



EUPVSEC

23 — 27
September

ACV —
Austria Center Vienna

Vienna —
Austria

EU **PVSEC** **2024**

41st European
Photovoltaic Solar Energy
Conference and Exhibition

**Conference
Programme —**

www.eupvsec.org



41st European Photovoltaic Solar Energy Conference and Exhibition

Conference Program

Monday, 23. September 2024

MONDAY MORNING

CONFERENCE OPENING

PLENARY PRESENTATIONS AP.1 / Scientific Opening

08:30 - 09:30

Manufacturing

Chairpersons:

Gabriele C. Eder
OFI, Vienna, Austria

Robert P. Kenny
European Commission JRC, Ispra, Italy

1AP.1.1 What's New in Silicon PV: A TOPCon Cell/Module Manufacturer's Perspective

Xinyu Zhang¹

¹ Jinko Solar, Haining, China

1AP.1.2 Module Technology Overview – A Manufacturing Perspective

Eszter (Esther) Voroshazi¹

¹ CEA, Le Bourget-du-Lac, France

1AP.1.3 3SUN The First European PV Gigafactory: Enabling Progress with Sustainable Energy

Marina Foti¹

¹ 3SUN, Catania, Italy

BECQUEREL PRIZE CEREMONY

09:30 - 10:00

Chairpersons:

Prof. Dr. Christophe Ballif
EPFL, Neuchâtel, Switzerland

Becquerel Prize Winner 2024

Daniel Lincot
CNRS, Palaiseau, France

Chairman of the Becquerel Prize Committee

Christophe Ballif

Director Sustainable Energy Center, CSEM, Director PV & Thin Film Electronics Laboratory, EPF

The Laudatio is given by:

Marika Edoff¹

¹ Uppsala University, Uppsala, Sweden

WELCOME MESSAGE

10:30 – 10:35

Gabriele Eder, General Chair EU PVSEC 2024

OPENING ADDRESSES

10:35 – 11:00

Leonore Gewessler, Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)

Jürgen Czernohorszky, Executive City Councillor for Climate, Environment & Democracy, City of Vienna

Christian Thiel, Head of the Energy Efficiency and Renewables Unit, Joint Research Centre, European Commission

KEYNOTE SPEECH

11:00 - 11:15

Global PV technology: Innovation, collaboration and yes, politics!

Rutger Schlatmann

HZB, Berlin, Germany; Chairman European Technology and Innovation Platform for Photovoltaics (ETIP PV)



MODERATED PANEL DISCUSSION - SOLAR EVERYWHERE: ADDRESSING THE CHALLENGES AND POTENTIAL OF GLOBAL PV EXPANSION

11:15 - 12:15

Chairpersons: Dr. Arnulf Jaeger-Waldau
European Commission JRC, Ispra, Italy

Nancy Haegel, Director of the National Center for Photovoltaics at NREL

Alessandro Barin, CEO Futura Sun

Walburga Hemetsberger, CEO Solar Power Europe

Andreas Bett, Director of Fraunhofer ISE

Leonore Gewessler, Federal Minister Austria, Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)

ORAL PRESENTATIONS 2AO.1

13:30 - 15:00 Inorganic and Organic Compound Solar Cells and Tandems

Chairpersons: Dr. Mirjam Theelen
TNO/Solliance, Eindhoven, The Netherlands
Dr. Ayodhya N. Tiwari
SOLTIWA, Duebendorf, Switzerland

2AO.1.1 Custom-Art: Kesterite Thin Film Technologies for Next Generation Customized PV Integration

Alejandro Pérez-Rodríguez¹, Pedro Vidal-Fuentes¹, Jacob Andrade-Arvizu¹, Yuancai Gong², Alex Jimenez-Arguijo², Edgardo Saucedo², Maarja Grossberg-Kuusk³, Romain Scaffidi⁴, Guy Brammert⁵, Bart Vermang⁵, G. Larramona⁶, C. Choné⁶, Dieter Meissner⁷, Kaia Ernits⁸, Martin Vetter⁷, C. Spudat⁷, Levent Güta⁹, Susan Schorr¹⁰, Jonathan Scragg¹¹, Alberto Mittiga¹², Romain Carron¹³, S. Resalati¹⁴, Lionel Tenchine¹⁵, E. Moscardini¹⁶, Andreas Zimmermann¹⁷, M. Olive¹⁸, P. Schiestl¹⁹, R. Gutierrez²⁰

¹ IREC, Sant Adrià de Besòs, Spain; ² UPC, Barcelona, Spain; ³ Tallinn University of Technology, Tallinn, Estonia; ⁴ UCLouvain, Louvain-la-Neuve, Belgium; ⁵ imec, Diepenbeek, Belgium; ⁶ IMRA Europe, Sophia Antipolis Cedex, France; ⁷ Crystalsol, Vienna, Austria; ⁸ Crystalsol, Tallinn, Estonia; ⁹ Carl von Ossietzky University of Oldenburg, Oldenburg, Germany; ¹⁰ HZB, Berlin, Germany; ¹¹ Uppsala University, Uppsala, Sweden; ¹² ENEA, Rome, Italy; ¹³ EMPA, Dübendorf, Switzerland; ¹⁴ Brookes University, Oxford, United Kingdom; ¹⁵ Industrial Technical Center for Plastics and Composites, Bellignat, France; ¹⁶ Ecorecycling, Rome, Italy; ¹⁷ Sunplugged, Wildermieming, Austria; ¹⁸ RESCOLL, Bordeaux, France; ¹⁹ KWS, Linz, Austria; ²⁰ Ayesa, Sevilla, Spain

2AO.1.2 Li-doping and Ag-alloying Interplay Shows the Pathway for Kesterite Solar Cells with Efficiency over 14%

Alex Jimenez-Arguijo¹, Yuancai Gong¹, Jialiang Huang², Kaiwen Sun², Sergio Giraldo¹, Xiaojing Hao², Edgardo Saucedo¹

¹ UPC, Barcelona, Spain; ² UNSW, Sydney, Australia

2AO.1.3 Rear Surface Passivation for Molecular Ink-Based, Submicron CuIn(S, Se)₂ Solar Cells

Sunil Suresh¹, Abraha Gidey Tadese¹, Towhid H. Chowdhury¹, Sachin R. Rondiya², Li Tao¹, Jian Liu¹, Bart Vermang³, Alexander R. Uhl¹

¹ University of British Columbia, Kelowna, Canada; ² Indian Institute of Science, Bengaluru, India; ³ Hasselt University, Genk, Belgium

2AO.1.4 Design Considerations of Cu(In,Ga)Se₂ as a Bottom Cell in a Tandem Structure

Ana Kanevce¹, Rico Gutzler¹, Stefan Paetel¹, Dominik Bagrowski¹, Dimitrios Hariskos¹, Theresa Magorian Friedlmeier¹

¹ ZSW, Stuttgart, Germany

2AO.1.5 GaAs//CuInGaSe-Based Multijunction Solar Cells with 30% Efficiency under Low Concentrated Sunlight

Kikuo Makita¹, Yukiko Kamikawa¹, Hidenori Mizuno¹, Ryuji Oshima¹, Yasushi Shoji¹, Shogo Ishizuka¹, Ralph Müller², David Lackner², Frank Dimroth², Takeyoshi Sugaya¹

¹ AIST, Tsukuba, Japan; ² Fraunhofer ISE, Freiburg, Germany



2AO.1.6 Antimony Selenide Solar Cells with an Inverted Superstrate Configuration

Chen Qian¹, Kaiwen Sun¹, Martin Green¹, Xiaojing Hao¹
¹ UNSW, Sydney, Australia

ORAL PRESENTATIONS 1AO.4

13:30 - 15:00 Silicon Material for Solar Cells: Growth, Stability and Reuse

Chairpersons: Dr. Ruy Sebastian Bonilla
 University of Oxford, Oxford, United Kingdom
 Dr. Alison Ciesla
 UNSW, Sydney, Australia

1AO.4.1 Potential for Recycled Silicon Solar Cells as Feedstock for New Ingot Growth

L.J.(Bart) Geerligs¹, Ando D. Kuypers¹, Mirjam J. Theelen¹
¹ TNO Energy Transition, Petten, The Netherlands

1AO.4.2 Epitaxially Grown Si Wafers Without Kerf-loss Ready for Efficiencies above 24 % After High Temperature Solar Cell Processing

Marion Drießen¹, Armin Richter¹, Clara Rittmann¹, Pascal Messmer¹,
 Giuliano Vescovi², Maxi Richter², Florian Schindler¹, Jan Benick¹, Charlotte Weiss¹, Stefan Janz¹
¹ Fraunhofer ISE, Freiburg, Germany; ² NexWafe, Freiburg, Germany

1AO.4.3 Impact of High-Temperature Processing Steps on the Long-Term Stability in n-Type FZ-Silicon

Melanie Mehler¹, Nicolas Weinert¹, Giso Hahn¹, Fabian Geml¹
¹ University of Konstanz, Konstanz, Germany

1AO.4.4 Impact of Rapid Thermal Processing on Bulk Lifetime and Surface Recombination Velocity of Crystalline Silicon with Passivating Tunnel Oxide Contacts

Franz-Josef Haug¹, Audrey Morisset¹, Sofia Libraro¹, Ezgi Genç¹, Julien Hurni¹, Christophe Ballif¹
¹ EPFL, Neuchâtel, Switzerland

1AO.4.5 LeTID in Industrial Ga-doped Cz-Si with Melt Recharging

Joshua Kamphues¹, Juri Miech¹, Xueqi Bai², Yichun Wang², Giso Hahn¹,
 Fabian Geml¹
¹ University of Konstanz, Konstanz, Germany; ² LONGI Green Energy Technology, Xi'an, China

1AO.4.6 Rapid Healing: How Hydrogenation Supercharges Full Recovery of Electron-Irradiation Defects in Ga-doped PERC Solar Cells

Guo Li¹, Zhuangyi Zhou¹, Chukwuka Madumelu¹, Peter Toth², Lennart van den Hengel³, Ferdinand Grozema³, Gavin Conibeer¹, Bram Hoex¹
¹ UNSW, Sydney, Australia; ² Extraterrestrial Power, Sydney, Australia; ³ TU Delft, Delft, The Netherlands

ORAL PRESENTATIONS 4AO.7

13:30 - 15:00 Advanced O&M Strategies and Methods

Chairpersons: Prof. Franz P. Baumgartner
 ZHAW, Winterthur, Switzerland
 Mr. Gerhard Mütter
 Gerhard Mütter e.U., Waldneukirchen, Austria

4AO.7.1 Best Practice Guidelines for the Use of Technical and Economic Key Performance Indicators

Sascha Lindig¹, Magnus Herz², Julien Deckx³, Julián Ascencio-Vásquez⁴,
 Karel De Brabandere³, Marios Theristis⁵, Bert Herteleer⁶, Erik Stensrud Marstein⁷
¹ UNIVERS, Munich, Germany; ² TÜV Rheinland, Cologne, Germany; ³ 3E, Brussels, Belgium; ⁴ UNIVERS, Redwood, United States of America; ⁵ Sandia, Albuquerque, United States of America; ⁶ KU Leuven, Leuven, Belgium; ⁷ IFE, Lillestrøm, Norway

4AO.7.2 Enhancing Photovoltaic Systems Decision Support System: A Framework for Data-driven Troubleshooting and Reporting

Mousa Sondoqah¹, Sandra Gallmetzer¹, Pablo Sebastian Enriquez Paez²,
 Atse Louwen¹, David Moser¹
¹ EURAC Research, Bolzano, Italy; ² BayWa r.e., Rome, Italy

4AO.7.3 Identifying Distinct Performance Patterns in Utility-Scale Photovoltaic Plants Using an Unsupervised Machine Learning Model

Ali Shakiba¹, Brendan Wright¹, Ziv Hameiri¹
¹ UNSW, Sydney, Australia

4AO.7.4 Recovering LeTID in PV Power Plants - A Feasibility Study

Esther Fokuhl¹, Paul Gebhardt¹, Alexander Kleinhans¹, Erdmut Schnabel¹,
 Cornelius Armbruster¹, Thomas Mikolajick², Viktor Wesselak³, Ingrid Hädrich¹, Daniel Philipp¹
¹ Fraunhofer ISE, Freiburg, Germany; ² Dresden University of Technology, Dresden, Germany; ³ Institute for Renewable Energy Technologies, Nordhausen, Germany

4AO.7.5 Enhancing Fault Diagnosis in Photovoltaic Plants: A Comprehensive Approach to Simultaneous Failures

Giosué Maugeri¹, Salvatore Guastella¹, Andrea Rossetti¹
¹ RSE, Milan, Italy

4AO.7.6 Design and Application of Intelligent Scalable Automatic Fault Detector for Commercial Photovoltaic Systems

Mücahid Candan¹, David Melgar¹, Christian Schill¹, Mete Çubukçu²
¹ Fraunhofer ISE, Freiburg, Germany; ² Solar Energy Institute of Ege University, Bornova, Türkiye



VISUAL PRESENTATIONS 3AV.1

13:30 - 15:00 PV Module Design and Manufacturing | BoS Components, Operation and Aging

Chairpersons: Dr. Eszter (Esther) Voroshazi
CEA, Le Bourget-du-Lac, France
Dr. Jens Moschner
KULeuven, Leuven, Belgium

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 2AO.2

15:15 - 16:45 Solar Cells based on CIGS and its Alloys

Chairpersons: Prof. Dr. Alejandro Pérez-Rodríguez
IREC, Sant Adria de Besos, Spain
Prof. Dr. Pere Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France

2AO.2.1 Special Introductory Presentation: A Comparison of Light Soaking Effects in High Efficiency Cu(In,Ga)Se₂ and (Ag,Cu)(In,Ga)Se₂ Solar Cells

Klara Kiselman¹, Jan Keller¹, Patrick Pearson¹, Erik Wallin², Marika Edoff¹
¹ Uppsala University, Uppsala, Sweden; ² First Solar European Technology Center, Uppsala, Sweden

2AO.2.2 Towards 1 V Open-Circuit Voltage with 1.5 eV Band Gap (Ag,Cu)(In,Ga)Se₂

Rico Gutzler¹, Dimitrios Hariskos¹, Ana Kanevce¹, Stephanie Spiering¹, Stefan Paetel¹, Wolfram Witte¹
¹ ZSW, Stuttgart, Germany

2AO.2.3 Modification Technique of Back Junction for Cu(In,Ga)Se₂ Solar Cells

Takahito Nishimura¹, Akira Yamada¹
¹ Tokyo Institute of Technology, Meguro-ku, Japan

2AO.2.4 Development of Wide-Bandgap Cu(In,Ga)Se₂ Solar Cells and Modules on Transparent Back Contacts

Wolfram Witte¹, Stefan Paetel¹, Dimitrios Hariskos¹, Angelika Demling², Regan G. Wilks², Marcus Bär², Cristiana F. Almeida Alves³, Rafael Cerqueira³, Sascha Sadewasser³, Nina Kochel⁴, Joanna Maciejewska⁴, Ajay Narasimhamurthy⁴, Marcin Morawski⁴, Andrzej Miszczuk⁴, Marek Basta⁴, Rico Gutzler¹
¹ ZSW, Stuttgart, Germany; ² HZB, Berlin, Germany; ³ INL, Braga, Portugal; ⁴ ROL, Poznań, Poland

2AO.2.5 A Comparison of the Environmental Impact of Integrated Flexible CIGS with Rigid CIGS and x-Si Modules

Mirjam Theelen¹, Lia de Simon², Mitchell Van der Hulst³, Diana Bizarro², Josco Kester⁴, Ando Kuypers¹, Mara Hauck²
¹ TNO partner in Solliance, Eindhoven, The Netherlands; ² TNO Circularity & Sustainability Impact, Utrecht, The Netherlands; ³ Radboud University, Nijmegen, The Netherlands; ⁴ TNO partner in Solliance, Petten, The Netherlands

ORAL PRESENTATIONS 1AO.5

15:15 - 16:45 Processes for Highly Efficient Si Solar Cells

Chairpersons: Dr. Francesca Menchini
ENEA, Rome, Italy
Dr. Marco Ernst
ANU, Canberra, Australia

1AO.5.1 Thermal Pre-treatment of as Cut Wafers for High Efficiency Silicon Heterojunction Solar Cells

Adrien Danel¹, Sebastiano Caccamo², Gustavo Rodrigues Lopes¹, Etienne Pihan¹, Mickael Albaric¹, Alessandro Fucile², Giulia Enrica Digeronimo², Bianca Passarella², Marcello Scuito², Cosimo Gerardi²
¹ CEA-INES, Le Bourget-du-Lac, France; ² ENEL, Catania, Italy

1AO.5.2 Wet-Chemically Grown Interfacial Oxide for Passivating Contacts Fabricated with an Industrial Inline Processing System

Byungsul Min¹, Philipp Noack², Bianca Wattenberg², Torsten Dippell², Henning Schulte-Huxel¹, Robby Peibst¹, Rolf Brendel¹
¹ ISFH, Emmerthal, Germany; ² Singulus Technologies, Kahl a. Main, Germany

1AO.5.3 Towards Leaner (Double Side) TOPCon Fabrication

Julien Hurni¹, Audrey Morisset¹, Ezgi Genç¹, Sofia Libraro¹, Christophe Allebé², Antoine Descoedres², Bertrand Paviet-Salomon², Franz-Josef Haug¹, Christophe Ballif¹
¹ EPFL, Neuchâtel, Switzerland; ² CSEM, Neuchâtel, Switzerland

1AO.5.4 Student Awards Finalist Presentation: Local p+ Poly-Si Passivating Contacts Realized by Direct FlexTrail Printing of Boron Ink and Selective Alkaline Etching for High Efficiency TOPCon Based Solar Cells

Berkay Uygun¹, Sven Kluska², Jana Isabelle Polzin², Jörg Schube², Katrin Krieg², Mike Jahn², Raşit Turan¹, Hisham Nasser¹
¹ ODTÜ-GÜNAM, Ankara, Türkiye; ² Fraunhofer ISE, Freiburg, Germany

1AO.5.5 Phosphorus- and Boron-Doped Poly-Si Passivating Contacts via Inkjet Printing

Jiali Wang¹, Sieu Pheng Phang¹, Thein N. Truong¹, Jinlei Ren², Marie Adier², Laura Creon², Paula Peres², Rene Chemnitzer², Pierre-Yves Corre², Zhuofeng Li¹, Hieu T. Nguyen¹, Daniel Macdonald¹, Josua Stuckelberger³
¹ Australian National University, Canberra, Australia; ² CAMECA, Gennevilliers, France; ³ LAPLACE Renewable Energy Technology, Shenzhen, China

1AO.5.6 Copper-based Metallization Approaches for Drastic Reduction of Silver Content in Heterojunction Solar Cells

Adeline Lanterne¹, Johann Jourdan¹, Agata Lachowicz², Laurie-Lou Senaud², Julien Diaz¹, Wilfried Favre¹
¹ CEA-INES, Le Bourget-du-Lac, France; ² CSEM, Neuchâtel, Switzerland



ORAL PRESENTATIONS 4AO.8

15:15 - 16:45 PV Plant Performance, Analysis, Monitoring and Fault Detection in Inverters

Chairpersons: Ms. Anna Heimsath
Fraunhofer ISE, Freiburg, Germany
Dr. Marios Theristis
Sandia National Laboratories, Albuquerque, United States of America

4AO.8.1 Uncertainty-Aware Estimation of Inverter Field Efficiency Using Bayesian Neural Networks in Solar Photovoltaic Plants

Gerardo Guerra¹, Pau Mercade Ruiz¹, Gaetana Anamiati¹, Lars Landberg²
¹ GreenPowerMonitor a DNV Company, Barcelona, Spain; ² DNV Denmark, Hellerup, Denmark

4AO.8.2 Analysis of Fault Detection and Defect Categorization in Photovoltaic Inverters for Enhanced Reliability and Efficiency in Large-scale Solar Energy Systems

Stephanie Malik¹, David Daßler¹, Dharm Patel¹, Carola Klute¹, Robert Klengel¹, Andreas Dietrich², Kai Kaufmann³, Carsten Hennig⁴, Leonard Kraft⁵, Matthias Ebert¹
¹ Fraunhofer IMWS, Halle (Saale), Germany; ² Deutsche Solarservice, Werder (Havel), Germany; ³ DENKweit, Halle (Saale), Germany; ⁴ saferay holding, Berlin, Germany; ⁵ Leipziger Energie, Leipzig, Germany

4AO.8.3 Anomaly Detection in Similarly Behaving Solar Inverters

Pau Mercade Ruiz¹, Gerardo Guerra¹, Gaetana Anamiati¹, Lars Landberg²
¹ GreenPowerMonitor, Barcelona, Spain; ² DNV Denmark, Copenhagen, Denmark

4AO.8.4 Loss Breakdown Analysis in PV Plants: Estimation of Curtailment Loss

Karel De Brabandere¹, Maitheli Nikam¹, Julien Deckx¹, Gofran Chowdhury¹
¹ 3E, Brussels, Belgium

4AO.8.5 Geospatial Referencing for Monitoring Data

Bernhard Kubicek¹, Evgenii Sovetkin², Marcus Rennhofer¹
¹ Austrian Institute of Technology, Vienna, Austria; ² IEK5-Photovoltaics, Guelich, Austria

4AO.8.6 Towards Higher Efficiency: Data Analysis and Optimization of PV String Wiring in a Long-Running Solar Power Plant

Žiga Miklič¹, Janez Krč¹, Marko Topič¹
¹ University of Ljubljana, Ljubljana, Slovenia

VISUAL PRESENTATIONS 3AV.2

15:15 - 16:45 PV Modules Reliability: Components, Failure Mechanisms, Testing & Modelling

Chairpersons: Dr. Ioannis (John) Tsanakas
CEA, Le Bourget-du-Lac, France
Dr. Guy Beaucarne
Dow Silicones Belgium, Seneffe, Belgium
Ms. Eve Krassowski
CE Cell Engineering, Kabelsketal, Germany

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 2AO.3

17:00 - 18:30 III-V Solar Cells & Space PV

Chairpersons: Dr. Gianluca Timò
RSE, Piacenza, Italy
Dr. Gerald Siefer
Fraunhofer ISE, Freiburg, Germany

2AO.3.1 Student Awards Finalist Presentation: Direct Growth of InGaP/GaAs/Si Triple-Junction Solar Cells with InAlGaAs Digital Alloy Filter Layers

Yeonhwa Kim¹, Hyunbeom Shin², Eunkyo Ju¹, May Angelu Madarang¹, Rafael Jumar Chu¹, Tsimafei Laryn¹, Taehee Kim¹, Younghyun Kim¹, Inho Kim¹, In-Hwan Lee³, Ho Kwan Kang², Won Jun Choi¹, Daehwan Jung¹
¹ KIST, Seoul, South Korea; ² KANC, Suwon, South Korea; ³ Korea University, Seoul, South Korea

2AO.3.2 Thermal Modeling of Triple-Junction Solar Cells Fan Out Wafer Level Packaging for Concentrated Photovoltaic

Konan Kouame¹, Abdul Rehman¹, Médéric Marcotte¹, Mylana Ney¹, Artur Turala¹, Mohamed Najah¹, Serge Ecoffey¹, Gwenaelle Hamon¹
¹ University of Sherbrooke, Sherbrooke, Canada

2AO.3.3 Overview for Tandem Solar Cell R&D Activities in Japan

Masafumi Yamaguchi¹, Tatsuya Takamoto², Kyotaro Nakamura¹, Ryo Ozaki¹, Hiroyuki Juso², Nobuaki Kojima¹, Yoshio Ohshita¹
¹ Toyota Technological Institute, Nagoya, Japan; ² Sharp Corporation, Nara, Japan

2AO.3.4 Towards a Robust Silicon PV Technology for Space

Romain Cariou¹, Nicolas Enjalbert¹, Clément Jamin¹, Océane Guillot¹, Adrien Danel¹, Samuel Harrison¹, Philippe Voarino¹, Jean-Baptiste Charpentier¹, Louis Perrotin¹, Thibaut Desrues¹, Vincent Barth¹, Romain Feilleux-Angineur¹, Sébastien Dubois¹
¹ CEA, Le Bourget-du-Lac, France

2AO.3.5 Space Applications for a Variety of Solar Cell Technologies

Stephen Taylor¹
¹ European Space Agency, Noordwijk, The Netherlands

2AO.3.6 Carrier Recombination in Ga-doped Silicon with Space Representative Electron Irradiations: Influence of the Material Composition

Océane Guillot¹, Romain Cariou¹, Nicolas Enjalbert¹, Adrien Danel¹, Corinne Aicardi², Sébastien Dubois¹
¹ CEA, Le Bourget du Lac, France; ² CNES, Toulouse, France



ORAL PRESENTATIONS 1AO.6

17:00 - 18:30 Highly Efficient Si Solar Cells

Chairpersons: Dr. Audrey Morisset
EPFL, Neuchâtel, Switzerland
Prof. Dr. Raşit Turan
METU, Ankara, Türkiye

1AO.6.2 Shedding a Light on UV-Induced Degradation of TOPCon Solar Cells

Muhammad Umair Khan¹, Chandany Sen¹, Michael Pollard¹, Yutong Wu², Ruirui Lv², Xinyuan Wu¹, Haoran Wang¹, Xutao Wang¹, Guangchun Zhang², Bram Hoex¹

¹ UNSW, Sydney, Australia; ² Canadian Solar, Jiangsu, China

1AO.6.3 Understanding the Electron Transport Mechanisms in MoOx-Based Layer Stack for Application in Simplified IBC-SHJ Solar Cells

Katarina Kovacevic¹, Yifeng Zhao¹, Paul Procel¹, Liqi Cao¹, Luana Mazzearella¹, Olindo Isabella¹

¹ TU Delft, Delft, The Netherlands

1AO.6.4 High Efficiency Solar Cells with Epitaxially Grown Silicon Wafers and TOPCon Passivating Contacts

Armin Richter¹, Clara Rittmann¹, Marion Drießen¹, Florian Schindler¹, Charlotte Weiss¹, Jan Benick¹, Stefan Janz¹

¹ Fraunhofer ISE, Freiburg, Germany

1AO.6.5 >24% Efficient Tunnel Back Contacted polyZEBRA Solar Cells

Jonathan Linke¹, Christoph Peter¹, Jan Hoß¹, Saman Sharbat Kalaghichi¹, Valentin Mihailetchi¹, Jan Lossen¹, Florian Buchholz¹

¹ ISC Konstanz, Konstanz, Germany

1AO.6.6 Optimized Ga-Doped Cz Wafers for POLO IBC Solar Cells with High Efficiency and Minimal LeTID Degradation

Thorsten Dullweber¹, Verena Mertens¹, Michael Winter¹, Sabrina Schimanke¹, Silke Dorn¹, Yevgeniya Larionova¹, Jan Schmidt¹, Rolf Brendel¹, Arne K. Dahle²

¹ ISFH, Emmerthal, Germany; ² NorSun, Årdalstangen, Norway

ORAL PRESENTATIONS 4AO.9

17:00 - 18:30 The Impact of Soiling on PV Systems

Chairpersons: Prof. João M. Almeida Serra
University of Lisbon, Lisbon, Portugal
Dr. Mari Øgaard
IFE, Kjeller, Norway

4AO.9.1 Modelling Performance and Maximum Allowed Costs for Anti-Soiling Coatings in Europe

Leonardo Micheli¹, Greg P. Smestad², Diego L. Talavera³

¹ Sapienza University of Rome, Rome, Italy; ² Sol Ideas Technology Development, San José, United States of America; ³ University of Jaén, Jaén, Spain

4AO.9.2 Mapping PV Soiling Losses in Europe through an Environmental-Based Model

Álvaro Fernández-Solas¹, Nicholas C. Riedel-Lyngskær², Fernanda Norde Santos¹, Mari Øgaard³, Jesús Polo⁴, Diego López Talavera⁵, Leonardo Micheli⁶

¹ DLR, Almería, Spain; ² European Energy, Søborg, Denmark; ³ Institute for Energy Technology, Kjeller, Norway; ⁴ CIEMAT, Madrid, Spain; ⁵ University of Jaén, Jaén, Spain; ⁶ Sapienza University of Rome, Rome, Italy

4AO.9.3 Qatar Dust Atlas Project: Deployment of a National Field Soiling and Environmental Parameters Monitoring Network

Brahim Aissa¹, Mohamed Abdelrahim², Mosab Kareem Subeh¹, Amir Abdallah¹, Benjamin Figgis¹, Juan Lopez Garcia¹, Veronica Bermudez Benito¹

¹ QEERI, Doha, Qatar; ² Bin Omran Trading & Telecommunications, Doha, Qatar

4AO.9.4 Quality Assurance from Laboratory to Field: Novel Test Solutions for Soiling-Prone PV Systems

Ioannis (John) Tsanakas¹, Rodrigo Moretón², Eric Pilat¹, Jorge Solórzano³, Jorge Veludo⁴, Kévin Garcia⁵

¹ CEA - INES, Le Bourget-du-Lac, France; ² QPV, Madrid, Spain; ³ Entec Solar, Madrid, Spain; ⁴ Galp Energia, Lisbon, Portugal; ⁵ CNR, Lyon, France

4AO.9.5 Cleaning of PV Through Rain: Experimental Study and Modelling Approaches

Fernanda Norde Santos¹, Elena Ruiz Donoso¹, Julie El Dik¹, Stefan Wilbert¹, Laura Campos Guzman¹, Natalie Hanrieder¹, Aránzazu Fernández García², Carmen Alonso García², Jesús Polo², Anne Forstinger³, Roman Affolter⁴, Robert Pitz-Paal⁵

¹ DLR, Almería, Spain; ² CIEMAT, Madrid, Spain; ³ CSP Services, Cologne, Germany; ⁴ CSP Services, Almería, Spain; ⁵ DLR, Cologne, Germany

4AO.9.6 Degradation Root-Cause Numerical Analysis of around 100 PV Modules Installed in Hot and Arid Desert Environment

Shahzada Pamir Aly¹, Kaushal Chapaner¹, Baloji Adothu¹, Jim Joseph John¹, Gerhard Mathiak¹, Vivian Alberts¹

¹ DEWA, Dubai, United Arab Emirates

VISUAL PRESENTATIONS 3AV.3

17:00 - 18:30 PV Modules Performance: Testing, Modelling Techniques and Outdoor Performance

Chairpersons: Ms. Gabi Friesen
SUPSI, Mendrisio, Switzerland
Mr. Jonathan Govaerts
imec, Genk, Belgium
Dr. Matevž Bokalič
University of Ljubljana, Ljubljana, Slovenia

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.



Tuesday, 24. September 2024

ORAL PRESENTATIONS 1BO.1

08:30 - 10:00 Silicon Bottom Cells for Tandem Photovoltaics | Dielectric Layer Related Defect Characterisation

Chairpersons: Prof. Dr. Giso Hahn
University of Konstanz, Konstanz, Germany
Prof. Dr. Stefan W. Glunz
Fraunhofer ISE, Freiburg, Germany

1BO.1.1 Towards TOPCon Based Bottom Cells: Current Challenges and Perspectives

Mario Hanser¹, Henning Nagel¹, Johannes Gry¹, Jana Polzin¹, Armin Richter¹, Jan Benick¹, Martin Bivour¹, Martin Hermle¹, Stefan Glunz¹
¹ Fraunhofer ISE, Freiburg, Germany

1BO.1.2 Thin Silicon Heterojunction Solar Cells in Perovskite Shadow: Bottom Cell Prospective

Ugochi Chime¹, Weiyuan Duan¹, Andreas Lambert¹, Karsten Bittkau¹, Volker Lauterbach¹, Kaining Ding¹, Uwe Rau¹, Tsevetelina Merdzhanova¹, Olexandr Astakhov¹
¹ FZJ, Jülich, Germany

1BO.1.3 Review on In-Free Recombination Junction Approaches for Two-Terminal Silicon / Perovskite Tandem Solar Cells

Pia Vasquez¹, Perrine Carroy¹, Batiste Marteau¹, Thibaut Desrues¹, Nathalie Nguyen¹, Muriel Matheron¹, Sofia Chozas², Federico Ventosinos², Henk J. Bolink², Delfina Muñoz¹, Amanda Merino Leiva¹
¹ CEA-INES, Le Bourget du Lac, France; ² University of Valencia, Valencia, Spain

1BO.1.4 Student Awards Finalist Presentation: Understanding Interface States in TiOx/Si Heterostructure by Analysing Temperature Dependence of Effective Carrier Lifetime

Yuto Michishita¹, Kazuhiro Gotoh², Shohei Fukaya¹, Yasuyoshi Kurokawa¹, Noritaka Usami¹
¹ Nagoya University, Nagoya, Japan; ² Niigata University, Niigata, Japan

1BO.1.5 Three Dimensional DLTS Analysis on Defects in Si Crystal Induced by a-Si Deposition

Yoshio Ohshita¹, Subhash Chand Yadav¹, Tomohiko Hara²
¹ Toyota Technological Institute, Nagoya, Japan; ² Ritsumeikan University, Kusatsu, Japan

1BO.1.6 Development and Characterization of N2O-plasma Oxide Layers for High-Temperature Passivating Contacts

Sofia Libraro¹, Lars Bannenberg², Theodosios Famprikis², David Reyes³, Julien Hurni¹, Christophe Ballif¹, Aicha Hessler-Wyser¹, Franz-Josef Haug¹, Audrey Morisset¹
¹ EPFL, Neuchâtel, Switzerland; ² TU Delft, Delft, The Netherlands; ³ EPFL, Lausanne, Switzerland

ORAL PRESENTATIONS 4BO.6

08:30 - 10:00 Performance and Degradation of PV Systems

Chairpersons: Ms. Sandra Gallmetzer
Eurac Research, Bolzano, Italy
Dr. Joshua S. Stein
Sandia National Laboratories, Albuquerque, United States of America

4BO.6.1 Student Awards Finalist Presentation: Estimating Photovoltaic System Degradation Using Limited Data

Anastasios Kladas¹, Ruben Menu¹, Bert Herteleer¹, Jan Cappelle¹
¹ KU Leuven, Leuven, Belgium

4BO.6.2 30+ Years of Operation – A Comprehensive Review of the Long-Term Performance of the Mont-Soleil PV System and its Peers

Hugo Quest¹, Christof Bucher², Matthias Burri², Christophe Ballif³, Alessandro Virtuani⁴
¹ 3S Swiss Solar Solutions, Thun, Switzerland; ² BFH, Burgdorf, Switzerland; ³ EPFL, Neuchâtel, Switzerland; ⁴ CSEM, Neuchâtel, Switzerland

4BO.6.3 High-Precision Thermal Modelling of Ground-Mounted PV and Implications for Degradation

Phillip Hamer¹, Moonyong Kim¹, Jack Petrapsch², Mattias Juhl², Bram Hoex¹
¹ UNSW, Sydney, Australia; ² 5B Solar, Mascot, Australia

4BO.6.4 Trend-Based Predictive Maintenance and Fault Detection Analytics for Photovoltaic Power Plants

Demetris Marangis¹, Panayiotis Michaelides¹, Andreas Livera¹, George Makrides¹, George E. Georgiou¹
¹ University of Cyprus, Nicosia, Cyprus

4BO.6.5 Utilizing Machine Learning for PV Climate Classification

Francisco Javier Triana de las Heras¹, Olindo Isabella¹, Malte Ruben Vogt¹
¹ TU Delft, Delft, The Netherlands

4BO.6.6 PV Module Operating Temperature: Reliable Extraction of Parameters from Dynamic Field Data

Anton Driesse¹, Jesus Polo²
¹ PV Performance Labs, Freiburg, Germany; ² CIEMAT, Madrid, Spain

ORAL PRESENTATIONS 3BO.11

08:30 - 10:00 Reliability of PV Modules: The Impact of Solar Cell Technology

Chairpersons: Ms. Eve Krassowski
CE Cell Engineering, Kabelsketal, Germany
Dr. Christian Thiel
European Commission JRC, Ispra, Italy

3BO.11.1 Special Introductory Presentation: Reliability of Commercial TOPCon PV Modules – An Extensive Comparative Study

Paul Gebhardt¹, Jochen Markert¹, Ulli Kräling¹, Esther Fokuhl¹, Ingrid Haedrich¹, Daniel Philipp¹
¹ Fraunhofer ISE, Freiburg, Germany



3BO.11.2 Assessing Soldering Flux-Induced Corrosion on TOPCon Solar Cell

Jiexi Fu¹, Chandany Sen¹, Haoran Wang¹, Muhammad Umair Khan¹,
Yutong Wu², Hao Song², Ruirui Lv², Bram Hoex¹

¹ UNSW, Sydney, Australia; ² CSI Solar, Jiangsu, China

3BO.11.3 Mitigation Strategies of Moisture-Induced Degradation in Silicon Heterojunction Solar Modules

Lucie Pirot-Berson¹, Romain Couderc¹, Romain Bodeux², Frédéric Jay¹,
Julien Dupuis³

¹ CEA-INES, Le Bourget Du Lac, France; ² EDF R&D-IPVF, Palaiseau, France; ³ EDF
R&D, Moret Loing et Orvanne, France

3BO.11.4 Investigation of Potential-induced Degradation and Recovery in Perovskite Minimodules

Junchuan Zhang¹, Haodong Wu¹, Yi Zhang², Fangfang Cao¹, Zhiheng
Qiu¹, Minghui Li¹, Xiting Lang¹, Yongjie Jiang¹, Yangyang Gou¹, Xirui Liu¹,
Abdullah M. Asiri³, Paul J. Dyson², Mohammad Khaja Nazeeruddin²,
Jichun Ye¹, Chuanxiao Xiao¹

¹ CAS, Ningbo, China; ² EPFL, Lausanne, Switzerland; ³ CEAMR, Jeddah, Saudi Arabia

3BO.11.5 Partial Shading Degradation Mapping in Monolithically Integrated Perovskite Modules

Klaas Bakker¹, Remi Aninat¹, Jonathan Henzel¹, Ilker Dogan¹, Valerio
Zardetto¹, Sjoerd Veenstra¹, Mirjam Theelen¹

¹ TNO, Eindhoven, The Netherlands

ORAL PRESENTATIONS 4BO.16

08:30 - 10:00 Technology, Performance and Economics of PV in/on Buildings

Chairpersons: Dr. Simon Boddaert
CSTB, Sophia Antipolis, France
Dr. Xu Zhihao
AIST, Tsukuba, Japan

4BO.16.1 A Systematic Approach for the Integration of BIPV Planning into the Construction Value Chain

Frank Ensslen¹, Mona Mühlich¹, Jan-Bleicke Eggers¹, Bruno Bueno¹

¹ Fraunhofer ISE, Freiburg, Germany

4BO.16.2 Boosting the Performance of Semi-Transparent PV Windows

Simona Villa¹, David Out¹, Nicolas Guillemin², Marcel Ribberink³, Roland
Valckenborg¹

¹ TNO, Eindhoven, The Netherlands; ² TNO, Petten, The Netherlands; ³ Pilkington,
Enschede, The Netherlands

4BO.16.3 Cost-Effective Energy Transition: Rooftop PV in European Union Buildings

Carmen Maduta¹, Delia D'Agostino¹, Sofia Tsemekidi-Tzeiranaki², Luca
Castellazzi¹

¹ European Commission JRC, Ispra, Italy; ² Network Research Belgium, Herstal, Belgium

4BO.16.4 Integrated Agri-BIPV Facade System: A Holistic Approach for Sustainable Built Environments

Dilara Güney¹, Talat Özden¹, İpek Gürsel Dino¹

¹ METU, Ankara, Türkiye

4BO.16.5 Dynamic BIPV Shading Systems: Performance Analysis for High TRL Validation and Market Transfer

Tian Shen Liang¹, Paolo Corti¹, Pierluigi Bonomo¹, Francesco Frontini¹

¹ SUPSI, Mendrisio, Switzerland

4BO.16.6 Study on Improvement of Power Generation for a Window by Solar Radiation Reflected from the Low-E Coating of a Semi Transparent Photovoltaic Module that is Equally Arranged Linear Double-Sided Solar Cells

Kazuhiko Umeda¹, Nobusato Kobayashi¹, Akira Yamaguchi¹, Akihiko
Nakajima², Kengo Maeda², Akihiro Kuraoka², Naoki Kadota²

¹ TAISEI, Tokyo, Japan; ² KANEKA, Tokyo, Japan

VISUAL PRESENTATIONS 2BV.1

08:30 - 10:00 Advances in Novel Materials, Devices and Concepts | New Modelling and Characterisation Techniques

Chairpersons: Prof. Antonio Martí Vega
UPM, Madrid, Spain
Dr. Theresa Magorian Friedlmeier
ZSW, Stuttgart, Germany

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 1BO.2

10:30 - 12:00 Advanced Silicon Solar Cell Characterisation in Laboratory and Production

Chairpersons: Dr. Karsten Bothe
ISFH, Emmerthal, Germany
Dr. Ronald Sinton
Sinton Instruments, Boulder, United States of America

1BO.2.1 Identification of Performance-relevant Optically Detected Defects by Correlative Data Analysis Approaches in Solar Cell Production

Manuel Meusel¹, Marko Turek¹

¹ Fraunhofer CSP, Halle (Saale), Germany

1BO.2.2 Analysis of Electroluminescence Data Imaging Using Physical Models and Machine Learning

Erell Laot¹, Jean-François Guillemoles², Daniel Ory¹, Jean-Baptiste Puel¹

¹ EDF R&D, Palaiseau, France; ² IPVF, Palaiseau, France

1BO.2.3 Integrated Inline Characterization Techniques for Improved Silicon Heterojunction Solar Cell Production

Christian Diestel¹, Saravana Kumar¹, Jonas Haunschild¹, Sebastian
Pingel¹, Stefan Rein¹

¹ Fraunhofer ISE, Freiburg, Germany

1BO.2.4 Contactless Quantitative Imaging of Series Resistance of Solar Cells

Yan Zhu¹, Thorsten Trupke¹, Ziv Hameiri¹

¹ UNSW, Sydney, Australia



1BO.2.5 Expert Knowledge, AI, and Simulation: Integrative Approaches for Quality Assurance in Solar Cell Manufacturing

Matthias Demant¹, Alexandra Woernhoer¹, Philipp Kunze¹, Wilkin Woehler¹, Leslie Kurumundayil¹, Johannes Greulich¹, Andreas Fell¹, Stefan Rein¹

¹ Fraunhofer ISE, Freiburg, Germany

ORAL PRESENTATIONS 4BO.7

10:30 - 12:00 Data Driven Field Inspection based on Imaging

Chairpersons: Dr. Gisele A. dos Reis Benatto
Technical University of Denmark, Roskilde, Denmark
Mr. Roland Einhaus
ZSW, Stuttgart, Germany

4BO.7.1 From Pixels to Insights: A Software Prototype for AI-Driven Complete Diagnostics of PV Plants

Ioannis (John) Tsanakas¹, Murielle Stepec¹, Duy-Long Ha¹, Rodrigo Moretón², Jorge Veludo³

¹ CEA - INES, Le Bourget du Lac, France; ² QPV, Madrid, Spain; ³ Galp Energia, Lisbon, Portugal

4BO.7.2 Quantitative Assessment of Solar Module Degradation from Daylight Photoluminescence Imaging

Oliver Kunz¹, Juergen W. Weber¹, Hugh Gottlieb¹, Alexander Slade¹, Ouyang Zi¹, Thorsten Trupke¹

¹ UNSW, Sydney, Australia

4BO.7.3 Redefining Failure Detection in PV Systems: A Comparative Study of GPT-4V(ision) and ResNet's Computer Vision in Aerial Infrared Imagery Analysis

Sandra Gallmetzer¹, Mousa Sondoqah¹, Lukas Koester¹, Atse Louwen¹, David Moser¹

¹ EURAC, Bolzano, Italy

4BO.7.4 Evaluation of Field Measurements on Hail Damage to Photovoltaic Modules

Evelyn Bamberger¹, Alexandre Voirol¹

¹ OST, Rapperswil, Switzerland

4BO.7.5 Evaluation of Daylight Filters for Electroluminescence Imaging of PV Modules Using Artificial Light as Controlled Image Noise

Gisele Alves dos Reis Benatto¹, Rodrigo Del Prado Santamaria¹, Thøger Kari¹, Liviu Stoicescu², Sergiu V. Spataru¹

¹ DTU, Roskilde, Denmark; ² Solarzentrum Stuttgart, Stuttgart, Germany

4BO.7.6 Enhancing UV-Fluorescence Imagery Analysis: Lessons from Extensive PV Module Inspection in Multi-MWp PV Power Stations

Claudia Buerhop-Lutz¹, Oleksandr Stroyuk¹, Oleksandr Mashkov¹, Jens Hauch¹, Marius Peters¹

¹ HI ERN, Erlangen, Germany

ORAL PRESENTATIONS 3BO.12

10:30 - 12:00 Reliability of PV Modules: The Impact of Polymers

Chairpersons: Dr. Matthieu Despeisse
CSEM, Neuchâtel, Switzerland
Dr. Guy Beaucarne
Dow Silicones Belgium, Seneffe, Belgium

3BO.12.1 Crosslinking Behavior of Ethylene Vinyl Acetate Copolymer Encapsulants in Dependence of the Additive Composition

Michael Wendt¹, Robert Heidrich¹, Patrick Wessel¹, Ralph Gottschalg¹, Anton Mordvinkin¹

¹ Fraunhofer CSP, Halle, Germany

3BO.12.2 Performance and Reliability of PV Modules Made with Novel Co-Extruded Encapsulant Containing UV Down-Shifting Compound

Maxime Babics¹, Romain Soulas¹, Marion Serasset¹, Timea Bejat¹, Amandine Boulanger¹, Vincent Barth¹, Eszter Voroshazi¹, Gabriele Bianca², Sebastiano Caccamo², Alessandro Fucile², Antonino Ragonesi², Cosimo Gerardi²

¹ CEA-INES, Le Bourget-du-Lac, France; ² 3SUN, Catania, Italy

3BO.12.3 How Does the Material Combination of Encapsulant and Rear Side Cover Influence the Degradation Behavior of Solar Modules?

Robert Heidrich¹, Patrick Wessel¹, Bengt Jäkel¹, Anton Mordvinkin¹, Marko Jankovec², Marko Topič², Ralph Gottschalg¹

¹ Fraunhofer CSP, Halle, Germany; ² University of Ljubljana, Ljubljana, Slovenia

3BO.12.4 Recent Developments in PV Module Backsheets - What Do We Really Know About Them?

Gernot Oreski¹, Chiara Barretta¹, Karl-Anders Weiß²

¹ PCCL, Leoben, Austria; ² Fraunhofer ISE, Freiburg, Germany

3BO.12.5 Evaluation of Degradation and Cracking Propensity of Emerging PV Backsheets after Accelerated Laboratory Weathering

Xiaohong Gu¹, Karissa Jensen¹, Stefan Mitterhofer¹, Ashlee Aiello¹, Hsin-Hsin Hsieh², Anabel Kadri³, Christopher Jin⁴, Joseph Moses⁵, Chiara Barretta⁶, Gernot Oreski⁶, Liang Ji⁷

¹ NIST, Gaithersburg, United States of America; ² ITRI, Hsinchu, Taiwan; ³ Tulane University, New Orleans, United States of America; ⁴ Montgomery Blair High School, Silver Spring, United States of America; ⁵ Morgan State University, Baltimore, United States of America; ⁶ PCCL, Leoben, Austria; ⁷ UL Solutions, Northbrook, United States of America

3BO.12.6 Damp Heat Stability of Lightweight Silicon Heterojunction Solar Modules with Various Encapsulation Materials and Architectures

Kai Zhang¹, Andreas Lambertz¹, Karsten Bittkau¹, Kaining Ding¹, Uwe Rau¹

¹ Forschungszentrum Jülich, Jülich, Germany



ORAL PRESENTATIONS 4BO.17

10:30 - 12:00 Characterisation, Reliability and Safety of PV in/on Buildings

Chairpersons: Ms. Simona Villa
TNO, Eindhoven, The Netherlands
Prof. Dr. Francesco Frontini
SUPSI, Mendrisio, Switzerland

4BO.17.1 Optimizing Urban Photovoltaic Systems: Small-Area High-Voltage Modules Assisted with Bypass-Diode

Luthfan Fauzan¹, Yeon Hyang Sim², Min Ju Yun², Hyek Young Choi², Dong Yoon Lee², Seung I. Cha³
¹ University of Science and Technology & Korea Electrotechnology Research Institute, Changwon, South Korea; ² Korea Electrotechnology Research Institute, Changwon, South Korea; ³ University of Science and Technology, Changwon, South Korea

4BO.17.2 Mechanically Robust and Environmentally Stable Novel Lightweight PV Modules for Building Integration Based on Polymeric Honeycomb

Umang Desai¹, Jonathan Govaerts², Bin Luo², Yuliya Voronko³, Gabriele Eder³, Jarne Saelens⁴, Wouter Winant⁴, Nikolina Pervan⁵, Gernot Oreski⁵, Antonin Faes⁶, Christophe Ballif⁶
¹ EPFL, Neuchatel, Switzerland; ² imec, Genk, Belgium; ³ OFI, Vienna, Austria; ⁴ Econcore, Leuven, Belgium; ⁵ PCCL, Leoben, Austria; ⁶ EPFL, CSEM, Neuchatel, Switzerland

4BO.17.3 Experimental Investigation of the Temperature Distribution in a BIPV Facade

Nanna Lysgaard Andersen¹, Markus Babin¹, Sune Thorsteinsson¹
¹ DTU Fotonik, Roskilde, Denmark

4BO.17.4 One Year of PV Related Fires: Analysis

Lenneke H. Slooff¹, Martina Duyvis², Roy Weghorst³, Marc Mergeay³
¹ TNO Energy Transition, Petten, The Netherlands; ² NIPV, Arnhem, The Netherlands; ³ NEN, Delft, The Netherlands

4BO.17.5 Bending of Building-Integrated PV (BIPV) Modules Based on Aluminum under Changing Temperature Conditions

Kevin Meyer¹, Wiebke Wirtz¹, Susanne Blankemeyer¹, Danny Lorenz², Fynn Klopp², Henning Schulte-Huxel¹
¹ ISFH, Emmerthal, Germany; ² MN Metall, Neustadt, Germany

4BO.17.6 Rooftop PV Potential Using a Digital Building Stock Model

Georgia Kakoulaki¹, Ana Martinez¹, Nigel Taylor¹, Szabo Sandor¹, Robert Kenny¹
¹ European Commission JRC, Ispra, Italy

VISUAL PRESENTATIONS 2BV.2

10:30 - 12:00 Compound and Organic Semiconductors

Chairpersons: Dr. Marika Edoff
Uppsala University, Uppsala, Sweden
Dr. Stephen Taylor
European Space Agency, Noordwijk, The Netherlands
Dr. Gerald Siefer
Fraunhofer ISE, Freiburg, Germany

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 1BO.3

13:30 - 15:00 Optimised Processes for the Manufacturing of TOPCon Solar Cells

Chairpersons: Dr. Elise Bruhat
HOLOSOLIS, Paris, France
Dr. Qi Wang
YIST, Jiangyin/Wuxi, China

1BO.3.1 Exploring the Impact and Challenges of Using Emerging Wafer Sizes in PV Manufacturing

Julian Reichle¹, Hardik Gohil¹, Avinash Kumar¹, Mehul Raval¹, Wolfgang Jooß¹, Peter Fath¹
¹ RCT Solutions, Konstanz, Germany

1BO.3.2 A Horizontal Double-Sided Copper Plating Technology Designed for Solar Cell Mass-Production

Lu Wang¹, Yusen Qin¹, Xiang Wang², Yibo Lu¹, Wenping Xu², Chengming Song², Meilin Peng³, Meixian Huang³, Jinning Li², Guohua Zhou¹, Jingjia Ji¹
¹ Jiangsu Xianghuan Technology, Wuxi, China; ² Shenzhen Mingchuang Intelligent Equipment, Shenzhen, China; ³ Jiangnan University, Wuxi, China

1BO.3.3 Comprehensive Analysis and Process Optimization for Wet-Chemical Alkaline Edge Isolation for Industrial TOPCon Solar Cells

Tobias Dannenberg¹, Jan Vollmer¹, Philipp Schmid¹, Katrin Krieg², Mert Isik², Martin Zimmer², Damian Brunner¹
¹ RENA, Freiburg, Germany; ² Fraunhofer ISE, Freiburg, Germany

1BO.3.4 High-Throughput Inline PVD- Tunnel-Oxide Layers for High Efficiency i-TOPCon Solar Cells

Eric Schneiderlöchner¹, Tina Dietsch¹, Henning Nagel², Winfried Wolke², Jana-Isabelle Polzin², Sebastian Mack², Volker Linß¹
¹ VON ARDENNE, Dresden, Germany; ² Fraunhofer ISE, Freiburg, Germany

1BO.3.5 Student Awards Finalist Presentation: Laser-Assisted Firing in High Volume Production: A Game Changer for Industrial TOPCon Solar Cells

Xutao Wang¹, Jing Yuan², Xinyuan Wu¹, Jianjun Nie², Yanyan Zhang², Xiaoyan Zhang², Weiguang Yang², Bram Hoex¹
¹ UNSW, Sydney, Australia; ² Jolywood (Taizhou) Solar Technology, Taizhou, China



1BO.3.6 Comprehensive Optimization of Glass Stencil Printing, Demonstrating Ultrafine Metal Fingers Below 10 µm

Tadeo Schweigstill¹, Niko Mielich¹, Aaron Vogt², Malte Schulz-Ruhtenberg², Jonas D. Huyeng¹, Florian Clement¹

¹ Fraunhofer ISE, Freiburg, Germany; ² LPKF Laser & Electronics, Garbsen, Germany

ORAL PRESENTATIONS 2BO.8

13:30 - 15:00 Novel PV Material and Conversion Concepts

Chairpersons: Prof. Dr. Marin Rusu
HZB, Berlin, Germany
Prof. Dr. Jozef (Jef) Poortmans
imec, Leuven, Belgium

2BO.8.1 Pathways for Silicon Solar Cells with Molecular Singlet Fission

Phoebe Pearce¹, Nicholas Ekins-Daukes¹

¹ UNSW, Sydney, Australia

2BO.8.2 Control of Hot Carrier Thermalization Rates in Nanowires for Advanced-Concept Photovoltaic Solar Cells

Hamidreza Esmailpour¹, Nabi Isaev¹, Imam Makhfudz², Markus Döblinger³, Jonathan Finley¹, Gregor Koblmüller¹

¹ TUM, Munich, Germany; ² Aix-Marseille University, Marseille, France; ³ LMU, Munich, Germany

2BO.8.3 Enhancing Triplet Transfer in Singlet Fission Solar Cells Through Optimising Band Alignment

Shona McNab¹, Alex J. Baldacchino¹, Alfie Jones¹, Alvin Mo¹, Alison Ciesla¹, Bram Hoex¹, Murad J. Y. Tayebjee¹, Michael P. Nielsen¹

¹ UNSW, Sydney, Australia

2BO.8.4 Harvesting the Sun 24 Hours a Day: A Hybrid Photovoltaic-Thermoradiative System

Iñigo Ramiro¹, Antonio Martí¹

¹ IES-UPM, Madrid, Spain

2BO.8.5 Design and Prototyping of Spectrum-Split-Type Concentrating Photovoltaic-Thermoelectric Hybrid Power Generator

Kenji Kamide¹, Ryoji Funahashi¹, Tomoyuki Urata¹, Yoko Matsumura¹, Jun Sakuma², Hidefumi Akiyama², Katsuto Tanahashi¹

¹ AIST, Tsukuba, Japan; ² University of Tokyo, Kashiwa, Japan

2BO.8.6 Hybrid Quantum/Thermionic Solar Converters

Christiana Honsberg¹, Stuart Bowden², Ian Sellers³, Stephen Goodnick¹

¹ Arizona State University, Tempe, United States of America; ² Solestial Solar, Tempe, United States of America; ³ University of Buffalo, Buffalo, United States of America

VISUAL PRESENTATIONS 4BV.3

13:30 - 15:00 Operation, Performance and Maintenance of PV Systems

Chairpersons: Mr. Gerhard Mütter
Gerhard Mütter e.U., Waldneukirchen, Austria
Dr. Joshua S. Stein
Sandia National Laboratories, Albuquerque, United States of America
Mr. Roland Einhaus
ZSW, Stuttgart, Germany

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

PANEL DISCUSSION

13:30 - 15:00 BO.13: Stable Perovskite Tandems: Hype or Hope?

Moderators: Dr. Veronica Bermudez Benito
QEERI, Doha, Qatar
Prof. Dr. Jan Christoph Goldschmidt
Philipps University of Marburg, Marburg, Germany

Join us for an insightful session as we delve into the pressing challenges surrounding the long-term stability of Tandem Perovskites and the implications of introducing new technologies into the market. The session will explore the current hype surrounding Tandem devices and Perovskites, while critically examining the timeframes required for scientific advancements to address key challenges and validate these technologies for commercial viability. Our discussion will encompass crucial aspects such as long-term reliability, scalability, bankability, standardization in testing, and the obstacles faced in transitioning from laboratory innovation to mass production. Furthermore, gain valuable insights into the strategies adopted by major silicon PV manufacturers in navigating this evolving landscape. Don't miss this opportunity to gain a comprehensive understanding of the complexities and opportunities at the intersection of technological innovation and market readiness

- 1 Panelist - Carolin Ulbrich, HZB, Germany
- 2 Panelist - Chris Case, Oxford PV, United Kingdom
- 3 Panelist - Xinyu Zhang, Jinko, China
- 4 Panelist - Ivan Gordon, imec, EERA, Belgium
- 5 Panelist - Peter Fath, RCT Solutions, Germany



ORAL PRESENTATIONS 1BO.4

15:15 - 16:45 New Concepts for the Manufacturing of IBC and HJT Solar Cells

Chairpersons: Dr. Adrien Danel
CEA, Le Bourget-du-Lac, France
Dr. Marina Foti
3Sun, Catania, Italy

1BO.4.1 Project “BUSSARD” – A Holistic Development of High-Efficiency Solar Cells Covering Innovative Front-End, Metallization and Interconnection Approaches

Andreas Lorenz¹, Jörg Schube¹, Veronika Nikitina¹, Markus Klawitter¹, Mike Jahn¹, Michael Linse¹, Sebastian Schweigert¹, Sebastian Mack¹, Jürg Schleuniger², Isabell Kegel², Stephane Toguem Fokoua², Oliver Mürdter-Feger³, Michael Mäser³, Lutz Engisch³, Ayala Kabla⁴, Doron Gurevich⁴, Fernando De La Vega⁴, Jonas Buddgard⁵, Maximilian Pospischil⁶, Markus Rinio⁷, Achim Kraft¹, Andreas Wolf¹, Martin Hermle¹, Florian Clement¹
¹ Fraunhofer ISE, Freiburg, Germany; ² Continental, Freiburg, Germany; ³ SWG, Frankenberg, Germany; ⁴ PV NanoCell, Migdal Ha'Emek, Israel; ⁵ Sticky Solar Power, Lidingö, Sweden; ⁶ Highline Technology, Freiburg, Germany; ⁷ Karlstad University, Karlstad, Sweden

1BO.4.2 Absent of Humidity: How Soldering Flux Caused Severe Corrosion-Induced Failure in Silicon HJT Compared to TOPCon Solar Cells

Haoran Wang¹, Chandany Sen¹, Xinyuan Wu¹, Jiexi Fu¹, Xutao Wang¹, Muhammad Umair Khan¹, Yutong Wu², Hao Song², Ruirui Lv², Bram Hoex¹
¹ UNSW, Sydney, Australia; ² CSI Solar, Jiangsu, China

1BO.4.3 IBC4EU: First Results of Industrialization of Low Cost, High Efficiency IBC Technology

Florian Buchholz¹, Daniel Tune¹, Tobias Messmer¹, Jonathan Linke¹, Manjunath Prasad¹, Juras Ulbikas², Arne Dahle³, Martijn Meereboer⁴, Francesca Fabris⁵, Erik Eikelboom⁵, Tom Borgers⁶, Rik Van Dyk⁶, Hariharsudan Sivaramakrishnan⁶, Samuel Harrison⁷, Josco Kester⁸, Jan Kroon⁸, Verena Mertens⁹, Thorsten Dullweber⁹, Ofer Shochet¹⁰, Isaac Rosen¹⁰, Ingo Röver¹¹, Wolfram Palitzsch¹¹, Yasmin Zaror¹², Johannes Stierstorfer¹², Aurimas Radzevicius¹³, Povilas Lukinskas¹³, Julius Denafas¹³, Tuomas Vanhanen¹⁴, Tuukka Savisalo¹⁴, Maximilian Pospischil¹⁵, Marian Breitenbücher¹⁵, Özlem Coşkun¹⁶, Melodie de I'epine¹⁷, Philippe Macé¹⁷
¹ ISC Konstanz, Konstanz, Germany; ² ProTechnologies, Vilnius, Lithuania; ³ Norsun, Årdalstangen, Norway; ⁴ Energyra, Westknollendam, The Netherlands; ⁵ Futurasun, Citadella, Italy; ⁶ imec, Genk, Belgium; ⁷ CEA INES, Le Bourget-du-Lac, France; ⁸ TNO, Amsterdam, The Netherlands; ⁹ ISFH, Hamelin, Germany; ¹⁰ Copprint, Jerusalem, Israel; ¹¹ LuxChemTech, Freiberg, Germany; ¹² WIP Renewable Energies, Munich, Germany; ¹³ Valoe Cells, Vilnius, Lithuania; ¹⁴ Valoe, Mikkeli, Finland; ¹⁵ Highline, Freiburg, Germany; ¹⁶ Kalyon PV, Ankara, Türkiye; ¹⁷ Becquerel Institute, Brussels, Belgium

1BO.4.4 Self-Aligned Phase Separation for IBC Cells Using PVD Polysilicon

Erik Hoffmann¹, Geoffrey Gregory¹, Massimo Centazzo¹, Muhammad Khan¹, Nabeel Khan¹, Verena Mertens², Sarah Spätlich², Ulrike Baumann², Thorsten Dullweber²

¹ EnPV, Karlsruhe, Germany; ² ISFH, Hamelin, Germany

1BO.4.5 Gas Phase, Selective Etching of Poly-Silicon for Layer Patterning

Laurent Clochard¹
¹ Nines Photovoltaics, Dublin, Ireland

1BO.4.6 Investigation of Ag-Reduction on Silicon Heterojunction Solar Cells (HJT) with Different Approaches

Yu Wu¹, Eric Kossen¹, Astrid Gutjahr¹, L.J.(Bart) Geerligs¹
¹ TNO, Petten, The Netherlands

ORAL PRESENTATIONS 2BO.9

15:15 - 16:45 Advanced Materials for PV Devices

Chairpersons: Dr. Phoebe Pearce
UNSW Sydney, Kensington, Australia
Dr. Iñigo Ramiro
UPM, Madrid, Spain

2BO.9.1 Sequential Growth of Wafer-Scale WSe₂ for Photovoltaic Applications

Katie M. Neilson¹, Sarallah Hamtaei², Koosha Nassiri Nazif¹, Joshua M. Carr³, Sepideh Rahimisheikh⁴, Frederick U. Nitta¹, Guy Brammertz², Jeffrey L. Blackburn⁵, Joke Hadermann⁴, Krishna C. Saraswat¹, Obadiah G. Reid⁵, Bart Vermang², Alwin Daus¹, Eric Pop¹
¹ Stanford University, Stanford, United States of America; ² Hasselt University/Imo-Imomec, Genk, Belgium; ³ Colorado University, Boulder, United States of America; ⁴ Antwerp University, Antwerp, Belgium; ⁵ NREL, Golden, United States of America

2BO.9.2 Single-Layer Carbon Nitride as an Efficient Metal-Free Organic Electron-Transport Material with a Tunable Work Function

Abdus Saboor¹, Oleksandr Stroyuk², Oleksandra Raievska², Chao Liu³, Jens Hauch², Christoph J. Brabec¹
¹ University of Erlangen–Nuremberg / HI-ERN, Erlangen, Germany; ² HI-ERN, Erlangen, Germany; ³ University of Erlangen–Nuremberg, Erlangen, Germany

2BO.9.3 Polymer-Based Electron Selective Contact for Crystalline Silicon Solar Cells

Thomas Tom¹, Eloi Ros², David Rovira², José Miguel Asensi¹, Regina Galceran¹, Pablo Ortega², Joaquim Puigdollers², Cristóbal Voz², Joan Bertomeu¹, Julian López-Vidrier¹
¹ University of Barcelona, Barcelona, Spain; ² UPC, Barcelona, Spain

2BO.9.4 Bandgap Engineering for High Efficiency Kesterite Thin Film Solar Cells

Jacob Andrade-Arvizu¹, Pedro Vidal-Fuentes¹, Robert Fonoll¹, Maxim Guc¹, Claudia Malerba², Maykel Courel³, Alejandro Pérez-Rodríguez¹, Victor Izquierdo-Roca¹
¹ IREC, Barcelona, Spain; ² ENEA, Rome, Italy; ³ CUValles, Jalsco, Mexico

2BO.9.5 Phosphorus-Doped Nanocrystalline Silicon as Electron Selective Contact for Germanium Thermophotovoltaic Cell

Mansur Gamel¹, Gema Lopez¹, Moisés Garín², Isidro Martín¹
¹ Technical University of Catalonia, Barcelona, Spain; ² UVIC-UCC, Barcelona, Spain



2BO.9.6 Atomic Layer Deposition of ZnO_(1-x)S_(x) Absorbers for Wide Bandgap UV-Selective Transparent PV Devices for BIPV Applications

Gustavo Álvarez¹, Victoria Rotaru¹, Jose Miguel Asensi², Pedro Vidal-Fuentes¹, Lorenzo Calvo-Barrio³, Maxim Guc¹, Cristobal Voz⁴, Alex J. Lopez-Garcia¹, Joaquim Puigdollers⁴, Victor Izquierdo-Roca¹, Alejandro Pérez-Rodríguez¹

¹ IREC, Barcelona, Spain; ² University of Barcelona, Barcelona, Spain; ³ CCiTUB, Barcelona, Spain; ⁴ UPC, Barcelona, Spain

ORAL PRESENTATIONS 3BO.14

15:15 - 16:45 Failure Modes and Degradation Mechanisms in PV Modules

Chairpersons: Prof. Ralph Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
Dr. Chiara Barretta
PCCL, Leoben, Austria

3BO.14.1 Damp-Heat Module Reliability: Three New Failure Modes in TOPCon That Are Absent in PERC

Chandany Sen¹, Haoran Wang¹, Muhammad Umair Khan¹, Jiexi Fu¹, Xinyuan Wu¹, Xutao Wang¹, Bram Hoex¹

¹ UNSW, Sydney, Australia

3BO.14.2 Analyses of Glass Quality and Its Influence on Mechanical Stability of Large Area PV Modules

Jochen Markert¹, Pascal Romer¹, Frank Ensslen¹, Enzo Job¹, Tobias Rist², Ingrid Hädrich¹, Daniel Philipp¹

¹ Fraunhofer ISE, Freiburg, Germany; ² Fraunhofer IWM, Freiburg, Germany

3BO.14.3 Polarization-Type Potential-Induced Degradation in Bifacial PERC Modules in the Field

Peter Hacke¹, Cecile Molto², Dylan J. Colvin², Ryan Smith³, Christopher DiRubio⁴, Matthew Gardeski⁴, Farrukh Ibne Mahmood⁵, Fang Li⁵, Jaewon Oh⁶, Govindasamy Tamizhmani⁵, Hubert Seigneur²

¹ NREL, Golden, United States of America; ² FSEC Energy Research Center University of Central Florida, Cocoa, United States of America; ³ Pordis, Austin, United States of America; ⁴ First Solar, Tempe, United States of America; ⁵ ASU, Mesa, United States of America; ⁶ University of North Carolina, Charlotte, United States of America

3BO.14.4 Shedding Light on PID and Recovery in High-Efficiency Crystalline-Silicon Technologies

Olatz Arriaga Arruti¹, Alessandro Virtuani¹, Bénédicte Bonnet-Eymard², Matthieu Despeisse², Christophe Ballif¹

¹ EPFL, Neuchâtel, Switzerland; ² CSEM, Neuchâtel, Switzerland

3BO.14.5 LeTID in Real Life: The Relevance and Importance of Accelerated Tests and Treatments

Arastoo Teymouri¹, Moonyong Kim¹, Li Wang¹, Catherine Chan¹, Ran Chen¹, Petra Manshanden², Astrid Gutjahr², Bas Van Aken², Jakob Jan Dijksterhuis³, Alison Ciesla¹

¹ UNSW, Sydney, Australia; ² TNO, Petten, The Netherlands; ³ Elsun, Roden, The Netherlands

3BO.14.6 Towards Establishing Criteria for Electrical Safety in Second-Use Photovoltaic (PV) Modules

Tadanori Tanahashi¹, Takashi Oozeki¹

¹ AIST, Koriyama, Japan

VISUAL PRESENTATIONS 4BV.4

15:15 - 16:45 Photovoltaic in/on Buildings

Chairpersons: Dr. Xu Zhihao
AIST, Tsukuba, Japan
Prof. Dr. Francesco Frontini
SUPSI, Mendrisio, Switzerland

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 4BO.5

17:00 - 18:30 Design and Coloring Techniques of PV for Buildings

Chairpersons: Ms. Delia D'Agostino
European Commission JRC, Ispra, Italy
Dr. Pierluigi Bonomo
SUPSI, Mendrisio, Switzerland

4BO.5.1 MorphoFlex: Integrating MorphoColor on Polymeric Films in Photovoltaic Modules

Benedikt Bläsi¹, Martin Mattenheimer¹, Christine Wellens¹, Jochen Markert¹, Andreas Wessels¹, Hubert Hauser², Jörg Mick², Leon Fels³, Brunhilde Kindle-Hasse³, Thomas Kroyer¹

¹ Fraunhofer ISE, Freiburg, Germany; ² temicon, Dortmund, Germany; ³ ROWO Coating, Herbolzheim, Germany

4BO.5.2 Developing Colored Solar Panels for BIPV Applications: A Photonic Glass Approach with Metal Oxide Nanospheres

Parisa Sharif¹, Eda Cevik², Sahin Coskun³, Husnu Emrah Unalan², Alpan Bek², Talat Ozden¹

¹ ODTÜ-GÜNAM, Ankara, Türkiye; ² METU, Ankara, Türkiye; ³ ESOGU, Eskisehir, Türkiye

4BO.5.3 Decorative Technique for Building-Integrated Photovoltaics by Using Cellulose Materials

Leo Adachi¹, Takaaki Kasuga², Manami Suzuki¹, Kota Goto¹, Masaya Nogi², Michio Kondo³, Hiroyuki Wada¹

¹ Tokyo Institute of Technology, Yokohama City, Japan; ² Osaka University, Ibaraki City, Japan; ³ Waseda University, Shinjuku City, Japan

4BO.5.4 Understanding the Outdoor Performance of Colored BIPV-Modules with Interference Coating

David Out¹, Roland Valckenborg¹, Petra Manshanden¹, Lourens van Dijk², Paul de Jong³

¹ TNO, Eindhoven, The Netherlands; ² Soluxa, Nijmegen, The Netherlands; ³ Solinso, Kessel, The Netherlands

4BO.5.5 Mitigating Angular Dependence of Structural-Colored PV Module by Introducing Texture Glass for Building-Integrated Photovoltaics Applications

Zhihao Xu¹, Takuya Matsui¹, Hitoshi Sai¹

¹ AIST, Tsukuba, Japan



4BO.5.6 Student Awards Finalist Presentation: Novel Colorimetry Approach for Building-Integrated Photovoltaic Applications

Marie Courtant¹, Janne Halme², Alejandro Borja Block¹, Antonin Faes¹, Aïcha Hessler-Wyser¹, Christophe Ballif¹

¹ EPFL, Neuchâtel, Switzerland; ² Aalto University, Espoo, Finland

ORAL PRESENTATIONS 2BO.10

17:00 - 18:30 New Modelling and Characterisation - Material Properties

Chairpersons: Mr. Oliver Fischer
Fraunhofer ISE, Freiburg im Breisgau, Germany
Dr. Ana Kanevce
ZSW, Stuttgart, Germany

2BO.10.1 In-depth Characterization Methodology for the Assessment of Passivation Impact in Halide Perovskite Solar Cells

Jonathan Parion¹, Santhosh Ramesh¹, Sownder Subramaniam¹, Henk Vrielinck², Filip Duerinckx¹, Hariharsudan Sivaramakrishnan Radhakrishnan¹, Jef Poortmans¹, Johan Lauwaert³, Bart Vermang¹

¹ imec, Genk, Belgium; ² Ghent University, Ghent, Belgium; ³ Ghent University, Zwijnaarde, Belgium

2BO.10.2 Student Awards Finalist Presentation: Implied Voltage of Sub-cells in Tandem Devices from Luminescence Images – The Beauty of Using a Narrow Bandpass Filter

Soma Zandi¹, Shuai Nie¹, Yan Zhu¹, Thomas Allen², Erkan Aydin², Esma Ugur², Jianghui Zheng³, Guoliang Wang³, Xu Liu¹, Anita Ho-Baillie³, Xiaojing Hao¹, Stefaan De Wolf², Thorsten Trupke¹, Ziv Hameiri¹

¹ UNSW, Sydney, Australia; ² KAUST, Thuwal, Saudi Arabia; ³ University of Sydney, Sydney, Australia

2BO.10.3 Thickness Variation Determination of Perovskite Solar Cells through Hyperspectral Reflectance Imaging

Ivar Loland Råheim¹, Robert Lee Chin², Ziv Hameiri², Ingunn Burud¹, Espen Olsen¹

¹ Norwegian University of Life Sciences, Ås, Norway; ² UNSW, Sydney, Australia

2BO.10.4 Improving the Investigation of Defect Properties through Temperature Dependent Modulated Photoluminescence

Hiba Haddara¹, Baptiste Berenguer², Sylvain Le Gall¹, Jean-François Guillemoles², Jean-Paul Kleider¹

¹ GeePs, Gif-sur-Yvette, France; ² IPVF, Palaiseau, France

2BO.10.5 Advanced Outdoor Degradation Analysis of Perovskite Solar Cells Using Bayesian Optimization

Joseph Chakar¹, Karim Medjoubi², Jorge Posada², Jean-Baptiste Puel², Yvan Bonnassieux¹

¹ LPICM, Palaiseau, France; ² IPVF, Palaiseau, France

ORAL PRESENTATIONS 3BO.15

17:00 - 18:30 Reliability of PV Modules: Testing and Modelling Approaches

Chairpersons: Dr. Ioannis (John) Tsanakas
CEA, Le Bourget-du-Lac, France
Ms. Ulrike Jahn
Fraunhofer CSP, Halle (Saale), Germany

3BO.15.1 Worldwide Moisture Ingress Modelling and Its Impact on Photovoltaic Module Degradation Predictions

Stefan Mitterhofer¹, Julian Ascencio-Vasquez², Ismail Kaaya³, Xiaohong Gu¹

¹ NIST, Gaithersburg, United States of America; ² UNIVERS, Redwood, United States of America; ³ imo-imomec, Genk, Belgium

3BO.15.2 Material Selection and Novel Reliability Testing for Floating Photovoltaic Modules

Nikoleta Kyranaki¹, Arvid van der Heide¹, Hamed Javanbakht Lomeri¹, Ismail Kaaya¹, Sara Bouguerra¹, Jens Moschner², Arnaud Morlier¹, Michaël Daenen¹

¹ Hasselt University, Genk, Belgium; ² KU Leuven, Leuven, Belgium

3BO.15.3 Outdoor Accelerated Ageing Tests Using Additional Thermal and Thermomechanical Stresses

Ebrar Ozkalay¹, Gabi Friesen¹, Alessandro Virtuani², Mauro Cacciavio¹, Christophe Ballif³

¹ SUPSI, Mendrisio, Switzerland; ² CSEM, Neuchâtel, Switzerland; ³ EPFL, Neuchâtel, Switzerland

3BO.15.4 Development of PV Module Hot Desert Test Cycle Protocol Extended Failure Modes and Effective Analysis

Baloji Adothu¹, Jim Joseph John¹, Gerhard Mathiak¹, Vivian Alberts¹, Bengt Jäckel², Ralph Gottschalg², Narendra S Shiradkar³, Amir A. Abdallah⁴, Juan Lopez Garcia⁴, Michael Salvador⁵, Bram Hoex⁶, Hussein A Kazem⁷, Muhammad Ashraful Alam⁸

¹ DEWA, Dubai, United Arab Emirates; ² Fraunhofer CSP, Halle, Germany; ³ IIT Bombay, Mumbai, India; ⁴ QEERI, Doha, Qatar; ⁵ KAUST, Thuwal, Saudi Arabia; ⁶ UNSW, Sydney, Australia; ⁷ Sohar University, Sohar, Oman; ⁸ Purdue University, West Lafayette, United States of America

3BO.15.5 Long-Term Degradation Rate of Photovoltaic Modules: A Meta-Analysis

Michael Straub-Mück¹, Jerome Geyer-Klingeberg¹, Andreas Rathgeber¹

¹ University of Augsburg, Augsburg, Germany

3BO.15.6 Solar Cell Crack Image Generation for Power Loss Prediction

Norman Jost¹, Emma Cooper¹, Benjamin Pierce¹, Brandon Byford¹, Jennifer Braid¹

¹ Sandia National Laboratories, Albuquerque, United States of America



VISUAL PRESENTATIONS 1BV.5

17:00 - 18:30 Silicon Material: Growth, Defects and Recycling | Manufacturing of Solar Cells and Related Tools & Processes

Chairpersons: Dr. Stefan Peters
Hanwha Q CELLS GmbH, Bitterfeld-Wolfen, Germany
Dr. Florian Schindler
Fraunhofer ISE, Freiburg, Germany

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

Wednesday, 25. September 2024

PLENARY PRESENTATIONS CP.1

08:30 - 10:00 PV Everywhere

Chairpersons: Alessandra Scognamiglio
ENEA, Portici, Italy
Roland M. E. Valckenborg
TNO, Eindhoven, The Netherlands

4CP.1.1 Keynote Presentation: Dynamic Agrivoltaics: An Agronomical tool to Protect Crops from Climate Change

Damien Fumey¹
¹ Sun'Agri, Clapiers, France

5CP.1.2 Where Agriculture Meets Energy: Assessing the EU's Agrivoltaic Potential

Anatoli Chatzipanagi¹, Georgia Kakoulaki¹, Nigel Taylor¹, Robert Kenny¹, Sandor Szabo¹, Ana Martinez Fenandez¹, Arnulf Jaeger-Waldau¹
¹ European Commission JRC, Ispra, Italy

4CP.1.3 Coloring Solutions for Building Integrated Photovoltaic Modules: A Review

Alejandro Borja Block¹, Jordi Escarre Palou², Marie Courtant¹, Alessandro Virtuani², Gianluca Cattaneo², Maxime Roten², Hengyu Li², Matthieu Despeisse², Aicha Hessler-Wyser¹, Umang Desai¹, Antonin Faes¹, Christophe Ballif¹
¹ EPFL, Neuchatel, Switzerland; ² CSEM, Neuchatel, Switzerland

4CP.1.4 Five Years of Trouble: Learnings from Floating Solar Field Testing in Challenging Conditions

Minne M. de Jong¹, Maarten Dörenkämper¹, Jan Kroon¹
¹ TNO, Eindhoven, The Netherlands

PLENARY PRESENTATIONS CP.2 | CP.3

10:30 - 12:30 Performance and Reliability | Thin Films and Tandems

Chairpersons: Dr. Gernot Oreski
PCCL, Leoben, Austria
Dr. Carolin Ulbrich
HZB, Berlin, Germany

3CP.2.1 Quality Assurance of materials for long life-time (Duramat initiative)

Teresa M. Barnes¹ Ashley Gaulding²
¹ NREL, Evergreen, United States of America; ² NREL, Golden, United States of America



4CP.2.2 Quality Assessment of Large Scale PV Systems Using Daylight Photoluminescence Imaging

Thorsten Trupke¹, Oliver Kunz¹, Jürgen W. Weber¹, Hugh Gottlieb¹, Alexander Slade¹

¹ UNSW, Sydney, Australia

4CP.2.3 Performance of Partial Shaded PV Generators Operated by Optimized Power Electronics Review an IEA PVPS T13 Activity

Franz P. Baumgartner¹, Sara Mirbagheri Golroodbari², Christof Bucher³, Matthew Berwind⁴, Felipe Valencia⁵, Ulrike Jahn⁶

¹ ZHAW, Winterthur, Switzerland; ² University Utrecht, Utrecht, The Netherlands; ³ Bern University, Bern, Switzerland; ⁴ Fraunhofer ISE, Freiburg, Germany; ⁵ ATAMOSTEC, Atacama, Chile; ⁶ Fraunhofer CSP, Halle (Saale), Germany

2CP.3.4 Perovskite PV Outdoors: From Single-Junction Single Cells to Mini-Modules and Tandems

Mark Khenkin¹, Marko Remec², Ulas Erdil³, Florian Scheler¹, Quiterie Emery¹, Marko Jankovec⁴, Cordula Wessendorf⁵, Erik Ahlswede⁵, Janardan Dagar¹, Steve Albrecht¹, Eva Unger¹, Bernd Stannowski¹, Rutger Schlatmann¹, Marko Topic⁴, Carolin Ulbrich¹

¹ HZB, Berlin, Germany; ² HZB & University of Ljubljana, Berlin, Germany; ³ HZB & Bielefeld University, Berlin, Germany; ⁴ University of Ljubljana, Ljubljana, Slovenia; ⁵ ZSW, Stuttgart, Germany

2CP.3.5 Perovskite/Silicon Triple Junction Devices: An Overview of the Progress and Results From the Triumph Project Funded Under Horizon Europe

Hariharsudan Sivaramakrishnan Radhakrishnan¹, Minasadat Heydarian², Maryam Heydarian², Kerem Artuk³, Christian Wolff³, Luis Restat⁴, Jonas Schön⁴, Devika Rajagopal¹, Ahmed Eljaouhari⁵, Kasimir Reichmuth², Jochen Hohl-Ebinger², Martin C. Schubert², René Köhler⁶, Martin Dimer⁶, Jons Bolding⁷, Floor Souren⁷, Martin Späth⁸, Petra Manshanden⁸, Cristian Villalobos¹, Jonathan Parion¹, Yinghuan Kuang¹, Selin Seyrek¹, Juliane Borchert², Florian Hilt⁹, Pilar Lopez-Varo⁹, Santhosh Ramesh¹, Henrik Pettersson¹⁰, José Alvarez¹¹, Henry Weber¹², Ralf G. Niemann¹², Lukas Kegelman¹², Fabian Fertig¹², Felipe Saenz¹³, Valérie Depauw¹, Veronika Nikitina², Sebastian Nold², Mustafa Yaşa¹⁴, Gökem Günbaş¹⁴, Selçuk Yerci¹⁴

¹ imec/imomec, Genk, Belgium; ² Fraunhofer ISE, Freiburg, Germany; ³ EPFL, Neuchâtel, Switzerland; ⁴ University of Freiburg, Freiburg, Germany; ⁵ RENA, Berg, Germany; ⁶ Von Ardenne, Dresden, Germany; ⁷ SALD, Eindhoven, The Netherlands; ⁸ TNO, Petten, The Netherlands; ⁹ IPVF, Palaiseau, France; ¹⁰ Dyname, Stockholm, Sweden; ¹¹ CNRS, Palaiseau, France; ¹² Qcells, Bitterfeld-Wolfen, Germany; ¹³ CSEM, Neuchâtel, Switzerland; ¹⁴ METU, Ankara, Turkey

2CP.3.6 CIGS – Excellent by itself and in Tandem

Susanne Siebentritt¹

¹ University of Luxembourg, Esch-sur-Alzette, Luxembourg

ORAL PRESENTATIONS 2CO.1

13:30 - 15:00 Processing, Characterisation, and Modelling of Perovskite/Silicon Tandems

Chairpersons: Prof. Dr. Ivan Gordon
imec, Genk, Belgium

Dr. Anna Robinson
Oxford PV, Oxford, United Kingdom

2CO.1.1 Student Awards Finalist Presentation: Tailoring Perovskite Crystallization and Interfacial Passivation in Efficient Fully-Textured Perovskite Silicon Tandem Solar Cells

Oussama Er-raji¹, Mohamed Mahmoud¹, Christoph Messmer¹, Oliver Fischer¹, Alexander Bett¹, Alexandra Ramadan², Alexander Reinholdt³, Angelika Schmitt³, Bhushan Kore¹, Martin Bivour¹, Florian Schindler¹, Jonas Schön¹, Martin Hermle¹, Martin C. Schubert¹, Juliane Borchert¹, Stefan Glunz¹, Patricia Schulze¹

¹ Fraunhofer ISE, Freiburg, Germany; ² University of Sheffield, Sheffield, United Kingdom; ³ Fraunhofer ISC, Würzburg, Germany

2CO.1.2 Diffusible Capping Layer Enabled Homogeneous Crystallization and Component Distribution of Hybrid Sequential Deposited Perovskite

Qiaojing Xu¹, Biao Shi¹, Yuncheng Li¹, Jingjing Liu¹, Yuxiang Li¹, Zetong SunLi¹, Pengfei Liu¹, Yubo Zhang¹, Cong Sun¹, Wei Han¹, Qian Huang¹, Dekun Zhang¹, Huizhi Ren¹, Xiaona Du¹, Ying Zhao¹, Xiaodan Zhang¹

¹ Nankai University, Tianjin, China

2CO.1.3 Surface and Interface Passivation for Perovskite Solar Cells and Perovskite/c-Si Tandems

Kerem Artuk¹, Felipe Saenz², Deniz Turkey¹, Mostafa Othman¹, Mounir D. Mensi³, Quentin Jeangros², Aïcha Hessler-Wyser¹, Christophe Ballif¹, Christian M. Wolff¹

¹ EPFL, Neuchâtel, Switzerland; ² CSEM, Neuchâtel, Switzerland; ³ EPFL, Sion, Switzerland

2CO.1.4 Ultrathin Atomic Layer Deposited Metal Oxides as Robust Passivating Interlayers at the Perovskite C60 Interface

Patricia Schulze¹, Johanna Modes¹, Armin Richter¹, Carl Hartwig², Stefan Lange², Oliver Fischer¹, Raphael Efinger¹, Martin Hermle¹, Andreas Bett¹, Juliane Borchert¹

¹ Fraunhofer ISE, Freiburg, Germany; ² Fraunhofer CSP, Halle, Germany

2CO.1.5 Multi-Scale Simulation of Non-Idealities in All-Perovskite Tandem Photovoltaic Modules

Urs Aeberhard¹, Nelly Natsch¹, Andrin Schneider¹, Simon Zeder¹, Beat Ruhstaller¹

¹ Fluxim, Winterthur, Switzerland

2CO.1.6 PV Multiscale Modelling of Perovskite / Silicon Two-Terminal Devices: from Accurate Cell Performance Simulation to Energy Yield Prediction

Paul Procel¹, Maarten Verkou², Bianca Passarella³, Diego Di Girolamo³, Giuliana Giuliano³, Olivier Dupré⁴, Youri Blom¹, Malte Vogt¹, Rudi Santbergen¹, Francesco Rametta³, Cosimo Gerardi³, Miro Zeman¹, Olindo Isabella¹

¹ TU Delft, Delft, The Netherlands; ² PV Works, Delft, The Netherlands; ³ 3Sun, Catania, Italy; ⁴ CEA-INES, Le Bourget du Lac, France



ORAL PRESENTATIONS 5CO.4

13:30 - 15:00 PV Module Recycling

Chairpersons: Dr. Karsten Wambach
Wambach-Consulting, Oberschöna GT Bräunsdorf, Germany
Dr. Carmen Alonso-García
CIEMAT, Madrid, Spain

5CO.4.1 A Novel and Universal Use of Silicon Kerf Loss and Other Silicon-Based Waste with Amazing Side Effects

Wolfram Palitzsch¹, Arvid Killenberg¹, Ingo Röver¹
¹ LuxChemtech, Freiberg, Germany

5CO.4.2 Comparative Analysis of Layer Thickness Measurement Methods for Photovoltaic Modules: A Comprehensive Study

Lukas Neumaier¹, Martin De Biasio¹, Gabriele Eder², Anika Gassner²
¹ Silicon Austria Labs, Villach, Austria; ² OFI, Vienna, Austria

5CO.4.3 Diamond Wire Process for Glass-Glass PV Modules Opening Prior to Materials Recycling

Fabrice Coustier¹, Roland Riva¹, Margot Pliquet¹, Claire Agraffail¹, Olivier Caille², Thomas Peccavet², Rui DeAlmeida², Wolfram Palitzsch³
¹ CEA/INES, Le Bourget-du-Lac, France; ² Mondragon Assembly, Orange, France; ³ LuxChemtech, Freiberg, Germany

5CO.4.4 Characterization of the Output-Fractions from Different Mechanical PV-Recycling Approaches

Anika Gassner¹, Gabriele Eder¹, Ferozan Azizi², Sonja Feldbacher³, Friedrich Bleicher⁴
¹ OFI, Vienna, Austria; ² MUL, Leoben, Austria; ³ PCCL, Leoben, Austria; ⁴ TU Vienna, Vienna, Austria

5CO.4.5 Recycling of MAPbI₃ Perovskite Solar Cells

Zhenni Wu¹, Mykhailo Sytnyk¹, Jiyun Zhang¹, Gülüşüm Babayeva¹, Jens Hauch¹, Christoph J. Brabec¹, Ian Marius Peters¹
¹ HI ERN, Erlangen, Germany

5CO.4.6 PV Waste Management in Australia: Strategic Site Selection Integrating Postcode-level Waste Projection and Logistic Optimisation

Rong Deng¹, Chence Niu¹, Verity Tan¹, Renate Egan¹, Vinayak Dixit¹
¹ UNSW, Sydney, Australia

VISUAL PRESENTATIONS 4CV.1

13:30 - 15:00 Solar Resource and Forecasting

Chairpersons: Prof. Dr. Wilfried G.J.H.M. van Sark
Utrecht University, Utrecht, The Netherlands
Dr. Manajit Sengupta
NREL, Golden, United States of America

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

PANEL DISCUSSION – INTERACTIVE WORKSHOP

13:30 - 15:00 CO.7: Social Acceptance of Ubiquitous-PV: The Era of Integrated Photovoltaics

Moderators: Mirella de Falco
University of Rome, Italy
Dr. Alexis Pascaris
NREL, Golden, USA

This session will explore the socio-political aspects of integrated photovoltaics (PV) from different perspectives and disciplinary fields with the aim of elevating diverse topics relevant to social perspectives and acceptance of new technologies, such as energy justice, economics, policy, and landscape design. Session panelists will provide high-level overviews of the various integrated PV applications (agrivoltaics, aquavoltaics, building-integrated PV) with an emphasis on the socio-political aspects related to each application. To build on the value of social perspectives, session panelists and audience members will participate in a “back casting” exercise to develop a roadmap for more successful research and development of integrated PV. This interactive and interdisciplinary approach to identifying the policies, programs, events, partnerships, and technological developments needed to address implementation barriers will enable researchers and practitioners to improve the role of integrated PV in the energy transition.

1 Panelist – Alessandra Scognamiglio, ENEA, Italy

2 Panelist – Thomas Reindl, SERIS, Singapore

3 Panelist – Pierluigi Bonomo, SUPSI, Switzerland

4 Panelist – Jordan Macknick, NREL, USA

5 Panelist – Eva Vandest, Amarenco, Solar Power Europe Chair of the Agrisolar workstream, France

ORAL PRESENTATIONS 2CO.2

15:15 - 16:45 Triple Junctions and Advanced Concepts in Perovskite-based Tandems

Chairpersons: Prof. Dr. Jan Christoph Goldschmidt
Philipps University of Marburg, Marburg, Germany
Dr. Patricia Schulze
Fraunhofer ISE, Freiburg, Germany

2CO.2.1 Wafer-Sized Nanostructuring of Perovskite-Silicon Tandem Solar Cells

Adrian Callies¹, Jenny Norberg¹, Johannes Gry¹, Patricia S. C. Schulze¹, Juliane Borchert¹, Oliver Höhn¹
¹ Fraunhofer ISE, Freiburg, Germany



2CO.2.2 Triple-Junction Perovskite–Perovskite–Silicon Photovoltaics

Hang Hu¹, Sophie X. An¹, Yang Li¹, Seyedamir Orooji¹, Roja Singh¹, Fabian Schackmar¹, Felix Laufer¹, Qihao Jin¹, Thomas Feeney¹, Alexander Diercks¹, Fabrizio Gota¹, Somayeh Moghadamzadeh¹, Ting Pan¹, Michael Rienäcker², Robby Peibst², Paul Fassl¹, Bahram Abdollahi Nejand¹, Ulrich W. Paetzold¹

¹ KIT, Karlsruhe, Germany; ² ISFH, Emmertal, Germany

2CO.2.3 Development of Monolithic Perovskite/Perovskite/Silicon Triple-Junction Solar Cells

Minasadat Heydarian¹, Luis Restat¹, Maryamsadat Heydarian¹, Yashika Gupta¹, Christoph Messmer¹, Alexander J. Bett¹, Martin Bivour¹, Florian Schindler¹, Martin Hermle¹, Martin C. Schubert¹, Patricia S. C. Schulze¹, Juliane Borchert¹, Stefan Glunz¹

¹ Fraunhofer ISE, Freiburg, Germany

2CO.2.4 High-Performance Flexible All-Perovskite Tandem Solar Cells and Mini-Modules

Huagui Lai¹, Jingwei Zhu², Radha Kothandaraman³, Severin Siegrist¹, Philipp Wechsler¹, Cong Chen², Ayodhya Tiwari¹, Dewei Zhao², Fan Fu¹

¹ EMPA, Dübendorf, Switzerland; ² Sichuan University, Chengdu, China; ³ EMPA, Dübendorf, Switzerland

2CO.2.5 Characterisation of Degradation Pathways of 3-Terminal Perovskite-Silicon Tandems After Outdoor Monitoring

Miha Kikelj¹, Laurie-Lou Senaud², Florent Sahl², Benjamin Lipovšek¹, Marko Topič¹, Christophe Ballif², Quentin Jeangros², Bertrand Paviet-Salomon²

¹ University of Ljubljana, Ljubljana, Slovenia; ² CSEM, Neuchâtel, Switzerland

2CO.2.6 Scalable Two-Terminal Perovskite-Cigs Tandem Solar Cells and Modules With Record Efficiencies

Radha Krishnan Kothandaraman¹, Shiro Nishiwaki¹, Huagui Lai¹, Romain Carron¹, Ayodhya Nath Tiwari¹, Fan Fu¹

¹ EMPA, Dübendorf, Switzerland

ORAL PRESENTATIONS 5CO.5

15:15 - 16:45 End-of-Life PV Modules & Ecology

Chairpersons: Dr. Garvin Heath
NREL, Golden, United States of America
Mr. Fabrice Coustier
CEA, Le Bourget-du-Lac, France

5CO.5.1 Metal and Silicon Recovery from Discarded Perovskite-On-Silicon Tandem Photovoltaic Panels: An Experimental Study

George Wong¹, Lian Duan¹, Alejandra GALARZA¹, Nicolas Loones¹, Iwan Zimmermann¹, Karsten Wambach², Lars Oberbeck¹

¹ IPVF, Palaiseau, France; ² Bifa Umweltinstitut, Augsburg, Germany

5CO.5.2 Defining Circularity via a Product-Level Circularity Metric

Mirjam Theelen¹, Marylou Kapinski¹, Niels van Loon¹, Simona Villa¹

¹ TNO partner in Solliance, Eindhoven, The Netherlands

5CO.5.3 PV Module ID: Data Driven Results to Enable PV Circularity and Address Toxicity Concerns Impacting Global Decarbonization

Taylor Curtis¹, Ashley Gaulding¹, Ligia Smith¹

¹ NREL, Golden, United States of America

5CO.5.4 Standardisation Activities on the Reuse of PV Modules in IEC TC82

Arvid van der Heide¹, Serge Noels², Jan Clynckx²

¹ imec/imo-imomec, Genk, Belgium; ² PV CYCLE, Brussels, Belgium

5CO.5.5 Bifacial Module Design to Ensure Critical Vegetation Growth and Soil Quality in Solar Parks

Kay Cesar¹, Bas Van Aken¹

¹ TNO, Petten, The Netherlands

5CO.5.6 Envisol – Presenting a Cross-Disciplinary Project on How PV Power Plants Influence Nature

Heine Nygard Riise¹, Erlend Hustad Honningdalsnes¹, Dagmar Hagen², Markus Sydenham², Anne Mehlhoop², Trond Simensen², Jonathan Rizzi³, Torunn Kjeldstad¹

¹ IFE, Kjeller, Norway; ² NINA, Trondheim, Norway; ³ NIBIO, Ås, Norway

ORAL PRESENTATIONS 4CO.8

15:15 - 16:45 Solar Resource Assessment

Chairpersons: Prof. Mike Zehner
Rosenheim Technical University of Applied Sciences, Rosenheim, Germany
Dr. Atse Louwen
Eurac Research, Bolzano, Italy

4CO.8.1 The Fourth Edition of the Best Practices Handbook for Solar Resource Data: An Introduction

Manajit Sengupta¹, Aron Habte¹, Elke Lorenz², Christian Gueymard³, Adam Jensen⁴, Jan Remund⁵, Wilfried Van Sark⁶, Stefan Wilbert⁷

¹ NREL, Golden, United States of America; ² Fraunhofer ISE, Freiburg, Germany; ³ Solar Consulting Services, Colebrook, United States of America; ⁴ DTU, Copenhagen, Denmark; ⁵ Meteotest, Berne, Switzerland; ⁶ Utrecht University, Utrecht, The Netherlands; ⁷ DLR, Almería, Spain

4CO.8.2 The New CAMS Radiation Service v4.6 – Method Improvements and Service Evolution with a Special Focus on Solar Energy

Jorge Lezaca¹, Marion Schroedter-Homscheidt¹, Faiza Azam¹, Gilles Fischer², Mireille Lefevre³, Laurent Saboret², Yves-Marie Saint-Drenan³

¹ DLR, Oldenburg, Germany; ² Vaisala, Sophia-Antipolis, France; ³ MINES Paris, Sophia-Antipolis, France

4CO.8.3 Statistical Downscaling of Solar Projections from Climate Models

Manajit Sengupta¹, Jaemo Yang¹, Aron Habte¹, Yu Xie¹, Douglas Nychka², Maggie Bailey², Soutir Bandyopadhyay²

¹ NREL, Golden, United States of America; ² Colorado School of Mines, Golden, United States of America

4CO.8.4 Towards the Optimal Horizon Computation Algorithm for High-Resolution Topography Data

Evgenii Sovetkin¹, Andreas Gerber¹, Bart E. Pieters¹

¹ Forschungszentrum Jülich, Jülich, Germany



4CO.8.5 Global Patterns of Solar Resource Short-Term Variability Based on Solargis Time Series Data

Juraj Betak¹, Martin Opatovsky¹, Konstantin Rosina¹, Marcel Suri¹
¹ Solargis, Bratislava, Slovakia

4CO.8.6 Impact of “Black Summer” Bushfire on Solar Power Generation across Australia

Shukla Poddar¹, Merlinde Kay¹, Bram Hoex¹
¹ UNSW, Sydney, Australia

ORAL PRESENTATIONS 3CO.10

15:15 - 16:45 Materials and Processes for PV Modules

Chairpersons: Dr. Tudor Timofte
ISC Konstanz, Konstanz, Germany
Dr. Veronica Bermudez Benito
QEERI, Doha, Qatar

3CO.10.1 Benchmarking of Encapsulant Materials for c-Si/Perovskite Tandem Modules

Petra Christöfl¹, Chiara Barretta¹, Marcel Kühne², Frans Opden Buijsch³, Sem Sals³, Quentin Jeangos⁴, Bernd Stannowski⁵, Gernot Oreski¹
¹ PCCL, Leoben, Austria; ² Hanwha Q CELLS, Thalheim, Germany; ³ The compound company, Geleen, The Netherlands; ⁴ CSEM, Neuchatel, Switzerland; ⁵ HZB, Berlin, Germany

3CO.10.2 Reliability Studies of PV Minimodules Using an Ethylene – Butyl Acrylate (EBA) Based Encapsulant and High Efficiency n-Type PV Cells

Ignacio Fidalgo¹, Inmaculada Campoy Felipe², Andreas Halm³
¹ Polaris Open Innovation, Oviedo, Spain; ² Repsol Química, Madrid, Spain; ³ ISC Konstanz, Konstanz, Germany

3CO.10.3 Mitigation of Edge Compression in Glass-Glass Modules by Local Pre-Crosslinking of the Encapsulant

Gernot M. Wallner¹, Gabriel Riedl¹, Robert Pugstaller¹
¹ University of Linz, Linz, Austria

3CO.10.4 Reducing Process Time of PV Module Lamination by Using Double-Side Heating System

Sraisth Sraisth¹, Aksel Kaan Oez², Djamel Eddine Mansour¹, Paul Gebhardt², Daniel Klaus³, Christine Wellens²
¹ RCT Solutions, Konstanz, Germany; ² Fraunhofer ISE, Freiburg, Germany; ³ Robert Buerkle, Freudenstadt, Germany

3CO.10.5 Development of Multi-Function 5-Layer Anti-Reflection Coating for Cover Glass of PV Module

Yiyu Zeng¹, Yajie Jiang¹
¹ UNSW, Sydney, Australia

3CO.10.6 Multilayer Antireflection Coating on Solar Module Glass by Magnetron Sputtering

Ning Song¹, Shuo Deng¹, Angus Gentle¹, Nathan Chang¹, Yuhao Cheng¹, Jialiang Huang¹, Martin A. Green¹
¹ UNSW, Sydney, Australia

VISUAL PRESENTATIONS 1CV.2

15:15 - 16:45 Processing & Characterisation of Crystalline Si based Solar Cells | Silicon Bottom Cells for Tandem Photovoltaics | Advances in Silicon Solar Cells Characterisation and Simulation

Chairpersons: Prof. Dr. Pere Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France
Dr. Francesca Menchini
ENEA, Rome, Italy
Dr. Marco Ernst
ANU, Canberra, Australia

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 2CO.3

17:00 - 18:30 New Modelling and Characterisation - Device Performance

Chairpersons: Dr. Theresa Magorian Friedlmeier
ZSW, Stuttgart, Germany
Ms. Soma Zandi
UNSW, Sydney, Australia

2CO.3.1 Special Introductory Presentation: Revealing Electric Losses in Perovskite Silicon Tandem Solar Cells – An Overview

Oliver Fischer¹, Anh Dinh Bui², Florian Schindler¹, Daniel Macdonald², Stefan W. Glunz¹, Martin C. Schubert¹
¹ Fraunhofer ISE, Freiburg, Germany; ² ANU, Canberra, Australia

2CO.3.2 Understanding Ion-Related Performance Losses in Perovskite-Based Solar Cells by Capacitance-Voltage Measurements and Simulation

Christoph Messmer¹, Jonathan Parion², Cristian V. Meza², Santhosh Ramesh², Martin Bivour³, Jonas Schön¹, Hariharsudan S. Radhakrishnan², Martin Schubert³, Stefan W. Glunz¹
¹ University of Freiburg, Freiburg, Germany; ² imec division IMOMEC and EnergyVille, Genk, Belgium; ³ Fraunhofer ISE, Freiburg, Germany

2CO.3.3 Understanding Outdoor-Characteristics and Bifaciality Effects of Full-Size Perovskite on Silicon Tandem Modules

David Chojniak¹, Marc Steiner¹, Kasimir Reichmuth¹, Alexandra Schmid¹, Gerald Siefer¹, Stefan W. Glunz¹
¹ Fraunhofer ISE, Freiburg, Germany

2CO.3.4 Analysis and Modelling of Recovery and Degradation Mechanisms in Perovskite Solar Cells

Guillem Álvarez-Pérez¹, Arthur Julien¹, Karim Medjoubi¹, Jean Baptiste Puel¹, Jean Francois Guillemoles¹
¹ IPVF, Paris, France

2CO.3.5 Developments in Thermophotovoltaics (TPV)

Esther López Estrada¹
¹ UPM, Madrid, Spain



ORAL PRESENTATIONS 5CO.6

17:00 - 18:30 Life Cycle Assessment of PV

Chairpersons: Dr. Wolfram Palitzsch
LuxChemtech, Freiberg, Germany
Mr. Keiichi Komoto
Mizuho Research & Technologies, Ltd., Tokyo, Japan

5CO.6.1 Sustainability Improvement of c-Si PV Manufacturing Through Increased Capacity, Integrated Factories and Technology Choice

Moritz Fath¹, Mehul Reval¹, Wolfgang Jooss¹, Peter Fath¹
¹ RCT Solutions, Konstanz, Germany

5CO.6.2 Maximizing Solar Sustainability: Analysis of the Leverages for Low-carbon Impact PV Manufacturing and Electricity Generation

Alexis Barrou¹, Alessandro Virtuani¹, Christophe Ballif¹, Bertrand Paviet-Salomon¹
¹ CSEM, Neuchâtel, Switzerland

5CO.6.3 Generating Simplified and Accurate Models to Assess the Environmental Impact of Perovskite/Silicon Tandem Modules by Parametric Approach

Lu Wang¹, Lars Oberbeck², Raphaël Jolivet¹, Mathilde Marchand Lassere¹, Paula Perez-Lopez¹
¹ PSL University, Sophia Antipolis, France; ² TotalEnergies, Paris Saclay, Norway

5CO.6.4 Carbon Footprint vs Reliability of Solar Photovoltaic Modules: A New Dilemma?

Alessandro Virtuani¹, Alexis Barrou¹, Bertrand Paviet-Salomon¹, Gianluca Cattaneo¹, Matthieu Despeisse¹, Christophe Ballif¹
¹ CSEM, Neuchâtel, Switzerland

5CO.6.5 Are BIPV Contributing to Environmental Sustainability? An Environmental LCA Analysis of Innovative BIPV Solutions

Cristina Polacchi¹, Atse Louwen¹, Mirjam Theelen², David Moser¹
¹ Eurac Research, Bolzano, Italy; ² TNO partner in Solliance, Eindhoven, The Netherlands

5CO.6.6 The Influence of Climate Specific Degradation on the Greenhouse Gas Emissions of PV Electricity

Sina Herceg¹, Ismail Kaaya², Julian Ascencio-Vásquez³, Marie Fischer¹, Karl-Anders Weiß¹, Liselotte Schebek⁴
¹ Fraunhofer ISE, Freiburg, Germany; ² EnergyVille, Genk, Belgium; ³ Envision Digital, Redwood, United States of America; ⁴ Technical University of Darmstadt, Darmstadt, Germany

ORAL PRESENTATIONS 4CO.9

17:00 - 18:30 Solar Forecasting

Chairpersons: Dr. Manajit Sengupta
NREL, Golden, United States of America
Prof. Dr. Wilfried G.J.H.M. van Sark
Utrecht University, Utrecht, The Netherlands

4CO.9.1 Satellite-based Forecasting: Can Deep Learning Replace CMV?

Nils Straub¹, Steffen Karalus¹, Elke Lorenz¹
¹ Fraunhofer ISE, Freiburg, Germany

4CO.9.2 Skill-driven Model Training for Solar Forecasting with Sky Images

Amar Meddahi¹, Arttu Tuomiranta¹, Sebastien Guillon¹
¹ TotalEnergies, Paris, France

4CO.9.3 Ramp Rate Metric Suitable for Solar Forecasting and Nowcasting

Bijan Nouri¹, Yann Fabel¹, Niklas Blum¹, Luis F. Zarzalejo², Andreas Kazantzidis³, Stefan Wilbert¹
¹ DLR, Almería, Spain; ² CIEMAT Energy Department, Madrid, Spain; ³ University of Patras, Patras, Greece

4CO.9.4 Fog and Snow Detection to Improve Regional Photovoltaic Power Prediction

Steffen Karalus¹, Wiebke Herzberg¹, Tobias Zech¹, Babak Jahani², Elke Lorenz¹
¹ Fraunhofer ISE, Freiburg, Germany; ² SRON, Leiden, The Netherlands

4CO.9.5 Photovoltaic Power Plants as Efficient Cloud Motion Detectors

Magnus Moe Nygård¹, Erling Ween Eriksen¹, Heine Nygard Riise¹
¹ IFE, Kjeller, Norway

4CO.9.6 Student Awards Finalist Presentation: How Connected Cars Can Improve Solar Forecasting - Expanding the Scale of Local Sensor Networks

Tobias Veihelmann¹, Maximilian Lübke¹, Norman Franchi¹
¹ Friedrich-Alexander-University, Erlangen, Germany

ORAL PRESENTATIONS 3CO.11

17:00 - 18:30 Emerging Interconnection Technologies

Chairpersons: Mr. Andreas Halm
ISC Konstanz, Konstanz, Germany
Dr. Laurie Burnham
Sandia National Laboratories, Albuquerque, United States of America

3CO.11.1 Special Introductory Presentation: IBC Heterojunction: The End of the Tunnel?

Jonathan Champlaud¹, Lison Marthey¹, Alessandro Virtuani¹, Loann Baume¹, Matthieu Despeisse¹, Jun Zaho¹, Damien Lachenal², Pierre Papet², Till Koessler², Ludovic Vuithier², Gizem Nogay³, Rainer Grischke³, Christophe Ballif¹
¹ CSEM, Neuchâtel, Switzerland; ² Meyer Burger Research, Hauterive, Switzerland; ³ Meyer Burger, Gwatt, Switzerland



3CO.11.2 Design Roadmap to Modules with 24% Efficiency

Max Mittag¹, Christian Reichel¹, Alexander Protti¹, Holger Neuhaus¹

¹ Fraunhofer ISE, Freiburg, Germany

3CO.11.3 Effect of Lowering Curing Temperature of Electrically Conductive Adhesives on Ribbon Connected Solar Cells

Veronika Nikitina¹, Tim Riehle¹, Leonhard Böck¹, Torsten Rößler¹

¹ Fraunhofer ISE, Freiburg, Germany

3CO.11.4 Towards Low Silver Electrical Conductive Adhesive for HJT Interconnection

Vincent Barth¹, Rémi Monna¹, Bertrand Hladys¹, Eszter Voroshazi¹, Gabriele Bianca², Sebastiano Caccamo², Alessandro Fucile², Antonino Ragonesi², Cosimo Gerardi², Antoine Perelman³

¹ CEA-INES, Le Bourget-du-Lac, France; ² 3SUN, Catania, Italy; ³ Université Grenoble Alpes / CEA Liten, Le Bourget-du-Lac, France

3CO.11.5 To Bypass or Not to Bypass: Integrating and Evaluating Parallel Connections and Bypasses in c-Si PV Laminates

Tom Borgers¹, Jonathan Govaerts¹, Hamed Javanbakht Lomeri¹, Apostolos Bakovasilis¹, Rik Van Dyck¹, Bart Reekmans¹, Hariharsudan Sivaramkrishnan Radhkrishnan¹, Jef Poortmans¹, Manuel Van den Storme², Guy Van den Storme²

¹ imec, Genk, Belgium; ² VdSWeaving, Oudenaarde, Belgium

VISUAL PRESENTATIONS 2CV.3

17:00 - 18:30 Perovskite-based Multijunctions | Perovskite Photovoltaics

Chairpersons: Dr. Nikoleta Kyranaki
Hasselt University, Genk, Belgium

Dr. Patricia Schulze
Fraunhofer ISE, Freiburg, Germany

Dr. Sjoerd Veenstra
TNO Energy Transition, Eindhoven, The Netherlands

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

Thursday, 26. September 2024

ORAL PRESENTATIONS 4DO.1

08:30 - 10:00 PV System Design and Optimisation

Chairpersons: Dr. Kari Lappalainen
Tampere University, Tampere, Finland
Mr. Dirk Stellbogen
ZSW, Stuttgart, Germany

4DO.1.1 Enhancing Bifacial Gain: Addressing Tracker Installation Challenges for Optimized Performance

Ismail Kaaya¹, David Moser², Richard de Jong¹, Olivier Dupon¹, Arnaud Morlier¹

¹ Hasselt University/Imo-Imomec, Genk, Belgium; ² Eurac Research, Bolzano, Italy

4DO.1.2 Assessing the Performance, Reliability, and Economic Impact of PV Systems Installation Parameters in Harsh Climates: Case Study Iraq

Mohammed Hameed¹, Ismail Kaaya², Richard de Jong², Roland Scheer³, Ralph Gottschalg¹

¹ Fraunhofer CSP, Halle (Saale), Germany; ² Imec/imo-imomec, Genk, Belgium; ³ MLU, Halle (Saale), Germany

4DO.1.3 A Techno-Economic Comparison Analysis for Optimal PV Revamping Strategies

Elina Bosch¹, André Penas¹, Philippe Macé¹, Gaëtan Masson¹, Fabrizio Bizzarri²

¹ Becquerel Institute, Brussels, Belgium; ² Enel Green Power, Rome, Italy

4DO.1.4 Increasing the Self-Sufficiency of the Terre Sainte Campus Microgrid by Expanding the PV Capacity While Minimizing the Cost

Tina Arizo Randrianantenaina¹, Josselin Le Gal La Salle¹, Sergiu Viorel Spataru², Mathieu David¹

¹ PIMENT, Saint-Pierre, Réunion; ² DTU, Roskilde, Denmark

4DO.1.5 A Matlab-Based Software Solution for Irradiance Sensor Allocation in European Solar PV Farms

Alba Alcañiz¹, Mathijs I. van Kouwen¹, Olindo Isabella¹, Hesam Ziar¹

¹ TU Delft, Delft, The Netherlands

4DO.1.6 Innovative Setups for Photovoltaic Solar Trackers to Really Boost the Electricity Generation per Square Meter of Occupied Surfaces

Rosario Carbone¹, Cosimo Borrello¹, Ferdinando Gioia¹

¹ University "Mediterranea" of Reggio Calabria, Reggio Calabria, Italy



ORAL PRESENTATIONS 2DO.6

08:30 - 10:00 Towards Improved Understanding of Perovskite Solar Cell Device Physics

Chairpersons: Prof. Dr. Shuzi Hayase
The University of Electro-Communications, Chofu, Japan
Ms. Petra Manshanden
TNO Energy Transition, Petten, The Netherlands

2DO.6.1 Bright Insights: Exploring Perovskite Formation Mechanisms with Combined Spectral Reflectance and Photoluminescence In-Situ Data

Nasim Rezaei-Hartmann¹, Thorsten Brand¹, Claudine Groß¹, Enno Malguth¹, Aleksandra Miaskiewicz², Marcel Roß², Viktor Škorjanc², Lars Korte², Steve Albrecht², Christian Camus¹

¹ LayTec, Berlin, Germany; ² HZB, Berlin, Germany

2DO.6.2 Study of the Degradation Kinetics and Lattice Reorganization of Triple Cation Perovskites Under X-Ray Radiation During XPS and XRD Characterization

Mirella Al Katrib¹, Pia Dally¹, Guillaume Vidon¹, Stefania Cacovich¹, Muriel Boutemy², Arnaud Etcheberry²

¹ IPVF, Palaiseau, France; ² ILV, Versailles, France

2DO.6.3 Efficient Charge Separation at 2D Ferroelectric Domains in Halide Perovskite Solar Cells

Jihoo Lim¹, Seungmin Lee², Hongjae Shim¹, Hyeonah Cho², Lei Wang¹, Jincheol Kim³, Claudio Cazorla⁴, Yong-Jin Kim⁵, Hanul Min², Minwoo Lee¹, S. Ravi P. Silva⁶, Xiaojing Hao¹, Jan Seidel¹, Dohyung Kim⁵, Jun Hong Noh², Jae Sung Yun⁶

¹ UNSW, Sydney, Australia; ² Korea University, Seoul, South Korea; ³ Macquarie University, Sydney, Australia; ⁴ UPC, Barcelona, Spain; ⁵ KIER, Daejeon, South Korea; ⁶ University of Surrey, Guildford, United Kingdom

2DO.6.4 Transient Currents Produced by Mobile Ions in Thick Metal-Semiconductor-Metal Devices

Leonardo Kopprio¹, Sylvain Le Gall¹, Aurore Brézard-Oudot¹, Koffi Ahanogbe¹, Pilar López-Varo², Nitin Mallik², Davide Ceratti², Jose Alvarez¹, Christophe Longeaud¹, Jean-Paul Kleider¹, Osbel Almora³

¹ GeePs, Gif-sur-Yvette, France; ² IPVF, Palaiseau, France; ³ University of Rovira i Virgili, Tarragona, Spain

2DO.6.5 Student Awards Finalist Presentation: Enhancing Crystallinity of Perovskite Materials through Rapid Microwave Annealing

Syed Nazmus Sakib¹, David N R Payne¹, Shujuan Huang¹, Binesh P Veetil¹

¹ Macquarie University, Sydney, Australia

2DO.6.6 Innovative Enhancement of Efficiency in Indoor Perovskite Solar Cells with a Wide Bandgap Through the Incorporation of Tunneling Junctions via a Self-Assembled 2D Dielectric Layer

Minwoo Lee¹, Jihoo Lim¹, Eunyoung Choi¹, Arman Mahboubi Soufiani², Seungmin Lee³, Fa-Jun Ma¹, Sean Lim¹, Jan Seidel¹, Dong Han Seo⁴, Ji-Sang Park⁵, Wonjong Lee⁶, Jongchul Lim⁶, Richard Francis Webster¹, Jincheol Kim⁷, Danyang Wang¹, Martin A. Green¹, Jung Hong Noh³, Xiaojing Hao¹, Jae Sung Yun¹

¹ UNSW, Sydney, Australia; ² HZB, Berlin, Germany; ³ Korea University, Seoul, South Korea; ⁴ KENTECH, Naju, South Korea; ⁵ Sungkyunkwan University, Suwon, South Korea; ⁶ Chungnam National University, Daejeon, South Korea; ⁷ Electronics Technology Institute, Seong-Nam, South Korea

ORAL PRESENTATIONS 5DO.11

08:30 - 10:00 Value and Competitiveness of PV in the Growing Market

Chairpersons: Ms. Izumi Kaizuka
RTS Corporation, Chuo-ku, Japan
Mr. Hubert Fechner
Austrian PV Technology Platform, Breitenfurt, Austria

5DO.11.1 A Snapshot of Global PV Market - 2023

Gaëtan Masson¹, Melodie de la Roche², Arnulf Jäger Waldau³, Izumi Kaizuka⁴, Amelia Oller Westerberg⁵, Jose Donoso⁶

¹ IEA PVPS Task 1, Brussels, Belgium; ² IEA PVPS Task 1, Lyon, France; ³ European Commission JRC, Ispra, Italy; ⁴ RTS Corporation, Tokyo, Japan; ⁵ Becquerel Sweden, Knivsta, Sweden; ⁶ UNEF, Madrid, Spain

5DO.11.2 Driving the Quest for Reliable and Bankable PV in Europe - Status and Targets in 2030

Ulrike Jahn¹, David Moser², Delfina Muñoz³, Paula Sánchez-Friera⁴

¹ Fraunhofer CSP, Munich, Germany; ² EURAC, Bolzano, Italy; ³ CEA, Le Bourget du Lac, France; ⁴ Solkeys, Gijón, Spain

5DO.11.3 Is The Value of (BI)PV Increasing or Decreasing Over Time?

Wouter Schram¹, Elham Shirazi¹

¹ University of Twente, Enschede, The Netherlands

5DO.11.4 The Role of Flexible Demand in Reducing the Utility-Scale PV Integration Costs: An Italian Case-Study

Elisa Veronese¹, David Moser¹

¹ EURAC Research, Bolzano, Italy

5DO.11.5 Wholesale Electricity Market Prices Forecast Considering Bidding Conditions Using Price Sensitivity

Shinji Hirota¹, Jindan Cui¹, Takashi Oozeki², Yuzuru Ueda¹

¹ Tokyo University of Science, Tokyo, Japan; ² National Institute of Advanced Industrial Science and Technology, Fukushima, Japan

5DO.11.6 Cost Analysis for a Small-Scale Hybrid, Hydrogen-Based PV Energy System

Marius C. Möller¹, Stefan Krauter¹

¹ University of Paderborn, Paderborn, Germany



ORAL PRESENTATIONS 3DO.16

08:30 - 10:00 PV Module Assessment and Classification

Chairpersons: Dr. Mauro Pravettoni
Technology Innovation Institute, Abu Dhabi, United Arab Emirates
Mr. Jonathan Govaerts
imec, Genk, Belgium

3DO.16.1 Holistic Analysis for Mismatch Losses in Photovoltaic Modules: Assessing the Impact of Inhomogeneity from Operational Conditions and Degradation Mechanisms on Power and Yield

Ammar Tummaleh¹, Max Mittag¹, Alexander Protti¹, Christian Reichel¹, Johannes Erb¹, Guido Willers², Holger Neuhaus¹
¹ Fraunhofer ISE, Freiburg, Germany; ² Fraunhofer CSP, Halle (Saale), Germany

3DO.16.2 Outdoor Performance and Reliability of Perovskite-Silicon Tandems: First Results of the NEXUS Project

Atse Louwen¹, Alexander Astigarraga¹, Juan José Stivanello¹, David Moser¹, Delfina Muñoz², Perrine Carroy², Markus Lenz³, Anika Sidler³, Jorge Ferrando⁴, Henk Bolink⁴, Seyedamir Orooji⁵, Ulrich W. Paetzold⁵, Hisham Nasser⁶, Talat Ozden⁶, Henry Snaith⁷
¹ Eurac Research, Bolzano, Italy; ² CEA-INES, Le Bourget du Lac, France; ³ School of Life Sciences FHNW, Muttens, Switzerland; ⁴ University of Valencia, Paterna, Spain; ⁵ KIT, Karlsruhe, Germany; ⁶ METU, Ankara, Türkiye; ⁷ University of Oxford, Oxford, United Kingdom

3DO.16.3 Quantitative Description of the Quality of Daylight Electroluminescence (dEL) Images Against Dark Room EL Images

Kabir Paul Sulca¹, Carmelo de Castro¹, Diego González-Francés¹, Cristian Terrados¹, Julián Anaya¹, Víctor Alonso¹, Miguel Ángel González¹, Oscar Martínez¹
¹ University of Valladolid, Valladolid, Spain

3DO.16.4 Photovoltaic Cell Defect Classification from Luminescence Images: Embedding and Clustering with Unsupervised Machine Learning

Brendan Wright¹, Rama Sharma¹, Ziv Hameiri¹
¹ UNSW, Sydney, Australia

3DO.16.5 Daylight Photoluminescence of Silicon Solar Panels in Operation by Electrical Modulation

Cristian Terrados¹, Diego Gonzalez-Frances², Kabir Paul Sulca², Miguel Ángel González², Oscar Martínez²
¹ University of Burgos, Burgos, Spain; ² University of Valladolid, Valladolid, Spain

3DO.16.6 Series Resistance Power Loss Analysis from Daylight Photoluminescence Imaging

Hugh Gottlieb¹, Oliver Kunz¹, Juergen Weber¹, Thorsten Trupke¹
¹ UNSW, Kensington, Australia

VISUAL PRESENTATIONS 4DV.1

08:30 - 10:00 Dual Use (Floating PV, Agrivoltaics, VIPV) and other Innovative PV Applications

Chairpersons: Dr. Roland M. E. Valckenborg
TNO, Eindhoven, The Netherlands
Dr. Jonathan Leloux
LuciSun, Sart-Dames-Avelines, Belgium
Prof. Dr. Angele Reinders
Eindhoven University of Technology, Eindhoven, The Netherlands

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 4DO.2

10:30 - 12:00 The Integrated Agrivoltaic Performance: Approaches, Modelling, Experiences

Chairpersons: Mr. Kay Cesar
TNO Energy Transition, Petten, The Netherlands
Dr. Thomas Reindl
SERIS, Singapore, Singapore

4DO.2.1 Shaping Europe's Agrivoltaic Future: Design of Four Innovative Demonstrators through Advanced Modeling in the SYMBIOSYST Project

S Prithivi Rajan¹, Jesus Robledo¹, Jonathan Leloux¹, Christian A. Gueymard¹, Angelo Pignatelli², Giovanni Borz³, David Moser³, Ismail Kaaya⁴, Shu-Ngwa Asaa⁴, Alexandros Katsikogiannis⁵, Martin Thalheimer⁶, Walter Guerra⁶, Marcel Macarulla⁷, Irma Roig⁷, Gil Gorchs⁷, Niels Groen⁸, James MacDonald⁹, Giuseppe Demofonti¹⁰, Cinja Seick¹¹, Giacomo Bosco¹²
¹ LuciSun, Brussels, Belgium; ² EF Solare, Milano, Italy; ³ EURAC, Bolzano, Italy; ⁴ Imec, Leuven, Belgium; ⁵ TU Delft, Delft, The Netherlands; ⁶ Laimburg, Laimburg, Italy; ⁷ UPC, Barcelona, Spain; ⁸ KUBO, South Holland, The Netherlands; ⁹ Engie-Lab, Barcelona, Spain; ¹⁰ Convert, Roma, Italy; ¹¹ Aleo, Prenzlau, Germany; ¹² Physee, Delft, The Netherlands

4DO.2.2 Agrivoltaic Impact on Photosynthesis Rates and Crops in Arid Climate

Christiana Honsberg¹, Greg Barron-Gafford², Robert Sampson³, Stuart Bowden⁴
¹ Arizona State University, Tempe, United States of America; ² University of Arizona, Tucson, United States of America; ³ Pegasus Solar, Phoenix, United States of America; ⁴ Solestial, Tempe, United States of America

4DO.2.3 Improving the Development of Hyperaccumulating Plants under Photovoltaic Systems as Part of a Brownfield Remediation Strategy

Julien Ancousture¹, Pierre Leglize², Emile Benizri², Ya Brigitte Assoa³
¹ University of Lorraine - CEA, Vandoeuvre-lès-Nancy, France; ² University of Lorraine - INRAE, Vandoeuvre-lès-Nancy, France; ³ Grenoble Alpes University - CEA, Le Bourget-du-Lac, France



4DO.2.4 Enhancing Agrivoltaics Synergies Through Tracking Optimization

Maddalena Bruno¹, Leonhard Gföllner¹, Matthew Berwind¹

¹ Fraunhofer ISE, Freiburg, Germany

4DO.2.5 Monitoring Sytem in an Agrivoltaic Greenhouse in Southern Spain

Natalie Hanrieder¹, Anna Kujawa¹, Sergio Gonzalez Rodriguez¹, Julian Kornas¹, Álvaro Fernandez Solas¹, Stefan Wilbert¹, Manuel Blanco¹, Ana Martínez Gallardo², Leontina Berzosa Álvarez², Adoración Amate González², Marina Casas Fernandez², Francisco Javier Palmero Luque³, Manuel López Godoy³, M. del Carmen Alonso Garcia⁴, José Carballo⁵, Robert Pitz-Paal⁶

¹ DLR, Almeria, Spain; ² ANECOOP, Valencia, Spain; ³ UAL-Anecoop, Almeria, Spain; ⁴ CIEMAT, Madrid, Spain; ⁵ CIEMAT, Almeria, Spain; ⁶ DLR, Cologne, Germany

4DO.2.6 Future-Proofing India's Energy: A Comprehensive Review and Strategy Optimisation for Agrovoltaic Systems

Abubakar Suleiman¹, Chan Hwang See¹, Firdaus Muhammad-Sukki¹, Sundaram Senthilarasu²

¹ Edinburgh Napier University, Edinburgh, United Kingdom; ² Teesside University, Middlesbrough, United Kingdom

ORAL PRESENTATIONS 2DO.7

10:30 - 12:00 Process Innovations for Perovskite Devices

Chairpersons: Dr. Aranzazu Aguirre
imec, Genk, Belgium

Dr. Sjoerd Veenstra
TNO Energy Transition, Eindhoven, The Netherlands

2DO.7.1 Special Introductory Presentation: Optimization of Hybrid Two-Step Inkjet Printed Perovskite Solar Cells

Raphael Pesch¹, Alexander Diercks¹, Julian Petry¹, Alexander Welle², Ronja Pappenberger¹, Fabian Schackmar¹, Helge Eggers¹, Johannes Sutter¹, Ulrich Lemmer¹, Ulrich W. Paetzold¹

¹ KIT, Karlsruhe, Germany; ² KIT, Eggenstein-Leopoldshafen, Germany

2DO.7.2 Scaling up Thermal Evaporation Processes for Perovskite Photovoltaics - From Point Sources to Linear Evaporators

Bruno Heimke¹, Carsten Deus¹, Jens Baumann¹, Paul Faßl², Julian Petry², Ullrich Wilhelm Paetzold², Marcel Ross³, Steve Albrecht³, Jona Kurpiers³

¹ VON ARDENNE, Dresden, Germany; ² KIT, Karlsruhe, Germany; ³ HZB, Berlin, Germany

2DO.7.3 DMF-Free Perovskite Cells: Vacuum Quenching and Performance Analysis

Toshimitsu Mochizuki¹, Shota Araki¹, Hidetaka Takato¹, Katsuto Tanahashi¹

¹ AIST, Koriyama, Japan

2DO.7.4 Large Scale Deposition of Perovskite Solar Cells and Modules by a Combined Evaporation and Slot-die Coating Approach

Adriana Paracchino¹, Ricardo Augusto Zanotto Razera¹, Michele De Bastiani¹, Florent Sahli¹, Daniel Jacobs¹, Lisa Champault¹, Christophe Ballif¹, Quentin Jeangros¹

¹ CSEM, Neuchâtel, Switzerland

2DO.7.5 Encapsulation of Perovskite Solar Cells by Vacuum Lamination

Robert Witteck¹, Duong Nguyen-Minh¹, Goutam Paul¹, Steven P. Harvey¹, Xiaopeng Zheng¹, Qi Jiang¹, Min Chen¹, Brian Habersberger², Ashley Gaulding¹, Emily Warren¹, Joseph M. Luther¹, Lance M. Wheeler¹

¹ NREL, Golden, United States of America; ² Dow Chemical, Houston, United States of America

ORAL PRESENTATIONS 3DO.12

10:30 - 12:00 Low Environmental Impact Module Design and Technologies

Chairpersons: Dr. Hamed Hanifi
AESOLAR, Königsbrunn, Germany

Dr. Sonja Feldbacher
PCCL, Leoben, Austria

3DO.12.1 Steps Towards a 100% Renewable Material Solar Module: Evaluating Material Substitutions for Encapsulation and Interconnection

Ringo Koepge¹, Matthias Pander¹, Anton Mordvinkin¹, Stephan Großer¹

¹ Fraunhofer CSP, Halle (Saale), Germany

3DO.12.2 New Encapsulant for PV Modules Designed for Recycle: A Lab Scale Prototype

Margot Pliquet¹, Alexis Brastel², Eeva Mofakhami¹, Timea Bejat¹, Pierre Piluso²

¹ CEA-INES, Le Bourget du Lac, France; ² CEA Liten, Grenoble, France

3DO.12.3 Laser-Assisted Ablation for Silicon Solar Panels Recycling

Remi Aninat¹, Maarten van der Vleuten¹, Kailan Kats¹, Julien Kolbecher¹, Anne Biezemans¹, Johan Bosman¹, Ando Kuypers¹, Mirjam Theelen¹

¹ TNO, Eindhoven, The Netherlands

3DO.12.4 Innovative Design-for-Recycle for Critical Material-Free Interconnection

Antoine Perelman¹, Vincent Barth¹, Fabien Mandorlo², Eszter Voroshazi¹

¹ CEA-INES, Le Bourget-du-Lac, France; ² INSA, Lyon, France

3DO.12.5 Bifacial Lightweight Solution without Glass

Alicia Buceta¹, Ana Belén Cuelli¹, Miguel Aguirre², Ana Linares³, Elena Llarena³, Silvia Cal³, Jaione Bengoechea¹

¹ CENER, Sarriguren, Spain; ² CENER, Madrid, Spain; ³ ITER, Santa Cruz Tenerife, Spain

3DO.12.6 Development of Novel Protective Coatings to Increase the Durability and Reliability of Glass-Free Lightweight PV Modules

Yuliya Voronko¹, Gabriele Eder¹, Elisabeth Reiser², Markus Babin³, Gernot Oreski⁴

¹ OFI, Vienna, Austria; ² KANSAL HELIOS AUSTRIA, Vienna, Austria; ³ DTU Electro, Roskilde, Denmark; ⁴ PCCL, Leoben, Austria



ORAL PRESENTATIONS 3DO.17

10:30 - 12:00 Outdoor Performance and Energy Yield Estimation

Chairpersons: Mr. Mauro Cacciavo
SUPSI, Canobbio, Switzerland
Dr. Ana Maria Gracia Amillo
CENER, Sarriuren, Spain

3DO.17.1 Special Introductory Presentation: PV Module Degradation in Hot Deserts: Laboratory and Outdoor Data Analysis

Gerhard Mathiak¹, Shahzada Pamir Aly¹, Kaushal Chapaneri¹, Balaji Adothu¹, Jim Joseph John¹
¹ DEWA R&D Center, Dubai, United Arab Emirates

3DO.17.2 Incidence Angle Effect: Results of an Interlaboratory Comparison of Measurements on Commercial-Size Modules

Mauro Pravettoni¹, Min Hsian Saw², Giorgio Bardizza³, Giovanni Bellenda⁴, Romain Couderc⁵, Gabi Friesen⁴, Werner Herrmann³, Shin Woei Leow², Stefan Riechelmann⁶, Arvid van der Heide⁷, Frank Weinrich⁶, Stefan Winter⁶
¹ TIL, Abu Dhabi, United Arab Emirates; ² SERIS, Singapore, Singapore; ³ TÜV-Rheinland, Cologne, Germany; ⁴ SUPSI, Mendrisio, Switzerland; ⁵ CEA-INES, Le Bourget-du-lac, France; ⁶ PTB, Braunschweig, Germany; ⁷ Imec/Imo-imomec, Genk, Belgium

3DO.17.3 Student Awards Finalist Presentation: Climate Specific Energy Rating (CSER) Analysis of Outdoor PV Field Data

Ismael Medina¹, Teodora S. Lyubenova¹, Ewan Dunlop¹
¹ European Commission JRC, Ispra, Italy

3DO.17.4 Module Parameters Extraction for Assessing Photovoltaic Energy Yield: A Comparative Approach

Ahmad Hashem¹, Frank Xu², Carlos Meza¹, Christos Monokroussos², Ralph Gottschalg³
¹ Hochschule Anhalt, Köthen, Germany; ² TÜV Rheinland (Shanghai), Shanghai, China; ³ Fraunhofer CSP, Halle (Saale), Germany

3DO.17.5 Performance and Degradation Evaluation of Crystalline Silicon Modules Under Different Open-Rack and Residential Mounting Configurations

Gabi Friesen¹, Ebrar Özkalay¹, Flavio Valoti¹, Mauro Cacciavo¹
¹ SUPSI ISAAC, Mendrisio, Switzerland

VISUAL PRESENTATIONS 5DV.2

10:30 - 12:00 Energy System Integration; Resilience and Security of Supply; Solar Fuels, Storage | PV Sustainability

Chairpersons: Dr. Garvin Heath
NREL, Golden, United States of America
Prof. Dr. Marta Victoria
Aarhus University, Aarhus, Denmark
Dr. Wolfram Palitzsch
LuxChemtech, Freiberg, Germany

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 4DO.3

13:30 - 15:00 The Integrated Agrivoltaic Performance: Different Climatic Conditions, Crops and Technologies

Chairpersons: Ms. Anatoli Chatzipanagi
European Commission JRC, Ispra, Italy
Dr. Bas Van Aken
TNO Energy Transition, Petten, The Netherlands

4DO.3.1 Comprehensive Methodology Applied to Solar Radiation Prediction for Dual Use for Vertical Agrivoltaics System

Arthur Poquet¹, Etienne Drahi¹, Jordi Badosa², Philippe Blanc³
¹ TotalEnergies Onetech, Palaiseau Cedex, France; ² LMD, Palaiseau, France; ³ Mines Paris, Sophia Antipolis Cedex, France

4DO.3.2 Reducing Wind Speeds and Boosting Agricultural Productivity with Vertical Bifacial Solar Panels

Erlend Hustad Honningdalsnes¹, Erik Stensrud Marstein¹, Dag Lindholm¹, Helge Bonesmo², Heine Nygard Riise¹
¹ IFE, Kjeller, Norway; ² Norwegian Institute of Bioeconomy Research, Trondheim, Norway

4DO.3.3 A Computational Comparison and Validation Between Ray Tracing Techniques Under Special Light-Sharing Trade off Scenarios in Photovoltaics

Hugo Sánchez Ortiz¹, Roxane Bruhwiler², Sebastian Dittmann¹, Nicolas De Cook², Carlos Meza¹, Frederic Lebeau², Ralph Gottschalg¹
¹ Hochschule Anhalt, Köthen, Germany; ² Liege University, Gembloux, Belgium

4DO.3.4 Automatic Agrivoltaic Site Selection: A User-Friendly Interface Powered by AHP Multicriteria Decision-Making

Andressa de Sousa Cardoso¹, Alfonso López Ruiz¹, María Isabel Ramos Galán¹, Juan Manuel Jurado Rodríguez¹, Francisco Ramón Feito Higuera¹
¹ University of Jaén, Jaén, Spain

4DO.3.5 Modelling, Design, and Performance Evaluation of Agri-PV Orchards

Odyseas Alexandros Katsikogiannis¹, Olindo Isabella¹, Hesam Ziar¹
¹ TU Delft, Delft, The Netherlands



4DO.3.6 Optimizing Light Transmission for Crop Growth: The Innovative Voltiris Agrivoltaic System

Jacques Levrat¹, Delphine Petri¹, Matthieu Despeisse¹, Christophe Ballif¹, Jonas Roch², Dominik Blaser², Max Bernheim²

¹ CSEM, Neuchâtel, Switzerland; ² Voltiris, Lausanne, Switzerland

ORAL PRESENTATIONS 2DO.8

13:30 - 15:00 Scalability of Perovskite Solar Modules

Chairpersons: Dr. Christian Camus
LayTec, Berlin, Germany

Dr. Nikoleta Kyranaki
Hasselt University, Genk, Belgium

2DO.8.1 Special Introductory Presentation: Line-Scan Luminescence Imaging of Large-Area Perovskite Modules - First Demonstration

Shuai Nie¹, Yan Zhu¹, Juergen W. Weber¹, Thorsten Trupke¹, Ziv Hameiri¹

¹ UNSW, Sydney, Australia

2DO.8.2 R2R Large Area Processing of Flexible Perovskite Solar Cells on In-Free Transparent Conductive Oxides

Ilker Dogan¹, Anuja Vijayan¹, Harrie Gorter¹, Hero 't Mannetje¹, Marcel Simor¹, Wiljan Verhees¹, Dorrit Roosen-Melsen¹, Herbert Lifka², Gayathri Mathiazhagan², Sjoerd Veenstra¹

¹ Solliance, Eindhoven, The Netherlands; ² HyET Solar, Arnhem, The Netherlands

2DO.8.3 Strategies to Improve Photovoltaic Performance and Stability of ~800 cm² Perovskite Solar Modules

Yinghuan Kuang¹, Tamara Merckx¹, Aranzazu Aguirre¹, Merve Tutundzic¹, Anurag Krishna¹, Jef Poortmans¹, Bart Vermang¹, Tom Aernouts¹

¹ imec, Genk, Belgium

2DO.8.4 Fully Printed Perovskite Solar Cells and Modules

Luigi Vesce¹, Elena Iannibelli¹, Karthikeyan Pandurangan², Maurizio Stefanelli¹, Hafez Nikbakht¹, Maria Laura Parisi², Adalgisa Sinicropi², Aldo Di Carlo¹

¹ University of Rome Tor Vergata, Rome, Italy; ² University of Siena, Siena, Italy

2DO.8.5 Key Developments for the Industrialization of Perovskite Photovoltaics

Erik Ahlsweide¹, Jonas Hanisch¹, Tina Wahl¹, Oliver Salomon¹, Cordula Wessendorf¹, Stefan Paetel¹, Michael Powalla¹

¹ ZSW, Stuttgart, Germany

ORAL PRESENTATIONS 2DO.18

13:30 - 15:00 Late News: Developments in High Efficiency Tandem Cells

Chairpersons: Prof. Dr. Olindo Isabella
Delft University of Technology, Delft, The Netherlands

Dr. Alessandro Virtuani

CSEM, Neuchâtel, Switzerland

2DO.18.1 High Efficiency all-perovskite Tandems and Triples

Philipp Tockhorn¹, Sebastian Berwig², Yeonghun Yun¹, Isabella Taupitz¹, Kevin Prince¹, Philippe Holzhey¹, Florian Riesebeck¹, Christiane Becker¹, Steve Albrecht¹

¹ HZB, Berlin, Germany; ² Martin Luther University, Halle (Saale), Germany

2DO.18.2 Development of 33.24% Perovskite/c-Si Solar Cells Using Industrially Fabricated TOPCon Device

Weiyuan Duan¹

¹ Jinkosolar, Yuhuan, China

2DO.18.3 Perovskite Tandems Efficiency Improvements Role in Cheaper Electricity

Christopher Case¹

¹ Oxford PV, Oxford, United Kingdom

2DO.18.4 Three-Terminal Perovskite/Silicon Tandems with Mismatched Energy Bandgaps

Gemma Giliberti¹, Antonio Fronteddu¹, Fabio Matteocci², Francesco di Giacomo³, Erica Magliano², Aldo Di Carlo², Federica Cappelluti¹

¹ Polytechnic University of Turin, Turin, Italy; ² C.H.O.S.E., Rome, Italy; ³ Solertix, Rome, Italy

VISUAL PRESENTATIONS 5DV.3

13:30 - 15:00 PV Diversification Upstream and Downstream - from Industry to Applications | Costs, Economics, Finance and Markets | The Revolution of PV

Chairpersons: Dr. Stephen Tay
NUS, Singapore, Singapore

Ms. Izumi Kaizuka

RTS Corporation, Chuo-ku, Japan

Mr. Philippe Malbranche

CEA, Le Bourget-du-Lac, France

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.



PANEL DISCUSSION

13:30 - 15:00 DO.13: Renewables 24/7: The challenges of integrating renewables into the future Electricity System

Moderators: Mr. Hubert Fechner
Austrian Technology Platform PhotoVoltaic (TPPV), Austria
Mr. Gerhard Mütter
Gerhard Mütter e.U., Waldneukirchen, Austria

A sustainable energy transition and a decarbonization of the power sector requires a complete replacement of the use of coal, natural gas and nuclear plants. Traditionally, those are the main generation sources of the "Base Load Power", understood as the minimum amount of electric power needed to be supplied to the electrical grid at a span of time.

The intermittence in time and location of most renewables have been presented historically as the hurdles that trigger operational, technical and scientific challenges in their effective integration granting still reliability and stability to the electricity grid.

So, what would be needed to be done in Electricity Grid so the power could be entirely provided by renewable energy sources 24/7?

A group of top Electricity System experts, covering the different angles of these challenges will discuss aspects like: High penetration of Renewables (with a focus on PV), digitalisation of the distribution grids, local load management incentives, storage and other flexibility enablers of the grid, PV revenues on the energy market at peak PV times, regulatory barriers or democratization of the energy sector.

1 Panelist - Walter Schaffer, Salzburg Netz, Austria

2 Panelist - Alfons Haber, e-control, Austria

3 Panelist - Gerd Heilscher, Technische Hochschule Ulm, Chair of IEA PVPS task 19, Austria

4 Panelist - David Moser, EURAC Research, Italy

5 Panelist - Andreas Hensel, Fraunhofer ISE, Germany

6 Panelist - Tsvetelina Merdzhanova, Forschungszentrum Jülich, Germany

ORAL PRESENTATIONS 4DO.4

15:15 - 16:45 Vehicle Integrated PV

Chairpersons: Dr. Bonna Newman
Lightyear, Helmond, The Netherlands
Prof. Ignacio Antón Hernández
UPM, Madrid, Spain

4DO.4.1 Solar Moves: The impact on Grid Electricity Demand of VIPV

Anna J. Carr¹, Ashish Binani¹, Akshay Bhoraskar², Oscar van de Water², Michiel Zult², René van Gijlswijk², Lenneke Slooff-Hoek¹

¹ TNO, Petten, The Netherlands; ² TNO, Den Haag, The Netherlands

4DO.4.2 Topical Review for Vehicle Integrated Photovoltaics

Masafumi Yamaguchi¹, Taizo Masuda², Yasuyuki Ota³, Kenji Araki³, Kensuke Nishioka³

¹ Toyota, Nagoya, Japan; ² Toyota, Susono, Japan; ³ University of Miyazaki, Miyazaki, Japan

4DO.4.3 Simulation and Concept Evaluation of Extendable Lightweight Photovoltaic Modules for Vehicle Integration under Wind Loads

Cornelius Herr¹, Marc Andre Schüler¹, Felix Basler¹, Daniel Christopher Joseph¹, Andreas Beinert¹, Pascal Romer¹, Martin Heinrich¹

¹ Fraunhofer ISE, Freiburg, Germany

4DO.4.4 Public Road Driving Tests of Toyota Prius Equipped with High-Efficiency Photovoltaic Modules Consist of III-V-Based Triple-Junction Solar Cells

Taizo Masuda¹, Masafumi Yamaguchi², Tatsuya Takamoto³, Kensuke Nishioka⁴

¹ Toyota Motor Corporation, Shizuoka, Japan; ² Toyota Technological Institute, Nagoya, Japan; ³ Sharp Corporation, Nara, Japan; ⁴ University of Miyazaki, Miyazaki, Japan

4DO.4.5 Industrialization of Curved Glass-Free PV Module for VIPV Applications

Antonin Faes¹, Gianluca Cattaneo¹, Fahrudin Mujović¹, Nelson Koch¹, Julien Robin², Hugo Martins³, Kléber Nicolet⁴, Umang Desai⁴, Matthieu Despeisse¹, Bénédicte Bonnet-Eymard¹, Christophe Ballif¹

¹ CSEM, Neuchâtel, Switzerland; ² Simoldes, Oliveira, Portugal; ³ Ceia, Matosinhos, Portugal; ⁴ EPFL, Neuchâtel, Switzerland

4DO.4.6 VIPV: Urban Shading Effect to Solar Radiation Estimation Method Using GIS: Case Study in Fukushima, Japan

Pawita Bunme¹, Hidenori Mizuno¹, Takumi Takashima¹, Takashi Oozeki¹

¹ AIST, Fukushima, Japan

ORAL PRESENTATIONS 2DO.9

15:15 - 16:45 Lifetime and Reliability of Perovskite Devices

Chairpersons: Dr. Mark Khenkin
HZB, Berlin, Germany
Ms. Adriana Paracchino
CSEM, Neuchâtel, Switzerland

2DO.9.1 Long-Term Perovskite Module Outdoor Performance in Different Outdoor Regions

Aranzazu Aguirre¹, Tamara Merckx¹, Santhosh Ramesh¹, Yinghuan Kuang¹, Anurag Krishna¹, Vasiliki Paraskeva², Maria N Hadjipanayi², Matthew Norton², Elias Peraticos², Tom Aernouts¹, Jef Poortmans¹

¹ imec, Genk, Belgium; ² University of Cyprus, Nicosia, Cyprus

2DO.9.2 TÜV Rheinland Specification on the I-V Characterization of Perovskite-Based PV Modules

Giorgio Bardizza¹, Qi Gao², Wenhao Xu², Yating Zhang², Christos Monokroussos²

¹ TÜV Rheinland, Milan, Italy; ² TÜV Rheinland, Shanghai, China



2DO.9.3 Comparative Study of Reverse Bias Degradation in Perovskite Solar Cells and Modules

Sujith Vishwanathreddy¹, Aranzazu Aguirre², Michael Daenen¹, Tom Aernouts³, Jef Poortmans⁴

¹ Hasselt University, Hasselt, Belgium; ² Imec, Hasselt, Belgium; ³ Imec, Genk, Belgium; ⁴ KU Leuven, Leuven, Belgium

2DO.9.4 Analyzing Ion Migration and Degradation in Perovskite Solar Cells: Insight from Outdoor Exposure and Accelerated Stress Testing

Takeshi Tayagaki¹, Sayaka Hirooka¹, Haruka Kobayashi¹, Kohei Yamamoto¹, Takuro N. Murakami¹, Masahiro Yoshita¹

¹ AIST, Tsukuba, Japan

2DO.9.5 One-Year Outdoor Testing of 4T Perovskite/Si PV Modules

Vasiliki Paraskeva¹, Maria Hadjipanayi¹, Matthew Norton¹, Elias Peratikos¹, Aranzazu Aguirre², Anurag Krishna², Santhosh Ramesh², Tom Aernouts², George E. Georgiou¹

¹ University of Cyprus, Nicosia, Cyprus; ² Hasselt University/Imo-Imomec, Genk, Belgium

2DO.9.6 Degradation Mechanisms in Interface-Engineered Perovskite Solar Cells with 2D Passivation Layer

Anyssa Derj¹, Karim Medjoubi¹, Anna Capitaine¹, Dounya Barrit², Marion Provost¹, Jean Rousset¹, Jorge Posada³

¹ IPVF, Palaiseau, France; ² Total Energies, Palaiseau, France; ³ EDF, Palaiseau, France

ORAL PRESENTATIONS 5DO.14

15:15 - 16:45 Energy System Integration with Storage

Chairpersons: Prof. Dr. Marta Victoria
Aarhus University, Aarhus, Denmark
Mr. Bruno Gaiddon
HESPUL, Lyon, France

5DO.14.1 Solar-Driven CO₂ Electroreduction under Realistic Irradiance, Temperatures and Diurnal Cycles

Thérèse Cibaka¹, Tsvetelina Merdzhanova¹, Guangxin Liu², Florian Seidler¹, Sergey Shcherbachenko¹, Chuyen Pham², Oleksandr Astakhov¹, Uwe Rau¹

¹ Forschungszentrum Jülich, Jülich, Germany; ² Forschungszentrum Jülich, Erlangen, Germany

5DO.14.2 Effects of the Operation Point on PV Systems Equipped with Energy Storage

Kari Lappalainen¹

¹ Tampere University, Tampere, Finland

5DO.14.3 Elevating Green Hydrogen Yields: A Comparative Study of Photovoltaic-Electrolyzer Coupling Strategies

Pablo Garcia-Linares¹, Alfonso González del Valle¹, Antonio Martí Vega¹

¹ UPM, Madrid, Spain

5DO.14.4 An Assessment of The Impact of Firm Power Contracts on Battery Degradation in Hybridised Solar PV - Battery Energy Storage Systems

Alexandra Sheppard¹, Øyvind Sommer Klyve², Magnus Moe Nygård², Jonathan Fagerström², Soumya Das²

¹ NTNU, Trondheim, Norway; ² IFE, Oslo, Norway

5DO.14.5 Student Awards Finalist Presentation: Power-to-Heat-to-Power Storage for Enhancing Photovoltaic Self-Consumption in Heat Electrification

Alicia López-Ceballos¹, Ignacio Antón¹, Carlos Cañizo¹, Alejandro Datas¹

¹ UPM, Madrid, Spain

5DO.14.6 Hybrid Photovoltaics, Batteries, Concentrating Solar Power and Thermal Energy Storage: An Economic Pathway to 100% Renewables?

Joshua S. Stein¹, Jennifer L. Braid¹, Luke McLaughlin¹, Nathan Schroeder¹, Jeremy Sment¹, Henk Laubscher¹

¹ Sandia National Laboratories, Albuquerque, United States of America

ORAL PRESENTATIONS 3DO.19

15:15 - 16:45 Modelling Techniques for PV Modules

Chairpersons: Theodoros Makris
RWE, , Germany
Dr. Christos Monokroussos
TÜV Rheinland, Shanghai, China

3DO.19.1 An Accurate Data-Driven Physical Model for Bifacial PV Power Estimation

Ali Sohani¹, Marco Pierro², David Moser², Cristina Cornaro¹

¹ University of Rome Tor Vergata, Rome, Italy; ² Eurac Research, Bolzano, Italy

3DO.19.2 Comparative Analysis of Temperature Estimation Models in Bifacial Photovoltaic Modules

Aline Kirsten Vidal de Oliveira¹, Isadora Maciel Queiroz¹, Marília Braga¹, Ricardo Rüther¹

¹ Federal University of Santa Catarina (UFSC), Florianópolis, Brazil

3DO.19.3 Benchmarking Models for IV Curves of Bifacial PV Modules

Martin Bartholomäus¹, Luca Morino¹, Peter Behrendorff Poulsen¹, Sergiu Viorel Spataru¹

¹ Technical University of Denmark, Roskilde, Denmark

3DO.19.4 A Calibratable PV Temperature Model that Integrates Wind Direction in a Realistic Way: Insights from Long-Term Outdoor Measurements

Gofran Chowdhury¹, Anastasios Kladas², Bert Herteleer², Jan Cappelle², Francky Catthoor³

¹ KU Leuven, Leuven, Belgium; ² KU Leuven, Ghent, Belgium; ³ imec, Leuven, Belgium

3DO.19.5 Apparent Intensity Dependence of Shunts in PV Modules: Revision of the Shunt Parameterization in De Soto Model and PVsyst

Nils-Peter Harder¹, José Cano García¹

¹ TotalEnergies, Palaiseau, France



3DO.19.6 Blind Photovoltaic Performance Modeling Comparison of Commercial Software

Lelia Deville¹, Marios Theristis¹, Kevin Anderson¹, Juergen Sutterlueti², Javier Lopez Lorente³, Kurt Rhee⁴, Matthew Prilliman⁵, Bruno Wittmer⁶, Michele Oliosi⁶, Felix Perez⁷, Maitheli Nikam⁸, Branislav Shnierer⁹, Joshua Stein¹

¹ Sandia National Laboratories, Albuquerque, United States of America; ² Gantner Instruments, Schruns, Austria; ³ DNV, Arnhem, The Netherlands; ⁴ Terabase Energy, San Diego, United States of America; ⁵ NREL, Golden, United States of America; ⁶ PVSyst, Satigny, Switzerland; ⁷ Rated Power, Madrid, Spain; ⁸ 3E, Brussels, Belgium; ⁹ Solargis, Bratislava, Slovakia

VISUAL PRESENTATIONS 4DV.4

15:15 - 16:45 PV System Engineering | Control and Systems for Power Systems with Renewables Integration

Chairpersons: Mr. Roland Bründlinger
AIT, Vienna, Austria
Prof. Franz P. Baumgartner
ZHAW, Winterthur, Switzerland

Detailed information on this session is presented in the section entitled 'EU PVSEC 2024 Visual Presentations'.

ORAL PRESENTATIONS 4DO.5

17:00 - 18:30 Floating, Integrated and Hybrid PV

Chairpersons: Dr. Jonathan Leloux
LuciSun, Sart-Dames-Avelines, Belgium
Prof. Dr. Angele Reinders
Eindhoven University of Technology, Eindhoven, The Netherlands

4DO.5.1 Implementing Offshore Monitored Data for the Offshore FPV System Model Validation

Sara Mirbagheri Golroodbari¹, Gijsbert Houtman², Dora de Jong², Wilfried van Sark¹
¹ Utrecht University, Utrecht, The Netherlands; ² Oceans of Energy, Leiden, The Netherlands

4DO.5.2 Exploiting the Full Performance Potential of (Offshore) Floating Photovoltaics Through Thermal Approaches: An Overview of Options

Oscar Delbeke¹, Jens D. Moschner¹, Johan Driesen¹
¹ KU Leuven/EnergyVille, Leuven, Belgium

4DO.5.3 Student Awards Finalist Presentation: Quantification of Differences in Humidity Stress Profiles Between Floating Photovoltaics and Ground Mounted Photovoltaics

Nathan Roosloot¹, François Clayer², Dag Lindholm¹, Curtis DeGasperi³, Ankur R. Desai⁴, Daniel Hornbach⁵, Katy Nugent⁶, Ulrike Obertegger⁷, Blaize Denfeld⁸, Piet Verburg⁹, Huaxia Yao¹⁰, James Rusak¹⁰, Kiyoko Yokota¹¹, Junhong Wang¹², Ian D. Jones¹³, Torunn Kjeldstad¹, Josefine H. Selj¹, Gaute Otnes¹

¹ IFE, Kjeller, Norway; ² Norwegian Institute for Water Research, Oslo, Norway; ³ King County, Seattle, United States of America; ⁴ University of Wisconsin-Madison, Madison, United States of America; ⁵ Macalester College, Saint Paul, United States of America; ⁶ University of Saskatchewan, Saskatoon, Canada; ⁷ Fondazione Edmund Mach, S. Michele all'Adige, Italy; ⁸ Swedish University of Agricultural Sciences, Uppsala, Sweden; ⁹ National Institute of Water & Atmospheric Research, Wellington, New Zealand; ¹⁰ Ministry of the Environment, Conservation and Parks, Ontario, Canada; ¹¹ State University of New York, Oneonta, United States of America; ¹² University at Albany, Albany, United States of America; ¹³ University of Stirling, Stirling, United Kingdom

4DO.5.4 Evaporation of Reservoir for Different Floating Photovoltaic Layouts

Baptiste Berlioux¹, Baptiste Amiot², Martin Ferrand², Rémi Le Berre³, Hervé Pabiau¹, Ronnie Knikker¹
¹ Univ Lyon INSA, Villeurbanne, France; ² CERE, Marne la Vallée, France; ³ EDF R&D, Écuille, France

4DO.5.5 Performance Analysis of a Zigzag Noise Barrier in a Belgian Highway

Sara Bouguerra¹, Richard de Jong¹, Fallon Colberts², Marta Casasola Paesa¹, Ismail Kaaya¹, Nikoleta Kyranaki¹, Arnaud Morlier¹, Michaël Daenen¹
¹ IMO-IMOMEC, Diepenbeek, Belgium; ² Zuyd University, Heerlen, The Netherlands

4DO.5.6 Hybrid (Tandem?) Implementation: Solar Spectrum Splitting PV/CSP for Thermal and Electrical Energy Harvesting

Jonathan Govaerts¹, Bart Reekmans¹, Patrick Choulat¹, Filip Duerinckx¹, Loic Tous¹, Bin Luo¹, Tom Borgers¹, Hariharsudan Sivaramakrishnan Radhakrishnan¹, Jef Poortmans¹, Hannes Laget², Qizheng Dou³, Francis Costa³, Lieven Stalmans³, Ravi Kishore⁴, Youri Meuret⁴, Georgi H. Yordanov⁴, Jens Moschner⁴, Tatjana Vavilkin⁵, Stefan Dewalle⁵
¹ imec, Genk, Belgium; ² Azteq, Genk, Belgium; ³ Borealis, Beringen, Belgium; ⁴ KULeuven, Leuven, Belgium; ⁵ Soltech, Genk, Belgium

ORAL PRESENTATIONS 5DO.10

17:00 - 18:30 Manufacturing PV in Europe | Social Aspects of PV

Chairpersons: Dr. Eero Vartiainen
Fortum Renewables Oy, Finland
Ms. Silvia Caneva
WIP Renewable Energies, Munich, Germany

5DO.10.1 Would an Increase in PV Modules Prices Impact the European PV Market?

Johan Lindahl¹, Gaëtan Masson², Elina Bosch², Amelia Oller Westerberg¹
¹ Becquerel Sweden, Stockholm, Sweden; ² Becquerel Institute, Brussels, Belgium



5DO.10.2 Reshoring PV Manufacturing to Europe: Can EU-made PV Compete in a Global Market?

Atse Louwen¹, Mohammad Dehghanimadvar², Nathan Chang², Julian Reichle³, Wolfgang Jooß³, Peter Fath³, Elisa Veronese¹, Cristina Polacchi¹, Jordi Veirman¹, David Moser¹

¹ Eurac Research, Bolzano, Italy; ² UNSW, Sydney, Australia; ³ RCT Solutions, Konstanz, Germany

5DO.10.3 Cost Driven Planning for New PV Production Facilities: Case Study for Setting-up a TOPCon Cell Factory in Europe

Baljeet Singh Goraya¹, Dilara Maria Subasi¹, Peter Henri Brailovsky Signoret¹, Vasileios Georgiou-Sarlikiotis¹, Sukesh Mysore Swamy¹, Estelle Gervais¹, Oscar Rodolfo Ortega Alvarado¹, Nico Wöhrle¹, Jochen Rentsch¹, Sebastian Nold¹

¹ Fraunhofer ISE, Freiburg, Germany

5DO.10.4 Challenges and Strategies for Establishing a Rooftop Photovoltaic System Crowdsourced by Students and Employees at a University

Marta Victoria¹, Zhe Zhang¹, Gorm B. Andresen¹, Parisa Rahdan¹, Ebbe K. Gøtske¹

¹ Aarhus University, Aarhus, Denmark

5DO.10.5 Adoption of Solar Green Electricity by Small and Medium-Sized Enterprises: A Case Study in Singapore on Motivations and Deterrents

Mavian Tay¹, Grace Wong¹, Siu-Kit Lau¹, Stephen Tay¹

¹ National University of Singapore, Singapore, Singapore

5DO.10.6 Social Acceptance of Floating Photovoltaics: from the General to the Local Perspective

Leonardo Micheli¹, Alice Zaghini¹, Fabio Bisegna¹

¹ Sapienza University of Rome, Rome, Italy

ORAL PRESENTATIONS 5DO.15

17:00 - 18:30 Resilience and Security of Supply

Chairpersons: Mr. Johannes Stierstorfer
WIP Renewable Energies, Munich, Germany
Dr. Tsvetelina Merdzhanova
Forschungszentrum Jülich, Jülich, Germany

5DO.15.1 Extraction of PV Yield Data from Smart Meter Data Disaggregation

Bas van der Ploeg¹, Wilfried van Sark¹

¹ Utrecht University, Utrecht, The Netherlands

5DO.15.2 Development of an Architecture for Power Interchange by Linking Photovoltaic and Electrification Vehicles

Jun Tsunoda¹, Tohru Kohno¹, Issei Suemitsu¹, Kengo Kumano¹

¹ Hitachi, Tokyo, Japan

5DO.15.3 Possibilities of PV Maximization for Achieving Positive Energy Districts with Respect to Building Density

Helmut Bruckner¹, Maarten Verkou², Simon Schneider³, Miro Zeman², Zain UI Abidin⁴, Rudi Santbergen⁴, Olindo Isabella⁴

¹ Sonnenplatz Grossschoenau, Grossschoenau, Austria; ² PV Works, Delft, The Netherlands; ³ FH Technikum Wien, Wien, Austria; ⁴ TU Delft, Delft, The Netherlands

5DO.15.4 Local Energy Hub for Urban Environment: Role of Energy Management System

Aihui Fu¹, Joel Bosrup², Simona Renzaglia¹, Milos Cvetkovic¹, Marjan Krejins¹, Miro Zeman¹, Olindo Isabella¹

¹ TU Delft, Delft, The Netherlands; ² Wintersol Energy, Utrecht, The Netherlands

5DO.15.5 Reliability Analysis of Coupled PV-Electrolyser Systems – Evaluation of OnSite Factors

Stefan Niederhofer¹, Marcus Rennhofer², Rene Hofmann³

¹ Austrian Institute of Technology, Obernberg am Inn, Austria; ² Austrian Institute of Technology, Vienna, Austria; ³ Vienna University of Technology, Vienna, Austria

5DO.15.6 Grid Supporting Powerplants on 100% Energy from PV and Wind

Gerhard Mütter¹, Andreas Hensel², Jan Winkelmann³

¹ Gerhard Mutter, Waldneukirchen, Austria; ² Fraunhofer ISE, Freiburg, Germany; ³ VENSYS Electrical Engineering, Diepholz, Germany

ORAL PRESENTATIONS 3DO.20

17:00 - 18:30 Shading and Soiling on PV Modules

Chairpersons: Dr. Anna J. Carr
TNO, Petten, The Netherlands
Dr. Giorgio Bardizza
TÜV Rheinland Solar GmbH, Köln, Germany

3DO.20.1 Simplified Simulation and Experiments for Hot-Spot Evaluation of Novel PV Module with Partial Shading

Jay Lin¹, Shiny Chen¹, Min-An Tsai², Yean-San Long², Wei Lun Yang²

¹ PV Guider, Taipei, Taiwan; ² ITRI, Hsinchu, Taiwan

3DO.20.2 Correlating Field Experimentation and Image Processing for the Assessment of Induced Losses from Thin Object Shading

Matthew Axisa¹, Marija Demicoli¹, Luciano Mule¹, Stagno¹

¹ University of Malta, Marsaxlokk, Malta

3DO.20.3 Laboratory Intercomparison on a Shading Resistance Classification of PV Modules

Stefan Riechelmann¹, Hendrik Sträter¹, Giorgio Bardizza², Werner Herrmann², Ebrar Özkalay³, Gabi Friesen³, Özcan Bazkir⁴, Alexandra Schmid⁵, Stefan Winter¹

¹ PTB, Braunschweig, Germany; ² TÜV Rheinland, Cologne, Germany; ³ SUPSI, Manno, Switzerland; ⁴ TÜBITAK, Ankara, Türkiye; ⁵ Fraunhofer ISE, Freiburg, Germany

3DO.20.4 Exploring Dust Particle Properties and PV Soiling Mapping: A Case Study in the Arid Landscape of a Desert Environment

Brahim Aissa¹, Atef Zekri², Mosab Kareem Subeh¹

¹ QEERI, Doha, Qatar; ² HBKU Core Labs, Doha, Qatar

3DO.20.5 Correlation Analysis Between Soiling Coverage, Light Transmittance, Short-circuit Current Losses and Characteristics of Deposited Dusts

Guido Willers¹, Nattakarn Sakarapunthip², Ralph Gottschalg¹, Klemens Ilse¹

¹ Fraunhofer CSP, Halle, Germany; ² KMUTT, Bangkok, Thailand



3DO.20.6 PV Module Cleaning under Hot Desert Conditions

Gerhard Mathiak¹, Afra Seentakath¹, Nithin Sha¹, Prashanth Gabbadi¹,
Arumugham Muthusamy¹, Kaushal Chapaneri¹

¹ DEWA R&D Center, Dubai, United Arab Emirates

OTHER PRESENTATIONS

17:00 - 18:30

Poster Award Winner Session

Friday, 27. September 2024

ORAL PRESENTATIONS 3EO.1

08:30 - 10:00 In Field Characterisation of PV Modules | BoS Components in Operation

Chairpersons: Dr. Teodora Stoyanova Lyubenova
Joint Research Centre, Ispra, Italy

Dr. Nikos Kopidakis
NREL, Golden, United States of America

3EO.1.1 Verification of In-Field Visual Inspection for Application on Utility-Scale PV Power Plants

Monphias Vumbugwa¹, Jacqueline Crozier McClelland¹, Ernest van Dyk¹,
Frederik Vorster¹, Oleksandr Stroyuk², Poland Michael¹, Roelof Roodt¹,
Ian Marius Peters², Claudia Buerhop-Lutz²

¹ Nelson Mandela University, Port Elizabeth, South Africa; ² FZJ -HI ERN, Erlangen, Germany

3EO.1.2 From Fab to Field - Quality Control with a Mobile PV Laboratory

Magnus Herz¹, Hamza Maaroufi¹, Giorgio Bardizza²

¹ TÜV Rheinland, Cologne, Germany; ² TÜV Rheinland, Milan, Italy

3EO.1.3 Reduction of Uncertainty of Outdoor PV Module Characterization: Test Field Experiences

Mariella Rivera¹, Christian Reise¹

¹ Fraunhofer ISE, Freiburg, Germany

3EO.1.4 Fully Integrated and System-Optimized Electronic Solutions on Solar Modules

Henning Schulte-Huxel¹, Tobias Manthey², Tobias Brinker², Paul Ranft³,
Henning Woock⁴, Tim Hahn², Leonardo Moerlein², Susanne Blankemeyer¹,
Adrian Skorcz³, Marc Köntges¹, Dirk Manteuffel², Jens Friebe²

¹ ISFH, Emmerthal, Germany; ² Leibniz University Hannover, Hannover, Germany; ³ Optimal Schmelzglasstechnik, Iserlohn, Germany; ⁴ who Ingenieurgesellschaft, Lubeck, Germany

3EO.1.5 MPP Tracking Losses of Module Level Power Electronics at Partial Module Shading

Franz P. Baumgartner¹, Adrian Widler¹, Linus Baumann¹

¹ ZHAW, Winterthur, Switzerland

3EO.1.6 Improvement of Tracking Algorithms using Machine Learning

Sarra Ben Brahim¹, Kai Saegebarth¹, Martin Dennenmoser², Alsayed Algergawy³

¹ Baywa, Munich, Germany; ² Baywa, Freiburg, Germany; ³ University of Passau, Passau, Germany



ORAL PRESENTATIONS 4EO.2

08:30 - 10:00 Planning of PV Systems | Digital PV

Chairpersons: Mr. Roland Bründlinger
AIT, Vienna, Austria
Mr. Michele Olisi
PVsyst, Satigny, Switzerland

4EO.2.1 BIPV and PV in a Multidisciplinary Building Information Modelling (BIM) Planning and Asset Management System

Astrid Schneider¹, Karin Stieldorf¹, Christian Schranz¹, Harald Urban¹, Alfred Waschl², Markus Feichtner³, Fedele Rende⁴, Andreas Aiello⁵, Martin Hauer⁶, Kurt Battisti⁷, Markus Dörn⁷, Jaqueline Scherret⁷, Christoph Treberspurg⁸

¹ TU Vienna, Vienna, Austria; ² buildingSMART, Vienna, Austria; ³ Sonnenkraft, Veith, Austria; ⁴ ACCA Software, Bagnoli, Italy; ⁵ ACCA Software, Vienna, Austria; ⁶ Bartenbach, Aldrans, Austria; ⁷ A-Null Development, Vienna, Austria; ⁸ Treberspurg and Partner, Vienna, Austria

4EO.2.2 Assessing Yield Disparities: Anticipated Versus Optimal Rooftop Solar Photovoltaic Systems and Implications for Prosumer Viability

Dominik Keiner¹, Dmitrii Bogdanov¹, Stefan Krauter², Christian Breyer¹

¹ LUT University, Lappeenranta, Finland; ² Paderborn University, Paderborn, Germany

4EO.2.3 Energy Yields and Wind Loads of Alternative PV Designs for Roofs in Snowy Climates

Maria Svedjeholm¹, Josefin Lampa¹, Anna Malou Petersson¹, Arvid Olofsson¹, Robin Andersson¹, Ehsan Fooladgar¹, Pirjo Estola², Mattias Lindh¹

¹ RISE, Umeå, Sweden; ² Lulea Energi, Lulea, Sweden

4EO.2.4 Digital Twin of Photovoltaic Power Plants Considering Spatio-Temporal Characteristics

Faruk Ugranlı¹, Eşref Deniz², Engin Karatepe³

¹ Izmir Bakircay University, Izmir, Türkiye; ² Entegro Enerji Sistemleri, Izmir, Türkiye; ³ Ege University, Izmir, Türkiye

4EO.2.5 Federated Learning and Homomorphic Encryption for Privacy-Preserving Load and PV Generation Prediction

Mousa Sondoqah¹, Atse Louwen¹, David Moser¹, Grazia Barchi¹

¹ EURAC, Bolzano, Italy

4EO.2.6 Impact and Frequency of Extreme Weather Events on the National Photovoltaic Power Supply

Leonardo Micheli¹

¹ Sapienza University of Rome, Rome, Italy

ORAL PRESENTATIONS 5EO.3

08:30 - 10:00 Challenges and Opportunities along the PV Value Chain

Chairpersons: Ms. Maria Getsiou
European Commission DG RTD, Brussels, Belgium
Mr. Philippe Malbranche
CEA, Le Bourget-du-Lac, France

5EO.3.1 European PV Manufacturing and LCOE: Ensuring Resilience and Competitiveness Through R&I and Industrial Policies

Ivona Kafedjiska¹, Christian Breyer², Chiara Busto³, Nabih Cherradi⁴, Peter Fath⁵, Bianca Lim⁶, David Moser⁷, Ralf Preu⁸, Eduardo Roman⁹, Rutger Schlatmann¹, Marko Topić¹⁰, Jutta Trube¹¹, Eero Vartiainen¹²

¹ HZB, Berlin, Germany; ² LUT University, Lappeenranta, Finland; ³ Eni, Novara, Italy; ⁴ Desert Technologies, Jeddah, Saudi Arabia; ⁵ RCT Solutions, Konstanz, Germany; ⁶ ISFH, Emmerthal, Germany; ⁷ Eurac Research, Bolzano, Italy; ⁸ Fraunhofer ISE, Freiburg, Germany; ⁹ TECNALIA, Bilbao, Spain; ¹⁰ University of Ljubljana, Ljubljana, Slovenia; ¹¹ VDMA, Frankfurt, Germany; ¹² Fortum Renewables, Espoo, Finland

5EO.3.2 Comparative Global PV Manufacturing Cost and Sustainable Pricing Assessment: China, Southeast Asia, India, USA, and Europe

Sebastian Nold¹, Baljeet Singh Goraya¹, Ralf Preu¹, Jochen Rentsch¹, Julian Reichle², Wolfgang Jooß², Peter Fath², Michael Woodhouse³

¹ Fraunhofer ISE, Freiburg, Germany; ² RCT Solutions, Konstanz, Germany; ³ NREL, Golden, United States of America

5EO.3.3 Assessing the Potential of Agrivoltaic Systems in Korea through Geospatial Analysis and Multi-Criteria Scenarios

Chang Yeol Yun¹, Changki Kim¹, Jinyoung Kim¹, Sangmin Jo², Yongil Kim³

¹ Korea Institute of Energy Research, Daejeon, South Korea; ² Korea Energy Economics Institute, Ulsan, South Korea; ³ Seoul National University, Seoul, South Korea

5EO.3.4 Integration of Photovoltaic Systems in the Austrian Power Plant Portfolio – A Geospatial Data Analysis

Stefan Übermayer¹, Fabian Leimgruber¹

¹ AIT, Vienna, Austria

5EO.3.5 Distributed Photovoltaics Provides Key Benefits for a Highly Renewable European Energy System

Parisa Rahdan¹, Elisabeth Zeyen², Cristobal Gallego-Castillo³, Marta Victoria¹

¹ Aarhus University, Aarhus, Denmark; ² TU Berlin, Berlin, Germany; ³ Technical University of Madrid, Madrid, Spain

5EO.3.6 Identifying the Ecological Implications of the Repowering of PV Systems

Marie Fischer¹, Sina Herceg¹, Karl-Anders Weiß¹, Liselotte Schebek²

¹ Fraunhofer ISE, Freiburg, Germany; ² Technical University of Darmstadt, Darmstadt, Germany



PLENARY PRESENTATIONS EP.1

10:30 - 12:00

Sustainability

Chairpersons:

David Moser
Eurac Research, Bolzano, Italy
Delfina Muñoz
CEA, Le Bourget-du-Lac, France

5EP.1.1 Future Material Demand for Global Silicon-Based PV Modules Under Net-Zero Emissions Target Until 2050

Chengjian Xu¹, Olindo Isabella¹, Malte Vogt¹

¹ Delft University of Technology, Delft, The Netherlands

1EP.1.2 Copper as Cost-Effective Alternative to Silver for Si Solar Cell Metallization – Status and Outlook

Florian Clement¹, Andreas Lorenz¹, Jonas Huyeng¹, Roman Keding¹, Jonas Bartsch¹, Sven Kluska¹, Andreas Brand¹, Jan Nekarda¹, Sebastian Pingel¹, Daniel Ourinson¹, Ralf Preu¹

¹ Fraunhofer ISE, Freiburg, Germany

5EP.1.3 Towards Reuse-ready PV: A Perspective on Recent Advances, Practices and Future Challenges

Ioannis (John) Tsanakas¹, Gernot Oreski², Gabriele Eder³, Anika Gassner³, Arvid van der Heide⁴, Daniela Ariolli⁵, Guillermo Oviedo Hernandez⁵, David Moser⁶, Karsten Wambach⁷

¹ CEA, Le Bourget-du-Lac, France; ² PCCL, Leoben, Austria; ³ OFI, Vienna, Austria; ⁴ imo-imomec, Genk, Belgium; ⁵ BayWa r.e., Milan, Italy; ⁶ Eurac Research, Bolzano, Italy; ⁷ Wambach-Consulting, Petersdorf, Germany

5EP.1.4 Enhancing Citizens' Participation in PV Deployment

Silvia Caneva¹, Duygu Celik¹, Chiara Busto², Chiara Candelise³, Alessia Cornella⁴, Letizia Bua⁵, Edouard Breniaux⁶, Nouha Gazbour⁷, Ivan Gordon⁸, Wander Jager⁹, Rudolf Kapeller¹⁰, Gökhan Kirkil¹¹, Paola Mazzucchelli¹², Osbel Almora Rodríguez¹³, Marcello Passaro¹⁴, Alessandro Sciallo¹⁵, Sebastien Lizin¹⁶, Alessandro Martulli¹⁶, Atse Louwen⁴, Hanna Dittmar¹⁷, Thomas Garabetian¹⁷, Rania Fki¹, Johannes Stierstorfer¹, Melanie Kern¹

¹ WIP Renewable Energies, Munich, Germany; ² Eni, Novara, Italy; ³ Bocconi University, Milan, Italy; ⁴ Eurac Research, Bolzano, Italy; ⁵ Eni, Milan, Italy; ⁶ Carnot Institute Chimie Balard Cirimat, Toulouse, France; ⁷ CEA, Le Bourget-du-Lac, France; ⁸ imec, Genk, Belgium; ⁹ University College Groningen, Groningen, The Netherlands; ¹⁰ Johannes Kepler University Linz, Linz, Austria; ¹¹ Kadir Has University, Istanbul, Türkiye; ¹² CIRCE, Zaragoza, Spain; ¹³ URV, Tarragona, Spain; ¹⁴ Sunzest Solar, Rotterdam, The Netherlands; ¹⁵ University of Turin, Turin, Italy; ¹⁶ Hasselt University, Hasselt, Belgium; ¹⁷ SolarPower Europe, Brussels, Belgium

12:00 – 13:00 CONFERENCE CLOSING

Welcome to the Closing Session

Highlights of the Conference

Ceremony of the Student Awards

Ceremony of the Poster Awards

Announcement upcoming PV events

What do we take home from the EU PVSEC?
Farewell and Closing



EU PVSEC 2024 VISUAL PRESENTATIONS

Monday, 23. September 2024

VISUAL PRESENTATIONS 3AV.1

13:30 - 15:00 PV Module Design and Manufacturing | BoS Components, Operation and Aging

Chairpersons: Dr. Eszter (Esther) Voroshazi
CEA, Le Bourget-du-Lac, France
Dr. Jens Moschner
KULeuven, Leuven, Belgium

3AV.1.1 Using DoE Mathematical Models for the Optimization of EVA and POE Encapsulant Additives

Fabio Silva¹, Kristof Proost¹
¹ IP FAB, Mechelen, Belgium

3AV.1.3 New Encapsulant Materials for Eco-Design PV: Thermochemical Characterization

Valeria Fiandra¹, Lucio Sannino¹, Concetta Andreozzi¹, Mario Tucci², Massimo Izzi²
¹ ENEA Portici, Naples, Italy; ² ENEA Casaccia, Rome, Italy

3AV.1.4 Challenges for Solder Interconnection Pushed by High-Efficiency Solar Cell Developments

Benjamin Grübel¹, Angela De Rose¹, Achim Kraft¹
¹ Fraunhofer ISE, Freiburg, Germany

3AV.1.5 Optimizing Sustainability: Balancing Antimony Content for Enhanced Optical Properties and Environmental Impact in Solar Glass

Anika Glaubitz¹, Sven Grüttner¹, Selim Yagci¹, Oliver Pfeiffer¹, Ulf Blieske¹
¹ University of applied Sciences Cologne, Cologne, Germany

3AV.1.6 Photovoltaic Modules Comprising III-V Cells Encapsulated in Composite Material

Oihana Zubillaga¹, Werther Cambarau¹, Naiara Yurrita¹, Jon Aizpurua¹, Juan M. Hernández¹, Gorka Imbuluzqueta¹, Francisco J. Cano¹, Eduardo Román Medina²
¹ TECNALIA, Donostia - San Sebastián, Spain; ² TECNALIA, Derio, Spain

3AV.1.7 Formulation and UV Ageing Behavior of Colored, Thermoplastic Encapsulants for Double Glass Photovoltaic Modules

Martin Huemer¹, Gernot M. Wallner¹, Andreas Brandstätter²
¹ University of Linz, Linz, Austria; ² Lenzing Plastics, Lenzing, Austria

3AV.1.8 Approach to Light-Weight of Bi-Facial Photovoltaic Module Structural Design

Yohan Noh¹, Jaehyeong Lee¹
¹ Sungkyunkwan University, Suwon-si, South Korea

3AV.1.10 Techno-Economic Analysis of Rectangular Solar Cells in PV Modules

Max Mittag¹, Hannah Hoffman¹, Nico Wöhrle¹, Alexander Protti¹, Sebastian Nold¹, Christian Reichel¹, Holger Neuhaus¹
¹ Fraunhofer ISE, Freiburg, Germany

3AV.1.11 Reliability of Aluminum-Copper Contact in PV Modules

Tobias Messmer¹, Andreas Halm¹
¹ ISC Konstanz, Konstanz, Germany

3AV.1.12 Lightweight Photovoltaic Modules Technologies: Reliability Evaluation and Market Opportunity

Julien Dupuis¹, Christine Abdel Nour¹, Paul Lefillastre¹
¹ EDF R&D, Palaiseau, France

3AV.1.13 Design and Investigation of Anti-Soiling Coatings for Mitigating Dust Accumulation on Photovoltaic Panels

Redouane Miloua¹, Attouya Bouzidi¹, Abdelkader Nakrela¹
¹ Djillali Liabès University, Sidi Bel-Abbes, Algeria

3AV.1.15 MgO/SiOX Adds Heat Dissipation Function to Crystalline Silicon Solar Cell Modules

Eiko Shimokata¹, Yasushi Sobajima¹, Keisuke Ohdaira², Atsushi Masuda³
¹ Gifu University, Gifu, Japan; ² JAIST, Nomi, Japan; ³ Niigata University, Niigata, Japan

3AV.1.16 Investigation of Temperature Homogeneity during Infrared Soldering of Silicon Solar Cells Using the Finite Element Method

Daniel Christopher Joseph¹, Angela De Rose¹, Dirk Eberlein¹, Onur Parlayan¹, Benjamin Grübel¹, Andreas J. Beinert¹, Holger Neuhaus¹
¹ Fraunhofer ISE, Freiburg, Germany

3AV.1.17 Impact of Textured Surfaces and Cleaning on Solar Panel Glass Transmittance

Aapo Poskela¹, Julianna Virjonen¹, Tommi Jokikyyny¹, Aleksi Kamppinen¹, Heikki Palonen¹, Kati Miettunen¹
¹ University of Turku, Turku, Finland

3AV.1.18 Analyzing the Changes in Electrically Conductive Adhesives During the Curing Process for Shingled Solar Cells

Meryem Ezgi Karahalli¹, Parisa Sharif¹, Cem Maden¹, Talat Ozden¹
¹ ODTU-GUNAM, Ankara, Türkiye

3AV.1.19 Ultra-thin Flexible Glass as Environmental Shield for CIGS Photovoltaic Modules

Nikolina Pervan¹, Sonja Feldbacher¹, Martina Harnisch², Tuuli Tettenborn², Andreas Zimmermann², Gernot Oreski¹
¹ PCCL, Leoben, Austria; ² Sunplugged, Wildermieming, Austria

3AV.1.20 Process Development and Material Evaluation of Photovoltaic Aluminum Facade Element for BIPV Applications

Ringo Koepge¹, Matthias Pander¹, Stephan Großer¹, Bengt Jaeckel¹
¹ Fraunhofer CSP, Halle (Saale), Germany

3AV.1.21 Low Temperature Encapsulation for Sensitive Solar Cell Technologies

Maria Van Eijndhoven¹, Jeroen Oderkerk², Geir Kristian Johnsen¹
¹ Borealis Polymers, Beringen, Belgium; ² Borealis, Stenungsund, Sweden

3AV.1.22 Material Properties Requirements for Frame Sealant and Junction Box Adhesives

Guy Beaucarne¹, Emmanuel Jadot¹, Dominique Culot¹, Rono Cao², Kayla Kenney³, Suraj Ahuja⁴
¹ Dow Silicones Belgium, Seneffe, Belgium; ² Dow, Shanghai, China; ³ Dow Silicones Corporation, Midland, United States of America; ⁴ Dow Chemical International, Mumbai, India



3AV.1.23 Solder Pastes in Shingled Modules

Karl Wienands¹, Ignacia Devoto¹, Nils Kopp², Carina Hallensleben², Rihoko Kizukuri², Matthias Helbig¹, Enita Kurtovic¹, Andreas Halm¹, Daniel Tune¹

¹ ISC Konstanz, Konstanz, Germany; ² TAMURA-ELSOLD, Ilsenburg, Germany

3AV.1.24 Polyethylene Glycol Enhances the Electrical Conductivity of Epoxy-based Adhesives with Low Silver Content for Application in Photovoltaics

Marianne Kronsbein¹, Norbert Willenbacher¹

¹ KIT, Karlsruhe, Germany

3AV.1.25 TiO₂/SiO_x Surface Coating on Crystalline Silicon-Based-Solar Cell Module to Provide Anti-Soiling Functionality

Koshiro Iwaki¹, Yasushi Sobajima¹, Keisuke Ohdaira², Atsushi Masuda³

¹ Gifu University, Gifu, Japan; ² JAIST, Nomi, Japan; ³ Niigata University, Niigata, Japan

3AV.1.26 Performance Analysis of Different Shading-Resistant PV Module Designs under Different Partial Shading Scenarios

Andreas Maixner¹, Tales Siquera¹, Matthias Pander², Jens Froebel², Bengt Jaeckel², Hamed Hanifi¹

¹ AESOLAR, Koenigsbrunn, Germany; ² Fraunhofer CSP, Halle, Germany

3AV.1.27 FoilMet®-Interconnect-Shingling: Latest Results of our Silver-, Copper-, Lead-, Solder- and Adhesive-free Cell & String Interconnection Technology for Crystalline Silicon PV Based on Laser Joined Pure Aluminum Foil

Jan Nekarda¹, Julian Weber¹, Max Mittag¹, Gernot Emanuel¹, Andreas Nägele¹, Ralf Preu¹

¹ Fraunhofer ISE, Freiburg, Germany

3AV.1.28 Analysis of Electrical Characteristics and Power Degradation of Split Heterojunction Solar Cells with Non-Destructive Cutting Laser Scriving

Guemhee Ham¹, Jae Hyeong Lee¹

¹ Sungkyunkwan University, Suwon-si, South Korea

3AV.1.29 Easy-to-Apply Multifunctional Nanocoatings for PV Systems in Desert Climate

Paulius Laurikėnas¹, Julius Denafas¹, Tadas Radavicius¹, Claudio Fernánde², Tamara Oroz², Jesús Cordón², Julian Crespo³, Dounia Dahlioui⁴, Hichame Laabassi⁴, Hélène Ben Khemis⁵, Zaher Khantouch⁵

¹ Solitek, Vilnius, Lithuania; ² Lurederra, Los Arcos, Spain; ³ Tecnan, Los Arcos, Spain; ⁴ MASEN, Rabat, Morocco; ⁵ ANME, Montplaisir, Tunisia

3AV.1.30 Optimising and Applying Conductive Pastes for Electrode Sheet and Cell/Module Integration Processes

Donggun Lim¹, Chang-soon Han²

¹ Korea National University of Transportation, Chungbuk, South Korea; ² Jeonnam Technopark, Stiftung, Jeollanam-do, South Korea

3AV.1.31 Light Plastic and Compact Micro-CPV Module

Corentin Jouanneau¹, Xavier Lepage², Konan Kouame³, Thomas Bidaud¹, Gwenaëlle Hamon¹, Maxime Darnon⁴

¹ University of Sherbrooke, Sherbrooke, Canada; ² Université de Sherbrooke, Sherbrooke, Canada; ³ Université de Sherbrooke, Immeuble P2, Sherbrooke, Canada; ⁴ CNRS / Université de Sherbrooke, Sherbrooke, Canada

3AV.1.32 Investigation on Laser-induced Efficiency Losses in P3 Scribing of Cu(In,Ga)Se₂ Thin-film Monolithic-integrated Modules

Seungsik Ham¹, Seonghoon Jeong¹, Eunseo Choi¹, Eun Pyung Choi¹, Gee-Yeong Kim¹, Won Mok Kim¹, David J. Hwang², Jeung-hyun Jeong¹

¹ KIST, Seoul, South Korea; ² SUNY, Albany, United States of America

3AV.1.33 Optimal Design for Flexible Solar Panels Attached around Cylindrical Poles

Hiroki Sugimoto¹

¹ PXP Corporation, Sagamihara, Japan

3AV.1.34 Exploring Fan-out Wafer Level Packaging for Concentrated Photovoltaics Modules

Médéric Marcotte¹, Artur Turala², Konan Kouame¹, Corentin Jouanneau², M. Kerbat³, Mylana Ney¹, Mohamed Najah¹, Serge Ecoffey¹, Gwenaëlle Hamon²

¹ Université de Sherbrooke, Immeuble P2, Sherbrooke, Canada; ² University of Sherbrooke, Sherbrooke, Canada; ³ Université de Sherbrooke, Sherbrooke, Canada

3AV.1.35 Design and Implementation of a CSI Photovoltaic Microinverter Prototype with High Frequency Switching

Francisco Guzman¹, Patricio Valdivia-Lefort¹, Antonio Sanchez¹, Rodrigo Barraza¹

¹ Federico Santa Maria Technical University, Santiago, Chile

3AV.1.36 Analysis of the Impact of Shading on PV Systems Located in Germany and Australia

Marija Milosavljeva¹

¹ Fronius International, Wels, Austria

3AV.1.37 PV Microinverters: Balcony Power Plants, Latest Efficiency Rankings, Yield Calculation for Overpowered Mini PV Systems

Stefan Krauter¹, Jörg Bendfeld¹

¹ Paderborn University, Paderborn, Germany

3AV.1.38 Aging Behavior of Polymeric Materials Used in Inverter Casings

Eric Helfer¹, Petra Christöfl¹, Julia Petro¹, Margit Lang¹, Gernot Oreski¹

¹ PCCL, Leoben, Austria

3AV.1.39 Performance of Arc Fault Circuit Interrupters in Photovoltaic Inverters Connected to Long DC Cables

Christof Bucher¹, Donat Hess¹, David Joss¹

¹ BUAS, Burgdorf, Switzerland

3AV.1.40 Design of the Substring MPP Tracker

Patrick Mader¹, Sascha Eckerter¹, Rainer Merz¹

¹ Karlsruhe University of Applied Sciences, Karlsruhe, Germany

3AV.1.41 Testing of Electronic Interface for Diagnostic Functions of Photovoltaic Systems

Edoardo Celi¹, Alessandro Minuto¹, Stefano Rizzi¹, Gianluca Timò¹

¹ RSE, Piacenza, Italy



VISUAL PRESENTATIONS 3AV.2

15:15 - 16:45 PV Modules Reliability: Components, Failure Mechanisms, Testing & Modelling

Chairpersons: Dr. Ioannis (John) Tsanakas

CEA, Le Bourget-du-Lac, France

Dr. Guy Beaucarne

Dow Silicones Belgium, Seneffe, Belgium

Ms. Eve Krassowski

CE Cell Engineering, Kabelsketal, Germany

3AV.2.1 Impact of Climatic Conditions in Degradation Assessment of PV Modules Exposed to Extreme High UV Solar Radiation

Valentina Navarro¹, Patricio Valdivia-Lefort¹, Rodrigo Barraza¹

¹ Federico Santa Maria Technical University, Santiago, Chile

3AV.2.2 PV Module Brush Abrasion Testing

Gerhard Mathiak¹, Nithin Sha¹, Prashanth Gabbadi¹, Yogesh Kumar¹, Afra Seentakath¹, Mark Mirza²

¹ DEWA R&D Center, Dubai, United Arab Emirates; ² Fraunhofer ISC, Würzburg, Germany

3AV.2.3 Numerical Simulation for Comparison of PV Module Designs Based on Outdoor Data in Desert Climates

Matthias Pander¹, Bengt Jaeckel¹, Klemens Ilse¹, Amir A. Abdallah²

¹ Fraunhofer CSP, Halle (Saale), Germany; ² QEERI HBKU, Doha, Qatar

3AV.2.5 Impact of Modern Cell Geometries on Power and Energy Loss due to Cell Cracks

Aniket Shirgupe¹, Ahmad Hashem², Ralph Gottschalg³

¹ Hochschule Anhalt, Halle (Saale), Germany; ² Hochschule Anhalt, Köthen, Germany; ³ Fraunhofer CSP, Halle (Saale), Germany

3AV.2.6 Approaching the Safety Limits for Powerful Modules

Nico J. Dekker¹, Gertjan J. de Graaf¹, Mark J. Jansen¹, Koen M. de Groot¹, Lenneke H. Slooff², Menno N. van den Donker³, Gerard de Leede³, Wouter van Strien¹, Tatjana Vavilkin⁴, Stefan Dewallef⁴, Peter Pasmans⁵

¹ TNO Solar Energy, Petten, The Netherlands; ² TNO Energy Transition, Petten, The Netherlands; ³ Solarge, Weert, The Netherlands; ⁴ Soltech, Genk, Belgium; ⁵ Endurans, Urmond, The Netherlands

3AV.2.7 Performance Evaluation of the Custom-Made Small PV Modules After Exposure to Saudi Arabia's Climatic Conditions Over 10 Long Years

Amir Al-Ahmed¹, Amjad Ali¹, Mohammed A. Alghamdi², Osama Asker², Ridha Ben Mansour¹, Firoz Khan¹, Atif S. Alzahrani¹

¹ KFUPM, Dhahran, Saudi Arabia; ² Gulf Renewable Lab, Dammam, Saudi Arabia

3AV.2.8 Analyzing the Effect of Damp Heat Test on Various PV Module Technologies, A Comparative Study

Ahmad Alheloo¹, Ali Almheiri¹, Baloji Adothu¹, Gerhard Mathiak¹, Vivian Alberts¹

¹ DEWA, Dubai, United Arab Emirates

3AV.2.9 Comparative Degradation Analysis of Emerging PV Module Technologies Undergoing Thermal Cycling

Ali Almheiri¹, Ahmad Alheloo¹, Baloji Adothu¹, Gerhard Mathiak¹, Vivian Alberts¹

¹ DEWA, Dubai, United Arab Emirates

3AV.2.10 Assessment of Critical Laminate Temperatures Increase by Fast IR-based Analysis of Hot Spots on Solar Cells

Stephan Grosser¹, Matthias Schak¹, Stefan Eiternick¹, Bengt Jaeckel¹, Marko Turek¹

¹ Fraunhofer CSP, Halle (Saale), Germany

3AV.2.11 Correlational Study on the Impact of Harsh Environment Stress Factors on the Ageing Effects of Several Encapsulation Materials for PV Modules

Tudor Timofte¹, Valentina Arias Reyes², Ignacia Maria Acevedo Devoto¹, Joachim Glatz-Reichenbach¹, Andreas Halm¹

¹ ISC Konstanz, Konstanz, Germany; ² Technical University Federico Santa Maria, Valparaíso, Chile

3AV.2.12 Determination of Environmental Factors Accelerating Degradation in Bifacial Modules Located in Santiago Including UVA, Uvb, Incident Radiation and Day-Night Temperature Variations.

Valentina Arias Reyes¹, Patricio Valdivia-Lefort¹, Iván González Echeverría¹, Rodrigo Barraza Vicencio¹

¹ Federico Santa Maria Technical University, Santiago, Chile

3AV.2.13 Electrical Characterization of Fresh and Degraded Photovoltaic Backsheets Based on Temperature and Humidity-Dependent DC Conductivity

Anagha E R¹, Shrikrishna V Kulkarni¹, Narendra Shiradkar¹

¹ IIT Bombay, Mumbai, India

3AV.2.14 Investigation of PV Module Degradation in Fixed and Single-axis Tracker in Hot Desert Climate

Baloji Adothu¹, Shahzada Pamiir Aly¹, Afra Seentakath Puthiyapurayil¹, Kaushal Chapaneri¹, Gerhard Mathiak¹, Vivian Alberts¹

¹ DEWA R&D Center, Dubai, United Arab Emirates

3AV.2.15 Experimental and Numerical Study of Glass Failure in a PV Module due to External Stresses

Kamal Harb¹, Zeina Hamam², Olivier Doucet², Jérémie Aime²

¹ ENS Paris Saclay, Gif-sur-Yvette, France; ² INES, Le Bourget-du-Lac, France

3AV.2.16 Performance Degradation Analysis of Glass/Glass Poly C-Si Photovoltaic Modules in a Mediterranean Climate: Experimental Insights

Amina Chahtou¹, El Amin Kouadri Boudjelthia¹, Nasreddine Belhaouas¹

¹ CDER, Algiers, Algeria

3AV.2.17 Tackling The Fire Safety in Glass Free PV Modules

Nikolina Pervan¹, Sonja Feldbacher¹, Umang Desai², Antonin Faes², Christophe Ballif², Gernot Oreski¹

¹ PCCL, Leoben, Austria; ² EPFL, Neuchâtel, Switzerland

3AV.2.18 Investigating PV Module Packaging Mechanical Properties with Cross-sectional Nano-indentation

Stefan Mitterhofer¹, Soshana Smith¹, Stephanie L. Moffitt¹, Xiaohong Gu¹

¹ NIST, Gaithersburg, United States of America



- 3AV.2.19 The Influence of the Configuration of TOPCon Technology Photovoltaic Modules on Resistance to Degradation in Damp Heat and Potential-Induced**
Harison Santos¹, Hugo Alvarez¹, Eduardo Mendes¹, Rodrigo Garcia¹
¹ BYD Energy do Brasil, Campinas, Brazil
- 3AV.2.20 Analysis and Material Modeling of Mechanical Property Degradation for Simulation of Weather Exposed Polymers**
Julia Petro¹, Volker Reisecker², Eric Helfer¹, Gernot Oreski¹, Thomas Antretter³, Margit Lang¹
¹ Polymer Competence Center Leoben, Leoben, Austria; ² TCKT, Wels, Austria; ³ Mining University Leoben, Leoben, Austria
- 3AV.2.21 Reliability Investigation of Structural Colour Interlayers for Coloured PV Modules**
Markus Babin¹, Roberto Boccardi¹, Alihsan Bagci¹, Nanna Lysgaard Andersen¹, Peter Behrendorf Poulsen¹, Sune Thorsteinsson¹, Karlis Petersons², Leif Yde², Jan Stensborg², Catarina Ferreira³, Joel Cox³, Irina Vyali⁴, Morten Madsen⁴
¹ Technical University of Denmark, Roskilde, Denmark; ² Stensborg, Roskilde, Denmark; ³ University of Southern Denmark, Odense, Denmark; ⁴ University of Southern Denmark, Sønderborg, Denmark
- 3AV.2.22 Diagnosing Potential Induced Degradation in Crystalline Silicon Photovoltaic Modules**
Aysha Mahmood¹, Rodrigo del Prado Santamaria¹, Peter B. Poulsen¹, Sergiu V. Spataru¹
¹ Technical University of Denmark, Roskilde, Denmark
- 3AV.2.23 Temperature and Humidity Environment Reliability Testing of Large Size PV Modules and Supporting Devices**
San-Yu Ting¹, Huan-Wu Lu¹, Wei-Lun Yang¹, Hsin-Hsin Hsieh¹, Min-An Tsai¹, Cho-Fan Hsieh¹
¹ ITRI, Hsinchu, Taiwan
- 3AV.2.24 Measurements and Modelling of Mechanical Stress in PV Modules**
Christoph Seiffert¹, Hallvard Fjær¹, Dag Lindholm¹, Sigurd Brattheim¹, Josefine Selj¹, Gaute Otnes¹
¹ IFE, Kjeller, Norway
- 3AV.2.25 On-Site Evaluation of Oxygen-Plasma Treated Glass Surfaces for Anti-Soiling Properties**
Brahim Aissa¹, Ayman Samara²
¹ QEERI, Doha, Qatar; ² HBKU Core Laboratories, Doha, Qatar
- 3AV.2.26 On the Study of Degradation in Heterojunction Technology Solar Modules**
Sung Hyun Kim¹, Hyunsoo Lim¹, Godeong Park¹
¹ KETI, SeongNam-Si, South Korea
- 3AV.2.27 Performance, Abrasion Resistivity and Anti-soiling Testing of Innovative, Nanostructured Antireflection Coatings Under Controlled and Standardized Conditions**
Charlotte Pfau¹, Guido Willers¹, Christos Allagiannis², Ioannis Arabatzis², Marko Turek¹
¹ Fraunhofer CSP, Halle (Saale), Germany; ² Nanophos, Lavrio, Greece

- 3AV.2.29 Comparative Analysis of Defect Types in Terrestrial and Floating Solar Modules After 15 Years of Operation: Implications for Design and Management**
Jae-hyeok Hur¹, Su-Mi Yang¹, Jeong Heon-seok¹
¹ Far East University, Eumseong-gun, South Korea
- 3AV.2.30 Development of Encapsulant-Less Crystalline Silicon Photovoltaic Modules and Their Durability Against Potential-Induced Degradation**
Keisuke Ohdaira¹, Shuntaro Shimpō¹, Huynh Thi Cam Tu¹
¹ JAIST, Ishikawa, Japan
- 3AV.2.31 Exploring Sodium-Related Salts for Insight into TOPCon Solar Cell Damp-heat Degradation**
Xinyuan Wu¹, Xutao Wang¹, Yutong Wu², Hao Song², Ruirui Lv², Yuanjie Yu², Tao Xu², Muhammad Umair Khan¹, Alison Ciesla¹, Chandany Sen¹, Guangchun Zhang², Bram Hoex¹
¹ UNSW, Sydney, Australia; ² Canadian Solar, Suzhou, China
- 3AV.2.32 Potential-Induced Degradation in Perovskite Devices: A Comparison Between Cells and Modules in an Inert Environment**
Robbe Breugelmans¹, Stijn Lammar², Aranzazu Aguirre³, Tom Aernouts³, Bart Vermang¹, Michaël Daenen¹
¹ Hasselt University, Hasselt, Belgium; ² KU Leuven, Leuven, Belgium; ³ Imec/Imo-imec, Genk, Belgium
- 3AV.2.33 Modelling the Moisture Ingress and Its Impact in PV Modules**
Youri Blom¹, Daniel Jimenez Pelarda¹, Ismail Kaaya², Nikoleta Kyranaki³, Olindo Isabella¹, Rudi Santbergen¹, Malte Ruben Vogt¹
¹ TU Delft, Delft, The Netherlands; ² imec, Genk, Belgium; ³ Hasselt University, Hasselt, Belgium
- 3AV.2.34 Identification of a Free Vibration and Natural Resonance of Solar Cells inside the Photovoltaic Module under the Laminated Glass/EVA Structure using a Laser Doppler Technique**
Shota Matsushita¹, Kenji Araki¹, Yasuyuki Ota¹, Kensuke Nishioka¹
¹ University of Miyazaki, Miyazaki, Japan
- 3AV.2.35 Evaluation of the Impact of the UV Excitation Intensity on the Ultraviolet Fluorescence Measurement System for Photovoltaics**
Zonghan Jiang¹, Carlos Meza¹, Ralph Gottschalg²
¹ Hochschule Anhalt, Koethen, Germany; ² Fraunhofer CSP, Halle (Saale), Germany
- 3AV.2.36 How to Mount your PV Modules: a Parametric Study of the Effect of Different Clamping Configuration on Mechanical Stresses in Framed PV Modules**
Pascal Romer¹, Andreas J. Beinert¹, Charlotte Hasselblatt¹, Cornelius Herr¹
¹ Fraunhofer ISE, Freiburg, Germany
- 3AV.2.37 Developing Highly Accelerated Stress Tests for PV Modules: A Detailed Comparison of the Pressure Cooker Test and the Damp Heat Test**
Angelika Beinert¹, Johannes Erb¹, Paul Gebhardt¹, Daniel Philipp¹, Ingrid Haedrich¹
¹ Fraunhofer ISE, Freiburg, Germany



3AV.2.39 DIC as a Thermo-Mechanical Characterisation Method for the Inner Layers in a Multi-Layer PV Module Structure

Marta Casasola Paesa¹, Nikolina Pervan², Bin Luo¹, Gernot Oreski², Jonathan Govaerts¹, Jef Poortmans¹, Hariharsudan Sivaramakrishnan¹, Michaël Daenen¹

¹ imec, Leuven, Belgium; ² PCCL, Leoben, Austria

3AV.2.40 FMEA Based Degradation Rate Evaluation to Study Impact of Different Failure Modes as Function of Mission Profiles

Bengt Jaeckel¹, Balaji Adothu², Matthias Pander¹

¹ Fraunhofer CSP, Halle (Saale), Germany; ² DEWA, Dubai, United Arab Emirates

3AV.2.41 Manufacturing and Extended Damp Heat (DH) Degradation Analysis of Low-power Interconnected Back Contact (IBC) Photovoltaic Modules

Julia Vincent¹, Ali Khouzam², Pierre-Olivier Logerais¹, Fabien Delaleux¹, Olivier Riou¹, Mustapha Elyakoubi³

¹ UPEC, Lieusaint, France; ² ICAM, Lieusaint, France; ³ SOLEMS, Palaiseau, France

3AV.2.42 Numerical Simulation of the Bypass Diode Failure Resistance and Those Power Consumption in a Photovoltaic Solar Module with Failed Bypass Diode

Ibuki Kitamura¹, Toshiyuki Hamada¹, Ikuo Nanno², Norio Ishikura³, Masayuki Fujii⁴, Shinichiro Oke⁵

¹ Osaka Electro-Communication University, Osaka, Japan; ² Ube College, Yamaguchi, Japan; ³ Yonago College, Tottori, Japan; ⁴ Oshima College, Yamaguchi, Japan; ⁵ Tsuyama College, Okayama, Japan

3AV.2.43 Polymer Additive Diffusion and the Impact on Encapsulant Reliability

Robert Heidrich¹, Marius Lüdemann¹, Anton Mordvinkin¹, Ralph Gottschalg¹

¹ Fraunhofer CSP, Halle, Germany

3AV.2.44 Outdoor Performances and Reliability of Perovskite Solar Modules

Karim Medjoubi¹, Anne Migan Dubois², Thomas Guillemot¹, Johan Parra³, Marion Provost¹, Nao Harada¹, Anyssa Derj¹, Armelle Yaiche¹, Dounya Barrit⁴, Jean Baptiste Puel¹, Daniel Ory¹, Julie Goffard¹, Jordi Badosa³, Jean Rousset¹, Jorge Posada¹

¹ IPVF, Palaiseau, France; ² Université Paris-Saclay, Gif-sur-Yvette, France; ³ Université Paris-Saclay, Palaiseau, France; ⁴ TotalEnergies, Paris la Defense, France

3AV.2.45 Impact of the Material Combination on the Barrier Properties and Their Stability in the Course of Accelerated Weathering

Daniel Schüsler¹, Patrick Wessel¹, Anton Mordvinkin¹

¹ Fraunhofer CSP, Halle, Germany

3AV.2.46 Investigation of Thermo-Mechanical Behavior of Encapsulation Materials Used in Solar Panel Production

Umrhan Dilmac¹, Meric Caliskan¹, Merve ÇORAK²

¹ Kalyon PV, Ankara, Türkiye; ² KalyonPV Research and Development Center, Ankara, Türkiye

3AV.2.47 Comparative Analysis of Indoor Simulated and Real Hail-Induced Damage on Photovoltaic Modules: A Study on Impact by Large Diameter Hailstones

Dominika Chudy¹, Mattia Ceretti¹, Ezio Cadoni¹, Daniele Forni¹, Giovanni Bellenda¹, Mauro Caccivio¹

¹ SUPSI, Mendrisio, Switzerland

3AV.2.48 Naturally Induced Aging of Different c-Si Solar Cell Technologies and Encapsulate Materials by Harsh Environment with High UV Radiation Doses

Valentina Arias¹, Ignacia Devoto², Tudor Timofte², Valeria Reyes¹, Danilo Estay¹, Patricio Valdivia¹, Andreas Halm², Rodrigo Barraza³

¹ Federico Santa María Technical University, Santiago, Chile; ² ISC Konstanz, Konstanz, Germany; ³ Adolfo Ibáñez University, Santiago, Chile

3AV.2.49 UV Exposure of Glass/Glass Coupons With Edge Seal and Different Encapsulants

Chiara Barretta¹, Lisa Meinhardt¹, Andreas Brandstaetter², Dieter Geier³, Roland Einhaus³, Abdulkarim Gok⁴, Gernot Oreski¹

¹ PCCL, Leoben, Austria; ² Lenzing Plastics, Lenzing, Austria; ³ ZSW, Stuttgart, Germany; ⁴ Gebze Technical University, Gebze, Türkiye

3AV.2.50 Material Screening for the Development of a Photovoltaic Module Using Biodegradable Materials from Renewable Raw Materials

Matthias Pander¹, Ringo Koepge¹, Anton Mordvinkin¹, Bengt Jaeckel¹

¹ Fraunhofer CSP, Halle (Saale), Germany

3AV.2.51 Failure Mode Analysis of Austria's first Road-Integrated Photovoltaic System

Alexander Erber¹, Bernhard Grasel¹

¹ University of Applied Sciences Vienna, Vienna, Austria

3AV.2.52 Effects of Encapsulant- Backsheet Combinations on Durability of Optical Properties

Jishnu Ramachandran Nair¹, Daniel Schuesler¹, Michael Wendt¹, Anton Mordvinkin¹

¹ Fraunhofer CSP, Halle, Germany

3AV.2.53 PID Outdoor Measurements, a New Test Setup

Joerg Kirchhof¹

¹ Fraunhofer IEE, Kassel, Germany

3AV.2.54 Coatings or tapes? Imaging Methods to Show the Successful Repair of Backsheet Cracks

Raffael Schifferegger¹, Yuliya Voronko¹, Anika Gassner¹, Gabriele C. Eder¹, Eric Tilly²

¹ OFI, Vienna, Austria; ² ENcome Energy Performance, Klagenfurt, Austria

3AV.2.55 Strain and Crack Detection in PV Module Glass

Savannah Bennett¹, Thilo Winkler¹, Claudia Buerhop-Lutz¹, Ian Marius Peters¹

¹ HI ERN, Erlangen, Germany

3AV.2.56 UV + Damp Heat Induced Power Losses in Fielded Utility N-Type Si PV Modules

Ashley Gaulding¹, Joseph Karas¹, Elizabeth C. Palmiotti¹, Steve Johnston¹, Dana B. Kern¹, Josh Gallon¹, John S. Mangum¹, Ingrid Repins¹, Timothy J. Silverman¹, Michael G. Deceglie¹

¹ NREL, Golden, United States of America

3AV.2.57 Effect of Weight Percent Graphene on Ethelyn Vinyl Acetate (EVA) Barrier Properties for Improved Photovoltaic Module Packaging Reliability

Emeka H. Amalu¹, Oluwagbemiga A. Fabunmi¹, David J. Hughes¹, Yongxin Pang¹, Michael Short¹

¹ Teesside University, Middlesbrough, United Kingdom



3AV.2.58 Qualification of a Transparent PET Based Backsheet in Combination with POE and EVA

Alessandro Anderlini¹, Angelika Beinert², Birgit Ingrid Hädrich²
¹ Coveme, Gorizia, Italy; ² Fraunhofer ISE, Freiburg, Germany

VISUAL PRESENTATIONS 3AV.3

17:00 - 18:30 PV Modules Performance: Testing, Modelling Techniques and Outdoor Performance

Chairpersons: Ms. Gabi Friesen
SUPSI, Mendrisio, Switzerland
Mr. Jonathan Govaerts
imec, Genk, Belgium
Dr. Matevž Bokalič
University of Ljubljana, Ljubljana, Slovenia

3AV.3.1 Enhanced Performance of PV Modules Using Hierarchically Structured Glass in Different Climatic Conditions

Cristina Leyre Pinto¹, Jaione Bengoechea¹
¹ CENER, Sarriguren-Navarra, Spain

3AV.3.2 Developing a Simplified I-V Translation Methodology in Accordance with IEC 60891:2021 Correction Procedure 2

Wenhao Xu¹, Yating Zhang¹, Qi Gao¹, Christos Monokroussos¹, Harald Mülleians², Werner Herrmann³, Giorgio Bardizza³
¹ TUV Rheinland, Shanghai, China; ² European Commission, Ispra, Italy; ³ TUV Rheinland Solar, Cologne, Germany

3AV.3.3 Multispectral Photovoltaic Module Characterization by Simultaneous Daylight Photoluminescence and Infrared Thermography Inspection

Lukas Koester¹, Atse Louwen¹, David Moser¹
¹ Eurac Research, Bolzano, Italy

3AV.3.4 Evaluation of the Glare Function of PV-Modules by Measuring Only the Cover Sheet

Wolfgang Nemitz¹, Roman Trattnig¹, Jakob Zehndorfer², Lukas Plessing³
¹ Joanneum Research, Weiz, Austria; ² Zehndorfer Engineering, Klagenfurt, Austria; ³ TPPV, Wien, Austria

3AV.3.5 Analysis of Field Performance based on Solar Cell Design

Sung Ho Hwang¹, Yoonmook Kang¹, Dongchul Suh²
¹ Korea University, Seoul, South Korea; ² Hoseo University, Chungnam, South Korea

3AV.3.6 Establishment of the Direct Sunlight Method for the Primary Calibration of Reference Solar Cells at PTB

Marcel Pastuschek¹, Ingo Kröger¹, Dirk Friedrich¹, Fatima Masic², Stefan Winter¹
¹ PTB, Braunschweig, Germany; ² Institute of Metrology of Bosnia and Herzegovina, Sarajevo, Bosnia

3AV.3.7 An Innovative Electrical-Thermal Model for Bifacial Photovoltaic Modules: Comprehensive Validation in Indoor and Outdoor Environments

Valentina González Becerra¹, Patricio Valdivia-Lefort¹, Rodrigo Barraza Vicencio¹
¹ Federico Santa Maria Technical University, Santiago, Chile

3AV.3.8 High-Output Bifacial Shingled Solar Module Design: Solar Cell and Shingled Module Modeling Methods

Seung ah Ur¹, Jaehyung Lee¹
¹ Sungkyunkwan University, Suwon, South Korea

3AV.3.9 A Data-Driven Calibration of the FEM Temperature Model with Wind Direction Input

Anastasios Kladas¹, Bert Herteleer¹, Jan Cappelle¹
¹ KU Leuven, Leuven, Belgium

3AV.3.10 Using the Equivalent Cell Temperature for Power Matrix Calculations

Hanna Ellis¹, Harald Muellejans¹, Teodora Lybenova¹, Diego Pavanello¹, Ewan D. Dunlop¹
¹ European Commission JRC, Ispra, Italy

3AV.3.11 A Gaussian Process Regression Model for a Time Series of IV Characteristics Under Varying Temperature and Irradiation Conditions

Timon Sebastian Vaas¹, Bart E. Pieters¹, Andreas Gerber¹, Evgenii Sovetkin¹, Uwe Rau¹
¹ Forschungszentrum Jülich, Jülich, Germany

3AV.3.12 Performance Measurements of Photovoltaic Devices Under Indoor Standard Testing Conditions

George Koutsourakis¹, Daniel Parsons¹, Gregory Burwell², Stefan Zeiske³, Ardalan Armin², Paul Meredith², James Blakesley¹
¹ NPL, Teddington, United Kingdom; ² Swansea University, Swansea, United Kingdom; ³ Northwestern University, Evanston, United States of America

3AV.3.13 Areal Cell Temperature Monitoring Using Array of In-laminate Integrated Sensors for Partial Shading Detection

Seyed Mojtaba Sadati Faramarzi¹, Georgi H. Yordanov², Arvid van der Heide¹, Jan Genoe¹, Jef Poortmans¹
¹ imec, Leuven, Belgium; ² KU Leuven, Leuven, Belgium

3AV.3.14 Maximum Power Output Predicting Algorithm of Solar Modules Based on Artificial Intelligence Technology

Ju-Hee Kim¹, Joonyoung Jeon¹, Yong Hyun Kim¹
¹ KOPTI, Gwangju, South Korea

3AV.3.15 Estimation of the Transmission and Albedo of PV Modules and Their Impact on the Performance of the PV System

Oume Lgheit Rhazi¹, Julien Dupuis¹, Romain Bodeux², Geoffrey Rachinel³
¹ EDF R&D-TREE, Moret-sur-Loing, France; ² EDF R&D-IPVF, Palaiseau, France; ³ EDF Renouvelables, Colombiers, France

3AV.3.16 A Parametric Approach for Estimation of PV Short-Circuit Current

Sergiu Mihai Hategan¹, Marius Paulescu¹
¹ West University of Timisoara, Timisoara, Romania

3AV.3.18 Power Matrix Validation of Long-Term Outdoor PV Field Data

Ismael Medina¹, Teodora Stoyanova Lyubenova¹, Ewan Dunlop¹
¹ Joint Research Centre, Ispra, Italy

3AV.3.19 Modeling of Junction Temperature for Crystalline Silicon Photovoltaic Module

Zewen chen¹, Baojie Lv¹, Ling Li¹, Gang Lu², Hong Yang¹
¹ Xi'an Jiaotong University, Xi'an, China; ² PV Industrial Innovation Center of State Power Investment Corporation, Xi'an, China



3AV.3.20 Analysis of Measurement Reproducibility for Photovoltaic Modules under Outdoor Test Conditions

Gang Lu¹, Qian Yang², Xin Huang³, Hong Yang³

¹ PV Industrial Innovation Center of State Power Investment, Xi'an, China; ² Xi'an University of Technology, Xi'an, China; ³ Xi'an Jiaotong University, Xi'an, China

3AV.3.21 Data Acquisition and Monitoring of Photovoltaic Modules to Quantify the Effect of Radiative Cooling Coating

José Miguel Asensi¹, Joan Bertomeu¹, Regina Galceran¹, Julian López-Vidrier¹, Javier Achiaga², Antonio Onteniente², Alejandra Jacobo², Ares Lladós², Neffer Gómez², Juliana Jaramillo²

¹ University of Barcelona, Barcelona, Spain; ² Cooling Photonics, Barcelona, Spain

3AV.3.22 Comparison of Changes in the Parameters of Five PV Modules Types After One Year in the Swiss Jura Mountains

Christof Bucher¹, Matthias Burri¹, Fabio Panduri¹, Mauro Caccivio², Gabi Friesen²

¹ BFH, Burgdorf, Switzerland; ² SUSPI, Mendrisio, Switzerland

3AV.3.23 A Comparative Study of TOPCon and PERC Photovoltaic Modules under Different Light Intensity Conditions

Baojie Lv¹, Zewen Chen¹, Ling Li¹, Gang Lu², Hong Yang³

¹ Xi'an Jiaotong University, Xi'an, China; ² PV Industrial Innovation Center of State Power Investment, Xi'an, China; ³ Xi'an Jiaotong University, Xi'an, China

3AV.3.24 Exact IV Curve Extraction of Damaged PV-Strings from Outdoor EL-Images

Pascal Koelblin¹, Liviu Stoicescu¹, Michael Reuter¹

¹ Solarzentrum Stuttgart, Stuttgart, Germany

3AV.3.25 Accurate Energy Performance Model for Bifacial PV Modules

Kristijan Brecl¹, Matevž Bokalič¹, Antonin Faes², Marko Topič¹

¹ University of Ljubljana, Ljubljana, Slovenia; ² CSEM, Neuchâtel, Switzerland

3AV.3.27 Outdoor Characterization Protocol of Bifacial PV Modules for Agri-PV Application

Federico Andreozzi¹, Gianluigi Bovesecchi¹, Marcello Petitta¹, Cristina Cornaro¹

¹ University of Rome Tor Vergata, Rome, Italy

3AV.3.28 Uncertainty Assessment in the Measurement of Solar Cells under Standard Test Conditions

Yating Zhang¹, Wenhao Xu¹, Qi Gao¹, Giorgio Bardizza², Werner

Herrmann², Christos Monokroussos¹

¹ TUV Rheinland, Shanghai, China; ² TUV Rheinland Energy, Cologne, Germany

3AV.3.29 Stabilization of Field-Aged Crystalline PV Modules Before STC Power Determination

Soha Essbai¹, Marcus Rennhofer¹, Ankit Mittal¹, Gusztav Ujvari¹, Thomas Weber², Brian Azzopardi³

¹ Austrian Institute of Technology, Vienna, Austria; ² PI Berlin, Berlin, Germany; ³ FIR Malta, Valetta, Malta

3AV.3.30 AC/DC Electroluminescence. The War of the Currents

Sergio Suarez¹, Jorge Lorenzo¹, Enrique Graña¹, Daniel Villoslada¹, Ignacio Fernandez¹, Sofia Rodriguez¹

¹ Enertis Applus, Madrid, Spain

3AV.3.31 Evaluation of the Contact Quality in Silicon Solar Cells and Modules Using LBIC Phase Mapping

Majid Salari¹, Jonas Buddgård², Markus Rinio¹

¹ Karlstad University, Karlstad, Sweden; ² Sticky Solar Power, Stockholm, Sweden

3AV.3.32 Nomenclature and Description of EL Observations: Cell Cracks and Other Findings

Bengt Jaeckel¹, Paul Schenk¹, Matthias Pander¹, Aswin Linsenmeyer², Stephan Rupp³, Jochen Kirch⁴

¹ Fraunhofer CSP, Halle (Saale), Germany; ² SUNSET Solar, Adelsdorf, Germany; ³ Hanwha Q CELLS, Bitterfeld-Wolfen (Thalheim), Germany; ⁴ Ing.-Büro Jochen Kirch, Leeder, Germany

3AV.3.33 An Investigation on the Uncertainty of Fill Factor

Diego Pavanello¹, Tony Sample¹, Harald Mülleijans¹

¹ European Commission JRC, Ispra, Italy

3AV.3.34 A Verification and Correction Methodology for Spectroradiometers under Natural Sunlight

Diego Pavanello¹, Seonyong Park², Antonio Romano³, Gianni Leanza³, Edoardo Celi⁴, Alessandro Minuto⁴, Mauro Pravettoni⁵, Shin Woei Leow⁶, Flavio Valoti⁷, Tobias Weigner⁸, Kevin Murray⁹

¹ European Commission JRC, Ispra, Italy; ² ESA, Noordwijk, The Netherlands; ³ ENEA, Portici, Italy; ⁴ RSE, Piacenza, Italy; ⁵ TII, Abu Dhabi, United Arab Emirates; ⁶ SERIS, Singapore, Singapore; ⁷ SUPSI, Mendrisio, Switzerland; ⁸ PVLAB, Potsdam, Germany; ⁹ North West Regional College, Derry, United Kingdom

3AV.3.35 Field Performance of BAPV System in Operation for 30 Years in Sweden

Emmanouil Psimopoulos¹, Frank Fiedler¹, André Augusto¹

¹ Dalarna University, Falun, Sweden

3AV.3.36 Outdoor Power Characterization of Bifacial Photovoltaic Modules: Method Discussion and Validation

Anelise Medeiros Pires¹, Marília Braga¹, Matheus Hohmann¹, Eduardo Augusto Brunetto¹, Ricardo Rüther¹

¹ UFSC, Florianópolis, Brazil

3AV.3.38 Daylight Electroluminescence Inspection of PV Panels On-site vs. Traditional EL Inspection with Silicon Cameras

Luis Alberto Carpintero¹, Diego González-Francés², Kabir Paul Sulca², Cristian Terrados², Carmelo de Castro², Victor Alonso², Miguel Ángel González Rebollo², Oscar Martínez²

¹ Cobra Instalaciones y Servicios, Valladolid, Spain; ² University of Valladolid, Valladolid, Spain

3AV.3.39 Photovoltaic Module Array Luminescence Image Preprocessing: Heuristic Algorithms for Perspective Correction and Cell Segmentation

Brendan Wright¹, Ali Shakiba¹, Rama Sharma¹, Ziv Hameiri¹

¹ UNSW, Sydney, Australia



3AV.3.40 Optical Inspection Approach for In-Line Industrial Monitoring of Nano and Micrometric Layers Quality in Thin Film Photovoltaics Technologies

Robert Fonoll-Rubio¹, Victoria Rotaru¹, Lilley Govinda², Ginner Laurin², Alice Motschi², Pedro Vidal-Fuentes¹, Stefan Paetel³, Krzysztof Stanik⁴, Konrad Wojciechowski⁴, Pierpaolo Spinelli⁴, Ignacio Becerril-Romero¹, Victor Izquierdo-Roca¹, Maxim Guc¹
¹ IREC, Sant Adria de Besos, Spain; ² AIT, Vienna, Austria; ³ ZSW, Stuttgart, Germany; ⁴ Saule, Wroclaw, Poland

3AV.3.42 Comparing Measured PV Module Power to Nameplate Values

Frank Weinrich¹, Stefan Riechelmann¹, Laura Stenzig¹, Stefan Winter¹
¹ PTB, Braunschweig, Germany

3AV.3.44 Finding the Cell to Module Performance Values for Industrial TOPCon and HJT Technologies

Sraisth Sraisth¹, Djamel Eddine Mansour¹, Hardik Gohil¹, Mehul Raval¹, Wolfgang Jooss¹
¹ RCT Solutions, Konstanz, Germany

3AV.3.45 The Impact of Module Degradation on the Economics of PV Projects

Harry Apostoleris¹, Balaji Adothu¹, Bengt Jaeckel², Gerhard Mathiak¹, Sgouris Sgouridis¹
¹ DEWA, Dubai, United Arab Emirates; ² Fraunhofer CSP, Halle, Germany

3AV.3.47 Outdoor Performance Assessment for PV Modules in High Radiation Environments

Robinson Cavieres¹, Felipe Valencia¹
¹ ATAMOSTEC, Santiago, Chile

3AV.3.49 Characterization and Performance Analysis of Bifacial and Monofacial Heterojunction PV Modules in Benguerir, MOROCCO

Imane Flouchi¹, Khadija El ainaoui², Yasmine EL MRABET³, Said Elhamaoui¹, Hassan Nounah², Khalid Bouabid⁴, Willem (Wim) Zaaïman⁵, Abdellatif Ghennioui¹
¹ Green Energy Park, Ben Guerir, Morocco; ² Ibn Zohr University, Ouarzazate, Morocco; ³ University of Science and Technologies of Tangier, Larache, Morocco; ⁴ University of Agadir, Agadir, Morocco; ⁵ European Commission JRC, Ispra, Italy

3AV.3.50 Improved Sampling of IV Measurements

Maximilian Schönauf¹, Elisabeth Schönauf¹, Darwin Daume¹, Markus Panhuysen², Achim Schulze³, Bernd Hüttli¹, Dieter Landes¹
¹ Coburg University of Applied Sciences, Coburg, Germany; ² Smartblue AG, Munich, Germany; ³ Rosenheim University of Applied Sciences, Rosenheim, Germany

3AV.3.52 Enhancing Production Forecasting of Grid-Connected PV Strings Operating Under Semi-Arid Climate Conditions

Khadija El ainaoui¹, Mhammed Zaimi¹, Imane Flouchi², Said Elhamaoui², Yasmine El mrabet², Abdellatif Ghennioui², El Mahdi Assaid¹
¹ University of Chouaib Doukkali, El Jadida, Morocco; ² Green Energy Park, Ben Guerir, Morocco

3AV.3.53 Evaluation of the Glare Function and Description of Key Measurement Procedures

Wolfgang Nemitz¹, Roman Trattnig¹, Jakob Zehndorfer², Markus Babin³, Lukas Plessing⁴
¹ Joanneum Research, Graz, Austria; ² Zehndorfer Engineering Consulting, Maria Rain, Austria; ³ DTU, Roskilde, Denmark; ⁴ TPPV, Vienna, Austria

VISUAL PRESENTATIONS 2BV.1

08:30 - 10:00 Advances in Novel Materials, Devices and Concepts | New Modelling and Characterisation Techniques

Chairpersons: Prof. Antonio Martí Vega
 UPM, Madrid, Spain
 Dr. Theresa Magorian Friedlmeier
 ZSW, Stuttgart, Germany

2BV.1.1 Development of an Interdigitated Back-Contacted Solar Cell Architecture as a Platform to Assess Emerging Absorbers and New Selective Contacts

Juan de Dios Castillo¹, Gerard Masmitjà¹, Pau Estarlich¹, Pablo Ortega¹, Cristobal Voz¹, Oriol Segura¹, Edgardo Saucedo¹, Massoud Karimipour², Sonia Ruiz², Mónica Lira², Joaquim Puigdollers¹
¹ UPC, Barcelona, Spain; ² ICN2, Barcelona, Spain

2BV.1.2 Annealed Phosphorus-doped Amorphous Silicon Layers as Electron Selective Contact for Crystalline Germanium Thermophotovoltaic Cells

Gerard Rivera¹, Mansur Gamel¹, Gema López¹, Moisés Garín², Isidro Martín¹
¹ UPC, Barcelona, Spain; ² University of Vic, Vic, Spain

2BV.1.3 Two Years under the Weather: Post-Mortem Analysis of Quantum Dot-Based Luminescent Solar Concentrators

Raimon Terricabres-Polo¹, Thomas de Bruin¹, Annanta Kaul¹, Wilfried van Sark¹, Celso de Mello Donega¹
¹ Utrecht University, Utrecht, The Netherlands

2BV.1.4 Damp Heat Test Characteristics of the Cu₂O Top Cell for Highly Efficient Cu₂O/Si Tandem Solar Cells

Atsushi Wada¹, Sara Yoshio¹, Soichiro Shibasaki¹, Naoyuki Nakagawa¹, Yuya Honishi¹, Yukitami Mizuno¹, Kodai Wakamatsu¹, Takashi Yamamoto¹, Motohiro Toyota¹, Yasutaka Nishida¹, Kanta Sugimoto², Junji Sano², Maho Hayase², Kazushige Yamamoto¹
¹ Toshiba, Kawasaki, Japan; ² Toshiba, Yokohama, Japan

2BV.1.8 Estimating the Photovoltaic Potential of Iron Disulfide Thin Films

Awais Zaka¹, Saeed Alhassan¹, Ammar Nayfeh¹
¹ Khalifa University, Abu Dhabi, United Arab Emirates

2BV.1.9 Effect of Heating Spin Coated Graphene for the Application as Transparent Conductive Electrodes in Solar Cells

Wafa Alnaqbi¹, Ayman Rezk¹, Shanavas Shajahan¹, Yarjan Abdul Samad¹, Ammar Nayfeh¹
¹ Khalifa University, Abu Dhabi, United Arab Emirates

2BV.1.10 Sensitization of Crystalline Silicon with Organic Dye Molecules

Lukáš Gdula¹, Branislav Dzurňák¹, Tom Markvart²
¹ Czech Technical University in Prague, Prague, Czech Republic; ² University of Southampton, Southampton, United Kingdom



2BV.1.11 Self-Organized Films of Carbazole Derivatives on Structured Silicon Substrates for Photovoltaic Application

Sergii Mamykin¹, Daria Kuznetsova¹, Nina Roshchina¹, Petro Smertenko¹, Saulius Grigalevicius², Gintare Krucaite², Raminta Beresneviciute², Simona Sutkuvienė³

¹ V. Lashkaryov Institute of Semiconductor Physics NAS Ukraine, Kyiv, Ukraine; ² Kaunas University of Technology, Kaunas, Lithuania; ³ Lithuanian University of Health Sciences, Kaunas, Lithuania

2BV.1.12 Student Awards Finalist Presentation: Research on Placement Angles for Luminescent Solar Concentrators: Simulating and Experimenting with Bifacial Photovoltaic Mosaic Devices

Xitong Zhu¹, Frits Reijnders¹, Michael Debije¹, Angèle H.M.E Reinders¹

¹ Eindhoven University of Technology, Eindhoven, The Netherlands

2BV.1.15 NiTiO₃ Based Highly Stable Heterojunction for Photovoltaic and Hydrogen Generation Applications

Nikita Chaudhary¹, Kaushik Ghosh¹

¹ Institute of Nanoscience and Technology, Mohali, Punjab, India

2BV.1.17 Low-Emissive ITO for High-Vacuum Photovoltaic-Thermal Application

Daniela De Luca¹, Umar Farooq², Paolo Strazzullo², Eliana Gaudino¹, Antonio Caldarelli¹, Marilena Musto², Roberto Russo¹, Emiliano Di Gennaro², Andreas Schüller³, Anna Krammer³

¹ National Research Council of Italy, Naples, Italy; ² University of Naples Federico II, Naples, Italy; ³ EPFL, Lausanne, Switzerland

2BV.1.18 Examination and Characterization of Thin Films of Cu₂Fe_{0.5}Co_{0.5}SnS₄ Produced using the Sol-Gel Technique, Excluding the Sulfurization Process

Safia Drissi¹, Abdelkader El Kissani¹, A. Abali¹, D. Ait Ihaj¹, Said Elmassi¹, Mohammed Bousseta¹, Lahoucine Amiri¹, Lahcen Nkhaili¹, Kassem El Assali¹, Abdelkader Outzourhit¹

¹ Cadi Ayyad University, Marrakesh, Morocco

2BV.1.20 Low-emissive Molybdenum doped ITO for High-Vacuum Photovoltaic-Thermal Application

Umar Farooq¹, Eliana Gaudino¹, Daniela De Luca¹, Antonio Caldarelli¹, Paolo Strazzullo¹, Emiliano Di Gennaro¹, Marilena Musto¹, Roberto Russo¹, Andreas Schüller², Anna Krammer²

¹ University of Naples Federico II, Naples, Italy; ² EPFL, Lausanne, Switzerland

2BV.1.21 UV Converting Films Based on Spray-Coated Zinc Oxide Nanoparticles

Marcin Michalowski¹, Katarzyna Znajdek¹, Maciej Sibinski¹

¹ Technical University of Lodz, Lodz, Poland

2BV.1.22 Evaluating Power Output of Terrestrial Thermoradiative Diodes with Atmospheric Modelling

Jamie Harrison¹, Phoebe Pearce², Fei Yang³, Michael Nielsen⁴, Helen Brindley³, Nicholas Ekins-Daukes³

¹ UNSW Sydney, Randwick, Australia; ² UNSW Sydney, Kensington, Australia; ³ UNSW, Sydney, Australia; ⁴ UNSW Australia, Sydney, Australia

2BV.1.24 Bi-layered Carrier Transporters for High-efficiency and Stable Perovskite Solar Cells/Module

Chun-Guey Wu¹

¹ National Central University, Jhongli, Taiwan

2BV.1.26 Optimizing Solar Simulator Spectrum for Accurate Efficiency Measurements of Perovskite Photovoltaics

Blago Mihaylov¹, Harald Muellejans¹, Tony Sample¹, Ewan Dunlop¹

¹ European Commission JRC, Ispra, Italy

2BV.1.27 Optimization of a Planar Perovskite Solar Cell Layer Thicknesses: Optical and Electrical Effects

Aleksi Kamppinen¹, Kati Miettunen¹

¹ University of Turku, Turku, Finland

2BV.1.28 Photoluminescence Imaging of Perovskite Solar Cells in Full Sunlight

Zhiwen Zheng¹, Felix Gayot¹, Juergen Weber¹, Yan Zhu¹, Ziv Hameiri¹

¹ UNSW, Sydney, Australia

2BV.1.29 Analysis of Color Alteration as a Novel Degradation Assessment Method for Perovskite Solar Cells

Rustem Nizamov¹, Aapo Poskela¹, Mahboubeh Hadadian¹, Maryam Esmailzadeh¹, Mikael Nyberg¹, Kati Miettunen¹

¹ University of Turku, Turku, Finland

2BV.1.30 Statistical Model of Outdoor Perovskite Performance

Petra Manshanden¹, Martin Späth¹, Mark Jansen¹, Valerio Zardetto², Arantxa Aguirre³, Valerie Depauw³, Mina Heydarian⁴, Juliane Borchert⁴

¹ TNO, Petten, The Netherlands; ² TNO, Eindhoven, The Netherlands; ³ imec, Genk, Belgium; ⁴ Fraunhofer ISE, Freiburg, Germany

2BV.1.31 TCAD Simulation of Graphene/Silicon Schottky Junction Solar Cells: Effect of Doping and Workfunction

Syed Usama Bin Afzal¹, Wafa Alnaqbi¹, Ayman Rezk¹, Ammar Nayfeh¹

¹ Khalifa University, Abu Dhabi, United Arab Emirates

2BV.1.32 Characterization and Degradation of Perovskite Mini-Modules

Rita Ebner¹, Ankit Mittal¹, Gusztav Ujvari¹, Maria Hadjipanayi², Vasiliki Paraskeva², George E. Georgiou², Afshin Hadipour³, Aranzazu Aguirre⁴, Tom Aernouts⁴, Thommaso Fontanot⁵, Sabrina Pechmann⁵, Silke Christiansen⁵, Valerio Zardetto⁶

¹ AIT Austrian Institute of Technology, Vienna, Austria; ² University of Cyprus, Nicosia, Cyprus; ³ Kuwait University, Kuwait, Kuwait; ⁴ imec, Genk, Belgium; ⁵ IKTS, Forchheim, Germany; ⁶ TNO, Eindhoven, The Netherlands

2BV.1.33 Triple-Junction Solar Cells: Sub-Cell IV Curve and Current Matching Point Analysis

Alexander J. Bett¹, Johanna Aulich¹, David Chojniak¹, Maryamsadat Heydarian¹, Oliver Fischer¹, Marc Steiner¹, Florian Schindler¹, Gerald Siefert¹, Jan Christoph Goldschmidt², Martin C. Schubert¹, Stefan W. Glunz¹

¹ Fraunhofer ISE, Freiburg, Germany; ² Philipps University of Marburg, Marburg, Germany

2BV.1.34 Subcell Resolved Electroluminescence Imaging of Monolithic Perovskite/Silicon Tandem Solar Cell for High Throughput Characterization

Ivanol Jaurece Djeukeu¹, Klaus Ramspeck¹, Jonas Horn¹, Michael Meixner¹, Enno Wagner², Stefan Glunz³

¹ halm elektronik, Frankfurt, Germany; ² Frankfurt University of Applied Sciences, Frankfurt, Germany; ³ Fraunhofer ISE, Freiburg, Germany



2BV.1.35 A Case Study of Certainly I-V Measurement of the Perovskite Solar Cell under Dim Light Intensity for Solar/ Indoor Lighting Application

Yean-San Long¹, Min-An Tsai¹, Hsin-Hsin Hsieh¹, Fan-Hsuan Yeh²

¹ ITRI, Hsinchu, Taiwan; ² Taipei First Girls High School, Taipei, Taiwan

2BV.1.36 Optical Characterization and Prediction with Neural Network Modeling of Various Stoichiometries of Perovskite Materials Using a Hyperregression Method

Soo Min Kim¹, Syed Dildar Haider Naqvi², Min Gu Kang², Hee-eun Song², SeJin Ahn²

¹ KICET, Gyeongsangnam-do, South Korea; ² KIER, Daejeon, South Korea

2BV.1.37 An ANN Model for Predicting the Effect of Solar Spectrum Variation on Tandem Solar Cell Current

Shilpi Shital¹, A. R. Burgers², Petra Manshanden², L. J. Geerligs², V. Zardetto², Neeraj Bokde¹, G. Coletti³

¹ TII, Abu Dhabi, United Arab Emirates; ² TNO, Petten, The Netherlands; ³ UNSW, Sydney, Australia

2BV.1.38 Towards Digital Twins by One-Dimensional Simulation of Thin-Film Solar Cells on the Example of Cu(In,Ga)Se₂

Matthias Maiberg¹, Chang-Yun Song¹, Marcin Morawski¹, Felix Neduck¹, Joshua Damm¹, Heiko Kempa¹, Dimitrios Hariskos², Wolfram Witte², Roland Scheer¹

¹ Martin-Luther-University Halle-Wittenberg, Halle, Germany; ² ZSW, Stuttgart, Germany

2BV.1.39 Perovskite Solar Cell Light-Soaking and Relaxation Modelling for Improved Energy Yield Predictions in Indoor Environments

Matija Pirc¹, Špela Tomšič¹, Marko Jošt¹, Marko Topič¹

¹ University of Ljubljana, Ljubljana, Slovenia

2BV.1.40 Loss Analysis of a Perovskite/Perovskite/Si

Luis Restat¹, Christoph Messmer¹, Maryamsadat Heydarian², Minasadat Heydarian², Jonas Schoen¹, Martin C. Schubert², Stefan W. Glunz¹

¹ University of Freiburg, Freiburg, Germany; ² Fraunhofer ISE, Freiburg, Germany

2BV.1.41 Modelling the Effects of Tandem Module Circuit Configurations

Daniel Tune¹, Ignacia Devoto¹, Ahmer A.B. Baloch², Bhaskar Parida², Vivian Alberts², Omar Albadwawi², Karl Wienands¹, Andreas Halm¹

¹ ISC Konstanz, Konstanz, Germany; ² DEWA Research & Development Center, Dubai, United Arab Emirates

2BV.1.42 Understanding the Fill Factor Losses in Monolithic Perovskite-Si Tandem Solar Cells

Deniz Turkey¹, Daniel A. Jacobs², Christophe Ballif¹, Christian M. Wolff¹

¹ EPFL, Neuchâtel, Switzerland; ² CSEM, Neuchâtel, Switzerland

2BV.1.43 An AI approach for Maximizing Tandem Photovoltaic Cell's Efficiency

Sherif Michael¹

¹ Naval Postgraduate School, Monterey, United States of America

2BV.1.44 A Multiscale Approach of the Impact of Perovskites Phase Transitions on Solar Cells Performances: From Fundamental Properties of Materials to Cell Efficiency

Philippe Baranek¹, James Patrick Connolly², Antoine Gissler¹, Philip Schulz³, Michel Rérat⁴, Roberto Dovesi⁵

¹ EDF R&D - IPVF, Palaiseau, France; ² GeePs-CentraleSupélec, Gif sur Yvette, France;

³ LPICM-CNRS, Palaiseau, France; ⁴ UPPA, Pau Cedex, France; ⁵ Accademia Delle Scienze di Torino, Torino, Italy

2BV.1.45 Enhanced Efficiency in Perovskite Solar Cells Through Microconcentration and Laser Patterning

Shiva Navazani¹, Mahdi Khorsand Riabi², Andrea Lanfranchi³, Hamed Mortazavainasab⁴, Narges Yaghoobi Nia⁵, Mahmoud Zendeheidi⁴, Alessio Bruttomesso⁶, Davide Comoretto³, Aldo Di Carlo⁴, Diego Colombara³

¹ University of Genoa, Genoa, Italy; ² CHOSE, Roma, Italy; ³ University of Genoa, Genova, Italy; ⁴ University of Rome II, Rome, Italy; ⁵ Ecole Polytechnique, Palaiseau, France; ⁶ OPTOPRIM S.R.L., Milano, Italy

VISUAL PRESENTATIONS 2BV.2

10:30 - 12:00 Compound and Organic Semiconductors

Chairpersons: Dr. Marika Edoff
Uppsala University, Uppsala, Sweden

Dr. Stephen Taylor
European Space Agency, Noordwijk, The Netherlands

Dr. Gerald Siefer
Fraunhofer ISE, Freiburg, Germany

2BV.2.1 Strain-Relaxation Analysis during Temperature Drop Process after Growth of GaAs/Si Hetero-Structure

Nobuaki Kojima¹, Yuito Yasukochi¹, Yoshio Ohshita¹

¹ Toyota Technological Institute, Nagoya, Japan

2BV.2.2 Thermomechanical Stress Concentration in the Vicinity of Wires or Ribbons in Silicon Modules for Space Applications

Louis Perrotin¹, Jean-Baptiste Charpentier¹, Romain Cariou¹, Clément Jamain¹

¹ Univ. Grenoble Alpes, CEA-INES, Le Bourget du Lac, France

2BV.2.3 Investigation on Radiation Resistance of GaInP/GaInAs/Ge Quantum Well Solar Cells

Wenyi Yang¹, Zimin Chen¹, Xiaobin Zhang², Gang Wang¹

¹ Sun Yat-sen University, Guangzhou, China; ² Zhongshan Uniwatt Technology, Zhongshan, China

2BV.2.5 Remote-Plasma CVD as a New Process for III-V Thin Films Growth

Lise Watrin¹, François Silva², Cyril Jadaud², Pavel Bulkin², Jean-Charles Vanel², Erik V. Johnson², Karim Ouaras², Pere Roca i Cabarrocas¹

¹ IPVF, Palaiseau, France; ² LPICM, Palaiseau, France

2BV.2.6 PECVD Grown Germanium Thin Films for Multijunction Solar Cell Applications

Paula Perez-Rodriguez¹, Devansh Sharma¹, Shubham Litke¹, Arno H. M. Smets¹

¹ TU Delft, Delft, The Netherlands

2BV.2.8 Improvement of the Efficiency of InGaP/GaAs Double Junction Solar Cell Bonded on Si Substrate by Optimizing Annealing Treatment Process

Hyo Jin Kim¹, Gwang Yeol Park¹, Woo Yong Jeong¹

¹ Photonics Energy Materials Research Center, Gwangju, South Korea



- 2BV.2.9 Modeling and Measurement of Lumped Series Resistance with Varying Illumination and Current Condition of Low-Bandgap Solar Cells**
Shipei Zhang¹, Xiawa Wang¹
¹ Duke Kunshan University, Kunshan, China
- 2BV.2.10 Innovative Rear Interface Designs to Scale Down (A)CIGS Absorber**
André F. Violas¹, António J.N. Oliveira¹, Enzo Ribeiro¹, Paulo A. Fernandes¹, Pedro M.P. Salomé¹, Jennifer P. Teixeira¹
¹ INL, Braga, Portugal
- 2BV.2.11 Color Implementation of Cu(In,Ga)Se₂ Thin-film Solar Cells with Multilayered Conductive Optical Filters**
Yong-Duck Chung¹, Dae-Hyung Cho¹, Rina Kim¹, Woo-Jung Lee¹, Tae-Ha Hwang¹, Soyoung Lim¹, Donghyeop Shin², Kihwan Kim², Mangu Kang¹
¹ ETRI, Daejeon, South Korea; ² KIER, Daejeon, South Korea
- 2BV.2.12 Boosting the CIGS Solar Cell Performance through K-Soaking Method: A Novel Post-Deposition Treatment**
Temujin Enkhbat¹, Hyun-Beom Shin², Ho Kwan Kang², Seongju Park¹, Jaehyung Jang¹
¹ KENTECH, Naju, South Korea; ² Korea Advanced Nano Fab Center, Suwon, South Korea
- 2BV.2.13 Effects of NaF Co-Evaporation on the Optoelectronic Properties of Cu(In,Ga)S₂ for Wide Bandgap Thin Film Solar Cells**
Arivazhagan Valluvar Oli¹, Kulwinder Kaur¹, Michele Melchiorre¹, Susanne Siebentritt¹
¹ University of Luxembourg, Belvaux, Luxembourg
- 2BV.2.14 Environmentally Friendly Methods for Silver Particles Recovery from CIGS Solar Cells Using Ultrasounds**
Ioanna Teknetzi¹, Burcak Ebin¹
¹ Chalmers University of Technology, Gothenburg, Sweden
- 2BV.2.15 Bottom-Up Grown CIGS Micro Absorber Arrays: Microstructure Analysis and Solar Cell Integration**
Jan Lucassen¹, Setareh Zahedi-Azad², Heike Voss³, Tristan Koehler¹, Ihab Kardosh¹, Owen Ernst², Sonja Cinque³, Jörn Bonse³, Jörg Krüger³, Torsten Boeck², Jens Martin², Martina Schmid¹
¹ University of Duisburg-Essen, Duisburg, Germany; ² Leibniz Institute for Crystal Growth, Berlin, Germany; ³ BAM, Berlin, Germany
- 2BV.2.17 Flexible Thin-Film CZTS Solar Cell based on an Electroplated Metallic Precursor Deposited on a Molybdenum/Glass Coated Stainless Steel Foil**
Io Mizushima¹, Peter Torben Tang¹, Christoph Kammerlander², Andreas Zimmermann²
¹ IPU, Virum, Denmark; ² Sunplugged, Affenhausen, Austria
- 2BV.2.18 Cd-free Buffer Layers for Kesterite Solar Cells**
Yudania Sánchez¹, Gustavo Álvarez¹, Alex Jimenez-Arguijo¹, Yuancai Gong¹, Edgardo Saucedo², Alejandro Pérez Rodríguez¹
¹ IREC, Barcelona, Spain; ² UPC, Barcelona, Spain
- 2BV.2.19 Improvement of Optical Properties of CZTSSe-Based Solar Cells and Photocathode Devices via Cadmium Doping**
Suyoung Jang¹, Jin Hyeok Kim¹
¹ Chonnam National University, Gwangju, South Korea

- 2BV.2.22 Unveiling Performance Limits in the Scale-Up of CZTSe Solar Cells: A Spectroscopic Big Data Investigation**
Pedro Vidal-Fuentes¹, Fabien Atlan¹, Jacob Andrade-Arvizu¹, David Payno¹, Robert Fonoll-Rubio¹, Alejandro Pérez-Rodríguez², Ignacio Becerril-Romero¹, Maxim Guc¹, Victor Izquierdo-Roca¹
¹ IREC, Sant Adria de Besos, Spain; ² University of Barcelona, Barcelona, Spain
- 2BV.2.23 Manufacturing, Characterisation and Stability Tests of Printed Organic Photovoltaic Devices for Indoor Applications**
Ignacio Ballesteros Garcia¹, Donia Fredj², Carmen M Ruiz Herrero¹, Hasan Alkhatib², Sadok Ben Dkhil², Judikaël Le Rouzo¹, Jörg Ackermann¹
¹ CNRS, Marseille, France; ² Dracula Technologies, Valence, France
- 2BV.2.25 Side Chain Modifications of Non-fullerene Acceptors for Increased Permittivity and Improved Non-halogenated Solvent Processability for Organic Solar Cells**
Peter Fürk¹, David Paarhammer¹, Suman Mallick¹, Jana Schaubeder¹, Matiss Reinfleds¹, Thomas Rath¹, Gregor Trimmel¹
¹ Graz University of Technology, Graz, Austria
- 2BV.2.26 Selective Area Epitaxy to Improve Performances of Zn₃P₂/InP Heterojunction Solar Cell**
Raphaël Lemerle¹, Melanie Micali², Marina Bal López², Valerio Piazza¹, Thomas Hagger¹, Didem Dede¹, Esther Alarcón Lladó², Anna Fontcuberta i Morral¹
¹ EPFL, Lausanne, Switzerland; ² AMOLF, Amsterdam, The Netherlands
- 2BV.2.27 Crystal Structure and Electronic Properties of Cu₂CdxZn_{1-x}SnS₄ Thin Films**
Marin Rusu¹, Galina Gurieva¹, Sergiu Levchenko¹, Leonid Bruc², Nicolai Curmei², Lazari Dermenji², Thomas Unold¹, Ernest Arushanov², Susan Schorr¹
¹ HZB, Berlin, Germany; ² Moldova State University, Chisinau, Moldova
- 2BV.2.28 Analyses of Cd(Te,Se) Thin Film Solar Cells with Different Selenium Gradients**
Olaf Zywitzki¹, Thomas Modes¹, Sagar Baitule², Bettina Späth², Bastian Siepchen²
¹ Fraunhofer FEP, Dresden, Germany; ² CTF Solar, Dresden, Germany
- 2BV.2.30 Fabrication of Highly Efficient CdTe/CdTe Thin Film Solar Cells With Emitter-Less Cell Structure**
Yanbo Cai¹, Hongxu Jiang¹, Kai Yi¹, Fei Liu¹, Guangwei Wang¹, Deliang Wang¹
¹ University of Science and Technology of China, Hefei, China
- 2BV.2.32 Navigating the Challenges of Establishing a Competitive Organic Photovoltaic Industry in Europe**
Thomas Kolbusch¹, Sven Bonus²
¹ Coatema Coating Machinery, Dormagen, Germany; ² Coatema Coating Machinery GmbH, Dormagen, Germany
- 2BV.2.33 Enhancing Crystal Growth in Low Temperature Process with Ag Doped CuInSe₂ Solar Cells for Bi-Facial Structure**
Dong-Hwan Jeon¹, Ali Amanat¹, Jae-Baek Lee¹, Shi-Joon Sung¹, Dae-Kue Hwang¹, Dae-Hwan Kim¹
¹ DGIST, Daegu, South Korea



- 2BV.2.34 Photovoltaic Performances of Dye-Sensitized Solar Cells based on Heavy-Atom-Free Materials**
Mi-Ra Kim¹, Sungsoo Park¹, Songyi Lee²
¹ Dong-Eui University, Busan, South Korea; ² Pukyong National University, Busan, South Korea
- 2BV.2.35 1.87 eV GaInP Photovoltaic Module for Indoor Light Energy Harvesting**
Yasushi Shoji¹, Kikuo Makita², Takeyoshi Sugaya²
¹ National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan; ² AIST, Tsukuba, Japan
- 2BV.2.36 Air Processed Asymmetric Squaraine Dyes for Photovoltaic Application**
Vilko Mandić¹, Floren Radovanović-Perić¹, Thomas Rath², Dragana Vuk¹
¹ University of Zagreb, Zagreb, Croatia; ² Graz University of Technology, Graz, Austria
- 2BV.2.37 In-depth Analysis of Ag Alloying in Metallic Precursor for Efficient Kesterite Solar Cells**
Mingrui He¹, Xiaojing Hao¹
¹ UNSW, Sydney, Australia

VISUAL PRESENTATIONS 4BV.3

13:30 - 15:00 Operation, Performance and Maintenance of PV Systems

Chairpersons: Mr. Gerhard Mütter
Gerhard Mütter e.U., Waldneukirchen, Austria
Dr. Joshua S. Stein
Sandia National Laboratories, Albuquerque, United States of America
Mr. Roland Einhaus
ZSW, Stuttgart, Germany

- 4BV.3.1 In-Situ Maintenance-Free Measurement of Soiling-Induced Power Losses in PV Arrays**
Michael Gostein¹, Damien Cosme², Quentin Berthet-Rayne², Julien Chapon³, William Stueve¹, Brahim Aïssa⁴, Benjamin Figgis⁴, Juan Lopez-Garcia⁴, Veronica Bermudez Benito⁴
¹ Atonometrics, Austin, United States of America; ² TotalEnergies, Doha, Qatar; ³ TotalEnergies, Paris, France; ⁴ QEERI, Doha, Qatar
- 4BV.3.3 Improving Performance Ratio Calculations through Optimizing Front POA Irradiance Sensor Positioning**
Marc A. N. Korevaar¹, Shuo Wang², Damon Nitzel¹, Nate Solofra³
¹ OTT Hydromet, Delft, The Netherlands; ² TUAS, Turku, Finland; ³ Merit Controls, Salem, United States of America
- 4BV.3.5 A Study on the Fault-Type Diagnosis Algorithm for Photovoltaic System using Cross Verification Method**
Min-Jae Oh¹, Jung-Min Moon¹, Ju-Hee Kim¹, Young-Ah Park¹, Minkook Kim¹, Joonyoung Jeon¹, Changheon Kim¹, Yong Hyun Kim¹, Myungwoo Son¹
¹ Korea Photonics Technology Institute, Gwangju, South Korea
- 4BV.3.6 A Method for Detecting PV Module's Degradation Due to Increased Local Resistance in Power Plant**
Tohru Kohno¹, Jun Tsunoda¹
¹ Hitachi, Tokyo, Japan

- 4BV.3.7 Comparative Performance Study between Single Axis Tracker and Fixed Tilt Solar PV Systems on a Hot Climate near Coastal Area in Oman**
Mazin Al Shidhani¹, Waleed Al Washahi¹, Abbas Al Lawati¹, Hamed Al Hashmi¹, Mohamed Al Busaidi¹, Habib Abdulkhalig¹
¹ Petroleum Development Oman, Muscat, Oman
- 4BV.3.8 Dependence of Series Resistance on Ideality Factor and Shunt Resistance in Online Photovoltaic Module Parametric Identification**
Heidi Kalliojärvi¹, Kari Lappalainen¹
¹ Tampere University, Tampere, Finland
- 4BV.3.9 Predictive Maintenance and Anomaly Detection Analytics for Utility-Scale Photovoltaic Plants**
Jesus Montes-Romero¹, Nino Heinze², Andreas Livera³, George Makrides³, Juergen Sutterlueti², Steve Ransome⁴, George E. Georgiou³, Demeteris Marangis³
¹ University of Jaen, Jaen, Spain; ² Gantner Instruments, Schruns, Austria; ³ University of Cyprus, Nicosia, Cyprus; ⁴ Steve Ransome Consulting, Kingston upon Thames, United Kingdom
- 4BV.3.10 Underwater Structures Inspection and Aquatic Organism Attachment Stability Analysis of Nearshore Floating Photovoltaic**
Hyunsik Jo¹, Jieun Lee¹, Jungi Jung¹, Changsub Won²
¹ K-water, Daejeon-Si, South Korea; ² Konkuk University, Seoul-Si, South Korea
- 4BV.3.11 Analysis of PV Module Failure and Power Degradation in Floating Photovoltaic**
Jieun Lee¹, Hyunsik Jo¹, Jungi Jeong¹, Wonwook Oh², Chang-sub Won³, Donghwan Kim⁴
¹ K-water, Daejeon, South Korea; ² Chungbuk Technopark, Chungcheongbuk-do, South Korea; ³ Konkuk University, Seoul, South Korea; ⁴ Korea University, Seoul, South Korea
- 4BV.3.12 Safety Analysis of PV Systems for Soundproof Tunnel Based on Voltage and Current Mismatch**
Juhee Jang¹, Chongmin Kim¹, Sujeong Oh¹
¹ Korea Electrical Safety, Wanju, South Korea
- 4BV.3.14 Improved Modelling of PV Systems with Snow Soiling for Optimized Local Energy Sharing**
Ida Fuchs¹, Ole-Morten Midtgård¹
¹ NTNU, Trondheim, Norway
- 4BV.3.15 Ensuring Photovoltaic Module Integrity Through Electroluminescence Imaging and Machine Learning Solutions**
Daniel J. Castillo Patton¹, Lucas Viani¹, Fernando García², Vicente Parra¹, Sofía Rodríguez-Conde¹, Jesús Cuasmas¹
¹ Enerdis Applus+, Madrid, Spain; ² UC3M, Madrid, Spain
- 4BV.3.16 RACONT2050 - Reliability and Comparison of New PV Technologies**
Domenico Chianese¹, Mauro Caccivio¹, Gabi Friesen¹
¹ SUPSI, Mendrisio, Switzerland
- 4BV.3.17 Monitoring based Automated PV Module Orientation Predictor**
Ernst Wittmann¹, Claudiva Buerhop-Lutz¹, Vincent Christlein², Vincent Le Corre¹, Christoph Brabec¹, Marius Peters¹
¹ HI ERN, Erlangen, Germany; ² Friedrich Alexander University, Erlangen, Germany



4BV.3.18 Comparative Analysis of String IV Measurement Methods for Fault Detection in Photovoltaic Systems

Martin Bartholomäus¹, Peter Behrendorff Poulsen¹, Sergiu Viorel Spataru¹

¹ Technical University of Denmark, Roskilde, Denmark

4BV.3.19 Installation of Twin 'Solar Labs' to Monitor Performances of Photovoltaic Solar Modules in Harsh Conditions

Giulio Mangherini¹, Valentina Diolaiti¹, Alfredo Andreoli¹, Simone Beneduce², Giacomo Gorni², Cosimo Mazzella², Fabio Melchiorre², Donato Vincenzi¹

¹ University of Ferrara, Ferrara, Italy; ² ENI, Novara, Italy

4BV.3.20 Revamping Options of a Stand-alone PV Facility

Cristian Terrados¹, Manuel García¹, David González¹, Salvador Seguí², Cristina Alonso¹

¹ University of Burgos, Burgos, Spain; ² University of Valencia, Valencia, Spain

4BV.3.21 Anomaly Detection and Visualization for Outdoor Photovoltaic

Goodfriend Whyte¹, Bart Pieters¹, Andreas Gerber¹

¹ Forschungszentrum Jülich, Jülich, Germany

4BV.3.22 AI-SafePV: An AI-Based Fault Detection Software Package for Enhancing Safety in Photovoltaic Arrays

Aref Eskandari¹, Jafar Milimonfared², Amir Nedaei², Mohammadreza Aghaei³

¹ Iran University of Science and Technology, Tehran, Iran; ² Amirkabir University of Technology, Tehran, Iran; ³ NTNU, Ålesund, Norway

4BV.3.23 DetectivePV: A Detection Software Package for Electrical Faults in Photovoltaic Arrays Based on Machine Learning Models

Aref Eskandari¹, Jafar Milimonfared², Amir Nedaei², Mohammadreza Aghaei³

¹ Iran University of Science and Technology, Tehran, Iran; ² Amirkabir University of Technology, Tehran, Iran; ³ NTNU, Ålesund, Norway

4BV.3.24 Wet Leakage and Insulation Test on String Level Through IEC 61215

Sergio Suarez¹, Jose Cantisano¹, Jonathan Vilela¹, Jose Maria Alvarez¹, Ignacio Fernandez¹, Sofia Rodriguez¹

¹ Enertis Applus, Madrid, Spain

4BV.3.25 TALOS: Autonomous Robotic Solutions for Operation and Maintenance in PV Scenarios

Nicolas Congouleris¹, Athanasios T. Balafoutis¹, Lisandro Puglisi², João Formiga³, Daniel Albuquerque³, Bruno Barrionuevo¹

¹ CERTH, Thermi, Greece; ² EDP Renewables, Madrid, Spain; ³ EDP NEW, Lisbon, Portugal

4BV.3.26 Harmonising Multi-sites Measurement of Photovoltaic Systems: Comprehensive Framework for Real-Life Test Conditions in a Maltese Environment

Brian Bartolo¹, Brian Azzopardi¹, Alexandre Mignonac², Marcus Rennhofer³, Bernhard Kubicek⁴, Rita Ebner⁴, Carlos Meza⁵, Melodie de l'Epine⁶, Eugenia Zugasti⁷, Steve Zerafa⁸

¹ The Foundation for Innovation and Research, Birkirkara, Malta; ² CEA, Cadarache, France; ³ AIT, Vienna, Austria; ⁴ AIT, Vienna, Austria; ⁵ HSA, Anhalt, Germany; ⁶ BI, Brussels, Belgium; ⁷ CENER, Pamplona, Spain; ⁸ PIXAM, Msida, Malta

4BV.3.27 Mediterranean Climate Impact on Photovoltaic Systems: Insights from Malta and Implications for Future European Integration

Brian Bartolo¹, Brian Azzopardi¹, Alexandre Mignonac², Marcus Rennhofer³, Bernhard Kubicek³, Rita Ebner³, Carlos Meza⁴, Melodie de l'Epine⁵, Eugenia Zugasti⁶, Steve Zerafa⁷

¹ The Foundation for Innovation and Research, Birkirkara, Malta; ² CEA, Cadarache, France; ³ AIT, Vienna, Austria; ⁴ HSA, Anhalt, Germany; ⁵ BI, Brussels, Belgium; ⁶ CENER, Pamplona, Spain; ⁷ PIXAM, Msida, Malta

4BV.3.28 Comparison of Physical, Machine Learning and Hybrid Models of Monofacial and Bifacial PV Systems

Jonas Petzschmann¹, Dirk Stellbogen¹, Manuel Heim¹

¹ ZSW, Stuttgart, Germany

4BV.3.29 Quantitative Shade Detection for PV Systems Based on Clearsky Data

Achim Schulze¹, Markus Panhuysen², Darwin Daume³, Maximilian Schönauf²

¹ Rosenheim Technical University of Applied Sciences, Rosenheim, Germany; ² Smartblue, Munich, Germany; ³ Coburg University of Applied Sciences, Coburg, Germany

4BV.3.30 Robust Electroluminescence Image Quality Metrics Based on Texture Analysis and Machine Learning

Thøger Kari¹, Gisele A. dos Reis Benatto¹, Rodrigo del Prado Santamaria¹, Sergiu Spataru¹

¹ DTU, Roskilde, Denmark

4BV.3.31 Forecasting the Lifetime of Photovoltaic Modules through Coupling a Physics-Based Degradation Model with 3D Heat Transfer Simulations

Timofey Golubev¹

¹ ThermoAnalytics, Calumet, United States of America

4BV.3.32 Development of a Model to Ensure the Safety of PV Systems Using FMEA

Sujeong Oh¹, Chongmin Kim¹, Juhee Jang¹

¹ Korea Electrical Safety Corporation, Wanju-gun, South Korea

4BV.3.33 Analysis of Output Efficiency Between Reused Solar Modules and New Modules (50kW : ECO, 50kW : New Bifacial PV module)

Jae-hyeok Hur¹, Han-Yeol Kim¹, Jeong-Eon Lee¹, Myoung-Geon Seo¹, Jihyan Yoo¹, Goong-hyun Nam¹, Su-Mi Yang¹

¹ Far East University, Eumseong-gun, CB, South Korea

4BV.3.34 Longtime Economic and Energetic Viability of PV Facilities in Castilla Y Leon, Spain

Eduardo Fernández-Cabal¹, Cristian Terrados-Lopez¹, Ignacio Garcia-Ruiz¹, Cristina Alonso-Tristan¹

¹ University of Burgos, Burgos, Spain

4BV.3.35 Long-Term Monitoring of Degradation and Defect in High-Voltage Strings Through Dark I-V Measurements

Samuele Chiesa¹, Gian Carlo Dozio¹, Domenico Chianese²

¹ SUPSI-ISEA, Lugano, Switzerland; ² SUPSI-ISAAC, Lugano, Switzerland

4BV.3.36 Machine Learning Techniques for Assessment of Open Circuit Voltage Loss in PV Systems

Sandra Riaño¹, Jose Domingo Santos¹, Miguel Esteras¹, Amaia Abanda¹, Javier del Ser²

¹ TECNALIA Research & Innovation, Derio, Spain; ² UPV / EHU, Bilbao, Spain



4BV.3.37 A Dependent Climatic Zone Dependency on the Impact of HSAT Use to the LCOE of Utility Scale PV Power Plants

Dhanup Pillai¹, Juan Lopez Garcia¹, Sachin Jain¹, Veronica Bermudez Benito¹

¹ HBKU-QEERI, Doha, Qatar

4BV.3.38 PV Module Cleaning Models Incorporating Weather Data Sets

Fnu Muhfizurrahmah¹, Christiana Honsberg¹

¹ Arizona State University, Tempe, United States of America

4BV.3.39 Real-time Monitoring and Diagnostic of Rooftop Monofacial PV System with Thermography Validation

Amr Osama¹, Giuseppe Marco Tina¹, Antonio Gagliano¹, Gabino Jiménez-Castillo², Francisco Jose Muñoz-Rodriguez²

¹ University of Catania, Catania, Italy; ² University of Jaén, Jaén, Spain

4BV.3.40 Geospatial Referencing from a Single Image

Evgenii Sovetkin¹, Andreas Gerber¹, Bernhard Kubicek², Bart E. Pieters¹

¹ Forschungszentrum Jülich, Jülich, Germany; ² AIT, Vienna, Austria

4BV.3.41 Outdoor Exposure Study on the Performance of Nine Different Types of Industrial PV Modules under 35° and under 90°

Luka Wernke¹, Maximilian Riedel¹, Björn Rau¹, Rutger Schlatmann¹, Carolin Ulbrich¹

¹ HZB, Berlin, Germany

4BV.3.42 Operation and Maintenance of Floating PV Systems – What is Unique About it?

Harsha Lakmal Walpita¹, Erik Stensrud Marstein¹, Bjørn Aarseth²

¹ University of Oslo, Oslo, Norway; ² IFE, Kjeller, Norway

4BV.3.43 Photovoltaic Output Power Modeling: A Hybrid Approach

Leticia de Oliveira Santos¹, Francisco Alexandre Andrade Souza², Tarek AlSkai³, Paulo C. M. Carvalho¹

¹ UFC, Fortaleza, Brazil; ² imec-NL, Wageningen, The Netherlands; ³ Wageningen University, Wageningen, The Netherlands

4BV.3.44 PV Failure Diagnosis using Combined Approaches of Imaging Techniques and Electrical Characterization

Daha Hassan Daher¹, Alexandre Mathieu², Dek Mouhomed¹, Léon Gaillard², Pierre-Olivier Logerais³, Christophe Menezo⁴

¹ CERD, Djibouti, Djibouti; ² Heliocity, Grenoble, France; ³ CERTES, Lieusaint, France; ⁴ CNRS, Le Bourget-du-Lac, France

4BV.3.45 Estimation of Annual Power Loss of a Solar PV System due to Rise in the Cell Temperature: A Case Study for Indian Climate

Shubham Kumar¹, P. M. V. Subbarao¹

¹ IIT Delhi, New Delhi, India

4BV.3.46 Snow Losses for Different PV Module Designs: Modelling and Validation in South-West Finland

Shuo Wang¹, Hugo E. Huerta¹, Sami Jouttijärvi², Kati Miettunen², Aleksi Heinonen¹, Samuli Ranta¹

¹ Turku University of Applied Sciences, Turku, Finland; ² University of Turku, Turku, Finland

4BV.3.47 A Case Study of Digital O&M Using the Physics and Machine Learning Estimation Model

Hye-mi Hwang¹, Woo-gyun Shin¹, Young-chul Ju¹, Seok-whan Ko¹

¹ KIER, Daejeon, South Korea

4BV.3.48 Predictive Analysis of Renewable Energy Generation Infrastructures Based on Big Data Algorithms: The Case of Soiling

Pedro J. Pérez-Higueras¹, João Gabriel Bessa¹, Florencia Almonacid-Cruz¹, Diego Lopez Talavera¹, Pablo Cárdenas¹, Raul Mata¹, Eduardo F. Fernández¹

¹ University of Jaén, Jaén, Spain

4BV.3.49 Quantifying the Global Impact of Soiling

Thore Müller¹, Franco Vicente Clandestino Muñoz¹, Kostiantyn Pogorelov¹

¹ PVRADAR Labs, Ebersberg, Germany

4BV.3.51 Applying Data-Driven Information Extraction and Machine Learning to Evaluate Massive Distributed Solar Farm Power Generation

Myeongchan Oh¹, Changki Kim¹, Chang Yeol Yun¹, Boyoung Kim¹, Hyun-Goo Kim¹

¹ KIER, Daejeon, South Korea

4BV.3.52 Defect Quantification System through Aerial Inspections

Sergio Suarez¹, Felix Rafael¹, Daniel Jason¹, Daniel Villoslada¹, Ignacio Fernandez¹, Sofia Rodriguez-Conde¹

¹ Enertis Applus, Madrid, Spain

4BV.3.53 Shaping European Collaboration on Photovoltaics: a Collaborative Platform for Simulation and Monitoring (COPLASIMON)

Simone Vitale¹, Jonathan Leloux², Hervé Colin³, Eric Pilat⁴, Stéphane Mollier³, Basem Idlbi⁵, R. Moretón⁶, Oscar Anchorena⁶, Christophe Salperwyck⁷, Christian Schill⁸

¹ LuciSun, Sart Dames Avelines, Belgium; ² LuciSun, Sart-Dames-Avelines, Belgium; ³ CEA, Le Bourget-du-Lac, France; ⁴ CEA, Le Bourget du Lac, France; ⁵ Ulm University of Applied Sciences (Technische Hochschule Ulm), Ulm, Germany; ⁶ Qualifying PhotoVoltaics, Madrid, Spain; ⁷ MyLight150, Auvergne-Rhône-Alpes, France; ⁸ Fraunhofer ISE, Freiburg, Germany

4BV.3.54 Estimation of Power Generation from a Bifacial PV Systems Using Times Data and Machine Learning

Woogyun Shin¹, Young-Chul Ju¹, Hye-Mi Hwang¹, Suk-whan Ko¹

¹ KIER, Daejeon, South Korea

4BV.3.55 Irradiance Losses and Gains in Vertical Bifacial Systems

Mari Øgaard¹, Erlend Hustad Honningdalsnes², Magnus Moe Nygård², Sean Erik Foss³

¹ IFE, Kjeller, Norway; ² Institute for Energy Technology, Kjeller, Norway; ³ Over Easy Solar, Oslo, Norway

VISUAL PRESENTATIONS 4BV.4

15:15 - 16:45

Photovoltaic in/on Buildings

Chairpersons:

Dr. Xu Zhihao

AIST, Tsukuba, Japan

Prof. Dr. Francesco Frontini

SUPSI, Mendrisio, Switzerland

4BV.4.1 Performance of Vertically Mounted Bifacial Photovoltaics on High-Rise Buildings in the Nordic Conditions

Bergpob Viriyoj¹, Sami Jouttijärvi², Matti Matti Jänkälä¹, Kati Miettunen²

¹ Aalto University, Espoo, Finland; ² University of Turku, Turku, Finland



- 4BV.4.2 Integrated Design Process Supporting the Customization of BIPV Applications Within Curtain Wall Facades Based on Quantum Dot-Luminescent Solar Concentrator Technology**
Martina Pelle¹, Claudio Castellan², Marcello La Rosa², Alexander Astigarraga¹, Giorgio Belluardo¹, Martino Gubert¹, Laura Maturi¹
¹ EURAC Research, Bolzano, Italy; ² Glass to Power, Rovereto, Italy
- 4BV.4.3 Reducing the Angular Colour Dependence of Building Integrated Photovoltaic Modules Based on Optical Interference Coatings**
Chang Chuan You¹, Ørnulf Nordseth¹, Arne Røyset², Tore Kolås²
¹ Institute for Energy Technology, Kjeller, Norway; ² SINTEF Industry, Trondheim, Norway
- 4BV.4.4 Maximizing Solar Electricity and Daylighting from Building Envelopes: A Smart Translucent Window Based on Concentrator Photovoltaics with Integrated Tracking**
Almudena Garcia-Sanchez¹, Guido Vallerotto¹, Steve Askins¹, Ignacio Antón¹, César Domínguez¹
¹ UPM, Madrid, Spain
- 4BV.4.5 A Pilot Measurement and Verification Line for Building Integrated Photovoltaic (BIPV), Solar Thermal (ST) and Hybrid Photovoltaic/Thermal (PV/T) Systems Facing Efficiency and Safety Requirements**
Olaia Aurrekoetxea-Arratibel¹, Nerea Otaño Aramendi¹, Susana Santamaria-Fernandez¹, Daniel Valencia-Caballero², Izaskun Alvarez-Alava³, Inigo López-Villamor³, Xabier Olano-Azkune¹
¹ TECNALIA, Azpeitia, Spain; ² Tecnalia, Donostia - San Sebastián, Spain; ³ TECNALIA, Derio, Spain
- 4BV.4.6 Design and Optimization of Structural Colored Interlayers for Building-Integrated Photovoltaic Applications**
Catarina Ferreira¹, Irina Vyalih², Markus Babin³, Roberto Boccardi³, Aliihsan Bagci³, Nanna Lysgaard Andersen³, Peter Behrendsdorff Poulsen³, Sune Thorsteinsson³, Karlis Petersons⁴, Joel Cox¹, Morten Madsen²
¹ University of Southern Denmark, Odense, Denmark; ² University of Southern Denmark, Sønderborg, Denmark; ³ Technical University of Denmark, Roskilde, Denmark; ⁴ Stensborg, Roskilde, Denmark
- 4BV.4.7 A Demonstration Study on Colored BIPV System of Construction Material Type in a Library Building**
SangMyung Kim¹, Jinhee Kim¹, Juntae Kim¹
¹ Kongju National University, Cheonan-si, South Korea
- 4BV.4.8 Comparative Analysis of Individual and Collective PV Integration Strategies for a Residential Neighborhood**
Qiuxian Li¹, Natasa Vulic², Hanmin Cai², Philipp Heer²
¹ KU Leuven, Ghent, Belgium; ² Urban Energy Systems Laboratory, Empa, Dübendorf, Switzerland
- 4BV.4.9 Shining Lights on Limits: Optimizing Luminescent Solar Concentrators for Solar Windows**
Thomas de Bruin¹, Wilfried Van Sark¹
¹ Utrecht University, Utrecht, The Netherlands
- 4BV.4.10 Modelling Framework for Optimizing Hybrid Photovoltaic-Thermal Systems in Combination with Seasonal Heat Storage**
Aron van Rossum¹, Zain Ul Abdin¹, David Martinez Aguilera¹, Olindo Isabella¹, Rudi Santbergen¹
¹ Delft University of Technology, Delft, The Netherlands

- 4BV.4.11 Performance Assessment of Novel Solar Energy Systems for Aged Neighbourhoods and Buildings in Dutch Cities**
Edward Otoo¹, Roel C. G. M. Loonen¹, Angèle H.M. E. Reinders¹
¹ Eindhoven University of Technology, Eindhoven, The Netherlands
- 4BV.4.12 Steel Framing/Structure as a Solution to Support BIPV Competitiveness**
Simon Boddaert¹, Jean-Pierre Reyat², Michel Dernis³, Philippe Alamy⁴
¹ CSTB, Sophia Antipolis, France; ² Semperstyl, Eragny Sur Oise, France; ³ Atrium Data, Paris, France; ⁴ EnerBim, Donneville, France
- 4BV.4.13 Advanced PV and Thermal Modeling for a Feasible and Efficient BAPV-T System Design and Evaluation**
Iñaki Cornago¹, Mikel Ezquer¹, Patxi Sorbet¹, Alicia Kalms¹, Gonzalo Diarce², Olatz Irulegi³, Fritz Zaversky¹
¹ CENER, Sarriguren, Spain; ² UPV/EHU, Bilbao, Spain; ³ UPV/EHU, San Sebastian, Spain
- 4BV.4.14 PV on Green Roofs. Over Two Years of Comparative Measurement Data From Various System Concepts, Supplemented by Simulation Results and General Considerations**
Markus Klenk¹, Roger Hiltbrand¹, Selina Pfyffer¹, Hartmut Nussbaumer¹
¹ ZHAW, Winterthur, Switzerland
- 4BV.4.15 BIPV Design and Performance Evaluation Using 5kW Shingled Solar Module**
Minseob Kim¹, Sungmin Yoon², Min-Joon Park², Eunae Jo², Kiseok Jeon², Jinho Shin², Eunbi Lee², Yujin Kim², Chaehwan Jeong²
¹ Chonnam National University, Gwangju, South Korea; ² KITECH, Gwangju, South Korea
- 4BV.4.16 Constructive Glass Protection on PV Facades**
Joachim Sting¹, Ralf Haselhuhn¹
¹ DGS, Berlin, Germany
- 4BV.4.17 Integration of PCM into PV Windows to Improve the Efficiency of Structures Based on LSC Technologies**
Giulio Mangherini¹, Baccaga Eleonora¹, Valentina Diolaiti¹, Alfredo Andreoli¹, Donato Vincenzi¹
¹ University of Ferrara, Ferrara, Italy
- 4BV.4.20 Guideline for the Realization of High PV Façades > 30 m**
Urs Muntwyler¹
¹ Dr. Schuepbach & Muntwyler, Bern, Switzerland
- 4BV.4.22 Semi-Transparent CIGS Thin-Film PV Modules**
Peter Borowski¹, Thomas Schutt², Julian Röder¹, Maik Schubert², Martin Hillmann², Kristian Herath², Subarna Sapkota², Volker Speer², Marko Stölzel¹, Rene Reichel², Thomas Dalibor¹
¹ AVANCIS, Munich, Germany; ² AVANCIS, Torgau, Germany
- 4BV.4.23 Assessing Photovoltaic-Thermal System Performance across Diverse Climates: An Economic and Environmental Comparative Analysis**
Zain Ul Abdin¹, Olindo Isabella¹, Rudi Santbergen¹
¹ Delft University of Technology, Delft, The Netherlands



4BV.4.24 Mass Customization 2.0 Project Produces BIPV Market Outlook Analysis and First Series of Semi-Fabricates based on Design Documents of Four BIPV-Products

Roland Valckenborg¹, Nikoleta Kyranaki², Simona Villa¹, Atse Louwen³, Paolo Corti⁴, Gernot Oreski⁵, Davide Colla⁶, Yuri van Bergen⁷, Marton Berkers⁸, Marc Meuris⁹, Andreas Haller¹⁰, Marcello LaRosa¹¹, Julian Witowski¹², Paolo Frigeri¹³, Jan Teunis¹⁴, Jan Mussche¹⁵, Jochen Schuermans¹⁶, Andreas Zimmerman¹⁷, Filip Uyttenhove¹⁸, Udo Buerger¹⁹, Marc Koetse¹, David Moser³, Francesco Frontini⁴, Michael Daenen²⁰, Cristina Polacchi³

¹ TNO, Eindhoven, The Netherlands; ² imo-imomec, Genk, Belgium; ³ Eurac Research, Bolzano, Italy; ⁴ SUPSI, Lugano, Switzerland; ⁵ PCCL, Leoben, Austria; ⁶ Applied Materials Italia, Treviso, Italy; ⁷ Bouwhulp Groep, Eindhoven, The Netherlands; ⁸ Duflex, Eindhoven, The Netherlands; ⁹ EnFoil, Genk, Belgium; ¹⁰ Ernst Schweizer, Hedingen, Switzerland; ¹¹ Glass to Power, Revereto, Italy; ¹² Industry 4.0 Maturity Center, Aachen, Germany; ¹³ IWIN, Manno, Switzerland; ¹⁴ Maan Glueing Technologies, Raalte, The Netherlands; ¹⁵ BMI Monier, Montfoort, The Netherlands; ¹⁶ Roartis, Genk, Belgium; ¹⁷ Sunplugged, Wildermieming, Austria; ¹⁸ VDL ETG, Eindhoven, The Netherlands; ¹⁹ Vitronic, Wiesbaden, Germany; ²⁰ imo-imomec, EnergyVille, Genk, Belgium

4BV.4.25 Rapid Shutdown System for PV Power Generation Using a Junction Box

Joonyoung Jeon¹, Minkook Kim¹, Yong Hyun Kim¹

¹ KOPTI, Gwangju, South Korea

4BV.4.26 A Strategic Approach to Enable Large-Scale Photovoltaic Energy Systems Deployment in Urban Areas

Joyce Arthllan Oliveira de Sousa¹, Martin Thebault², Lamia Berrah¹

¹ USMB, Annecy, France; ² USMB, Le Bourget-du-Lac, France

4BV.4.27 Performance Assessment of Colorful BIPV Facade in Norway

Junjie Zhu¹, Jørgen Young²

¹ IFE Institute for Energy Technology, Kjeller, Norway; ² Isola Solar, Larvik, Norway

4BV.4.28 Implementing Strain Relief for Improved Reliability of BIPV Modules Built on Aluminum Facade Elements

Wiebke Wirtz¹, Kevin Meyer¹, Susanne Blankemeyer¹, Thomas

Daschinger¹, Henning Schulte-Huxel¹

¹ ISFH, Emmertal, Germany

4BV.4.29 CONIPHER BIPV Facades: Design and Performance Prediction

Ya-Brigitte Assoa¹, Philippe Thony¹, Emmanuel Schmitt², Olivier Bizzini³, Stephane Gelibert³, Vincent Bressy⁴, Olivier Wiss¹, Alexandre Plissonnier¹, Zeina Hamam¹

¹ CEA, Le Bourget-du-Lac, France; ² Vicat, L'Isle-d'Abeau, France; ³ Araymond, Grenoble, France; ⁴ Workspaces-architecture, Grenoble, France

4BV.4.30 The Potential of Plug&Plug PV in Switzerland

Jan Remund¹, Anne-Kathrin Weber¹, Lukas Meyer¹, Christof Bucher²,

David Joss², Theo Zwahlen²

¹ Meteotest, Bern, Switzerland; ² BFH, Burgdorf, Switzerland

4BV.4.31 Colored Building Integrated Photovoltaic(BIPV) Demonstration in Aesthetic aspects and Power Generation Analysis for Korean School Buildings Case

Kyu-Jin Kim¹, Seungjoon Lee¹, Sangmoon Lee¹, Hyunwoo Jeon²

¹ Korea Conformity Laboratories, Geumcheon-gu, South Korea; ² BIMS, Seoul, South Korea

4BV.4.32 Integration of Transparent Photovoltaic Panels into Buildings

Mujde Altin¹, Nilsah Özar¹

¹ Dokuz Eylul University, Izmir, Türkiye

4BV.4.33 Integrating FIDES Reliability Prediction into Building-Integrated Photovoltaic Systems

Fereshteh Poormohammadi¹

¹ KU Leuven, Leuven, Belgium

4BV.4.34 Installing Solar Panels with Integrated Sealants

David McDougall¹

¹ HB Fuller, Vancouver, United States of America

4BV.4.35 Advancing BIPV Modeling Efficiency for Better Performance Assessment: Co-Simulation Integration

Abdella Alzade¹, Dirk Saelens²

¹ KU Leuven, Leuven, Belgium; ² KU Leuven EnergyVille, Heverlee, Belgium

4BV.4.36 Large-Area Colored PV Panels via Cost-Effective SOL-GEL Dipping Technique

Matas Rudzikas¹, P. Dubravskij², Eglė Fataraitė-Urbonienė¹, Jolanta Doneliene¹

¹ The Applied Research Institute for Prospective Technologies, Vilnius, Lithuania; ² JSC "Modern E-Technologies", Vilnius, Lithuania

4BV.4.37 Insights of a Colored Wall-Mounted BIPV System in the Nordics

Sigrid Rønneberg¹, Chang Chuan You¹, Bent Thomassen¹, Nathan

Roosloot¹, Gaute Otnes¹

¹ Institute for Energy Technology, Kjeller, Norway

VISUAL PRESENTATIONS 1BV.5

17:00 - 18:30 Silicon Material: Growth, Defects and Recycling | Manufacturing of Solar Cells and Related Tools & Processes

Chairpersons: Dr. Stefan Peters

Hanwha Q CELLS GmbH, Bitterfeld-Wolfen, Germany

Dr. Florian Schindler

Fraunhofer ISE, Freiburg, Germany

1BV.5.1 Dynamics of Plasma-Assisted Epitaxial Silicon Growth Driven by a Hydrogen-Incorporated Nanostructure for Novel Applications

Joon-Ho Oh¹, Tae Kyung Lee², Jeong-Ho An¹, Sung-In Mo¹, Ji-Eun Hong¹, Hee-eun Song³, Ka-Hyun Kim⁴

¹ KIER, Ulsan, South Korea; ² Gyeongsang National University, Jinju, South Korea; ³ KIER, Daejeon, South Korea; ⁴ Chungbuk National University, Cheongju, South Korea

1BV.5.2 Evaluation of Temperature Dependent Stress Around Electrodes in Crystalline Silicon Solar Cells by Raman Spectroscopy

Koki Hasebe¹, Koki Ide¹, Ryo Yokogawa¹, Kyotaro Nakamura², Yoshio Ohshita², Noboru Yamada³, Atsushi Ogura¹

¹ Meiji University, Kawasaki, Japan; ² Toyota Technological Institute, Nagoya, Japan; ³ Nagaoka University of Technology, Nagaoka, Japan

1BV.5.4 Silicon Recovered from Photovoltaic Module for Lithium-Ion Battery

Gwan-Dong Cho¹, Jin-Seok Lee¹, Gi-Hwan Kang¹

¹ KIER, Daejeon, South Korea



- 1BV.5.5 Investigation of Rapid Thermal Annealing (RTA) Effects on Behaviour Mechanisms of Oxygen and Carbon Impurities in Mono-Silicon Wafers**
Nurhayat Yıldırım¹, Sertaç Eroğlu², Merve ÇORAK³
¹ Kalyon PV, Ankara, Türkiye; ² Eskisehir Osmangazi University, Eskisehir, Türkiye; ³ KalyonPV Research and Development Center, Ankara, Türkiye
- 1BV.5.6 Metallurgical Recycling of Kerf Loss Waste**
Tinotenda Mubaiwa¹, Jafar Safarian¹
¹ NTNU, Trondheim, Norway
- 1BV.5.7 Increasing the Productivity of the Czochralski Process Applying Machine Learning**
Frank Mosel¹, Lukas Kulhavy², Dorra Baccar²
¹ PVA Crystal Growing Sytems, Wettenberg, Germany; ² THM, Friedberg, Germany
- 1BV.5.8 Thermal Deactivation of Boron-Oxygen Defects in Compensated n-Type Silicon**
Rune Søndena¹, Per-Anders Hansen¹, Bent Thomassen¹, Øyvind Mjøs², Tyke Naas²
¹ IFE, Kjeller, Norway; ² REC Solar Norway, Kristiansand, Norway
- 1BV.5.15 Highest Throughput Laser Processing for Thin Plated Contacts**
Eduardo Alvarez-Brito¹, René Haberstroh¹, Georg Hoppe¹, Andreas Brand¹, Sven Kluska¹, Fabian Meyer¹, Jale Schneider¹, Jan Nekarda¹
¹ Fraunhofer ISE, Freiburg, Germany
- 1BV.5.16 Enhancement of Photocurrent Generation in Amorphous Silicon Heterojunction (SHJ) Solar Cells Through the Integration of Plasmonic Nanoparticles**
Brahim Aissa¹, Alessandro Sinopoli¹
¹ QEERI, Doha, Qatar
- 1BV.5.17 Flexible A-Si Thin Film Solar Cell Using Multi-Layered Colored Transparent Electrodes of AZO Material**
Jung-Dae Kwon¹, Soo-Won Choi¹, Myunghun Shin²
¹ KIMS, Changwon, South Korea; ² Korea Aerospace University, Goyang, South Korea
- 1BV.5.19 Mixture of Initiators with Different Initiation Temperatures for Low Temperature Curing Silver Pastes**
Hyunsoo Lim¹, Sung Hyun Kim¹
¹ KETI, Seongnam-si, South Korea
- 1BV.5.21 Impact of Optimization for Mass Production PERC Solar Cell with Efficiency above 23%**
Cheng-Wen Kuo¹, Ta-Ming Kuan¹, Yung-Chih Li¹, Chun-Wei Lee¹, Wei-Lo Chueh¹, Li-Guo Wu¹, Shih-Chieh Lin¹, Cheng-Yeh Yu¹
¹ TSEC, Hsinchu, Taiwan
- 1BV.5.22 Overview of Mandatory and Optional Additives in Wet Chemical Process Steps in Manufacturing for Industrial TOPCon Solar Cells**
Damian Brunner¹, Philipp Schmid¹, Jan Vollmer¹, Tobias Dannenberg¹, Benedikt Straub¹, Fabian Dorn¹, Michael Passig¹, Erdogan Celik¹, Martin Weber¹, Ahmed Eljaouhari¹
¹ RENA Technologies, Freiburg, Germany
- 1BV.5.23 Poly-Si Removal for TOPCon Solar Cells: A Comprehensive Comparison of Different Approaches and their Cost-effectiveness**
Jan Vollmer¹, Tobias Dannenberg¹, Philipp Schmid¹, Katrin Krieg², Sebastian Mack², Martin Zimmer², Damian Brunner¹
¹ RENA Technologies, Freiburg, Germany; ² Fraunhofer ISE, Freiburg, Germany

- 1BV.5.24 The Impact of Conductive Paste Composition on the LECO Process for TOPCon Solar Cells**
Chun-Ping Lin¹, Chih-Jeng Huang¹, Han-Chen Chang¹, Sung-Yu Chen¹, Bang-Hao Wu², Cheng-Liang Cheng², Ying-Yuan Huang³
¹ ITRI, Tainan, Taiwan; ² TeraSolar Energy Material, Miaoli, Taiwan; ³ National Cheng Kung University, Tainan, Taiwan
- 1BV.5.25 Improvement of the Industrial TOPCon Solar Cell Production by Novel Plasma Power Supply for Oxide Passivation and Silicon Deposition**
Wojciech Gajewski¹, Jana-Isabelle Polzin², Marc Hofmann², Anna Wiktoria Oniszcuk¹, Jakub Studniarek¹
¹ TRUMPF Huettinger, Zielonka, Poland; ² Fraunhofer ISE, Freiburg, Germany
- 1BV.5.26 Improved Efficiency in Silicon Solar Cells using Nano Silver-doped Self-passivating Nickel Contacts**
Melisa Korkmaz Arslan¹, Berkeli Akgayev², Serdar Akbayrak², Rasit Turan¹, Veysel Unsur¹
¹ ODTÜ-GÜNAM, Ankara, Türkiye; ² Necmettin Erbakan University, Konya, Türkiye
- 1BV.5.27 Investigations on Additives for Batch Cluster Processing for Industrial TOPCon Solar Cells**
Philipp Schmid¹, Jan Vollmer¹, Tobias Dannenberg¹, Benedikt Straub¹, Fabian Dorn¹, Ahmed Eljaouhari¹, Damian Brunner¹
¹ RENA Technologies, Freiburg, Germany
- 1BV.5.28 Realistic Estimation of Industrial TOPCon Cell Efficiencies**
Mehul Raval¹, Pirmin Preis², Lejo Koduvelikulathu², Gourab Das¹, Wolfgang Jooß¹
¹ RCT Solutions, Konstanz, Germany; ² ISC Konstanz, Konstanz, Germany
- 1BV.5.29 Selective Laser Ablation of SiNx in PERC Solar Cells Via Green Femtosecond Ultrashort Pulsed Laser**
Frank Reil¹, Nastaran Hayati-Roodbari¹, Agata Lachowicz², Valentin Satzinger¹, Wolfgang Nemitz¹, Roman Trattng¹
¹ Joanneum Research, Weiz, Austria; ² CSEM PV, Neuchâtel, Switzerland
- 1BV.5.30 Optimizing Mechanical and Electrical Properties of Ni/Cu/Ag-Plated Contacts on i-TOPCon Solar Cells**
Christian Schmiga¹, Abdelaziz Boudelloua¹, René Haberstroh¹, Jonas Eckert¹, Sven Kluska¹, Florian Clement¹
¹ Fraunhofer ISE, Freiburg, Germany
- 1BV.5.31 Addressing Edge Recombination Losses in Shingle Cells by Holistic Optimization of the Process Sequence**
Alexander Göbel¹, Elmar Lohmüller¹, Dirk Wagenmann¹, Norbert Kohn¹, Marc Hofmann¹, Jonas D.Huyeng¹, Ralf Preu¹
¹ Fraunhofer ISE, Freiburg, Germany
- 1BV.5.32 Optimized Division-Conditions of Shinlged Heterojunction Solar Cells by Infra Red Laser Irradiation**
Eunbi Lee¹, Min-Joon Park², Sungmin Yoon², Eunae Jo², Kiseok Jeon¹, Minseob Kim², Jinho Shin², Yujin Kim², Chaehwan Jeong²
¹ Yonsei University, Seoul, South Korea; ² Korea Institute of Industrial Technology, Gwangju, South Korea
- 1BV.5.33 Effective Contact Formation in Crystalline Silicon Solar Cells via Current Injection Methods**
Soohyun Bae¹
¹ KIER, Daejeon, South Korea



1BV.5.34 Characterization of TiO_x as Electron Selective Contact Using Low-Temperature Oxidation Process via High-Pressure Sputtering

Franciso José Pérez Zenteno¹, Sebastian Duarte¹, Rafael Benítez¹, G. Godoy¹, Ignacio Torres², Rocío Barrio², D. Caudevilla¹, Sari Algaidy³, Rodgar García-Hernansanz¹, J. Olea¹, D. Pastor¹, Alvaro Del Prado¹, Eric García-Hemme¹, E. San Andrés¹, Lars Rebohle⁴

¹ Complutense University of Madrid, Madrid, Spain; ² CIEMAT, Madrid, Spain; ³ Polytechnical University of Madrid, Madrid, Spain; ⁴ HZDR, Dresden, Germany

1BV.5.35 Production Perc Solar Cell Loss Analysis and Efficiency Improvement up to 23.2%

Mert Kahraman¹, Metehan Gülaydin¹, Burcu Gümüş Çiftci¹, T. Meriç Yanar¹, Hatice Duman²

¹ Kalyon PV, Ankara, Türkiye; ² Kalyon, Ankara, Türkiye

1BV.5.37 Combined Laser Contact Opening and Plating Study on the Metallization of Tunnel Oxide Passivated Contact Solar Cells

Mutlu-Iskender Muglali¹, Jim Bovatsek², Irene Kubitzka¹, Torsten Voss¹, Scott White²

¹ Atotech, Berlin, Germany; ² Spectra-Physics Lasers, San Jose, United States of America

1BV.5.38 Acidic Wet-Chemical Etching of Silicon Wafer Surfaces Using Hydrofluoric Acid and Perbromates

Nils Schubert¹, Niklas Zomack¹, André Stapf¹, Edwin Kroke¹

¹ TU Bergakademie Freiberg, Freiberg, Germany

1BV.5.39 Copper Metallization for Industrial Heterojunction and Topcon Cells

Agata Lachowicz¹, Jun Zhao¹, Hatice Duman², Nurhayat Yıldırım², Christophe Ballif¹, Bertrand Paviet-Salomon¹

¹ CSEM, Neuchâtel, Switzerland; ² Kalyon, Ankara, Türkiye

1BV.5.40 Wet Chemical Etching of Silicon Wafers with Aqueous HF-(HCl)-HClO₃ Mixtures

Ann-Lucia Neumann¹, Nils Schubert¹, André Stapf¹, Niklas Zomack¹, Edwin Kroke¹

¹ TU Bergakademie Freiberg, Freiberg, Germany

Wednesday, 25. September 2024

VISUAL PRESENTATIONS 4CV.1

13:30 - 15:00	Solar Resource and Forecasting
Chairpersons:	Prof. Dr. Wilfried G.J.H.M. van Sark Utrecht University, Utrecht, The Netherlands
	Dr. Manajit Sengupta NREL, Golden, United States of America

4CV.1.1 Analyses of the Correlation between Irradiance and Clouds based on Meteorological Datasets and All-Sky-Images to Understand the Most Significant Input Variable of PV-Systems

Fabian Pauls¹, Nils Laube¹, Mike Zehner¹, Gerhard Papst², Joe Schreder²

¹ Rosenheim Technical University of Applied Sciences, Rosenheim, Germany; ² CMS Ing. Dr. Schreder, Kirchbichl, Austria

4CV.1.2 Enhancing Power Grid Resilience through Short Term Solar Irradiance Forecasting Using Convolutional Neural Networks

Khadija Barhmi¹, Sara Mirbagheri Golroodbari¹, Wilfried Van Sark¹

¹ Utrecht University, Utrecht, The Netherlands

4CV.1.3 Enhancing Photovoltaic Power Forecasting Accuracy with a Network of All-Sky Imagers and Meteorological Sensors Deployed in a PV Test Field

Andreas Boschert¹, Mike Zehner¹, Grit Behrens², Florian Fehring², Alexander Kruse², Christian Kurz³, Michele Rascher⁴, Katrin Anneser⁵

¹ Technical University of Applied Sciences Rosenheim, Rosenheim, Germany; ² University of Applied Sciences and Arts Bielefeld, Bielefeld, Germany; ³ meteocontrol, Augsburg, Germany; ⁴ Timeless Planet, Bad Wörishofen, Germany; ⁵ Deutsche Bundesstiftung Umwelt, Osnabrück, Germany

4CV.1.4 Hindcasting Solar Irradiance by Machine Learning Using Photovoltaic Data

Maximilian Schönauf¹, Darwin Daume², Markus Panhuysen¹, Tristan Kreller², Joseph Lachmann², Achim Schulze³, Bernd Hüttli², Dieter Landes²

¹ Smartblue, Munich, Germany; ² Coburg University of Applied Sciences, Coburg, Germany; ³ Rosenheim Technical University of Applied Sciences, Rosenheim, Germany

4CV.1.5 Climate Clustering for PV Interest

Anastasios Kladas¹, Karel Lagast¹, Bert Herteleer¹, Jan Cappelle¹

¹ KU Leuven, Leuven, Belgium

4CV.1.6 Advancing Solar Resource Data: The Validation Journey of 3E's Satellite-Based Irradiation Data

Philippe Malcorps¹, Gofran Chowdhury¹

¹ 3E, Brussels, Belgium

4CV.1.7 Meteorism Version 9.0

Graf Pascal¹, Jan Remund¹, Michael Schmutz¹, Mathias Aschwanden¹, David Urwyler¹, Gerhard Zaugg¹

¹ Meteotest, Bern, Switzerland

4CV.1.8 Resource-efficient PV Energy Yield Nowcasting with Sky Images: A Hybrid Global Annealing Schedule

Markos Kousounadis-Knousen¹, Apostolos Bakovasilis², Francky Catthoor³, Pavlos Georgilakis¹

¹ NTUA, Athens, Greece; ² imo-imomec, Genk, Belgium; ³ imec, Leuven, Belgium



4CV.1.9 Variability of Solar Radiation in the Context of a Flat Region Highly Loaded with Aerosols

Dunia Bachour¹, Daniel Perez-Astudillo¹
¹ HBKU/Qatar Foundation, Doha, Qatar

4CV.1.10 Towards Climate-Neutral Energy: Assessing Equations for Solar Power Optimization

Mahesh Sutaraya¹, Luiz Fonseca², Raphael Abrahão², Haresh Vaidya¹
¹ University of Applied Sciences, Feuchtwangen, Germany; ² Federal University of Paraíba, João Pessoa, Brazil

4CV.1.11 Site-Dependent Evaluation of the ECMWF IFS-HRES and IFS-COMPO Intra- and Day-ahead Forecasts with Respect to Surface Solar Irradiances

Jorge Lezaca¹, Marion Schroedter-Homscheidt¹, Yves-Marie Saint-Drenan²
¹ DLR, Oldenburg, Germany; ² MINES Paristech, Sophia-Antipolis, France

4CV.1.12 Intraday Solar Irradiance Forecasting Using Public Cameras

Roy Sarkis¹, Ilker Oguz¹, Demetri Psaltis¹, Mario Paolone¹, Christophe Moser¹, Luisa Lambertini¹
¹ EPFL, Lausanne, Switzerland

4CV.1.13 Enhancing Spatial Resolution and Expanding Spatiotemporal Coverage of PVGIS Datasets

Olympia Gounari¹, Nigel Taylor², Ana Martinez², Nikos Alexandris²
¹ TRASY International, Greece, Greece; ² European Commission JRC, Ispra, Italy

4CV.1.14 Irradiance Transposition and Reflections in BIPV Installations

Stefan Grünsteidl¹, Peter Borowski¹, Thomas Dalibor¹
¹ Avancis, Munich, Germany

4CV.1.15 Exploring the Impact of Data Quality and Availability on PV Power Plant Yield Prediction Using Machine Learning and Analytical Models

Alexander Pruehler¹, Marcus Rennhofer¹, Bernhard Kubicek¹, Martin Gröschl²
¹ AIT, Vienna, Austria; ² TU Wien, Vienna, Austria

4CV.1.16 Enhancing Solar Radiation Accuracy Using High-Resolution Satellite Cloud Products

Yu Xie¹, Manajit Sengupta¹, Mike Foster², Coda Philips²
¹ NREL, Golden, United States of America; ² University of Wisconsin, Madison, United States of America

4CV.1.19 Evaluation of the Impact of Local Sensing Data and Feature Extraction Techniques on High Frequency Intra-Hour Irradiance Forecasting

Erling Ween Eriksen¹, Heine Nygard Riise¹, Magnus Moe Nygård¹
¹ Institute for Energy Technology, Kjeller, Norway

4CV.1.20 Tracking Shadow Band Methodology for Accurate and Cost-Effective Diffuse Horizontal Irradiance Measurements

Mário Pó¹, Erik Haverkamp², Kees Hoogendijk¹, Satoshi Nishikawa³
¹ EKO Instruments Europe, Den Haag, The Netherlands; ² Radboud University, Nijmegen, The Netherlands; ³ EKO Instruments, Tokyo, Japan

4CV.1.21 Irradiance Modeling for Integrated PV with OpenStreetMap

Michael Gordon¹, Evgenii Sovetkin¹, Andreas Gerber¹, Bart E. Pieters¹
¹ Forschungszentrum Jülich, Jülich, Germany

4CV.1.23 Availability of Solar Energy on Vehicle Roofs in German Road Network

Christian Braun¹, Christian Schill¹, Nicolas Holland¹, Elke Lorenz¹, Alexander Kleinhans¹, Felix Basler¹, Martin Kaiser¹
¹ Fraunhofer ISE, Freiburg, Germany

4CV.1.24 METEOSAT Datasets in the NSRDB: An Introduction

Manajit Sengupta¹, Aron Habte¹, Grant Buster¹, Yu Xie¹, Brandon Benton¹, Michael Foster², Galen Maclaurin¹
¹ NREL, Golden, United States of America; ² University of Wisconsin, Madison, United States of America

4CV.1.25 Physics Informed Graph Neural Networks for Multi-site Solar Forecasting

Jelena Simeunovic¹, Baptiste Schubnel¹, Pierre-Jean Alet¹, Pascal Frossard², Rafael Carrillo¹
¹ CSEM, Neuchâtel, Switzerland; ² EPFL, Lausanne, Switzerland

4CV.1.26 Integrating Physical and Machine Learning Approaches for Enhanced Photovoltaic Power Output Prediction

Caixia Li¹, Ziheng Liu¹, Pengfei Zhang¹, Bohan Zhang¹, Xiaojing Hao¹
¹ UNSW, Sydney, Australia

4CV.1.27 Dimensionality Reduction of Environmental Data for Long-Term PV Performance Analysis Using Graph Based Methods

Srijani Mukherjee¹, L. Vuillon¹, Ioannis (John) Tsanakas¹
¹ CEA, Le Bourget-du-Lac, France

4CV.1.28 Statistical Methods for Monitoring Pyranometer Drift in Solar Radiation Operational Data

Lucas Silva¹, Rodrigo S. Queiroz¹, Nathianne Andrade¹, Danielle B. Cavalcante¹
¹ Delfos Energy, Fortaleza, Brazil

4CV.1.29 Performance Evaluation of Utility Scale Solar PV Power Projects in the State of Gujarat, India

Saurabh Motiwala¹, Sudarshan Kumar¹, Ashish Kumar Sharma², Ishan Purohit³
¹ IIT Bombay, Mumbai, India; ² International Finance Corporation (World bank Group), Mumbai, India; ³ International Finance Corporation (World bank Group), Delhi, India

4CV.1.30 Development of a Large Ensemble Predictions Creating Method Based on MEPS

Shuntaro Nakayama¹, Hideaki Ohtake¹, Takahiro Takamatsu¹, Takashi Oozeki¹
¹ National Institute of Advanced Industrial Science and Technology, Koriyama, Japan



VISUAL PRESENTATIONS 1CV.2

15:15 - 16:45 Processing & Characterisation of Crystalline Si based Solar Cells | Silicon Bottom Cells for Tandem Photovoltaics | Advances in Silicon Solar Cells Characterisation and Simulation

Chairpersons: Prof. Dr. Pere Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France

Dr. Francesca Menchini
ENEA, Rome, Italy

Dr. Marco Ernst
ANU, Canberra, Australia

1CV.2.1 N- and p-Type Si-Based Passivating Contacts by Sputtering

Christophe Allebé¹, Antoine Descoeudres¹, Patrick Wyss¹, Bertrand Paviet-Salomon¹, Christophe Ballif¹

¹ CSEM, Neuchâtel, Switzerland

1CV.2.2 Approaches for Reducing Metallization-Induced Losses in Industrial TOPCon Solar Cells

Sebastian Mack¹, Daniel Ourinson¹, Marius Messmer¹, Christopher Tessmann¹, Katrin Krieg¹, Jonas Huyeng¹, Johannes Greulich¹, Andreas Wolf¹, Florian Clement¹

¹ Fraunhofer ISE, Freiburg, Germany

1CV.2.3 Universal Interface Treatment for Dopant-Free Materials Applied to Silicon Heterojunction Solar Cells

Liqi Cao¹, Paul Procel Moya¹, Yifeng Zhao¹, Luana Mazzarella¹, Katarina Kovačević¹, Engin Özkol¹, Miro Zeman¹, Olindo Isabella¹

¹ TU Delft, Delft, The Netherlands

1CV.2.4 Effect of the Stack Passivation Multi-Layer on the Potential-Induced Degradation of Bifacial Crystalline Si Photovoltaic Cells and Modules

Pei-Ying Lin¹, Kai-Wei Yang Yang¹, Hung-Ming Lin¹, Hsiu-Hung Liu¹, Chen-Po Yu¹, Chun-Liang Chiang¹

¹ United Renewable Energy, HSinchu, Taiwan

1CV.2.5 Unveiling the Synergy of Nanowires and PEDOT:PSS for Silicon Solar Cell Fabrication and Leading to Mechanical Flexibility

Deepak Sharma¹, Ruchi Kumari Sharma², Arman Ahnood¹, Sanjay Kumar Srivastava²

¹ RMIT University, Melbourne, Australia; ² AcSIR, Ghaziabad, India

1CV.2.7 Polysilicon Passivation - Tunneling Oxide Routes and Annealing Conditions Effect on Passivation

Per-Anders Hansen¹, Junjie Zhu¹, Rune Søndena¹

¹ IFE, Oslo, Norway

1CV.2.8 Forming Localised Direct Metal-Silicon Contacts Through Controlled Pinhole Formation in Si/Al₂O₃/HfO₂ Stacks

Anup Yadav¹, Sophie L. Pain¹, Ailish Wratten¹, Luke Wilkins¹, Ebris Khorani¹, Brendan F. M. Healy¹, Nicholas E. Grant¹, John D. Murphy¹

¹ University of Warwick, Coventry, United Kingdom

1CV.2.9 Optimization and Integration of Room Temperature RF Sputtered ICO(:H) as TCO Layers in High-Performance SHJ Devices

Engin Özkol¹, Maria M. R. Magalhães², Yifeng Zhao¹, Liqi Cao¹, Paula Perez-Rodriguez¹, Katarina Kovačević¹, Paul Procel¹, Manuel João Mendes², Miro Zeman¹, Olindo Isabella¹

¹ TU Delft, Delft, The Netherlands; ² NOVA University, Lisbon, Portugal

1CV.2.10 Selective p+ Poly-Si Fingers for TOPCon Front Contact Passivation

Jan Hoß¹, Saman Sharbaf Kalaghchi¹, Mertcan Comak¹, Jonathan Linke¹, Jan Lossen¹, Lejo Koduvelikulathu¹

¹ ISC Konstanz, Konstanz, Germany

1CV.2.11 Effect of Deposition Temperature, Power Density, SiH₄ Flow Rate and PH₃ Doping Concentration on the Nanocrystal Growth in n-Type Amorphous Silicon Layer

Milad Ghasemi¹, Arghavan Salimi¹, Hisham Nasser¹, Raşit Turan¹

¹ ODTÜ-GÜNAM, Ankara, Türkiye

1CV.2.12 Dipole Induced Work Function Shift at N-Side Back Contact in Dopant Free Si HJ Solar Cell

Laura Lancellotti¹, Eugenia Bobeico¹, Marco Della Noce¹, Lucia Vittoria Mercaldo¹, Giuseppe Nasti¹, Elena Santoro¹, Lurie Usatii¹, Paola Delli Veneri¹

¹ ENEA, Portici, Italy

1CV.2.13 Transparent Base Contacts for Dopant Free Silicon Heterojunction Solar Cells

Luca Serenelli¹, Claudia Malerba¹, Luca Martini¹, Francesca Menchini¹, Enrico Salza¹, Glauco Stracci¹, Pietro Mangiapane¹, Mario Tucci¹

¹ ENEA, Rome, Italy

1CV.2.14 Intrinsic Amorphous Silicon Bilayers for Surface Passivation in Silicon Heterojunction Solar Cells

Busra Altinsoy¹, Valerie Depauw², Devika Rajagopal², Hariharsudan Sivaramakrishnan Radhakrishnan², Hisham Nasser¹, Raşit Turan¹

¹ METU, Ankara, Türkiye; ² imec, Leuven, Belgium

1CV.2.15 Bifacial a-Si:H Transparent Solar Cells for Building Integrated Photovoltaics

Gustavo Álvarez¹, Pau Estarlich², Pablo Rafael Ortega², Gerard Masmitja², Cristobal Voz², Alex J. Lopez-Garcia¹, Joaquim Puigdollers², Alejandro Pérez-Rodríguez¹

¹ IREC, Barcelona, Spain; ² UPC, Barcelona, Spain

1CV.2.16 Review and Highlights of More Than 30 Years Research on Ever Improving Technology for PERC Solar Cells at Fraunhofer ISE

Elmar Lohmüller¹, Sabrina Lohmüller¹, Pierre Saint-Cast¹, Johannes Greulich¹, Stefan Glunz¹, Ralf Preu¹

¹ Fraunhofer ISE, Freiburg, Germany

1CV.2.17 Investigating Interfacial Phenomena in Copper-Covered, n-Type Polysilicon-Based Contacts by Electron Microscopy

Reyu Sakakibara¹, Agata Lachowicz², Julien Hurni¹, Christophe Allebé², Bertrand Paviet-Salomon², Franz-Josef Haug¹, Christophe Ballif¹, Aïcha Hessler-Wyser¹, Audrey Morisset¹

¹ EPFL, Neuchâtel, Switzerland; ² CSEM, Neuchâtel, Switzerland



1CV.2.18 Introduction to SOLSTICE Project – Critical Material Substitution to Boost Photovoltaic Solar Cells Annual Production Capacities

Frédéric Jay¹, Sebastien Dubois¹, Jean-Luc Deschanvres², Daniel Bellet², Carmen Jimenez², David Muñoz-Rojas², Jean François Pierson³, Alexandre Nomine³, Arnaud Fouchet⁴, Valerie Demange⁵, Nathanaelle Schneider⁶, Frederique Ducroquet⁷, Thomas Fix⁸, Mona Treguer-Delapierre⁹

¹ CEA-INES, Le Bourget-du-Lac, France; ² CNRS, Grenoble, France; ³ Institut Jean Lamour, Nancy, France; ⁴ CRISMAT, Caen, France; ⁵ CNRS, Rennes, France; ⁶ IPVF, Palaiseau, France; ⁷ CROMA, Grenoble, France; ⁸ ICube, Strasbourg, France; ⁹ ICMCB, Pessac, France

1CV.2.19 Robustness of Electrical Quality of Ion Implanted Black Silicon Emitters: Comparison Between Different Ion Implantation Service Providers

Olga Morozova¹, Kexun Chen¹, Behrad Radfar¹, Hele Savin¹, Ville Vähänissi¹

¹ Aalto University, Espoo, Finland

1CV.2.20 Self-Developed GaN Like Passivating Layer on e-Beam evaporated in situ Doped Poly-Si:Ga Passivated Emitters with iVoc>704 mV

Salar Habibpur Sedani¹, Ilker Yildiz¹, Bülent Arıkan¹, Hasan Hüseyin Canar¹, Gökhan Altiner¹, Yiğit Mert Kaplan¹, Hisham Nasser¹

¹ ODTÜ-GÜNAM, Ankara, Türkiye

1CV.2.21 AZO Thin Films as a Low Work Function TCO For Heterojunction Solar Cells Applications

Claudia Malerba¹, Luca Serenelli¹, Luca Martini¹, Francesca Menchini¹, Alberto Mittiga¹, Enrico Salza¹, Galuco Stracci¹, Mario Tucci¹

¹ ENEA, Rome, Italy

1CV.2.22 Excellent Passivation of Silicon Surfaces by HFO₂ Layers Deposited Using Scalable Spatial Atomic Layer Deposition

Jan Schmidt¹, Michael Winter¹, Floor Souren², Jons Bolding², Hindrik de Vries²

¹ ISFH, Emmerthal, Germany; ² SALD, Eindhoven, The Netherlands

1CV.2.23 High-Efficiency TOPCon Solar Cells with Well-Defined Localized Poly Si Contacts

Sun Ziqiang¹, Yi Qin¹, Xiankun Cheng¹, Haibin Yu¹, Xiulin Jiang¹

¹ JA Solar, Yangzhou, China

1CV.2.26 Design Rules for TOPerc Bottom Structures for Perovskite/ Silicon Solar Cells

Eni Muka¹, Hisham Nasser¹, Raşit Turan¹

¹ ODTÜ GÜNAM, Ankara, Türkiye

1CV.2.29 Aluminum Zinc Oxide Layers by High-Pressure Sputtering for TOPCon Solar Cells

Sebastian Duarte-Cano¹, Laura Torrecilla¹, Daniel Caudevilla¹, Francisco Perez-Zenteno¹, Rafael Benitez-Fernandez¹, Guillermo Godoy-Perez¹, Rodrigo Garcia-Hernansanz¹, Eric Garcia-Hemme¹, Javier Olea¹, David Pastor¹, Alvaro Del Prado¹, Enrique San Andres¹, Sari Algaidy²

¹ Complutense University of Madrid, Madrid, Spain; ² Polytechnical University of Madrid, Madrid, Spain

1CV.2.30 Modified p-type c-Si Bottom Cells for Si/Perovskite Tandem Solar Cell

Inho Kim¹, Dong-Jin Choi¹, Yonghyun Kim¹, In Woo Choi¹, Jong-Keuk Park¹, Doh-Kwon Lee¹

¹ KIST, Seoul, South Korea

1CV.2.31 Accelerated Degradation Test Using Damp-Heat of n-Type Crystalline Silicon Photovoltaic Modules

Tomihisa Tachibana¹, Katsuhiko Shirasawa¹, Katsuto Tanahashi¹

¹ AIST, Koriyama, Japan

1CV.2.35 A Comprehensive Analysis of the Series Resistance for Different Interdigitated Back Contact Solar Cell Geometries

Alona Otaegi¹, Telmo Isasi¹, Eneko Cereceda¹, Vanesa Fano¹, Eneko Ortega¹, Nekane Azkona¹, José Rubén Gutiérrez¹, Juan Carlos Jimeno¹

¹ UPV/EHU, Bilbao, Spain

1CV.2.36 Advanced Preparation and Microscopic Analysis Methods for Protection of Intellectual Properties Related to Next-Generation Cell Technologies

Stefan Lange¹, Marko Turek¹, Stephan Großer¹, Debby Yang¹, Jan Hoß², Jonathan Linke², Christian Hagendorf³, David Adner⁴

¹ Fraunhofer CSP, Halle (Saale), Germany; ² ISC Konstanz, Konstanz, Germany; ³ Anhalt University of Applied Sciences, Koethen, Germany; ⁴ Martin-Luther-University Halle-Wittenberg, Halle (Saale), Germany

1CV.2.37 Accuracy of Hysteresis Correction for Silicon Heterojunction Solar Cells – A Simulation Study

Jonas Kern¹, Hannes Wagner-Mohnsen², Johannes Heitmann¹, Matthias Müller¹

¹ Freiberg University of Mining and Technology, Freiberg, Germany; ² WAVELABS Solar Metrology Systems, Leipzig, Germany

1CV.2.38 Contactless Carrier Lifetime Characterization of Silicon Heterojunction Structures at Elevated Temperatures

Gergely Havasi¹, David Krisztián¹, Zs. Gombás², Zoltan Adam², Ferenc Korsós¹

¹ Semilab, Budapest, Hungary; ² EcoSolifer Modulgyártó, Budapest, Hungary

1CV.2.39 Bias Light Intensity Effect on EQE Analysis for PERC Solar Cell

Hatice Duman¹, Güven Korkmaz¹

¹ KalyonPV, Ankara, Türkiye

1CV.2.40 Defect Analysis of Heterojunction Solar Cells Fabricated on Black Silicon Surface by Capacitance Spectroscopy

Arghavan Salimi¹, Ozan Aydin¹, Milad Ghasemi¹, Rasit Turan¹, Hisham Nasser¹, Alexander Gudovskikh², Artiom Baranov², Alexander V. Uvarov², E. A. Vyacheslavova², Alina A. Maksimova²

¹ ODTÜ-GÜNAM, Ankara, Türkiye; ² Alferov University, Saint-Petersburg, Russia

1CV.2.42 Improved Accuracy of Photoluminescence Images for Quality Control in Solar Cell Production

Robin Wienberg¹, Jonas Haunschild¹, Saravana Kumar¹, Jurriaan Schmitz², Stefan Rein¹

¹ Fraunhofer ISE, Freiburg, Germany; ² University of Twente, Enschede, The Netherlands



1CV.2.43 Wavelength and Magnetic Field Effects on the Spectral Response and External Quantum Efficiency of a Bifacial Silicon Solar Cell by using the Photoconductivity Method

Amadou Diao¹, Adama Ndiaye¹, Mountaga Boiro¹, Senghane Mbodji²
¹ Cheikh Anta Diop University, Dakar-Fann, Senegal; ² Alioune Diop University, Bambey, Senegal

1CV.2.44 Simulation and Design Optimization of Interdigitated Back Contact Silicon Solar Cells with Dopant-Free Asymmetric Hetero-Contacts

You-An Li¹, Chun-Ping Lin², Ying-Yuan Huang²
¹ National Yang-Ming Chiao Tung University, Tainan, Taiwan; ² National Cheng Kung University, Tainan, Taiwan

1CV.2.45 Numerical Modeling and Design Optimization of Industrial Tunnel Oxide Passivated Contact Solar Cells with Selective Passivated Contacts on the Front

Yi-Ping Lin¹, Chun-Ping Lin², Jin-Cheng Chen¹, Han-Chen Chang³, Ying-Yuan Huang²
¹ National Yang Ming Chiao Tung University, Tainan, Taiwan; ² National Cheng Kung University, Tainan, Taiwan; ³ ITRI, Tainan, Taiwan

1CV.2.46 Analysis of Efficiency and Property Changes with Si Solar Cell Degradation

Han-Yeol Kim¹, Jae-Hyeok Hur¹, Jeong-Eon Lee¹, Myoung-Geon Seo¹, Su-Mi Yang¹
¹ Far East University, Eumseong-gun, South Korea

1CV.2.47 Modeling and Experimental Validation of Solar Cell Performance Across Varied Temperatures

Selin Cansu Gölboylu¹, Hatice Duman¹, Melisa Demir¹, Meriç Çalışkan Arslan¹
¹ Kalyon PV, Ankara, Türkiye

1CV.2.48 Impact of Regeneration Processes on Implied-V(OC) and Suns-V(OC) Values in Perc Solar Cells

Alihan Kumtepe¹, Özlem Coşkun¹, Çağdaş Eğin¹, Hatice Duman²
¹ Kalyon PV, Ankara, Türkiye; ² Kalyon, Ankara, Türkiye

VISUAL PRESENTATIONS 2CV.3

17:00 - 18:30 Perovskite-based Multijunctions | Perovskite Photovoltaics

Chairpersons: Dr. Nikoleta Kyranaki
Hasselt University, Genk, Belgium
Dr. Patricia Schulze
Fraunhofer ISE, Freiburg, Germany
Dr. Sjoerd Veenstra
TNO Energy Transition, Eindhoven, The Netherlands

2CV.3.1 Direct Incorporation of Hydrogen in Transparent Conductive Electrodes via Reactive Sputtering

Bruno Vicari Stefani¹, Timothy Jones¹, John O'Sullivan², Ruy Sebastian Bonilla², Matthew Wright², Thien Truong³, Gregory J. Wilson¹
¹ CSIRO Energy, Mayfield West, Australia; ² University of Oxford, Oxford, United Kingdom; ³ NREL, Golden, United States of America

2CV.3.2 Industrial Scale Low Damage Sputter Deposition of Transparent Conductive Oxides (TCOs) as Front Electrode for Perovskite Solar Cells

Marlene Härtel¹, Katja Mayer-Stillich¹, Pablo Reyes-Figueroa², Martin Dimer³, Bernd Stannowski¹
¹ HZB, Berlin, Germany; ² Formerly: HZB, Berlin, Germany; ³ Von Ardenne, Dresden, Germany

2CV.3.4 Simulations of The Electrical Behavior of Voltage-matched and Current-matched Monolithic Series-interconnected Two-terminal Perovskite-Cigse Tandem Solar Cells under Varying Outdoor Conditions

Nicolas Otto¹, Christof Schultz¹, Guillermo Farias-Basulto², Rutger Schlatmann¹, Eva Unger², Bert Stegemann¹
¹ HTW Berlin, Berlin, Germany; ² HZB, Berlin, Germany

2CV.3.6 Materials and Device Architectures for Monolithic Perovskite/Silicon-Heterojunction Tandem Solar Cells

Eugenia Bobeico¹, Maria Federica Caso¹, Antonella De Maria¹, Marco Della Noce¹, Manuela Ferrara¹, Vera La Ferrara¹, Laura Lancellotti¹, Lucia V. Mercaldo¹, Giuseppe Nasti¹, Gennaro V. Sannino¹, Elena Santoro¹, Pietro Scognamiglio¹, Gabriella Rametta¹, Iurie Usatii¹, Paola Delli Veneri¹
¹ ENEA, Portici, Italy

2CV.3.7 Laser Processes for Tandem Perovskite Solar Cells and Modules in Glove Boxes and Air with Pico, Sub-nano and Nano Second Laser in IR, Green and UV

Stefan Bergfeld¹, Tsvetelina Merdzhanova²
¹ Aachen University of Applied Science, Jülich, Germany; ² Bergfeld Lasertech, Aachen, Germany

2CV.3.10 Monolithic Perovskite/Silicon Tandem Solar Cells: ARC and Front Electrode Optimization

Xuzheng Liu¹, Mohammad Gholipour¹, Faranak Sadegh¹, Ronja Pappenberger¹, Julian Petry¹, Rohit Chavan¹, Paul Fassl¹, Ulrich Wilhelm Paetzold¹
¹ KIT, Karlsruhe, Germany

2CV.3.11 Optimisation of MA-free Lead-tin Perovskite Absorber and Interfaces in All Perovskite Tandem Solar Cells

Jules Allegre¹, Polyxeni Tsoulka¹, Baptiste Berenguer², Mathieu Frégnaux³, Muriel Bouttemy³, Philip Schulz², Noëlla Lemaître¹, Solenn Berson¹, Kilian Alcocer⁴
¹ CEA-INES, Le Bourget du Lac, France; ² IPVF, Palaiseau, France; ³ ILV, Versailles, France; ⁴ CEA, Grenoble, France

2CV.3.13 Scalable Room Temperature Pulsed Laser Deposition of Metal Oxide Charge Transport Layers in P-I-N Perovskite Solar Cells towards Tandem with Silicon

Kilian Alcocer¹, Florian Dupont², Solenn Berson¹
¹ CEA-INES, Le Bourget du Lac, France; ² CEA-LETI, Grenoble, France

2CV.3.14 PEAI - Indeed an Effective Synergistic Modification Material to Improve All Perovskite Tandem Solar Cell Efficiency to Nearly 27%

Huan Bi¹, Hiroshi SEGAWA², Qing SHEN¹, Hayase SHUZI¹
¹ The University of Electro-Communications, Tokyo, Japan; ² The University of Tokyo, Tokyo, Japan



2CV.3.15 Synergic Use of Bi-Dimensional Materials for Large Area Perovskite/Silicon Tandem Devices

Antonio Agresti¹, Sara Pescetelli¹, Enrico Leonardi², Hanna Pazniak³, Francesco Bonaccorso⁴, Marina Foti⁵, Emmanuel Kymakis⁶, Aldo Di Carlo¹

¹ University of Rome Tor Vergata, Rome, Italy; ² GreatCell Solar Italia, Rome, Italy; ³ The University of Grenoble Alpes, Grenoble, France; ⁴ BeDimensional, Genova, Italy; ⁵ 3SUN, Catania, Italy; ⁶ Hellenic Mediterranean University, Heraklion, Greece

2CV.3.16 Construction of a Linear PVD Evaporator for the Deposition of C60/SnO2 Electron Contact Layers in a SALD Hybrid System

Volker Sittinger¹, Tino Harig¹, Tobias Graumann¹, Sven Pleger¹, Christian Beyen¹

¹ Fraunhofer IST, Braunschweig, Germany

2CV.3.17 Potential Induced Degradation Free Perovskite-Silicon Tandem Solar Cells

Kristijan Brecl¹, Matevž Bokalič¹, Gašper Matič¹, Lisa Champault², Quentin Jeangros², Marko Topič¹

¹ University of Ljubljana, Ljubljana, Slovenia; ² CSEM, Neuchâtel, Switzerland

2CV.3.18 Experimental Analysis and Modelling of Metastability Behavior in Perovskite-based Solar Cells for Accurate Energy Yield Estimation in Real-world Operating Conditions

Špela Tomšič¹, Matija Pirc¹, Matej Planinšek¹, Marko Jošt¹, Benjamin Lipovšek¹, Marko Topič¹

¹ University of Ljubljana, Ljubljana, Slovenia

2CV.3.19 First Perovskite Thin Films Elaborated Entirely by Close Space Sublimation on Si Textured Wafers for Upscaling Si/Perovskite Tandem Devices

Polyxeni Tsoulka¹, Gauthier Lefevre², Stephanie Pouget², Ferdinand Ledee², Frederic Roux², Louis Grenet², Solenn Berson¹

¹ CEA, Le Bourget-du-lac, France; ² CEA, Grenoble, France

2CV.3.20 Opto-Electrical Simulation of Perovskite / Perovskite / Silicon Triple Junction Solar Cells

Youri Blom¹, Malte Ruben Vogt¹, Hisashi Uzu², Gensuke Koizumi², Kanji Yamamoto², Olindo Isabella¹, Rudi Santbergen¹

¹ TU Delft, Delft, The Netherlands; ² Kaneka, Tokyo, Japan

2CV.3.21 PK-Si Tandem Solar Cells Encapsulation: Towards Industrial Packaging and Reliability

Claire Audoin¹, Vincent Barth¹, Amandine Boulanger¹, Guillaume Capron¹, Matthias Demuylder¹, Noëlla Lemaitre¹, Adrien Rivalland¹, Joel Wytenbach¹

¹ CEA-LITEN-INES, Le Bourget du Lac, France

2CV.3.24 Microstructural analysis on the conformity of chemical vapour deposition (CVD) perovskite thin-films on Silicon for Tandem PV devices

Ange Chen¹, Emma Holder¹, Adrian Element¹, Yong Li¹, Kenrick F. Anderson¹, Timothy W. Jones², Benjamin Duck¹, Noel Duffy¹, Gregory Wilson¹

¹ CSIRO Energy, Newcastle, Australia; ² CSIRO Energy Technology, Mayfield West, Australia

2CV.3.25 Controlling the Film Properties of SnO2 in Perovskite Solar Cells Using Scalable Spatial Atomic Layer Deposition

Hindrik de Vries¹, Floor Souren¹, Jons Bolding¹, S.R. Ratnasingham², Mehrdad Najafi³

¹ SALD, Eindhoven, The Netherlands; ² TNO Energy Transition, Petten, The Netherlands; ³ TNO Energy Transition, Eindhoven, The Netherlands

2CV.3.28 Development of High Efficiency Perovskite Solar Cells by Bayesian Optimization

Naoto Eguchi¹, Fukazawa Taro¹, Hiroyuki Kanda¹, Kohei Yamamoto¹, Takashi Miyake¹, Takuro Murakami¹

¹ National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan

2CV.3.29 Beyond Lead: The Influence of Composition and the Crystallization Step on the Photovoltaic Performance of Tin Halide Perovskite Films

Stefan Moscher¹, Konrad Binter¹, Lukas Troi¹, Fernando Warchomicka¹, Gregor Trimmel¹, Thomas Rath¹

¹ Graz University of Technology, Graz, Austria

2CV.3.31 Thermal Stability of Perovskite Solar Cells Effected by Ionic Liquid Dopant Fixed in Spiro-OMeTAD

Kohei Yamamoto¹, Takuro N. Murakami¹

¹ AIST, Tsukuba, Japan

2CV.3.32 Highly Stable and Luminescent CsPbBr3/Ethylene Vinyl Acetate (EVA) Composite Film for Realizing Coloured PV

Minya Zhou¹, Yuanxun Liao¹, Shujuan Huang², Martin Green¹, Yajie Jiang¹

¹ UNSW, Sydney, Australia; ² Macquarie University, Sydney, Australia

2CV.3.33 Beyond the Lab-Scale: Perovskite Photovoltaic Fabrication and Industrial Assessment with Automatic Slot-Die Coater

Maurizio Stefanelli¹, Simon Ternes¹, Luigi Vesce¹, Marco Balucani², Aldo Di Carlo¹

¹ University of Rome Tor Vergata, Rome, Italy; ² RISE Technology, Padova, Italy

2CV.3.34 Reasoning the Change in Device Parameters with Deposition Power of NiOx for Low-Dimensional Perovskite Solar Cells

Bhumika Sharma¹, Vani Pawar¹, Sushobhan Avasthi¹

¹ Indian Institute of Science, Bengaluru, India

2CV.3.36 Analysis of Reverse-Bias Stability of FAPbBr3 Semi-Transparent Perovskite Solar Cells

Noah Tormena¹, Alessandro Caria¹, Matteo Buffolo¹, Carlo De Santi¹, Nicola Trivellin¹, Andrea Cester¹, Gaudenzio Meneghesso¹, Enrico Zanon¹, Fabio Matteocci², Aldo Di Carlo², Matteo Meneghini¹

¹ University of Padova, Padova, Italy; ² University of Rome, Rome, Italy

2CV.3.38 Al2O3 Capping Layer for Improved Performance of Perovskite Solar Cells

Zan Ajdic¹, Marko Jost¹, Marko Topic¹

¹ University of Ljubljana, Ljubljana, Slovenia

2CV.3.39 Optimizing Performance in CsPbI3 Perovskite Quantum Dots through Pb-Site Ion-Doping Strategy

Pouriya Naziri¹, Umut Aydemir¹, Naeimeh Sadat Peighambaroust¹

¹ Koc University, Istanbul, Türkiye



- 2CV.3.40 Optimizing Perovskite Solar Cell Performance Through Tailored Variations in Thickness and Bandgap: A TCAD Simulation Study**
Amaan Chougale¹, Muntaser Almansoori¹, Ayman Rezk¹, Ammar Nayfeh¹
¹ Khalifa University, Abu Dhabi, United Arab Emirates
- 2CV.3.41 Perovskite Solar Cell Production via Thermal Evaporation: Obstacles to Accelerate Absorber Deposition**
Julian Petry¹, Alexander Diercks¹, Thomas Feeney¹, Ulrich W. Paetzold¹, Paul Fassi¹
¹ KIT, Karlsruhe, Germany
- 2CV.3.42 Perovskite Solar Cells Prepared in a Hybrid Process that Uses Ambient and Moisture-Free Conditions to Produce HTM-Free Architectures with Back Contacts Based on Carbon Compounds**
Carlos González Montesdeoca¹, Luis Manuel Ocaña González¹, Benjamín Jesús González Díaz², Sara González Pérez², María Elena Llerena García¹
¹ Technological Institute for the Renewable Energies, Granadilla de Abona, Spain; ² University of La Laguna, San Cristóbal de La Laguna, Spain
- 2CV.3.43 Enhancing Efficiency and Stability of CsPbI₃ Perovskite Quantum Dots Through Co²⁺-Doping**
Pouriya Naziri¹, Naeimeh Sadat Peighambaroust¹, Umut Aydemir¹
¹ Koc University, Istanbul, Türkiye
- 2CV.3.44 Standardized Test Routines for the Assessment of Potential Induced Degradation of Perovskite Solar Cells**
Beyza Durusoy¹, David Adner², Marko Turek³
¹ METU, Ankara, Türkiye; ² Martin-Luther-University, Halle, Germany; ³ Fraunhofer CSP, Halle, Germany
- 2CV.3.45 Evaluation of Perovskite Devices Under Real and Extreme Operating Conditions - A Fundamental Step Toward Practical Applications**
Marília Braga¹, Lucas Augusto Zanicoski Sergio¹, Anelise Medeiros Pires¹, Ricardo Rüther¹
¹ Federal University of Santa Catarina (UFSC), Florianópolis, Brazil
- 2CV.3.46 Enhancing Measurement Protocols for Perovskite Photovoltaic Devices: Insights from the VIPERLAB Project**
Eugenia Zugasti¹, Javier Diaz¹, Natalia Maticiu², Stephane Cross³
¹ CENER, Sarriguren, Spain; ² HZB, Berlin, Germany; ³ CEA-INES, Le Bourget du Lac, France
- 2CV.3.47 A Clean Doping Strategy of Spiro-OMeTAD for Efficient and Stable Perovskite Solar Cells**
Feng Wang¹, Tiankai Zhang¹, Feng Gao¹
¹ Linköping University, Linköping, Sweden
- 2CV.3.48 Sequentially Hybrid Vacuum-Processed Multi-Cation Halide Perovskite**
Felix Battran¹, Erik Ahlswede¹, Micheal Powalla¹
¹ ZSW, Stuttgart, Germany
- 2CV.3.50 Unveiling the Charge Transport Mechanism in Quasi-2D Halide Perovskites Through KPFM and c-AFM Analysis**
Hongjae Shim¹, Jonghoon Han², Jihoo Lim¹, Jan Seidel¹, Martin Green¹, Shujuan Huang², Jae Sung Yun³, Jincheol Kim²
¹ UNSW, Sydney, Australia; ² Macquarie University, Sydney, Australia; ³ University of Surrey, Guildford, United Kingdom

- 2CV.3.51 Solvent Engineering Driven Morphology Control of Perovskite Under Air Ambient Device Fabrication**
Nitin Bansal¹, Shivam Porwal², Trilok Singh¹
¹ IIT Delhi, New Delhi, India; ² IIT Kharagpur, Kharagpur, India
- 2CV.3.53 Novel Sn CVD Precursor for Depositing SnO₂ Thin Film as Transparent Conductive Oxide**
Yoshio Ohshita¹, Toshinori Numata¹, Atsushi Ogura², Hyunju Lee², Hideaki Machida³
¹ Toyota Technological Institute, Nagoya, Japan; ² Meiji University, Kawasaki, Japan; ³ Gas-Phase Growth, Koganei, Japan
- 2CV.3.54 Development of MAPbI₃ Films via Evaporation Methods as Photoactive Layer in Perovskite Solar Cells**
Lucia V. Mercaldo¹, Manuela Ferrara¹, Maria Federica Caso¹, Giuseppe Nasti¹, Corinna Ponti², Gennaro V. Sannino², Carmen Serpico², Paola Delli Veneri¹
¹ ENEA, Portici, Italy; ² University of Naples Federico II, Naples, Italy
- 2CV.3.55 Roll-to-roll Printed SnO₂ for Flexible n-i-p Perovskite PV**
Thomas Kraft¹, Ville Holappa¹, Riikka Suhonen¹
¹ VTT Technical Research Centre of Finland, Oulu, Finland
- 2CV.3.56 The Interface Engineering and the Use of 2D Materials to Scaling up the Production of Perovskite Solar Modules**
Sara Pescetelli¹, Antonio Agresti¹, Paolo Mariani¹, Hanna Poznyak², Enrico Leonardi³, Francesco Bonaccorso⁴, Emmanuel Kymakis⁵, Aldo Di Carlo¹
¹ University of Rome Tor Vergata, Rome, Italy; ² Grenoble Alpes University, Grenoble, France; ³ GreatCell Solar Italia, Rome, Italy; ⁴ BeDimensional, Genoa, Italy; ⁵ Hellenic Mediterranean University, Heraklion, Greece
- 2CV.3.57 Wide Bandgap Perovskite Solar Module Geometry Optimization by Single-diode Modeling Leading >98% Geometrical Fill Factor >80% Fill Factor**
Bahri Eren Uzuner¹, Amir Zarean Afshord¹, Aranzazu Aguirre², Tom Aernouts², Gökem Günbaş¹, Yinghuan Kuang², Selçuk Yerci¹
¹ METU, Ankara, Türkiye; ² Hasselt University/Imo-Imomec, Genk, Belgium
- 2CV.3.58 Improving Efficiency of Film-Type Perovskite Solar Cells with Current Collection Through-hole Electrodes**
Makoto Konagai¹, Yuya Momose¹, Naoki Suyama¹, Ryosuke Ishikawa¹
¹ Tokyo City University, Tokyo, Japan
- 2CV.3.60 Mitigation of Parasitic Leakage Current in Indoor Perovskite Photovoltaic Modules Using Porous Alumina Interlayer**
Gyeong G. Jeon¹, Da Seul Lee², Min Jun Choi¹, You-Hyun Seo³, Shujuan Huang⁴, Jong H. Kim¹, Seong Sik Shin², Jincheol Kim⁴
¹ Ajou University, Suwon, South Korea; ² Sungkyunkwan University, Suwon, South Korea; ³ Korea Research Institute of Chemical Technology, Daejeon, South Korea; ⁴ Macquarie University, Sydney, Australia
- 2CV.3.61 Micro Inverted Pyramid Formation in Titanium Dioxide Layer by Pulsed Laser Irradiation to Improved Electron Transport in MAPbI₃-Based Photovoltaic Devices**
Luis Ocaña¹, Carlos Montes¹, Benjamín González-Díaz², Sara González-Pérez², Elena Llerena¹
¹ ITER, Granadilla de Abona, Spain; ² University of La Laguna, San Cristóbal de La Laguna, Spain



2CV.3.63 Demonstration of industrially scalable chemical vapour deposition (CVD) process for production of high-efficiency perovskite photovoltaics

Emma Holder¹, Adrian Element¹, Yong Li¹, Faiazul Haque¹, Kenrick F. Anderson¹, Timothy W. Jones¹, Benjamin Duck¹, Noel Duffy¹, Gregory Wilson¹

¹ CSIRO Energy, Newcastle, Australia

2CV.3.64 Photoluminescence and Lifetime Stability of Pentacene and Oxide Perovskites Nanoparticles Films on Nanotextured Silicon Substrate

Rémi Ndioukane¹, Abdoul Kadri Diallo¹, Diouma Kobor¹, Sergio de Armas Rillo², Fernando Lahoz Zamorro²

¹ Ziguinchor University, Ziguinchor, Senegal; ² Universidad de La Laguna, Santa Cruz de Tenerife, Spain

2CV.3.65 High-Efficient Perovskite Solar Cells via Composition Modification with Cesium/Polymer Additives

Hamaneh Zarenezhad¹, Shervin Daneshvarasal¹, Sarp Kaya¹

¹ Koç University, Istanbul, Türkiye

2CV.3.66 Perovskite Solar Cell Upscaling with Low Temperature Industrial Sputtering Deposition Technique for Thin Oxide Electron Transport Layer

Hafez Nikbakht¹, Luigi Vesce², Fabio Matteocci³, Maurizio Stefanelli⁴, Elena Iannibelli², Karthikeyan Pandurangan⁵, Antonio Cricenti⁶, Marco Luce⁶, Paolo Mariani⁴, Maria Laura Parisi⁵, Adalgisa Sinicropi⁵, Aldo Di Carlo⁴

¹ University of Rome "Tor Vergata", Rome, Italy; ² University of Rome Tor Vergata, Rome, Italy; ³ C.H.O.S.E, Rome, Italy; ⁴ University of Rome II, Rome, Italy; ⁵ University of Siena, Siena, Italy; ⁶ CNR, Rome, Italy

2CV.3.67 Theoretical Investigation of CsSn1-xGexI3 Perovskite Solar Cells Using Graded Band Gap Profiles

Arya Narayanan¹, Dip Prakash Samajdar²

¹ PDPM Indian Institute of Information Technology Design and Manufacturing, Jabalpur, India, Jabalpur, Madhya Pradesh, India; ² PDPM Indian Institute of Information Technology Design and Manufacturing, Jabalpur, India, Khamaria, Chakdehi, Madhya Pradesh 482005, India

2CV.3.68 Methylammonium Tetrafluoroborate Additive for Spontaneous Heterointerface Modulation in FAPbI3-Based Perovskite Solar Cells

Daisuke Kubota¹, Ryuzi Katoh², Hiroyuki Kanda³, Takurou N. Murakami¹, Naoyuki Nishimura¹

¹ National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan; ² Nihon University, Tokyo, Japan; ³ National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan

2CV.3.69 Compositional Engineering of Double-cation Single-halide Perovskite for Efficient Solar Cell Fabrication under Air Ambient Conditions

Mrittika Paul¹, Binita Boro², Amreesh Chandra², Trilok Singh³

¹ Indian Institute of Technology, Kharagpur, IIT Campus, Kharagpur, India; ² IIT Kharagpur, Kharagpur, India; ³ Indian Institute of Technology, Delhi India, New Delhi, India

2CV.3.70 Enhancing Ambient Stability of Formamidinium-Cesium Lead Halide Perovskite Solar Cells Fabricated under Air Ambient Conditions

Binita Boro¹, Snehangshu Mishra¹, Paulomi Singh¹, Basudev Lahiri¹, Trilok Singh¹

¹ IIT Kharagpur, Kharagpur, India

2CV.3.71 Optimization of Mixed-cation Mixed-halide Perovskites for Indoor Photovoltaic Application

Snehangshu Mishra¹, Binita Boro¹, Trilok Singh²

¹ IIT, Kharagpur, India; ² IIT, New Delhi, India

2CV.3.72 Unveiling the Strategy of SDBS Induced Perovskite Solar Cell in an Air Ambient

Paulomi Singh¹, Binita Boro², Nitin Bansal³, Shivam Porwal⁴, Trilok Singh³

¹ Indian Institute of Technology, Delhi, Hauz Khas, New Delhi, India; ² IIT Kharagpur, Kharagpur, India; ³ Indian Institute of Technology, Delhi India, New Delhi, India; ⁴ , Kharagpur, India

2CV.3.73 Development of a Mid-Gap Perovskite Hybrid(EV-S) Process for PRV/PRV/CIGS Triple Tandem Solar Cells

Hyeonwook Park¹, Donghyeop Shin², Muhammad Rehan², Kihwan Kim², Chinho Park³, Jae Ho Yun¹

¹ Korea Institute of Energy Technology (KENTECH), Naju, South Korea; ² KIER, Daejeon, South Korea; ³ Korea Institute of Energy Technology (KENTECH), Seoul, South Korea

2CV.3.74 Interface Engineering for Perovskite Solar Cells Using Polymer-Based Antisolvent Technique

Lingeswaran Arunagiri¹, Feng Wang², Feng Gao²

¹ Linköping University, Linköping, Sweden; ² Linköping University, Linköping, Sweden



VISUAL PRESENTATIONS 4DV.1

08:30 - 10:00 Dual Use (Floating PV, Agrivoltaics, VIPV) and other Innovative PV Applications

Chairpersons: Dr. Roland M. E. Valckenborg
TNO, Eindhoven, The Netherlands

Dr. Jonathan Leloux
LuciSun, Sart-Dames-Avelines, Belgium

Prof. Dr. Angele Reinders
Eindhoven University of Technology, Eindhoven, The Netherlands

4DV.1.1 Enhancing Agrivoltaic Performance with Bifacial Photovoltaic Modules and Concentration

Elmehdi Mouhib¹, Leonardo Micheli², Florencia Almonacid¹, Eduardo F. Fernández¹, Pedro J. Pérez-Higueras¹

¹ University of Jaén, Jaén, Spain; ² Sapienza University of Rome, Rome, Italy

4DV.1.3 Bifacial Panels for Agrivoltaics and Crop Influence: Expected Benefits

Miguel-Ángel Muñoz-García¹, María Beatriz Nieto¹, Guillermo Pedro Moreda-Cantero¹, Carmen Alonso-García², Luís Fialho³, Fátima Baptista³

¹ UPM, Madrid, Spain; ² CIEMAT, Madrid, Spain; ³ University of Évora, Évora, Portugal

4DV.1.4 Analysis of the Use of Bifacial Solar Panels in Vertical Placement and Their Temporal Coupling in Agrivoltaic Irrigation

Guillermo-Pedro Moreda-Cantero¹, Raúl Sánchez-Calvo¹, Luis Juana-Sirgado¹, Delia Rodríguez Lucas², Miguel-Ángel Muñoz-García¹

¹ UPM, Madrid, Spain; ² Harvard University, Cambridge, United States of America

4DV.1.5 Comparison of Photovoltaic Green Roofs and Agricultural Photovoltaics Across Climate Zones – Benefits and Recommendations

Faizatu Zahrah Rahmaniah¹, Stephen Tay¹

¹ National University of Singapore, Singapore, Singapore

4DV.1.6 Design and Methodology for an Agrovoltaic Pilot Project in the Alentejo Region

Helena Oliveira¹, Lisa Bunge¹, Luís Fialho¹, Paulo Infante¹, Pedro Horta¹

¹ University of Evora, Evora, Portugal

4DV.1.8 Growing Greener. First Step on the Journey to Maximize Agri-Voltaic Potential

Gofran Chowdhury¹, Giovanni Borz², David Moser²

¹ 3E, Brussels, Belgium; ² Eurac Research, Bolzano, Italy

4DV.1.9 Assessing the Agrivoltaic Potential in Hot Desert Climates

Juan Lopez-García¹, Sachin Jain¹, Daniel Perez-Astudillo¹, Dunia Bachour¹, Dhanup Pillai¹, Veronica Bermudez-Benito¹

¹ HBKU, Doha, Qatar

4DV.1.10 AgriPV in Norway: Evaluating the Initial Performance and Lessons Learned

Steve Völler¹, Marisa Di Sabatino¹, Gaute Stokkan², Richard J. Randle-Boggis²

¹ NTNU, Trondheim, Norway; ² SINTEF Industry, Trondheim, Norway

4DV.1.11 Comprehensive Simulation Method for Analyzing the Land-Use Efficiency of Agrivoltaics Across Diverse Agricultural Landscapes

Leonhard Gfuellner¹, Lisa-Marie Bieber¹, Maddalena Bruno¹, Adrian Ernst¹, Matthew Berwind¹

¹ Fraunhofer ISE, Freiburg, Germany

4DV.1.12 Dual-Use Potential of AgriVoltaics in Portugal – Case Study of Herdade da Sobreira de Baixo

Lisa Bunge¹, Cláudia Fernandes², Filipe Serra², Daniel Albuquerque², João Formiga², Diogo Cordeiro³, André Soeiro³, Luís Fialho¹, Jose Almeida Silva¹

¹ University of Évora, Évora, Portugal; ² EDP NEW, Sacavém, Portugal; ³ EDP, Lisbon, Portugal

4DV.1.13 Resilience Using Vehicle-Mounted PV: Required Number of Vehicles

Soma Kawate¹, Kenji Araki¹, Yasuyuki Ota¹, Kensuke Nishioka¹

¹ University of Miyazaki, Miyazaki, Japan

4DV.1.14 VIPV: Implementing New Shading Model in Energy Flow Model

Anna J. Carr¹, Ashish Binani¹, Sanne van den Broek², Lenneke Slooff-Hoek¹, Arthur Weeber²

¹ TNO, Petten, The Netherlands; ² TU Delft, Delft, The Netherlands

4DV.1.15 High Power Photovoltaic of Flexible c-Si Shingled Photovoltaic Modules for Mobility Integrated Photovoltaic

Jinho Shin¹, Sung-Min Youn², Min Joon Park², Eunae Jo², Ki seok Jeon², Min Seob Kim¹, Eun bi Lee², Chaehwan Jeong²

¹ Chonnam National University, Gwangju, South Korea; ² KITECH, Gwangju, South Korea

4DV.1.16 IEA HEV TCP PVPS Task 17: VIPV Business Plan - The Long Way to the Mass Market

Urs Muntwyler¹

¹ Dr. Schüpbach & Muntwyler, Bern, Switzerland

4DV.1.17 Cost-Competitiveness Analysis for Infrastructure Integrated PV

Jose Maria Vega de Seoane¹, Elina Bosch², André Penas², Philippe Macé², Gaëtan Masson²

¹ Becquerel Institute España, San Sebastian, Spain; ² Becquerel Institute, Brussels, Belgium

4DV.1.19 Hydroecological Monitoring of Floating Solar Power Plants in the Context of Climate Change

Konstantin Ilgen¹, Dirk Schindler², Christian Braun¹, Robert Ladwig³, Ralph Zähringer¹, Jan Wannenwetsch¹, Marco Lennard Trentmann¹, Alexander Kleinhans¹, David Melgar¹, Leonhard Gfuellner¹, Matthew Berwind¹, Jens Lange²

¹ Fraunhofer ISE, Freiburg, Germany; ² University of Freiburg, Freiburg, Germany; ³ University of Aarhus, Aarhus, Denmark



4DV.1.20 Quantifying Thermal Dynamics: FPV System Analysis in Lake Beilen Based on Measured Data

Niek van den Nobelen¹, Annanta Kaul¹, Sara Golroodbari¹, Wilfried van Sark¹

¹ Utrecht University, Utrecht, The Netherlands

4DV.1.21 Comparative Thermal Analysis: Evaluation of System Configuration Differences in FPV Power Plants

Monica Nicola¹, Konstantin Ilgen¹, Matthew Berwind¹

¹ Fraunhofer ISE, Freiburg, Germany

4DV.1.22 Sierra Brava Floating Photovoltaic Plant: Real Data vs Simulation Software

Derivaldo Duarte¹, Luis Fialho¹, Manuel Pedro Ivens Collares-Pereira¹, Pedro Horta¹, Sara Pereira¹, Maria Cebria², Nerea Vidal²

¹ University of Évora, Évora, Portugal; ² Acciona, Madrid, Spain

4DV.1.23 Numerical Model for Wave Motions and Loads of Multibody Floating Photovoltaic Structures

Antonio Mikulić¹, Ivan Catipovic¹, Neven Alujević¹, Inno Gatin²

¹ University of Zagreb, Zagreb, Croatia; ² Cloud Towing Tank, Zagreb, Croatia

4DV.1.24 Port of Sines Energy Transition: Photovoltaic Solutions Addressing R4 Concept

Joana Correia¹, Luís Fialho¹, Pedro Horta¹

¹ University of Évora, Évora, Portugal

4DV.1.26 Integrating PVs in Nature Based Solutions: The Case of the Urban Green Spaces New Plan in Rimini, Italy

Paolo Picchi¹, Maurizio Cocchi¹, Filippo Piva²

¹ ETA Florence, Florence, Italy; ² PAMPA Studio, San Marino, San Marino

4DV.1.27 Accelerate Product Development for PV in Alpine Installations

Anika Gassner¹, Gabriele Eder¹, Ebrar Özkalay², Gabi Friesen², Markus Feichtner³, Mauro Caccivio², Friedrich Bleicher⁴

¹ OFI, Vienna, Austria; ² SUPSI PVLab, Mendrisio, Switzerland; ³ Sonnenkraft Energy, St. Veit a.d. Glan, Austria; ⁴ TU Wien, Vienna, Austria

4DV.1.28 A Brief Investigation on Agrivoltaic in European Countries

Sara Mirbagheri Golroodbari¹, Nabih Cherradi², Kay Cesar³, Bas van Aken³, Tim Kaasjager³, Paolo Picchi⁴, Bonna Newman⁵

¹ Utrecht University, Utrecht, The Netherlands; ² Empower Sun, Baar, Switzerland; ³ TNO, Petten, The Netherlands; ⁴ ETA-Florence Renewable Energies, Florence, Italy; ⁵ LightYear, Helmond, The Netherlands

4DV.1.29 Back Irradiance Measurements and Influence of the Ground Coverage on the Production of a Bifacial Agri-PV System

Diogo Vicente¹, Dmitri Boutov¹, João Serra¹

¹ University of Lisbon, Lisbon, Portugal

4DV.1.30 Field Characterization of Vertical and Tilted Agrivoltaic Installations

Kamran Ali Khan Niazi¹, Marta Victoria¹

¹ Aarhus University, Aarhus, Denmark

4DV.1.31 Assessing the Impact of Open Field Agrivoltaics on Microclimates; Modelling the Potential Heat Flux and Evapotranspiration

Richmond Kuleape¹, Matthew Berwind², Brendon Bingwa², Max Trommsdorff², Anna Heimsath², Martine van der Ploeg³, Werner Platzer², Dierk Bauknecht¹

¹ University of Freiburg, Freiburg, Germany; ² Fraunhofer ISE, Freiburg, Germany; ³ Wageningen University & Research, Wageningen, The Netherlands

4DV.1.32 Analysis and Comparison of Solar Data Retrieved from Buses in Funchal, Madeira and Lisbon, Portugal

Guus Janssen¹, Miguel Centeno Brito², Angele Reinders¹, Ivo Costa³

¹ Eindhoven University of Technology, Eindhoven, The Netherlands; ² University of Lisbon, Lisbon, Portugal; ³ IDL- Instituto Dom Luiz, Lisbon, Portugal

4DV.1.33 Assessing the Energy Yield and Irradiance Distribution in Complex Crop Canopies Under Fixed and Tracking Agrivoltaic Systems

Shu-Ngwa Asa¹, Ismail Kaaya¹, Olivier Dupon¹, Richard de Jong¹, Sara Bouguerra¹, Arvid van der Heide¹, Arnaud Morlier¹, Hariharsudan Sivaramakrishnan Radhakrishnan¹, Jef Poortmans¹, Michael Daenen¹

¹ Hasselt University/Imo-Imomec, Genk, Belgium

4DV.1.34 Economic Attractiveness of Agrivoltaics in Different Regulation Status – Case Study

Elina Bosch¹, André Penas¹, Carolina Plaza², Philippe Macé¹, Gaëtan Masson¹

¹ Becquerel Institute, Brussels, Belgium; ² Becquerel Institute France, Lyon, France

4DV.1.35 The Impact of the Placement of Albedo Boosters on the Energy Yield in Fixed and Tracking Agrivoltaic Systems

Shu-Ngwa Asa¹, Ismail Kaaya¹, Olivier Dupon¹, Richard de Jong¹, Sara Bouguerra¹, Arvid van der Heide¹, Arnaud Morlier¹, Hariharsudan Sivaramakrishnan Radhakrishnan¹, Jef Poortmans¹, Michael Daenen¹

¹ imo-imomec, Genk, Belgium

4DV.1.36 PV on Infrastructure in the Netherlands

Corry de Keizer¹, Maarten Dörenkämper¹, Minne de Jong¹

¹ TNO, Eindhoven, The Netherlands

4DV.1.38 Optimizing Land Productivity with Customized Tracking Algorithms for Single-Axis Trackers in Agrivoltaic Systems

Gaurang Chhappia¹, Djaber Berrian¹, Johannes Linder¹

¹ Belectric, Kollitzheim, Germany

4DV.1.39 Potential Assessment and Techno-economic Viability of Utility Scale Floating Solar Photovoltaics (FSPV) in India

Saurabh Motiwala¹, Sudarshan Kumar¹, Ashish Kumar Sharma², Ishan Purohit³

¹ IIT Bombay, Mumbai, India; ² PV Diagnostics, Mumbai, India; ³ International Finance Corporation (World bank Group), Delhi, India

4DV.1.40 Environmental Sustainability of Floating PV

Daniela Seitz¹

¹ Radboud University, Nijmegen, The Netherlands

4DV.1.42 Modelling of Wave-Induced Losses for Floating Photovoltaics

Vilde Stueland Nysted¹, Lars Einar S. Stieng¹, Manish Kumar², Nathan Roosloot¹, Gaute Otnes¹, Torunn Kjeldstad¹, Josefine Helene Krogh Selj¹

¹ Institute for Energy Technology, Kjeller, Norway; ² Himachal Pradesh University, Shimla, India



VISUAL PRESENTATIONS 5DV.2

10:30 - 12:00 Energy System Integration; Resilience and Security of Supply; Solar Fuels, Storage | PV Sustainability

Chairpersons: Dr. Garvin Heath
NREL, Golden, United States of America
Prof. Dr. Marta Victoria
Aarhus University, Aarhus, Denmark
Dr. Wolfram Palitzsch
LuxChemtech, Freiberg, Germany

5DV.2.1 Techno-Economic Analysis of Residential PV-Battery Energy System in Nordics

Lauri Karttunen¹, Sami Jouttijärvi¹, Johannes Niskanen¹, Hugo Huerta², Samuli Ranta², Kati Miettunen¹

¹ University of Turku, Turku, Finland; ² Turku University of Applied Sciences, Turku, Finland

5DV.2.2 On the Statistics of Photovoltaics in Europe

Wilfried van Sark¹, Anton Driesse²

¹ Utrecht University, Utrecht, The Netherlands; ² PV Performance Labs, Freiburg, Germany

5DV.2.4 Sizing of Energy Storage Systems for Different Levels of PV and Wind Power in Combined PV-Wind Power Plants

Micke Talvi¹, Kari Lappalainen¹

¹ Tampere University, Tampere, Finland

5DV.2.6 Quantitative Evaluation Method for Regional Variations in Electricity Supply-Demand Balance Fluctuation by Weather Forecast Error

Issei Suemitsu¹, Tohru Kohno¹, Jun Tsunoda¹, Kengo Kumano¹

¹ Hitachi, Tokyo, Japan

5DV.2.7 Batteries in Direct-Coupled PV-Driven Water Splitting Systems: Stability and Synergistic Efficiency Gain

Oleksandr Astakhov¹, Uchechi Chibuko¹, Florian Seidler¹, Sergey Shcherbachenko¹, Uwe Rau¹, Tsvetelina Merdzhanova¹

¹ FZJ, Jülich, Germany

5DV.2.8 From Predictions to Profit of a Hybrid Prosumer Pilot: A Forecast-based Robust Battery Dispatch

Mojtaba Eliassi¹, Anouk Hut¹, Gofran Chowdhury¹

¹ 3E Belgium, Brussels, Belgium

5DV.2.9 Hybrid Energy Storage Systems Design Tool

Ana Catarina Neves Foles¹, Luís Fialho¹, Luís Fava¹, Pedro Matos², Pedro Horta¹

¹ University of Évora, Évora, Portugal; ² Capwatt Services, Maia, Portugal

5DV.2.10 Solar PV and Battery Microgrid for Electric Cooking - Case Study Eco Moyo Education Centre in Kenya

Audun Bangsund¹, Stian Rummelhoff¹, Ida Fuchs¹

¹ NTNU, Trondheim, Norway

5DV.2.11 Integrating Bifacial PV Forecast to Energy Management System for Mixed-Use Buildings

Hugo E. Huerta¹, Shuo Wang¹, Samuli Ranta¹

¹ Turku UAS, Turku, Finland

5DV.2.12 Optimization of Vanadium Redox Flow Battery Performance for Solar PV Integrated Electric Vehicle Charging Station

Ankur Bhattacharjee¹

¹ BITS Pilani, Hyderabad, India

5DV.2.14 Challenges and Learning Lessons in Residential Energy Storage Projects

Amanda Mendes Ferreira Gomes¹, Aline Kirsten Vidal de Oliveira¹, Marília Braga¹, Ricardo Rütther¹

¹ UFSC, Florianópolis, Brazil

5DV.2.17 Load Shifting in Energy Communities by Providing User-Centered Recommendations – Forecast, Optimization and Potential

Lukas Gaisberger¹, Georgios Chasparis², Wolfgang Traummüller³

¹ University of Applied Sciences Upper Austria, Wels, Austria; ² Software Copetence Center Hagenberg, Hagenberg, Austria; ³ BLUE SKY Wetteranalysen, Attnang, Austria

5DV.2.18 Fast Oscillations Damping Control for PV-BESS Power Plants

Alex Renan Arrifano Manito¹, Pedro Torres¹, Marcelo Pinho Almeida¹, Gilberto Figueiredo², José Cesar Almeida³, Roberto Zilles¹

¹ USP, São Paulo, Brazil; ² Fluminense Federal University, Niterói, Brazil; ³ Mackenzie Presbyterian University, São Paulo, Brazil

5DV.2.19 Optimal Use of Batteries on PV Systems for Solving Problems Caused by Predictable Partial Shadings

Rosario Carbone¹, Cosimo Borrello¹, Ferdinando Gioia¹

¹ University "Mediterranea" of Reggio Calabria, Reggio Calabria, Italy

5DV.2.20 Techno-Economic Assessment of Pumped Storage Hydro Power in Hybrid Operation with Floating Photovoltaic and Battery Energy Storage

Andreas Patha¹, Sebastian Steinlechner¹, Johannes Kathan¹, Antonia Golab², Johann Auer²

¹ AIT, Vienna, Austria; ² Vienna University of Technology, Vienna, Austria

5DV.2.21 Digital Twin of Low Voltage Grids with high PV Contribution

Basem Idlbi¹, Yannick Hömmen¹, Sabrina Krähmer¹, Dietmar Graeber¹

¹ Ulm University of Applied Sciences, Ulm, Germany

5DV.2.22 Open Architecture for Battery Interfaces: Opportunities for Technological Advancements and Community Benefits

Anna Ponomarenko¹, Konstantin Rozanov², Claudia Gutierrez Collave²

¹ Lauder Business School, Vienna, Austria; ² CF Energy, Vienna, Austria

5DV.2.25 Ecological Evaluation of Novel Agrivoltaic Systems: A Comparative Life Cycle Assessment

Miriam Godinez¹, Marc-Andre Schnaiker¹, Anna Heimsath¹, Kamran Ali Khan Niazi², Marta Victoria², Jan Cappelle³, Cas Lavaert³, Matthew Berwind¹

¹ Fraunhofer ISE, Freiburg, Germany; ² Aarhus University, Aarhus, Denmark; ³ KU Leuven, Leuven, Belgium

5DV.2.27 Guideline on Life Cycle Assessment of Agrivoltaic Systems

Maria Anna Cusenza¹, Andrea Danelli¹, Pierpaolo Girardi¹

¹ RSE, Milan, Italy

5DV.2.28 Are Bio-Based Materials Suitable for PV?

Lison Marthey¹, Sonja Feldbacher², Olatz Arriaga Arruti¹, Xavier Bulliard¹, Pierrick Duvoisin¹, Alexis Barrou¹, Laurie-Lou Senaud¹, Bertrand Paviet-Salomon¹, Matthieu Despeisse¹, Gernot Oreski², Christophe Ballif¹

¹ CSEM SA, Neuchâtel, Switzerland; ² PCCL, Leoben, Austria



- 5DV.2.29 Cradle-to-Cradle Recycling to Support the Transition to 100% Renewable Energies**
Ilan Marius Peters¹
¹ FZJ - HI ERN, Erlangen, Germany
- 5DV.2.30 Enhanced Solar Grade Film Separation Process for Recycling of Photovoltaic Modules**
Merve Çorak¹, Bedrettin Aydoğan¹, Hatice Duman¹, Meriç Çalışkan Arslan¹, Ramazan Alpay², Nihan Akın Sönmez²
¹ Kalyon PV, Ankara, Türkiye; ² Gazi University, Ankara, Türkiye
- 5DV.2.31 Life Cycle Assessment of Processing and Refining Secondary Raw Materials from Silicon PV Manufacturing in the ICARUS Project**
Rene Peche¹, Matthias Seitz¹, Karsten Wambach¹
¹ Bifa Environmental Institute, Augsburg, Germany
- 5DV.2.33 Beyond the Material Recovery: Exergy and Environmental Analysis of Solar Panel Recycling**
Simon Jech¹, Neha Garg¹, Kati Miettunen², Annukka Santasalo-Aarnio¹
¹ Aalto University, Espoo, Finland; ² University of Turku, Turku, Finland
- 5DV.2.36 Comparison of Organic Solvents for Chemical Recycling of Photovoltaic Panels**
Olivia Bowen¹, Anna Kuczynska-Lazewska², Rong Deng¹
¹ UNSW, Sydney, Australia; ² Gdansk University of Technology, Gdansk, Poland
- 5DV.2.37 Holistic Assessment of Scenarios for Future PV Deployment Considering Circular Economy in the EU Using PV ICE**
Fabian Spera¹, Andreas Schwarz¹, Robin Graeber¹, Oliver Pfeiffer¹, Ulf Blieske¹
¹ Cologne University of Applied Sciences, Cologne, Germany
- 5DV.2.38 Student Awards Finalist Presentation: Development and Testing of a Thermomechanical Procedure to Assess the Disassembly Potential of a Photovoltaic Module**
Asier Murillo¹, Cristina Pinto¹, Alicia Buceta¹, Eugenia Zugasti¹, Antonio Urbina², Jaione Bengoechea¹
¹ CENER, Sarriguren, Spain; ² Public University of Navarre, Pamplona, Spain
- 5DV.2.39 Assessment of the Performance and Potential Reuse of Repaired Photovoltaic Modules in Real Operating Conditions**
María Beatriz Nieto-Morone¹, Carmen Alonso-García¹, Félix García-Rosillo¹, Miguel Ángel Muñoz-García²
¹ CIEMAT, Madrid, Spain; ² UPM, Madrid, Spain
- 5DV.2.40 Which is the Most Environmentally Friendly PV Technology: c-Si Solar Cells or Perovskite Silicon Tandem Solar Cell?**
Elisabetta Brivio¹, Andrea Danelli¹, Pierpaolo Girardi¹, Maria Anna Cusenza²
¹ RSE, Milan, Italy; ² Ricerca sul Sistema Energetico RSE S.p.A., Milan, Italy
- 5DV.2.41 Considering the Environmental Consequences of the Evolution of the Risk of Extreme Natural Events on a PV Installation: A Morphological Analysis-based Prospective Method Applied to Life Cycle Assessment**
Alejandra Cue Gonzalez¹, Eric Rigaud¹, Paula Perez-Lopez¹, Philippe Blanc¹
¹ PSL University, Valbonne, France

- 5DV.2.42 Riding The Wave: Opportunities and Constraints to Reuse and Resale of Photovoltaic PV Modules in South Africa**
Nicole Crozier¹, Jacqueline Crozier McClelland², Ernest van Dyk², Catherina Schenck¹, Palisa Ntsala²
¹ University of the Western Cape, Cape Town, South Africa; ² Nelson Mandela University, Nelson Mandela Bay, South Africa
- 5DV.2.43 Comprehensive Analysis on Mechanical Methods for Recycling Photovoltaic Modules**
Josefina Ottitsch¹, Matthias Thin¹, Anika Gassner¹, Gerhard Wiesinger¹, Christoph Einspieler¹, Friedrich Bleicher¹
¹ TU Wien, Vienna, Austria
- 5DV.2.44 Future Material Demand for Global Silicon-based Photovoltaic Systems**
Chengjian Xu¹, Olindo Isabella¹, Malte Ruben Vogt¹
¹ Delft University of Technology, Delft, The Netherlands
- 5DV.2.46 Water Jet Cutting for Multi-Stage Delamination of Si-based Photovoltaic Modules: Practical Experimentation**
Ferozan Azizi¹, Ulrich Spitzer¹, Ewald Perndorfer², Thomas Nigl¹
¹ Montanuniversität Leoben, Leoben, Austria; ² Perndorfer Maschinenbau, Kallham, Austria
- 5DV.2.47 Circularity in the PV Industry – Detailed Analysis of Environmental Impacts for Reused PV Panels**
Alejandra Galarza¹, Pierre-Philippe Grand¹, Nicolas Vandamme¹, Anaïs Gouabault², Juan Alzate², Nicolas Defrenne², Marie Lacombe², Lars Oberbeck³
¹ IPVF, Palaiseau, France; ² SOREN, Paris, France; ³ IPVF, Paris, France
- 5DV.2.48 Multi-Loop Recycling of Perovskite Solar Cells**
Yanxue Wang¹, Zhenni Wu², Mykhailo Sytnyk¹, Jiyun Zhang², Gülüşüm Babayeve¹, Jens Hauch¹, Christoph Brabec², Ilan Marius Peters²
¹ HI ERN, Erlangen, Germany; ² FAU, Erlangen, Germany
- 5DV.2.50 Assessment of EU PV Circular Supply Chain Circularity Constraints**
Tadas Radavicius¹, Stefan Groesser²
¹ SoliTek/Vilnius TECH, Vilnius, Lithuania; ² Bern University of Applied Sciences, Bern, Switzerland
- 5DV.2.51 Environmental Analysis of High Vacuum Flat Plate Hybrid Photovoltaic-Thermal Collectors**
Annalisa Di Napoli¹, Paolo Strazzullo¹, Roberto Russo², Marilena Musto¹
¹ University of Naples Federico II, Naples, Italy; ² National Research Council of Italy, Naples, Italy
- 5DV.2.53 Separation of EoL PV Modules Using Liquid-Based Methods to Achieve Better Recycling Quality**
Sonja Feldbacher¹, Daniel Schwabl², Ferozan Azizi³, Gabriele Eder⁴, Anika Gassner⁴, Thomas Nigl³, Gernot Oreski¹
¹ PCCL, Leoben, Austria; ² Circulyzer, Leoben, Austria; ³ University of Leoben, Leoben, Austria; ⁴ OFI, Vienna, Austria
- 5DV.2.54 Adapted Application of Photovoltaic Solar Panels in the Field of Agro-Industry**
Aliou Badji¹, Diouma Kobor¹
¹ Ziguinchor University, Ziguinchor, Senegal



5DV.2.55 Managing Potential Environmental and Human Health Risks of Potential Hazardous Material Leaching from Photovoltaic Modules
Mitchell Rencheck¹, Cara Libby¹, Angelique Montgomery², Joshua S. Stein²

¹ EPRI, Palo Alto, United States of America; ² Sandia National Laboratories, Albuquerque, United States of America

5DV.2.57 Solar Photovoltaic Panels Recycling Solutions in China

Gangqi Cheng¹, Haoran Yuan², Jing Gu², Honggang Fan², Benteng Wu², Hui Zhang¹

¹ China National Resources Recycling Association, Beijing, China; ² Guangzhou Institute of Energy Conversion, Guangzhou, China

VISUAL PRESENTATIONS 5DV.3

13:30 - 15:00 PV Diversification Upstream and Downstream - from Industry to Applications | Costs, Economics, Finance and Markets | The Revolution of PV

Chairpersons: Dr. Stephen Tay
NUS, Singapore, Singapore

Ms. Izumi Kaizuka
RTS Corporation, Chuo-ku, Japan

Mr. Philippe Malbranche
CEA, Le Bourget-du-Lac, France

5DV.3.1 An In-Depth Look at the European Ingot-Wafer Supply Chain

Oscar Rodolfo Ortega Alvarado¹, Estelle Gervais¹, Johan Lindahl², Baljeet Goraya¹, Peter Brailovsky¹, Sebastian Nold¹

¹ Fraunhofer ISE, Freiburg, Germany; ² ESMC, Brussels, Belgium

5DV.3.2 Economic Analysis of Solar PV Industrialization

Thibault Deletombe¹, Hyun Jin Julie Yu¹, Patrice Geoffron²

¹ CEA, Gif sur yvette, France; ² Paris-Dauphine University, Paris, France

5DV.3.4 PV as a Building Material for the Energy Transition: Creation of a European BIPV Platform for Solar Architecture

Pierluigi Bonomo¹, Francesco Frontini¹, Angela Grassi², Heinz Ossenbrink², Giulio Poggiani², Lucia Montoni², Greta Battaglia³

¹ SUPSI, Mendrisio, Switzerland; ² ETA-Florence Renewable Energies, Florence, Italy; ³ SUPSI, Manno, Switzerland

5DV.3.6 The Role and Impact of Building-Applied PV in the Norwegian Energy System Under Different Transition Pathways

Stine Fleischer Myhre¹, Eva Rosenberg¹, Heine Nygard Riise²

¹ IFE, Lillestrom, Norway; ² IFE, Kjeller, Norway

5DV.3.7 Towards a Common Strategy for Agri-PV in Europe - The Italian Perspective

Celeste Mellone¹, Alessandra Scognamiglio², Giancarlo Ghidesi³, Giulia Guidetti⁴

¹ Green Horse Advisory, Rome, Italy; ² ENEA, Rome, Italy; ³ REM Tec, Rome, Italy; ⁴ Green Horse Advisory, Milan, Italy

5DV.3.8 Comparative Legal and Administrative Aspects of Agri-PV

Michael Frey¹, Antonia Kallina¹, Rahel Alia Müller¹

¹ University of Applied Sciences Kehl, Kehl, Germany

5DV.3.9 The Impacts of Large-Scale Implementation of Solar Power in the Nordic Power Market

Dilshika Kavishani Heenatigala Kankanamge¹, Jaakko Jääskeläinen¹, Sanna Syri¹

¹ Aalto University, Espoo, Finland

5DV.3.11 Student Awards Finalist Presentation: Technical and Economic Analysis of the Implementation of Battery Energy Storage Systems (BESS) for Nodes in the National Electric System (SEN) with High Concentration of Solar Energy

Fernando Flores Lizana¹, Patricio Valdivia-Lefort¹, Rodrigo Barraza Vicencio¹

¹ Federico Santa Maria Technical University, Santiago, Chile

5DV.3.12 Global Warming as a Solar Heat Engine Problem: Using Photovoltaics to Reverse Climate Change

Christiana Honsberg¹, Stuart Bowden², Ian Sellers³, Richard King¹, Stephen Goodnick¹

¹ Arizona State University, Tempe, United States of America; ² Solestial Solar, Tempe, United States of America; ³ University of Buffalo, Buffalo, United States of America

5DV.3.13 The Role of Coupling the Heating, Cooling and Power Sectors to Achieve 100% Renewable Heating and Cooling in Europe

Olgu Birgi¹, Dominik Rutz¹, Rainer Janssen¹

¹ WIP Renewable Energies, Munich, Germany

5DV.3.20 Analysis of Transport Costs of Solar Modules and Components

Max Mittag¹, Tim Straube¹, Christian Reichel¹

¹ Fraunhofer ISE, Freiburg, Germany

5DV.3.21 Fabrication Planning of Module Manufacturing Plants – Parameter Analysis of Site Parameters and Modelling Tools

Max Mittag¹, Christian Reichel¹, Hannah Hoffman¹, Holger Neuhaus¹

¹ Fraunhofer ISE, Freiburg, Germany

5DV.3.23 How the End of Net-Metering Affects Your Energy Bill: A Case Study for the Netherlands

Minne M. de Jong¹, Sebastiaan la Fleur¹

¹ TNO, Eindhoven, The Netherlands

5DV.3.26 Techno-Economic and Life-Cycle Assessment of Recycling Pathways for Perovskite on Silicon Tandem Modules

Lian Duan¹, Alejandra GALARZA¹, George Wong¹, Lars Oberbeck²

¹ IPVF, Palaiseau, France; ² TotalEnergies OneTech, Paris La Défense, France

5DV.3.27 Sensitivity of Electricity Price in the Finnish Market with Increasing Solar Energy Production

Sami Jouttijärvi¹, Seela Tervo², Lauri Karttunen¹, Hugo Huerta³, Samuli Ranta³, Kati Miettinen¹

¹ University of Turku, Turku, Finland; ² Aalto University, Espoo, Finland; ³ TUAS, Turku, Finland



5DV.3.28 Potential for International Policy and Industry Measures Across Diverse BIPV Markets

Momir Tabakovic¹, Michiel van Noord², Nuria N. Martín-Chivelet³, Wilfried van Sark⁴, Otto Bernsen⁵, Francesca Tilli⁶, Angelo Baggini⁶, Rebecca Yang⁷, Janne Halme⁸, Elin Daun⁹

¹ FH Technical Wien, Vienna, Austria; ² RISE Research Institutes of Sweden, Stockholm, Sweden; ³ CIEMAT, Madrid, Spain; ⁴ Utrecht University, Utrecht, The Netherlands; ⁵ Netherlands Enterprise Agency (RVO), Utrecht, The Netherlands; ⁶ University of Bergamo, Roma, Italy; ⁷ RMIT University, Melbourne, Australia; ⁸ Aalto University, Aalto, Finland; ⁹ RISE Research Institutes of Sweden, Lund, Sweden

5DV.3.30 Assessing the Role of Photovoltaic Systems in Meeting the Energy Needs of Data Centers in Africa: A Bottom-Up Analysis

Marco Pittalis¹, Georgia Kakoulaki², Iolanda Saviuc¹

¹ European Commission JRC, Ispra, Italy; ² European Commission Joint Research Centre, Ispra, Italy

5DV.3.32 Rules, Regulations, Taxes and Subsidies Versus Globalisation and Events: Evaluating the Impact of Policymaking on Residential PV Deployment

Bert Herteleer¹, Wilfried van Sark²

¹ KU Leuven, Ghent, Belgium; ² Utrecht University, Utrecht, The Netherlands

5DV.3.33 The Benefits of a Hybrid Wind-PV Power Plant at Competitive Wholesale Electricity Market – Case Finland

Simeon Seppälä¹, Sanna Syri¹, Iraj Moradpoor¹

¹ Aalto University, Helsinki, Finland

5DV.3.34 Profitability of Utility-Scale Photovoltaic Systems in Finland

Seela Tervo¹, Sami Jouttijärvi², Kati Miettunen², Sanna Syri¹

¹ Aalto University, Espoo, Finland; ² University of Turku, Turku, Finland

5DV.3.35 Enhancing Energy Generation of Bifacial Photovoltaic Systems with Permeable Albedo Enhancement Composite

Filippos Farmakis¹, Alexandros I. Droudakis², George I. Tzinoglou²

¹ Democritus University of Thrace, Xanthi, Greece; ² Thrace NG, Alimos (Athens), Greece

5DV.3.40 Empowering Energy: The Rise of Community-driven Solutions in a Decentralized Landscape

Domenico Vito¹, Martina Bosone², Barbara Pirelli³

¹ SDSU, San Diego, United States of America; ² CNR, Naples, Italy; ³ Independent Lawyer, Taranto, Italy

5DV.3.41 Public Acceptance of Energy-Efficient Buildings

Duygu Celik¹, Silvia Caneva¹, Nicholas de la Vega², Gregory (Greg) Arrowsmith², Céline Suchet², Nathalie Richet², Riccardo Pinotti², Roberto Lollini³, Mayam Fakhari³, Cornelia Partsch⁴, Alain Zarli⁴, Nerea Gomez⁴

¹ WIP Renewable Energies, Munich, Germany; ² EUREC, Brussels, Belgium; ³ Eurac Research, Bolzano, Italy; ⁴ ECTP, Brussels, Belgium

5DV.3.42 Hands-On Training in Photovoltaic Reliability Assessment: A Multinational Educational Approach under the PROMISE Project

Carlos Meza¹, Brian Azzopardi², Bernhard Kubicek³, Aritz Legarrea Oyarzun⁴, Ana Gracia Armillo⁴, Melodie de L'Epine⁵, Steve Zerafa⁶, Austėja Mockeviciute-Azzopardi², Carmel Azzopardi², Brian Bartolo²

¹ Anhalt University of Applied Sciences, Koethen, Germany; ² The Foundation for Innovation and Research, Valletta, Malta; ³ AIT, Vienna, Austria; ⁴ CENER, Sarriren, Spain; ⁵ ICARES Consulting, Brussels, Belgium; ⁶ PIXAM, Valletta, Malta

5DV.3.43 Challenges of Energy Communities at Universities – A Virtual Approach

Matevž Bokalič¹, Matej Guštin¹, Ana Belen Cristóbal², Marta Victoria³, Afonso Cavaco⁴, Luís Fialho⁴, Alexander Gerber⁵, Marko Topič¹

¹ University of Ljubljana, Ljubljana, Slovenia; ² UPM, Madrid, Spain; ³ Aarhus University, Aarhus, Denmark; ⁴ University of Évora, Évora, Portugal; ⁵ inscico, Kleve, Germany

5DV.3.45 Developing Communication Formats for a Positive Energy Transition Focusing on Photovoltaic – A Delphi Design Sprint Approach

Anne Karrenbrock¹, Laura Züll¹, Eva-Maria Grommes¹, Stefanie Könen¹, Sofia Scropo², Anne-Maren Feldhof¹, Ulf Blieske¹, Thorsten Schneiders¹, Valérie Varney¹, Laura Popplow¹

¹ University of Applied Sciences Cologne, Cologne, Germany; ² University of Applied Science Cologne, Cologne, Germany

5DV.3.46 TRANSIT: Empowering Sustainable Energy Futures through Innovative Education and Grid-Integrated Roadmap Development

Brian Azzopardi¹, Daniel Busuttil², Araceli Hernandez Bayo³, Ali Ehsan⁴, Eduardo Martinez Cesenia⁴

¹ The Foundation for Innovation and Research, Birkirkara, Malta; ² MCAST, Paola, Malta;

³ Madrid Polytechnic University, Madrid, Spain; ⁴ The University of Manchester, Manchester, United Kingdom

5DV.3.48 Coincidence of Photovoltaic Electric Generation During Heat Waves: An Example Analysis for Northern Italy

Danny Parker¹, Karthik Panchabikesan¹, Delia D'Agostino², Dru Crawley³, Linda Lawrie⁴

¹ Florida Solar Energy Center, Cocoa, United States of America; ² European Commission JRC, Ispra, Italy; ³ Bentley Systems, Ismaning, Germany; ⁴ DHL Consulting, Pagosa Springs, United States of America

VISUAL PRESENTATIONS 4DV.4

15:15 - 16:45 PV System Engineering | Control and Systems for Power Systems with Renewables Integration

Chairpersons: Mr. Roland Bründlinger
AIT, Vienna, Austria

Prof. Franz P. Baumgartner
ZHAW, Winterthur, Switzerland

4DV.4.1 Assessing Glare Hindrance Three Ways in Fixed Tilt and Tracking PV Systems

Ashish Binani¹, Antonius R. Burgers¹, Kay Cesar¹, Bas Van Aken¹

¹ TNO, Petten, The Netherlands

4DV.4.2 ALIENCE- Alpine PV Competence

Hartmut Nussbaumer¹, Roger Hiltbrand¹, Selina Pfyffer¹, Markus Klenk¹, Christof Bucher², Matthias Hügi², Sina Spring², Gabi Friesen³, Mauro Caccivio³, Ebrar Özkalay³, Evelyn Bamberger⁴, Christof Biba⁴

¹ ZHAW, Winterthur, Switzerland; ² BUAS, Bern, Switzerland; ³ SUPSI, Mendrisio, Switzerland; ⁴ OST, Rapperswil, Switzerland



- 4DV.4.3 Complementary Guide for the Electrical Design of Grid-Connected PV Systems**
Bruno Gaiddon¹, Marielle Perrin¹, Elika Saidi-Chalopin², Salomé Durand³, David Gréau⁴, Bakari Soumare⁵, Mathieu Mansouri⁶, François Saugues⁷, Olivier Verdeil⁸, Gérard Moine⁹
¹ Hespul, Lyon, France; ² Consuel, Paris, France; ³ SER, Paris, France; ⁴ Enerplan, La Ciotat, France; ⁵ INES PFE, Le Bourget-du-Lac, France; ⁶ CRER, La Crèche, France; ⁷ Stäubli, Hésingue, France; ⁸ Independent PV expert, Lyon, France; ⁹ Solarcoop, Mornant, France
- 4DV.4.4 Electricity Market Driven Net Present Value Optimization for PV Plants Across Europe**
Marta Irena Murkowska¹
¹ EMD International, Aalborg, Denmark
- 4DV.4.5 Increasing the Proportion of Winter Electricity through Design Optimisation of Photovoltaic Roof Systems**
Hartmut Nussbaumer¹, Roger Hiltbrand¹, Selina Pfyffer¹, Andreas Dreisiebener², Markus Klenk¹
¹ ZHAW, Winterthur, Switzerland; ² A777 Gartengestaltung, Seuzach, Switzerland
- 4DV.4.7 Implementation of a Sub-Hourly Clipping Correction in PVsyst**
Michele Oliosi¹, André Mermoud¹, Bruno Wittmer¹, Agnes Bridel-Bertomeu¹, Robin Vincent¹
¹ PVsyst, Satigny, Switzerland
- 4DV.4.9 Finding the Optimal Size and Design of a Microgrid Energy System Using Genetic Algorithm**
Josselin Le Gal La Salle¹, Mathieu David¹, Philippe Lauret¹
¹ University of La Reunion, Saint-Pierre, Réunion
- 4DV.4.10 Highest Energy Yields per Area for PV Systems on Flat Roofs**
Hartmut Nussbaumer¹, Roger Hiltbrand¹, Selina Pfyffer¹, Lona Tulinski¹, Janis Preisig¹, Markus Klenk¹
¹ ZHAW, Winterthur, Switzerland
- 4DV.4.12 Impacts of Measures to Achieve Dispatchability on the Cost of PV-Bess Power Plants**
Alex Renan Arrifano Manito¹, Pedro Torres¹, Marcelo Pinho Almeida¹, Gilberto Figueiredo², José Cesar Almeida³, Roberto Zilles¹
¹ USP - University of São Paulo, Sao Paulo, Brazil; ² Fluminense Federal University, Niterói, Brazil; ³ Mackenzie Presbyterian University, Sao Paulo, Brazil
- 4DV.4.13 Analysis of Irradiation Differences on Substring Level of Modules in Solar Parks**
Sascha Eckert¹, Krisztián Kerekes², Patrick Mader², Rainer Merz²
¹ HKA, Ettlingen, Germany; ² HKA, Karlsruhe, Germany
- 4DV.4.14 Using Standard PV Mounting Structures with Spaced Modules in Agrivoltaic Applications**
Alex Renan Arrifano Manito¹, Marcelo Pinho Almeida¹, Bruno Vieira¹, Maria Cristina Fedrizzi¹, Roberto Zilles¹
¹ USP, São Paulo, Brazil
- 4DV.4.15 Optimization Analysis for the Best Sizing and Operation of Photovoltaic Generators in Distributed Electricity Systems**
Jacopo Baldacci¹, Ciro Lanzetta¹, Antonio Piazzzi¹, Nabi Taheri², Mauro Tucci²
¹ i-EM, Livorno, Italy; ² University of Pisa, Pisa, Italy

- 4DV.4.17 A New Approach to Floating Solar: An All-Plastic Design for Challenging Inland Waters**
Maarten Dörenkämper¹, Jan Willem Heuseveldt², Marcel Broune², Roel Verlaek³, Paul de Blok⁴, Menno van den Donker², Marcel van Pagee⁴, Minne de Jong¹
¹ TNO, Pattern, The Netherlands; ² SABIC Europe, Bergen op Zoom, The Netherlands; ³ Solarge, Weert, The Netherlands; ⁴ RKT, Tholen, The Netherlands
- 4DV.4.18 Quantifying the Global Potential of Albedo Enhancing Materials**
Thore Müller¹, Franco Vicente Clandestino Muñoz¹, Kostiantyn Pogorelov¹
¹ PVRADAR Labs, Ebersberg, Germany
- 4DV.4.19 Optimising Solar Asset Performance through Smart Module Installation using Above's Digital Twin Technology**
Imke Meyer¹, Chisanupong Thawanyavitchajit², Ricardo Velasco³, Inaki Perez⁴, Will Hitchcock⁵, Henrique Balchada⁵
¹ Mott MacDonald, Brighton, United Kingdom; ² Mott MacDonald, Madrid, Spain; ³ Mott MacDonald, Bogota, Colombia; ⁴ Mott MacDonald, Bangkok, Thailand; ⁵ Above Surveying, Colchester, United Kingdom
- 4DV.4.20 Experimental Comparison of Solar Absorption Characteristics Using Different Colors**
Sedong Kim¹
¹ Korea Institute of Industrial Technology, Chungcheongnam-do, South Korea
- 4DV.4.21 Development of an Approach to Calculate the Potential of Solar Rooftop PV**
Sabrina Krähmer¹, Basem Idlibi², Kaouter Belkilani¹, Dietmar Graeber¹
¹ Ulm University of Applied Sciences, Ulm, Germany; ² Ulm University of Applied Sciences (Technische Hochschule Ulm), Ulm, Germany
- 4DV.4.22 Bifacial PV Modules on Rooftops: Assessing Energy Gains Under Different Weather Conditions**
Marco Ernst¹, X. Liu¹, Charles Alexis Asselineau¹, Daniel Chen², Chris Huang³, Alison Lennon²
¹ ANU, Canberra, Australia; ² Sundrive Solar, Kirrawee, Australia; ³ Sundrive Solar, Sydney, Australia
- 4DV.4.23 Energy Yield of the PV Pappel**
Hermann Kopetz¹
¹ TU Vienna, prof. emeritus, Krumpendorf, Austria
- 4DV.4.24 Design and Experimental Realization of Foldable and Movable PV System for a Charge Station**
Algirdas Belažentis¹, P. Dubravskij¹, Matas Rudzikas¹, Tomas Razvinovičius²
¹ Protech, Vilnius, Lithuania; ² JSC "Modern E-Technologies", Vilnius, Lithuania
- 4DV.4.26 Direct Driving MW Scale Appliances with PV Power Plants Using Medium Voltage DC Grids**
Jens Merten¹, Gregory Guyot¹, Jeremy Martin¹, Matthias Tuma², Boris Sucic³, Holger Borchering⁴, Patrick Spanier¹, Johannes Stierstorfer⁵, Rania Fki⁵, Zhiyu Cao⁶, Peter Wallmeier⁶, Stéphane Latrouite⁷, Yann Garnier⁷, Ghislain Ginot⁸, Victor Goncalves⁸, Nuno Taveira⁹, Geber Villa Fernandez⁹, Eddy Lavorel¹⁰, Tarek Lamara¹⁰, Björn Fischer¹⁰
¹ CEA, Le Bourget du Lac, France; ² McPhy, Wildau, Germany; ³ JSI, Ljubljana, Slovenia; ⁴ TH OWL, Lemgo, Germany; ⁵ WIP Renewable Energies, Munich, Germany; ⁶ AEG Power Solutions, Warstein-Belecke, Germany; ⁷ TPE France, Courlaoux, France; ⁸ ARCEL, Champagne au Mont D'Or, France; ⁹ ENFASYS, Gijon, Spain; ¹⁰ REC Wafer Norway, Porsgrunn, Norway

