Ultrahigh Radiant Fluxes

Alexander Panchak[1], Pavel Pokrovskiy[1], Maxim Shvarts[1]
Presented by Maxim Shvarts[1]
[1] *Ioffe Institute*

F-01 Output Energy Predictions for Hybrid Concentrator III-V / Planar Thin-Film Modules

Maxim Shvarts[1], Viktor Emelyanov[1], Ekaterina Aronova[1]
[1] *Ioffe Institute*

F-02 Soiling and Abrasion Losses in CPV

Jaione Bengoechea[1], Ana Rosa Lagunas[1], Ignacio Manero[1], Miguel Murillo[1], Aitor Barrenetxea[1]
[1] *National Renewable Energy Centre*

F-03 Electricity Enhancement and Thermal Energy Production from Concentrated Photovoltaic Integrated with 3-Layered Microchannel Heat Sink

Idris Al-Siyabi[1], Sourav Khanna[1], Senthilarasu Sundaram[1], Tapas Mallick[1]
Presented by Mazin AL-Shidhani[2]
[1] *University of Exeter;* [2] *Cardiff University*

F-04 Photovoltaic System Integrated with Phase Change Material for South West UK Climate

Sourav Khanna[1], K S Reddy[2], Tapas K Mallick[1]
Presented by Mazin AL-Shidhani[3]
[1] *University of Exeter;* [2] *Indian Institute of Technology Madras;* [3] *Cardiff University*

F-05 Modelling SMRs by Means of Standardized Component Cells

Ruben Nunez[1], Ignacio Antón[1], Rebeca Herrero[1], Marta Victoria[1], César Domínguez[1], Stephen Askins[1], Norman Jost[1], Luis Javier San Jose[1]
[1] *Instituto de Energía Solar - UPM*

F-06 Validation of the Binning Technique for Yearly Energy Yield Calculations Using Random Bandgap Combinations

Jose M. Ripalda[1], Jeronimo Buencuerpo[1], Ivan García[2]
[1] *MN CSIC;* [2] *Instituto de Energía Solar - UPM*

F-07 Analysis on Fluctuation of Atmospheric Parameters and its Impact on Performance of CPVs

Kenji Araki[1], Yasuyuki Ota[2], Kan-Hua Lee[1], Takumi Sakai[2], Kensuke Nishioka[2], Masafumi Yamaguchi[1]
[1] *Toyota Technological Institute;* [2] *University of Miyazaki*

G-01 Possibility of the Static LCPV to Mechanical-Stack III-V// Si Module

Kenji Araki[1], Kan-Hua Lee[1], Masafumi Yamaguchi[1]
[1] *Toyota Technological Institute*

G-02 Can Remote Epitaxy Make Cheap Multijunctions? Technical and Economic Considerations of a New III-V Manufacturing Process

Harry Apostoleris[1], Matteo Chiesa[1], Ibraheem Almansouri[1]
[1] *Khalifa University of Science and Technology*

G-03 Permanent Bonding Process for Thin Multijunction Solar Cell Integration

Clément Laucher[1], Clément Colin[1], Franck Melul[1], Mathieu de Lafontaine[1], Maïté Volatier[1], Maxime Darnon[1], Vincent Aimez[1], Abdelatif Jaouad[1]
[1] *University of Sherbrooke*

G-04 Evaluation of Microlens Efficiency for Solar Micro-Concentrators

Fausta Loffredo[1], Fulvia Villani[1], Carmine Cancro[1], Giuseppe Nenna[1], Aniello Borriello[1], Riccardo Miscioscia[1], Carla Minarini[1], Franco Roca[1]

[1] *ENEA*

G-05 Trough-Lens-Cone Optics with Microcell Arrays: High Efficiency at Low Cost

Richard Norman[1], Brad Siskavich[2], Simon Fafard[1], Laurent Bechou[1], Richard Ares[1], Vincent Aimez[1], Luc Frechette[1]

[1] *University of Sherbrooke;* [2] *xVI Technologies Inc.*

G-06 Development of a Novel Concentrating Photovoltaic Prototype Based on Solar Spectrum Splitting Technology

Michele Tonezzer[1], Paolo Bernardoni[1], Donato Vincenzi[1], Paolo Decarli[2], Silvio Fugattini[1], Micol Boschetti[1]

[1] *University of Ferrara;* [2] *Trentino Rainbow Energy*

H-01 Understanding the Effect of Shunt Resistances in Multijunction Solar Cells and its Application to Reliability Analysis

Ivan Lombardero[1], Carlos Algora[1]

[1] *Instituto de Energía Solar - UPM*

I-01 Technical Specification IEC TS 62989 ED 1 – Primary Optics for Concentrator Photovoltaic Systems

Ralf Leutz[1], David Miller[2], Philippe Voarino[3], Marta Victoria[4], Steve Scott[5], Peter Nitz[6], René Kogler[7], Hideto Kasai[8], Rebeca Herrero[4], César Dominguez[4], Sam Carter[9], Stephen Askins[4], Thomas Arndt[7], Thorsten Hornung[6]

[1] *leopil - Leutz Optics and Illumination UG;* [2] *National Renewable Energy Laboratory (NREL);* [3] *CEA - INES;* [4] *Instituto de Energía Solar - UPM;* [5] *Reflexite;* [6] *Fraunhofer ISE;* [7] *Evonik Industries AG;* [8] *Kuraray Co., Ltd.;* [9] *RayGen Resources Pty Ltd*

J-01 InGaAs Metamorphic Laser (λ=1064 nm) Power Converters with Over 44% Efficiency

Nikolay Kalyuzhnyy[1], Viktor Emelyanov[1], Sergey Mintairov[1], Maxim Shvarts[1]

[1] *Ioffe Institute*

J-02 InGaAs/GaAs Reciever for Infrared (λ=1064 nm) Laser Power Conversion

Vladimir Khvostikov[1], Nikolay Kalyuzhnyy[1], Sergey Mintairov[1], Nataliia Potapovich[1], Svetlana Sorokina[1]

Presented by Nikolay Kalyuzhnyy[1]

[1] *Ioffe Institute*

J-03 Analysis of Direct Normal Irradiation for CPVT System in South Korea

Seong Hyun Kang[1], Yong Hyun Kim[2], Jeong Eun Choi[1], Seong Jegarl[1], Seung Pil Moon[1]

[1] *Korea Electric Power Cooperation;* [2] *Korea Photonics Technology Institute*

J-04 The High Energy Efficiency for the CPVT System with the Double Concentrate Reflector and Dual Heat Exchange Technology

Yong Hyun Kim[1], Nam Hwang[1], Ku-rak Jung[1], Hangju Ko[1], Seunghyun Kang[2], Seung Pil Moon[3]

Presented by Nikolay Kalyuzhnyy[1]

[1] *Korea Photonics Technology Institute;* [2] *Korea Electric Power Cooperation;* [3] *Korea Power Cooperation*

J-05 Addressing Secondary Optical Element Misalignment of Concentrator Photovoltaic-Thermoelectric Hybrid Receivers, via Multispectral Computer Vision, Artificial Neural Networks, Deep Learning and a Thermoelectric-Enhanced Spectral Emissivity Map Correction Technique

Matthew H. Rolley[1], Tracy K. N Sweet[1]

[1] *Cardiff University*

J-06 Experimental Comparison of a III:V Triple-Junction Concentrator Photovoltaic-Thermoelectric (CPV-TE) Hybrid Module with Commercial CPV and Flat Plate Silicon Modules

Matthew H. Rolley[1], Tracy K. N Sweet[1], Luka Eerens[1], Juan Pablo Ferrer-Rodríguez[2], Eduardo F. Fernández[2]

[1] *Cardiff University;* [2] *University of Jaén*

J-07 EnerShade - A Low Concentration PV and Thermal Hybrid System as Building Integration Solution

Daniel Sánchez[1], Eduardo Gil[1], María Martínez[1], Cesáreo Alamillo[1], Gustavo Calvo-Parra[1], Oscar de la Rubia[1]

[1] *ISFOC*

J-08 On the Efficiency of Hybrid PV/CSP Systems

Joya Zeitouny[1], Alexis Vossier[1], Eugene Katz[2], Alain Dollet[1], Gilles Flamant[1], Jeffrey Gordon[2]

[1] *PROMES-CNRS;* [2] *Ben-Gurion University of the Negev*

13:20 - 14:40 **Lunch Break**

14:40 - 16:00 Session 6: Concentrating Optics

Chairs: Ignacio Rey-Stolle (IES-UPM), Daniel Chemisana (University of Lleida)

14:40 CPV Generator with Dish Reflector and Fly's Eye Receiver

Justin Hyatt

Steward Observatory The University of Arizona

15:00 A Comparative Study of Four Secondary Optical Elements for CPV Systems

Sarah El Himer[1], Ali Ahaitouf[1], Sara El-Yahiaoui[1], Abdallah Mechaqrane[1], Abdallah Ougazzaden[2]

[1] *Université Sidi Mohammed Ben Abdellah;* [2] *Georgia Tech-Lorraine*

15:20 Electrically Influence of Temperature on an Off Axis Mirrors by Means of METHOD with Two Reflective Receivers with 3J Solar Cells

Philippe Voarino[1], Romain Couderc[1], Arnaud Ritou[1], Paolo Vagliasindi[2], Loris Todesco[2], Rolando Parmesani[2], Mathieu Baudrit[1]

[1] *CEA;* [2] *ASSE S.r.l*

15:40 Improvements in the Manufacturing Process of Achromatic Doublet on Glass (ADG) Fresnel Lens

Guido Vallerotto[1], Marta Victoria[1], Stephen Askins[1], Ignacio Antón[1], Gabriel Sala[1]

[1] *Instituto de Energía Solar - UPM*

16:00 - 16:20 Industry Session

16:00 Presentation Andaltec

16:05 Presentation AZUR SPACE

16:10 Presentation BSQ Solar

16:15 Presentation Sumitomo Electric

16:20 - 17:00 Coffee Break

17:00 - 18:20 Session 7: Modules and Measurements (I)

Chairs: Gerald Siefer (Fraunhofer ISE), Rebeca Herrero (IES-UPM)

17:00 Computer Vision Algorithm for Relative Misalignments Estimation in CPV Modules

Luis Javier San José[1], Ignacio Antón[1], Rebeca Herrero[1]
[1] *Instituto de Energía Solar - UPM*

17:20 Impact of the Temperature Dependence of CPV Optics Transmittance on the Current Mismatch of Multi-Junction

Norman Jost[1], Ignacio Antón[1], César Dominguez[1], Marta Victoria[1], Ruben Nuñez[1], Rebecca Herrero[1], Stephen Askins[1]
[1] *Instituto de Energía Solar - UPM*

17:40 Dense Array CPV Receivers: Impact of the Cooling Device on the Net PV Output for Different Illumination Profiles

Jerome Barrau[1], Gerard Laguna[1], Montse Vilarrubí[1], Alvaro Fernàndez[1], Gonzalo Sisó[1], Joan Rosell[1], Manel Ibañez[1], Josep Illa[1], Ferran Badia[1], Luc Fréchette[2], Maxime Darnon[2], Louis Michel Collin[2], Alain Dollet[3]
[1] *University of Lleida;* [2] *University of Sherbrooke;* [3] *PROMES-CNRS*

18:00 How Will CPV Deliver on its Original Promise? A Pathway to High Efficiency at Competitive Cost

Harry Apostoleris[1], Marco Stefancich[2], Ibraheem Almansouri[1], Matteo Chiesa[1]
[1] *Khalifa University of Science and Technology;* [2] *Dubai Electricity and Water Authority*

19:00 Conference Dinner (see page 25 for more information)

Wednesday, April 18, 2018

09:00 - 10:40 Session 8: CPV Systems (II)

Chairs: Alain Dollet (CNRS - PROMES), Maike Wiesenfarth (Fraunhofer ISE)

09:00 ALCHEMI – A Low Cost, High Efficiency, Optoelectronic HCPV Module for 1000x Operation

Geoffrey Duggan[1]
Presented by Andrew Johnson[2]
[1] *Fullsun Photovoltaics Limited;* [2] *IQE PLC*

09:20 Central Receiver Photovoltaics - A New Generation of Solar Power

John Lasich
RayGen Resources Pty Ltd

09:40 Maintenance of CPV Plants, How Much Does it Cost?

Eduardo Gil[1], Cesar Alamillo[1]
[1] *ISFOC*

10:00 MEGASOL: A First Feedback from a 2.2 MWp CPV Plant

Mousaab Benhammane[1], Philippe Voarino[1], Alexandre Mignonac[2], Grégoire Pichenot[1], Mathieu Baudrit[1], Gilles Notton[3]
[1] *CEA - INES;* [2] *CEA Tech;* [3] *Laboratory SPE – University of Corsica*

10:20 Set-Up and Evaluation of 53 kW Concentrated Solar PV in India

Gerald Siefer[1], Soumen Sardar[2], Shashank Ojha[2], Jaspal Singh[2], Vishal Singh[2], Jatinder Singh Chandok[2], Marc Steiner[1], Alexander Wekkeli[1]
[1] *Fraunhofer ISE;* [2] *NETRA NTPC Limited*

10:40 - 11:20 **Coffee Break**

11:20 - 11:40 Invited Talk

Chair: Marc Steiner (Fraunhofer ISE)

Light Plastic Integrated Micro CPV Module: PIC

Michihiko Takase[1], Masaharu Terauchi[1], Nobuhiko Hayashi[1], Hikaru Nishitani[1], Takuji Inohara[1], Youichirou Aya[1], Shutetsu Kanayama[1], Bunji Mizuno[1]
[1] *Panasonic Corporation*

Michihiko Takase

Michihiko Takase studied vacuum deposition processes in Hyogo, Japan, and received his master's degree of engineering from Himeji Institute of Technology. His professional career started in 1992 at Panasonic and engaged in developing of ultra-low energy ion doping and plasma doping process for an ultra-fine CMOS and vacuum process of a plasma display panel. As lecturer of ultra-shallow junction, he was invited to Semiconductor Research Seminar sponsored by Prof. J. Nishizawa in 2000. He was also in charge of starting up and improving the yield of the mass productions of plasma display, micro wave, and so on. He is a project manager of CPV which is supported by NEDO as a Japanese national project.

11:40 - 13:20 Session 9: Modules and Measurements (II)

Chairs: Maxim Shvarts (Ioffe Institute), Sarah Bernardis (CEA)

11:40 **4-Terminal CPV Module Capable of Converting Global Normal Irradiance Into Electricity**

Juan Francisco Martinez Sanchez[1], Marc Steiner[1], Maike Wiesenfarth[1], Frank Dimroth[1]

[1] *Fraunhofer ISE*

12:00 **Achieving Wide-Acceptance Angle and High On-Axis Performance Static Low-Concentration Module Using Hybrid Lens Arrays**

Kan-Hua Lee[1], Kenji Araki[1], Nobuaki Kojima[1], Masafumi Yamaguchi[1]

[1] *Toyota Technological Institute*

12:20 **Investigating the Spectral Nature of Soiling and its Impact on Multi-Junction CPV Systems**

Eduardo F. Fernández[1], Leonardo Micheli[2], Florencia Almonacid[1], Matthew Muller[2]

[1] *Universidad de Jaén;* [2] *National Renewable Energy Laboratory (NREL)*

12:40 **Influence of Ground Cover Ratio on Optimum Inverter Size in CPV Plants**

Pedro M. Rodrigo[1], Eduardo F. Fernández[2], Florencia M. Almonacid[2], Pedro J. Pérez-Higueras[2]

[1] *Universidad Panamericana;* [2] *University of Jaén*

13:00 **CPV for Space**

Matthew Lumb[1], Brent Fisher[2], Kenneth Schmieder[3], Phillip Jenkins[4], Robert Walters[4]

[1] *George Washington University;* [2] *Formerly of Semprius Inc.;* [3] *Naval Research Laboratory;* [4] *US Naval Research Laboratory*

13:20 - 14:40 Lunch Break

14:40 - 16:00 Session 10: CPV Hybrid Systems and Concepts

Chair: Ned Ekins-Daukes (UNSW)

14:40 Progress in Agriculture Photovoltaic Leveraging CPV

Jan Ingenhoff[1], Luqing Liu[2], Wen Liu[1], Fangzin Zhang[1], Ming Li[1], Dahan Qiang[1], Xinyi Zhang[2], Zili He[2], Quinglang Ou[1]

[1] *Institute of Advanced Technology of University of Science and Technology of China;* [2] *USTC - University of Science and Technology*

15:00 Cost-Competitiveness of Hybrid III-V-Si Concentrator Photovoltaic Systems

Kan-Hua Lee[1], Kenji Araki[1], Nobuaki Kojima[1], Masafumi Yamaguchi[1]

[1] *Toyota Technological Institute*

15:20 Hybrid Photovoltaic and Thermoelectric Module for CPV-T with Heat Exchange Applications

Ryo Tamaki[1], Takeshi Toyoda[2], Yoichi Tamura[2], Akinari Matoba[2], Toshiharu Minamikawa[2], Misato Imai[3], Masayuki Tokuda[3], Megumi Masui[3], Yoshitaka Okada[1]

[1] *RCAST, The University of Tokyo;* [2] *Industrial Research Institute of Ishikawa;* [3] *ACTREE Corporation*

15:40 InGaP/Ge and GaAs/Ge Double-Junction Solar Cells for Thermal-CPV Hybrid Energy Systems

Boussairi Bouzazi[1], Artur Turala[1], Richard Arès[1], Simon Fafard[1], Vincent Aimez[1]

[1] *University of Sherbrooke*

16:00 - 16:30 Closing Session

Closing

Ignacio Antón, Instituto de Energía Solar - UPM

Conference Wrap-up

Myles Steiner, National Renewable Energy Laboratory (NREL)

Announcement CPV-15

Ali Ahaitouf, Université Sidi Mohammed Ben Abdellah

16:30 - 19:00 Technical Tour

Conference Dinner

The CPV-14 Conference Dinner will take place at the restaurant EL MESTO, a winery and olive mill located in the outskirts of Puertollano where dinner guests will indulge themselves, enjoying and tasting the most traditional food and drinks of Castilla-La Mancha.

Date: Tuesday, April 17
Fee: 55 € incl. VAT (pre-registration is required)

Location: Restaurante EL MESTO
Calle Ucrania, 2 (1.647,15 km)
13500 Puertollano

Schedule:
Bus transfer will be available. Buses will leave from 18:45 in front of the conference venue.
19:00 Visit Olive Mill and Winery
20:00 Conference Dinner
from 21:30 Buses will return to Puertollano

Technical Tour

The CPV-14 Technical Tour will take place on Wednesday, April 18 after the closing session and will cover the Centro Nacional del Hidrógeno (National Hydrogen Center), as well as the ISFOC facilities

Date: Wednesday, April 18
Start time: Approx. 16:30. The bus will leave after the closing session in front of the conference venue.
Return: Approx. 19:00 to Puertollano

Fee: € 28 incl. VAT (the tour is already fully booked)

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General Information

Registration

Each participant has to register in person at the registration desk to collect a conference bag and name badge before attending any sessions. Please make sure to wear your badge for admission to all sessions and side events. Participants who have lost their badge should report to the registration desk.

Registration times are during conference hours, starting at 8:00.

Posters

Please mount your poster before the start of the poster session. Do not remove your poster until the end of the conference. Posters are an important part of the scientific program and should be displayed the whole time.

Please remove your poster before you leave. Remaining posters will be discarded.

Speaker Information

All presentations must be handed in at the Media Upload Desk one hour before your session. You will not be able to display your presentation directly from your laptop computer or USB flash drive. Our technical support team will welcome you at the Media Upload Desk during all conference days, starting at 8:00.

Please meet your session chair(s) inside the conference room at least 10 minutes prior to the beginning of your oral session to acquaint yourself with the technical equipment.

Certificate of Attendance

A certificate of attendance for participants will only be available on-site at the registration desk and cannot be issued after the conference.

Conference Proceedings

The proceedings will be published open access with AIP, the American Institute of Physics (www.aip.org) after the conference, covering papers with sufficient scientific quality. This collaboration will provide optimum visibility of the proceedings and ensure that the authors' publications remain traceable and citable. Final online papers will be freely accessible on the AIP website and contain an ISBN number for each volume as well as individual DOI numbers for each paper.

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All participants who want to use the contact feature can confirm their admission to receive e-mails from other conference participants in the Download Area. The first contact will occur indirectly via the conference system in the Download Area. No personal data will be handed out.

WiFi Access

WiFi access will be available free of charge in the large exhibition room. Please see signs on-site for login details.

The listed companies and institutions have supported the 14th International Conference on Concentrator Photovoltaic Systems. Through their generous contributions they have made this conference a success in presenting a great opportunity to share knowledge and push the boundaries of solar science. **We thank our Sponsors.**

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