EU PVSEC

# EU PVSEC 2023

40th European
Photovoltaic Solar Energy
Conference and Exhibition

**18 — 22 September** 2023

**Lisbon** — Portugal

**CCL** — Lisbon Congress Centre

www.eupvsec.org

## Conference Programme


**Sunday, 17 September 2023**

## PV ACADEMY

Taking place on Sunday, 17 September, the PV Academy is an educational format consisting of tutorials presented leading experts which will give a deep insight into selected PV research & development topic and supports the global PV community with the mission:

- to educate about the fundamentals of different PV technologies
- to facilitate newcomers in the field to understand and contribute to PV research as well as follow talks at PV specialist conferences
- to summarize and contextualize the latest developments in PV research
- to give graduates and educators the opportunity to refresh and update their knowledge

The PV Academy will be held in the Faculty of Sciences of the University of Lisbon, Campo Grande 016, 1749-016 Lisboa, Portugal, Room 6.1.36 (Building C6).

Sessions:

- Perovskite Solar Cells from R&D to Industrial Manufacturing
- Characterization of Silicon Solar Cells and Modules
- Sustainability and Circular Economy for PV

For further info, and to see the detailed programme, please visit Programme (eupvsec.org).

IMPORTANT NOTE: Kindly note that registration to the PV Academy is not included in the Conference ticket and a separate registration is required.

# CONFERENCE PROGRAMME

*Please note, that this Programme may be subject to alteration and the organisers reserve the right to do so without giving prior notice. The current version of the Programme is available at* ***www.photovoltaic-conference.com.***

*(i) = invited*

**Monday, 18 September 2023**

**MONDAY MORNING**

**CONFERENCE OPENING**

**PLENARY SESSION AP.1 /Scientific Opening**

**08:30 – 09:30 Sustainable PV**

**Chairpersons:**

Robert P. Kenny
European Commission JRC, Ispra, Italy

João M. Almeida Serra
University of Lisbon, Portugal

**AP.1.1** **Net-Zero Growth in the Solar PV Sectors: an International Analysis of Manufacturers and Policies**
A. Arcipowska, S. Blanco Perez, M. Jakimow & B. Baldassarre
European Commission JRC, Sevilla, Spain
D. Polverini
European Commission DG GROW, Brussels, Belgium

**AP.1.2** **Invited**

**AP.1.3** **A Comprehensive Study of Silicon Solar Cell Technologies Across the Globe for Sustainable Integrated Manufacturing**
J. Reichle, W. Jooss, M.C. Raval & P. Fath
RCT Solutions, Konstanz, Germany

**09:30 – 12:30** **Becquerel Prize Ceremony**
**Opening Addresses**
**Moderated Panel Discussion**

Monday, 18 September 2023

**ORAL PRESENTATIONS 2AO.1**

**13:30 – 15:00 Novel Materials for PV Devices**

**Chairpersons:**

Antonio Martí Vega
UPM, Madrid, Spain

Christiana Honsberg *(i)*
Arizona State University, Tempe, USA

**2AO.1.1** **When Chalcogenides Meet Halides: A New Family of Photovoltaic Materials Is Emerging?**
I. Caño Prades, A. Navarro Güell, E. Maggi, M. Jimenez Guerra, S. Giraldo, Z. Jehl, M. Placidi, J. Puigdollers González & E. Saucedo
UPC, Barcelona, Spain

**2AO.1.2** **Optical Design and Bandgap Engineering in Ultrathin Si/Ge Multiple Quantum Wells Solar Cell**
H. Meddeb, M. Götz-Köhler, K. Gehrke & M. Vehse
DLR, Oldenburg, Germany

**2AO.1.3** **BaCu2Se2 Thin Film Properties by a Combinatorial Study for Photovoltaics**
M. Rusu, J.A. Marquez-Prieto, H. Hempel, L. Choubrac, R. Schwiddessen, G. Gurieva, P. Reyes-Figueroa, R. Wenisch, M. Schleuning, C.A. Kaufmann, I. Lauermann, S. Schorr & T. Unold
HZB, Berlin, Germany

**2AO.1.4** **Student Awards Finalist Presentation: Key Aspects for a High Efficiency Kesterite Solar Cell Baseline Production**
A. Jimenez Arguijo
IREC, Barcelona, Spain
M. Placidi, S. Giraldo, J. Puigdollers González, E. Saucedo & Y. Gong
UPC, Barcelona, Spain

**2AO.1.5** **Germanium Based TPV Cells with Efficiencies over 30%. Science or Fiction?**
P. Martin, V. Orejuela, C. Sanchez-Perez, I. Garcia & I. Rey-Stolle
UPM, Madrid, Spain

**2AO.1.6** **2D Ferroelectric Semiconductors with Variable Gap for Photovoltaics: Functionalized In2Se3 Nanolayers**
R. Minnings & A.I. Shkrebtii-Chkrebtii
Ontario Tech University, Oshawa, Canada

## ORAL PRESENTATIONS 1AO.4

**13:30 – 15:00 Silicon Material for Solar Cells and Its Defects**

**Chairpersons:**

Noritaka Usami
Nagoya University, Japan

Invited

**1AO.4.1 Special Introductory Presentation: P-Type Ga Doped Cz-Si as Alternative for Carrier Selective Contact Solar Cells**
J. Horzel, S. Mack, H. Höffler, W. Kwapil & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

**1AO.4.2 Material Quality of Industrial Czochralski-Grown Gallium-Doped p-Type Wafers with Melt Re-Charging**
R. Basnet, T. Le, Z. Yang, M. Ismael & D. Macdonald
ANU, Canberra, Australia
C. Sun
LONGi Green Energy Technology, Shaanxi, China

**1AO.4.3 Investigation of Thermal Donors in Czochralski Silicon and Their Influence on Solar Cell Performance**
J. Huang, J. Li, S. Yuan, D. Yang & X. Yu
Zhejiang University, Hangzhou, China

**1AO.4.4 Hydrogen-Defect Reactions in Solar Silicon from First Principles**
J. Coutinho, D. Gomes & V.J.B. Torres
University of Aveiro, Portugal
T.O. Abdul Fattah, V. Markevich & A. Peaker
University of Manchester, United Kingdom

**1AO.4.5 The Effect of Hydrogen on Boron-Oxygen-Related Degradation and Regeneration in Crystalline Silicon**
R. Søndenå & H. Haug
Institute for Energy Technology, Kjeller, Norway
P.M. Weiser & E. Monakhov
University of Oslo, Norway

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## ORAL PRESENTATIONS 4AO.7

**13:30 – 15:00 Field Performance – Imaging, Temperature, Climate**

**Chairpersons:**

Alba Alcañiz
Delft University of Technology, The Netherlands

Alessandro Virtuani
CSEM, Neuchâtel, Switzerland

**4AO.7.1 Aerial Photoluminescence Imaging of PV Modules**
B. Doll, E. Wittmann, C. Buerhop-Lutz, J.A. Hauch & I.M. Peters
HI ERN, Erlangen, Germany
L. Lüer & C.J. Brabec
FAU, Erlangen, Germany

**4AO.7.2 Automated PV Module Working Point Detection towards Large Scale Daylight Photoluminescence Inspection**
L. Koester
Eurac Research, Bolzano, Italy

**4AO.7.3 Student Awards Finalist Presentation: Analysis of Performance of PV Systems and Insights on Packaging Degradation Using NIR Spectroscopy**
C. Barretta, M. Bredács, E. Helfer & G. Oreski
PCCL, Leoben, Austria
S. Lindig & A. Astigarraga
Eurac Research, Bolzano, Italy

**4AO.7.4 Impact of Climate Change on Photovoltaic Performance**
A. Mathieu, M. Thebault & G. Fraisse
LOCIE, Le Bourget-du-Lac, France
S. Kraiem & L. Gaillard
Heliocity, Grenoble, France
S. Thebault
CSTB, Saint Martin D'Hères, France
S. Boddaert
CSTB, Sophia Antipolis, France

**4AO.7.5 PV Performance in the Years After Extreme Weather Events**
D.C. Jordan, K. Perry, K. Anderson, R. White & C. Deline
NREL, Golden, USA

**4AO.7.6 Global High-Resolution Map of the Lowest Expected Operating Temperature for Optimum Sizing of PV Arrays**
A. Skoczek, J. Betak, J. Veres & T. Cebecauer
Solargis, Bratislava, Slovakia
J.A. Ruiz Arias
University of Malaga, Spain

**VISUAL PRESENTATIONS 3AV.1**

**13:30 – 15:00 PV Module Design and Manufacturing / Electronic Systems for BOS**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**ORAL PRESENTATIONS 2AO.2**

**15:15 – 16:45 Advanced and Novel Concepts for PV Devices**

**Chairpersons:**

Jozef (Jef) Poortmans
imec, Leuven, Belgium

Invited

**2AO.2.1 Role of Contacts in the Operation of Valley-Photovoltaic Devices**
U. Aeberhard
Fluxim, Winterthur, Switzerland

**2AO.2.2 Hot-Carrier Effect and Inverted Pyramid Structure to Achieve 4% Efficiency for Solar Energy Below Si Bandgap from Metal-Silicon Junction Solar Cell**
H.-T. Lin, C.-H. Chang & C.-F. Lin
National Taiwan University, Taipei, Taiwan

**2AO.2.3 Thermodynamics of Hybrid Quantum/Thermionic Converters Doubling One-Junction Solar Cell Efficiency Limit**
C. Honsberg & S. Goodnick
Arizona State University, Tempe, USA
I.R. Sellers
University of Oklahoma, Norman, USA

**2AO.2.4 Carrier-Thermal-Escape Mitigation in a Quantum-Dot-in-Perovskite Intermediate Band Solar Cell**
U. Deneb Menda, G. Ribeiro, J. Deuermeier, D. Nunes, S. Jana, R. Martins & M.J. Mendes
CENIMAT/I3N, Caparica, Portugal
E. López, I. Artacho & I. Ramiro
UPM, Madrid, Spain

**2AO.2.5 Probing Triplet Sensitization Mechanism of Thin Film Halide Perovskite in Different Annihilator Molecules**
K. Prashanthan & R.W. MacQueen
HZB, Berlin, Germany
L. Frohloff & P. Amsalem
HU Berlin, Germany

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**2AO.2.6 Architecture of Novel Symmetrical Bifacial Perovskite/Si/Perovskite PV Modules and LCOE Comparison in Bifacial Applications**
A. Martin & M. Hull
IPVF, Palaiseau, France
P.P. Grand & J. Rousset
EDF, Palaiseau, France
L. Oberbeck
TotalEnergies OneTech, Paris, France

**ORAL PRESENTATIONS 1AO.5**

**15:15 – 16:45 Passivating Contacts – Devices**

**Chairpersons:**

Giso Hahn
University of Konstanz, Germany

Delfina Muñoz
CEA, Le Bourget-du-Lac, France

**1AO.5.1 Q.Antum Neo: Qcells Silicon Technology with > 25% Cell Conversion Efficiency Fabricated with Mass-Production Processes**
F. Fertig, M. Schaper, I. Höger, K. Petter, E. Jarzembowski, M. Junghänel, C. Klenke, A. Weihrauch, M. Schley, H.-C. Ploigt, O. Kwon, A. Schönmann, O. Tobail, K. Kim, A. Schwabedissen, M. Kauert, K. Duncker, R. Hönig, J. Cieslak, S. Hörnlein, F. Stenzel, B. Faulwetter-Quandt, J. Scharf, F. Kersten, B.G. Lee, C. Ke, S. Tind Kristensen, O. Schnelting, C. Baer, M. Queck, G. Zimmermann, M. Köhler, N. Lampa, B. Pohl-Hampel, L. Burtone, L. Niebergall, M. Schütze, S. Schulz, S. Peters, A. Mette, M. Fischer & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**1AO.5.2 23.5%-Efficient POLO Back Junction Solar Cell with Industrial PECVD AlOx/SiNy Passivation**
B. Min, V. Mertens, Y. Larionova, T. Brendemühl, T. Dullweber, R. Peibst & R. Brendel
ISFH, Emmerthal, Germany

**1AO.5.3 Localization of Front-Side Passivating Contacts for Direct Metallization of High-Efficiency c-Si Solar Cells**
J. Hurni, A. Morisset, S. Libraro, E. Genc, C. Ballif & F.-J. Haug
EPFL, Neuchâtel, Switzerland

**1AO.5.4 Poly-Si (n) Removal for TOPCon Solar Cells**
K. Krieg, S. Mack & M. Zimmer
Fraunhofer ISE, Freiburg, Germany
J. Vollmer, T. Dannenberg & D. Brunner
RENA Technologies, Gütenbach, Germany

**1AO.5.5** **Towards Leaner Fabrication of High-Efficiency TOPCon C-Si Solar Cells**
A. Morisset, E. Genc, J. Hurni, S. Libraro, F.-J. Haug & C. Ballif
EPFL, Neuchâtel, Switzerland
C. Allebé & B. Paviet-Salomon
CSEM, Neuchâtel, Switzerland

**1AO.5.6** **Development and Process Optimization of a P-IBC Solar Cell with PECVD Deposited Passivated Contacts**
L. Rachdi, D. Rudolph, J. Lossen & L.J. Koduvelikulathu
ISC Konstanz, Germany

## ORAL PRESENTATIONS 4AO.8

**15:15 – 16:45** **Modelling PV Systems Performance and Degradation**

**Chairpersons:**

João M. Almeida Serra
University of Lisbon, Portugal

Franz Baumgartner
ZHAW, Winterthur, Switzerland

**4AO.8.1** **Impact of Analytic Decision Making on Photovoltaic Degradation Rate Estimations Using Synthetic Datasets**
M. Theristis, B.G. Pierce & J.S. Stein
Sandia National Laboratories, Albuquerque, USA
J. Ascencio-Vasquez
Envision Digital, Redwood, USA

**4AO.8.2** **Modeling the Moisture-Induced Degradation in PV-Modules with Silicon Heterojunction Solar Cells**
S. Ravindrababu, P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany

**4AO.8.3** **Long-Term PV System Modelling and Degradation Using Neural Networks**
G. Guerra, P. Mercade Ruiz & G. Anamiati
DNV, Barcelona, Spain
L. Landberg
DNV, Hellerup, Denmark

**4AO.8.4** **Climate and Technology Dependent Performance Loss in a Fleet of 10,000 PV Systems**
A. Louwen, S. Lindig & D. Moser
Eurac Research, Bolzano, Italy
G. Chowdhury
3E, Brussels, Belgium

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**4AO.8.5** **Tuning PV Temperature Estimation Models Using Normalized Efficiency**
A. Kladas, B. Herteleer & J. Cappelle
KU Leuven, Ghent, Belgium

**4AO.8.6** **Clipping-Corrected Performance Ratio: an Improved Metric for Photovoltaic System Assessment**
J.C. Blakesley & G. Koutsourakis
NPL, Teddington, United Kingdom
E. Koumpli, G. Luchetta Martins, A. Panoui & J. Muller
Statkraft UK, London, United Kingdom

## VISUAL PRESENTATIONS 3AV.2

**15:15 – 16:45** **Module Reliability**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 2AO.3

**17:00 – 18:30** **New Modelling and Characterisation of Perovskite and other Materials**

**Chairpersons:**

Iñigo Ramiro
UPM, Madrid, Spain

Theresa Magorian Friedlmeier
ZSW, Stuttgart, Germany

**2AO.3.1** **Analysis of Optoelectronic Characterization Data via Bayesian Inference: A Desktop-Scale MCMC Method**
C. Fai, A.J.C. Ladd & C.J. Hages
University of Florida, Gainesville, USA

**2AO.3.2** **Optical, Noninvasive Characterization Platform for Fast Prediction of Device Performance of Perovskite Photovoltaics**
S. Ternes, F. Laufer, B. Hacene, K. Geistert, F. Schackmar, J. Petry, P. Fassl & U.W. Paetzold
KIT, Karlsruhe, Germany

**2AO.3.3** **Modelling and Statistical Analysis of Perovskite Solar Cells Degradation Measurements to Distinguish Mechanisms**
A. Julien, J.-B. Puel & J.-F. Guillemoles
IPVF, Palaiseau, France

**2AO.3.4** **Towards More Reliable JV Measurement Procedures of Perovskite-Silicon Tandem Solar Cells: the Role of Transient Device Effects and Measurement Conditions**
C. Messmer
University of Freiburg, Germany
D. Chojniak, A.J. Bett, S.K. Reichmuth, J. Hohl-Ebinger, M. Bivour, M. Hermle, J. Schön, M.C. Schubert & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

**2AO.3.5** **Student Awards Finalist Presentation: Spatially Resolved and Subcell-Selective Implied Open-Circuit Voltage Measurements on Perovskite Silicon Tandem Solar Cells**
O. Fischer, F. Schindler, S.W. Glunz & M.C. Schubert
Fraunhofer ISE, Freiburg, Germany
A.D. Bui & H.T. Nguyen
ANU, Canberra, Australia

**2AO.3.6** **Radiative Cooling of Solar Cells with Cement-Based Materials**
M. Cagnoni, P. Testa & F. Cappelluti
Polytechnic University of Turin, Italy
J.S. Dolado
UPV/EHU, San Sebastian, Spain

## ORAL PRESENTATIONS 1AO.6

**17:00 – 18:30** **Passivating Contacts – Processing Technology / Heterojunction Solar Cells**

**Chairpersons:**

Barbara Terheiden
University of Konstanz, Germany

Rasit Turan
METU, Ankara, Turkey

**1AO.6.1** **Formation of Interfacial Silicon Oxide by Magnetron Sputtering: towards PVD in-Line Processing of Tunnel Oxide Passivating Contacts**
T. Dietsch, V. Linss & E. Schneiderlöchner
VON ARDENNE, Dresden, Germany
W. Wolke, H. Nagel, S. Mack & M. Bivour
Fraunhofer ISE, Freiburg, Germany

**1AO.6.2** **Sputtered Poly-Si Layers for the Formation of n- and p-Type Passivating Contacts**
A. Descoeudres, C. Allebé, P. Wyss, C. Ballif & B. Paviet-Salomon
CSEM, Neuchâtel, Switzerland

**1AO.6.3** **LeTID in PERC Cells from Gallium-Doped Czochralski Silicon: Extent, Accelerated Testing and Mitigation via an Adapted Firing Process**
J.M. Greulich, D. Ourinson & S. Rein
Fraunhofer ISE, Freiburg, Germany
F. Maischner, W. Kwapil & S.W. Glunz
University of Freiburg, Germany

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**1AO.6.4** **Interdigitated-Back-Contacted Silicon Heterojunction Solar Cells Featuring Novel MoOx-Based Contact Stacks**
K. Kovacevic, Y. Zhao, P. Procel Moya, L. Cao, L. Mazzarella & O. Isabella
Delft University of Technology, The Netherlands

**1AO.6.5** **Progress in Applying a Maskless Patterned Plasma Process for the Fabrication of Interdigitated Back Contact Crystalline Silicon Heterojunction Solar Cells**
J. Wang, W. Wang, P. Bulkin, D. Daineka, P. Roca i Cabarrocas & E.V. Johnson
LPICM-CNRS, Palaiseau, France
S. Filonovich
TotalEnergies, La Défense, France
J. Alvarez
CNRS, Gif-sur-Yvette, France

**1AO.6.6** **Fabrication of Thin Silicon-Heterojunction Solar Cells for Bendable Perovskite/c-Si Tandem Solar Cells**
K. Saito, H. Shishido & R. Ishikawa
Tokyo City University, Setagaya, Japan

## ORAL PRESENTATIONS 4AO.9

**17:00 – 18:30** **Impact of Soiling and Snow**

**Chairpersons:**

Invited

Invited

**4AO.9.1** **Inverter Data-Based Snow Detection for Snow Loss and Shedding Rate Quantification**
E.C. Cooper, J.L. Braid & L. Burnham
Sandia National Laboratories, Albuquerque, USA

**4AO.9.2** **Assessing PV Energy Loss due to Snow with Meteorological Models**
A. Skoczek, B. Schnierer, L. Helienek & T. Harcinikova
Solargis, Bratislava, Slovakia

**4AO.9.3** **The Impact of Soiling in Europe: Estimation and Error Induced by Typical Loss Assumptions**
A. Fernández-Solas & E.F. Fernández
University of Jaén, Spain
L. Micheli
Sapienza University of Rome, Italy
N.C. Riedel-Lyngskær
Technical University of Denmark, Roskilde, Denmark

**4AO.9.4** **The Accuracy of PV Soiling Estimation through Image Analysis: Results of an International Round Robin**
L. Micheli
Sapienza University of Rome, Italy
G.P. Smestad
Sol Ideas Technology Development, San Jose, USA
C. Anderson, M. Cholette & G. Picotti
Queensland University of Technology, Brisbane, Australia
P. Fuke & A. Kottantharayil
IIT Bombay, Mumbai, India
A. Hachicha
University of Sharjah, United Arab Emirates
K. Ilse, M.Z. Khan & G. Willers
Fraunhofer CSP, Halle (Saale), Germany
M. Karim
University of Derby, United Kingdom
H. Merkle
Cranfield University, Bedford, United Kingdom
D.C. Miller & J.M. Newkirk
NREL, Golden, USA
F. Wiesinger
German Aerospace Center, Almería, Spain

**4AO.9.5** **Soiling Assessment and Cleaning Decision for Photovoltaic Feasibility Project: a Case Study on a Mining Site in Morocco**
M. Abraim & A. Ghennioui
Green Energy Park, BenGuerir, Morocco
H. Ghennioui
USMBA, Fez, Morocco
N. Hanrieder & S. Wilbert
DLR, Almeria, Spain

**4AO.9.6** **Short-Term Power Prediction of Photovoltaic Systems for Detection of Shading and Soiling Scenarios Using Machine Learning Techniques**
T. Kappler & M. Hiller
Karlsruhe Institute of Technology, Germany

**VISUAL PRESENTATIONS 3AV.3**

**17:00 – 18:30** **PV Module Performance**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*



**Tuesday, 19 September 2023**

**ORAL PRESENTATIONS 1BO.1**

**08:30 – 10:00** **Heterojunction Solar Cells**

**Chairpersons:**

Pere Roca i Cabarrocas
IPVF, Palaiseau, France

Paola Delli Veneri
ENEA, Portici, Italy

**1BO.1.1** **Heat Assisted Intensive Light Soaking on Silicon Heterojunction Solar Cells**
W. Duan, K. Bittkau, A. Lambertz & K. Ding
Forschungszentrum Jülich, Germany
T. Rudolph, H.T. Gebrewold, U. Rau, D. Qiu & M.A. Yaqin
RWTH Aachen University, Germany
X. Xu
Longi Green Energy, Shaanxi, China

**1BO.1.2** **Particles and Their Influence towards SHJ Solar Cell Pseudo-Efficiencies**
A. Fischer, I. Voicu & A. Steinmetz
Fraunhofer ISE, Freiburg, Germany

**1BO.1.3** **Ionic-Compounds as Work Function Modifier Layers for Electron Extraction in Crystalline Silicon Solar Cells**
J.D.J. Ibarra Michel, D. Yan & J. Bullock
University of Melbourne, Australia
A.H. Tuan Le & Z. Hameiri
UNSW, Sydney, Australia

**1BO.1.4** **Bifacial Silicon Heterojunction Solar Cells with MoOx as Hole Collector and Ultrathin TCO Layers**
L. Cao, P. Procel, L. Mazzarella, Y. Zhao, C. Han, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

**1BO.1.5** **Excellent Surface Passivation on a Pyramidal Textured Si Surface by Wet Chemically Grown Al-Induced Charged Oxide Inversion Layer**
H. Nakajima, H. Thi Cam Tu & K. Ohdaira
JAIST, Nomi, Japan

**1BO.1.6** **Process Optimization for Edge Passivation and High Efficiency Shingle Heterojunction Cells Compatible with Industry**
M. Albaric, B. Martel, S. Harrison & S. Edouard
CEA, Le Bourget-du-Lac, France

## ORAL PRESENTATIONS 4BO.6

**08:30 – 10:00 Data Driven O&M**

**Chairpersons:**

Gerhard Mütter
Enery, Vienna, Austria

Anna Heimsath
Fraunhofer ISE, Freiburg, Germany

**4BO.6.1 Estimation of Next-Day PV Power and Prediction Error Range Using Physical Model and Short-Term Learning by Gradient Boost Decision Tree**
S. Sato & Y. Ueda
Tokyo University of Science, Japan
K. Utsunomiya, J. Sasaki, M. Okada, S. Yoshikawa & K. Yamaguchi
Japan Weather Association, Tokyo, Japan

**4BO.6.2 Understanding the Consequences of Switching to a Predictive O&M Strategy**
E. Sarquis Filho, B. Müller & P.J. Costa Branco
Instituto Superior Tecnico da Universidade de Lisboa, Portugal

**4BO.6.3 Using PV Efficiency Models with Monitoring Data to Identify Faults and Degradation**
A. Driesse
PV Performance Labs, Freiburg, Germany

**4BO.6.4 Advanced Data-Driven Solar Analytics and Streamlined Workflows for Utility-Scale Plants**
L. Pikolos, J. Montes-Romero, A. Livera, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
J. Sutterlueti
Gantner Instruments, Schruns, Austria
S. Ransome
Steve Ransome Consulting, Kingston upon Thames, United Kingdom

**4BO.6.5 Identifying Operational Issues and Critical Performance Factors of Single-Axis Trackers in Large Utility-Scale PV Systems**
J. Ascencio-Vasquez, C. Ho, J. Obrecht & Z. DeFreitas
Envision Digital, Redwood City, USA
M. Theristis & J.S. Stein
Sandia National Laboratories, Albuquerque, USA

**4BO.6.6 Solution Matrix for Economically Optimized O&M of PV Systems**
S. Gallmetzer, S. Lindig & D. Moser
Eurac Research, Bolzano, Italy
M. Herz
TÜV Rheinland Energy, Cologne, Germany

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## ORAL PRESENTATIONS 3BO.11

**08:30 – 10:00 Reliability in Harsh Environments**

**Chairpersons:**

Ian Marius Peters
HI ERN, Erlangen, Germany

Chiara Barretta
PCCL, Leoben, Austria

**3BO.11.1 Identification and Analysis of Metallization Defects in Hot Middle East Desert-Operated Photovoltaic Modules**
S. Kumar, B. Adothu, Z. Shekason, A. Moosawi, A. Seentakath, K. Chapaneri, J.J. John, G. Mathiak & V. Alberts
DEWA, Dubai, United Arab Emirates
B. Jaeckel, D. Daßler & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

**3BO.11.2 A New Intrinsic Module Parameter Approach for Degradation Assessment of Photovoltaic Modules: Results Based on Desert Data**
D. Somasekharan Pillai, A. Abdallah, M. Abdelrahim & M. Elgaili
QEERI, Doha, Qatar

**3BO.11.3 Hot Desert Standard Development for Improved PV Module Reliability and Durability in Middle-East Region**
J.J. John, S. Kumar, B. Adothu, G. Mathiak & V. Alberts
DEWA, Dubai, United Arab Emirates
B. Jaeckel
Fraunhofer CSP, Halle, Germany

**3BO.11.4 PV Module Abrasion by Robot Cleaning: An 18-Month Field Test**
B.W. Figgis, A.A. Abdallah, M.M. Kivambe, A. Samara, B. Aissa, J. Lopez-Garcia & V. Bermudez Benito
QEERI, Doha, Qatar

**3BO.11.5 PV Module Mission Profile from Middle East Deserts**
B. Jaeckel, D. Daßler & M. Pander
Fraunhofer CSP, Halle (Saale), Germany
J.J. John, S. Kumar & B. Adothu
DEWA, Dubai, United Arab Emirates

**3BO.11.6 Adhesion Testing of Edge Sealants for Floating PV Applications**
N. Roosloot, J.H. Selj & G. Otnes
Institute for Energy Technology, Kjeller, Norway
G. Kegelart & B.H. Riise
Sunlit Sea, Trondheim, Norway

## ORAL PRESENTATIONS 4BO.16

**08:30 – 10:00 Developments in Coloured BIPV Modules for Improved Visual Appearance**

**Chairpersons:**

Alessandra Scognamiglio
ENEA, Portici, Italy

Francesco Frontini
SUPSI, Canobbio, Switzerland

**4BO.16.1 Highly Efficient Decorative Technique for Building-Integrated Photovoltaics by Using Mica Pigment and Textured Surface**
L. Adachi, S. Kubota & H. Wada
Tokyo Institute of Technology, Yokohama, Japan
Z. Xu, H. Sai & M. Kondo
AIST, Tsukuba, Japan

**4BO.16.2 Arbitrary Coloration of Solar Cells with Reduced Losses of Efficiency for Greater Public Acceptance**
H.A. Yetkin, Y.S. Zhang, R.G. Poeira, H. Agha, S. Gharabeiki, L. Merges, J. Lagerwall & P.J. Dale
University of Luxembourg, Esch-sur-Alzette, Luxembourg

**4BO.16.3 Optimized Color Characterization for Solar Photovoltaic Laminates**
A. Borja Block & C. Ballif
EPFL, Neuchâtel, Switzerland
J. Escarre Palou, A. Faes & A. Virtuani
CSEM, Neuchâtel, Switzerland

**4BO.16.4 Structural-Colored PV Modules with Reduced Angle Dependence for Building-Integrated Photovoltaics Applications**
Z. Xu, T. Matsui, K. Matsubara & H. Sai
AIST, Tsukuba, Japan

**4BO.16.5 Structured Interference Layer Systems for the Color Design of Integrated PV Systems**
A. Wessels, L. Christen, T. Kroyer, B. Bläsi & O. Höhn
Fraunhofer ISE, Freiburg, Germany

**4BO.16.6 IAM Losses in Colored BIPV: from the Lab to the Field**
A. Bertomeu i Baldé, M. Babin & S. Thorsteinsson
DTU, Roskilde, Denmark

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## VISUAL PRESENTATIONS 2BV.1

**08:30 – 10:00 Modelling, New Materials, Devices and Characterisation Techniques / New Modelling and Characterisation Techniques**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 1BO.2

**10:30 – 12:00 Characterisation and Modelling of Si Solar Cells**

**Chairpersons:**

Invited

Ronald Sinton
Sinton Instruments, Boulder, USA

**1BO.2.1 Student Awards Finalist Presentation: Novel Method for the Extraction of the Implied Voltages of Silicon Wafers and Solar Cells from Luminescence-Based Measurements**
S. Zandi, A.M. Soufiani, Z. Hameiri & T. Trupke
UNSW, Sydney, Australia

**1BO.2.2 New Approaches to Edge Passivation of Laser Cut Silicon Solar Cells**
A. Thukaram, D. Rudolph, A. Halm & D. Tune
ISC Konstanz, Germany

**1BO.2.3 On the Robustness of the Determination of Metal-Induced Recombination from Photoluminescence Images on Solar Cells**
C. Leon, J. Greulich & S. Rein
Fraunhofer ISE, Freiburg, Germany

**1BO.2.4 Numerical Optimization of nc-SiC/SiO2 Based Transparent Passivating Contacts in Silicon Heterojunction Solar Cells**
K. Bittkau & K. Ding
Forschungszentrum Jülich, Germany
H.T. Gebrewold & U. Rau
RWTH Aachen University, Germany
K. Qiu
Zhejiang Aiko Solar Energy Technology, Yiwu, China

**1BO.2.5 Correlation Analysis of Rapid Inline Quantum Efficiency Measurements for an Accelerated Failure and Loss Assessment**
M. Turek & M. Meusel
Fraunhofer CSP, Halle (Saale), Germany

**1BO.2.6 Relation Between Top-Cell Bandgap and Silicon Bottom-Cell Thickness in Double-Junction 2-Terminal Silicon-Based Tandem Solar Cells**
H. Ziar
Delft University of Technology, The Netherlands

## ORAL PRESENTATIONS 4BO.7

**10:30 – 12:00 Operation of PV Systems in Specific Contexts**

**Chairpersons:**

Joshua S. Stein
Sandia National Laboratories, Albuquerque, USA

Invited

**4BO.7.1 Vertical Bifacial PV Systems: Modeling and Performance Analysis of a Low-Weight System for Flat Roofs**
M.B. Øgaard, S. Rønneberg, V.S. Nysted, G. Otnes & H.N. Riise
Institute for Energy Technology, Kjeller, Norway
S.E. Foss & T. Mongstad
Over Easy Solar, Oslo, Norway

**4BO.7.2 Digital Twin of Vertical PV System Helps to Identify Unexpected Thermal Behaviour**
A.J. Carr, J. Liu, A. Binani, K. Cesar & B.B. Van Aken
TNO, Petten, The Netherlands

**4BO.7.3 Do Floating PV Systems Warm Up the Water Body?**
S.Z. Mirbagheri Golroodbari & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

**4BO.7.4 Effects of Wind Turbine Dynamic Shading on Combined Solar and Wind Farms**
N. Dekker, L. Slooff & G. de Graaff
TNO Solar Energy, Petten, The Netherlands
J. Hovius
Vattenfall, Amsterdam, The Netherlands
R. Jonkman & R. van der Sanden
Heliox, Best, The Netherlands
J. Zuurbier
Uw-Stroom, Warmenhuizen, The Netherlands
J. Pronk
Prosoldiga, Schagen, The Netherlands

**4BO.7.5 The Early Death of PV Systems in Asian Sites Set in Industrial Areas**
A.M. Nobre, S. Pranav, T. Pakdeepinyo, J. Ward & R. Jaswal
Cleantech Solar, Singapore, Singapore
S.S. Chouhan, A. Gaurav & A.K. Sharma
PV Diagnostics, Mumbai, India

**4BO.7.6 PV Generation Forecasting Utilizing a Classification-Only Approach**
S. Theocharides, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

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## ORAL PRESENTATIONS 3BO.12

**10:30 – 12:00 Cell Related Reliability Challenges**

**Chairpersons:**

Olatz Arriaga Arruti
EPFL, Neuchâtel, Switzerland

Bengt Jaeckel
Fraunhofer CSP, Halle (Saale), Germany

**3BO.12.1 Field-Representative Evaluation of PID-Polarization in TOPCon PV Modules by Accelerated Stress Testing**
P. Hacke
NREL, Golden, USA
S.V. Spataru
Technical University of Denmark, Roskilde, Denmark
B. Habersberger
Dow, Houston, USA
F.I. Mahmood
Arizona State University, Tempe, USA

**3BO.12.2 Influence of Salt on PID Susceptibility of PV Modules for High Salinity Floating Applications**
R. Couderc & L. Sicot
CEA, Le Bourget-du-Lac, France
B. Roman & P. Buttin
CEA, Bouguenais, France
C. Toulemonde
Géosel Manosque, Rueil-Malmaison, France

**3BO.12.3 Damp Heat Stability of Flexible Lightweight Silicon Heterojunction Solar Modules**
K. Zhang, M.A. Yaqin, K. Ding, A. Lambertz, K. Bittkau, W. Duan & U. Rau
FZ Jülich, Germany
O. Mashkov, B. Doll, I.M. Peters & C.J. Brabec
FZ Jülich, Erlangen, Germany

**3BO.12.4 Al2O3 Barrier Layers: a Novel Approach to Preventing Humidity-Induced Failure in Heterojunction Solar Modules**
C. Sen, H. Wang, X. Wu, M.U. Khan, C. Chan & B. Hoex
UNSW Australia, Sydney, Australia
L. Mao, F. Jiang & G. Zhang
CSI Solar, Suzhou, China

**3BO.12.5** **Implementation of a Stabilization Procedure to Mitigate the Influence of LID and LETID on PV Module Reliability Test Results**
E. Fokuhl, A. Beinert, G. Mülhöfer, D. Philipp, B.I. Hädrich & P. Gebhardt
Fraunhofer ISE, Freiburg, Germany
V. Wesselak
Nordhausen University of Applied Sciences, Germany
T. Mikolajick
TU Dresden, Germany

**3BO.12.6** **Durability Testing and Packaging Strategies for Metal-Halide Perovskite/Silicon Tandem PV Modules**
M. Owen-Bellini, Q. Jiang, R. Bramante, V. LaSalvia, E. Warren & K. Zhu
NREL, Golden, USA

## ORAL PRESENTATIONS 4BO.17

**10:30 – 12:00** **BIPV in the Energy Transition: Analysis, Assessment and Lessons Learned**

**Chairpersons:**

Invited

Lenneke H. Slooff
TNO Energy Transition, Petten, The Netherlands

**4BO.17.1** **Integrated-Photovoltaics in Buildings and Infrastructures: A Carbon Footprint Perspective**
A. Virtuani
CSEM, Neuchâtel, Switzerland
A.B. Block, N. Wyrsch & C. Ballif
EPFL, Neuchâtel, Switzerland

**4BO.17.2** **Cross-Sectional Analysis of BIPV- Installations: Performance Evaluation as Building Component and Energy Generator**
F. Frontini
SUPSI, Canobbio, Switzerland
H.R. Wilson
Fraunhofer ISE, Freiburg, Germany
G.C. Eder
OFI, Vienna, Austria
S. Thorsteinsson & M. Babin
DTU, Roskilde, Denmark
J. Adami
EURAC, Bolzano, Italy
R. Yang
RMIT, Melbourne, Australia
M.C. Nuria
CIEMAT, Madrid, Spain
S. Boddaert
CSTB, Sophia Antipolis, France

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**4BO.17.3** **Ex Post Assessment of Economic and Energy Performances of Four BIPV Retrofits Configurations**
E. Bosch, P. Macé & G. Masson
Becquerel Institute, Brussels, Belgium

**4BO.17.4** **Photovoltaic Systems on Building Roofs: Research about Fire Behavior Rating**
P. Cancelliere
Italian National Fire Services, Rome, Italy
G. Manzini
RSE, Milan, Italy
G. Traina
Giordano Institute, Gatteo, Italy
F. Parolini
SUPSI, Mendrisio, Switzerland

**4BO.17.5** **The Role of PV within New EU Building Targets to Achieve Climate Neutrality**
D. D'Agostino, C. Maduta & R. Kenny
European Commission JRC, Ispra, Italy

**4BO.17.6** **BIM Supports and Secure BIPV Design & Engineering**
P. Alamy
Enerbim, Seilh, France
E. Saretta
SUPSI, Mendrisio, Switzerland
M. Dallapiccola
Eurac Research, Bolzano, Italy
M. Cordier
OPTIMAL COMPUTING, Mons, Belgium
D. Valencia
Tecnalia, Derio, Spain

## VISUAL PRESENTATIONS 2BV.2

**10:30 – 12:00** **Perovskite Photovoltaics**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 1BO.3

**13:30 – 15:00 Progress in High Throughput Cell Manufacturing**

**Chairpersons:**

Damian Brunner
RENA Technologies, Freiburg, Germany

Pierre Verlinden
Amrock, McLaren Vale, Australia

**1BO.3.1 Next Generation High-Throughput Cell Production Technologies - Impact on Equipment Capex, Footprint, and Labour Requirements**
B.S. Goraya, V. Georgiou-Sarlikiotis, M. Meßmer, A. Wolf, M. Zimmer, M. Klawitter, A. Lorenz, D. Ourinson, J. Schneider, G. Emanuel, J. Greulich, F. Clement & S. Nold
Fraunhofer ISE, Freiburg, Germany

**1BO.3.2 The Opportunity and Challenge for the Mass Production of Topcon Solar Cell**
W. Deng, H. Chen, X. Ye & G. Zhang
CSI Solar, Suzhou, China

**1BO.3.3 Study of Different Interfacial Oxides for Industrial N-Polysilicon Passivation on Polo-IBC Solar Cells**
V. Mertens, S. Dorn, J. Langlois, M. Stöhr, Y. Larionova, R. Brendel & T. Dullweber
ISFH, Emmerthal, Germany
N. Ambrosius
LPKF Laser & Electronics, Garbsen, Germany
T. Pernau & H. Haverkamp
centrotherm international, Blaubeuren, Germany

**1BO.3.4 A Simplified and Masking-Free Doping Process for IBC Solar Cells Using an APCVD-BSG-PSG Layer Stack for Laser Doping Followed by a High Temperature Step**
M. Heilig, D. Wurmbrand, G. Hahn & B. Terheiden
University of Konstanz, Germany

**1BO.3.5 Demonstration of an Industrial Concept for the Metallization and Interconnection of p-IBC Cells using Aluminium Foil by Laser Processes**
G. Emanuel, O. John, J. Paschen, M. Melati Menegassi, A. Nägele, J.D. Huyeng & J.-F. Nekarda
Fraunhofer ISE, Freiburg, Germany
J. Lossen & T. Messmer
ISC Konstanz, Germany
T. Pernau
centrotherm international, Blaubeuren, Germany

**1BO.3.6 Alternative Metallization: Screen Printed Nickel Contacts with Graphene Layer in between**
B. Akgayev, A. Sezgin, M. Yilmaz & V. Unsur
Necmettin Erbakan University, Konya, Turkey

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## ORAL PRESENTATIONS 2BO.8

**13:30 – 15:00 Industry Compatible Processes for Perovskite PV Modules**

**Chairpersons:**

Sjoerd Veenstra
TNO Energy Transition, Petten, The Netherlands

Florent Sahli
CSEM, Neuchâtel, Switzerland

**2BO.8.1 Special Introductory Presentation: Thermally Evaporated Self-Assembled Monolayers as Lossless Interfaces for Upscaling P-I-N Perovskite Solar Cells**
T.J. Feeney, A. Farag, J. Petry, D.B. Ritzer, F. Schackmar, A. Diercks, I.M. Hossain, M.A. Ruiz-Preciado, Y. Li, B.A. Nejand, F. Laufer, R. Singh, U.W. Paetzold & P. Fassl
KIT, Karlsruhe, Germany
K. Küster & U. Starke
Max Planck Institute for Solid State Research, Stuttgart, Germany
R. Bäuerle
Innovation Lab, Heidelberg, Germany
M. Hentschel
4th Physics Institute and Research Centre SCoPE, Stuttgart, Germany

**2BO.8.2 Advanced Laser Structuring for Perovskite Solar Modules with Geometrical Fill Factor over 99.5% and Efficiency of 20.7%**
F. Di Giacomo, L.A. Castriotta, F. Matteocci & A. Di Carlo
University of Rome Tor Vergata, Italy

**2BO.8.3 Along the Way towards Highly Efficient and Stable Large-Scale Perovskite Solar Modules**
Y. Kuang, X. Zhang, T. Merckx, A. Aguirre, A. Krishna, J. Poortmans, B. Vermang & T. Aernouts
imec, Genk, Belgium
M. Tutundzic
Hasselt University, Belgium
Y. Zhan
Fudan University, Shanghai, China

**2BO.8.4 Fully Printed Low-Temperature Perovskite Solar Cells and Modules**
L. Vesce, M. Stefanelli, H. Nikbakht & A. Di Carlo
University of Rome "Tor Vergata", Italy

**2BO.8.5 Report of 1245mm*635mm Perovskite Module Passing Full Sequence of IEC61215 and IEC61730**
B. Yan, Q. Hou & J. Yao
Microquanta Semiconductor, Hangzhou, China

**Panel Discussion BO.13**

**13:30 – 15:00 PV Community and Society**

*The aim of this round table is to serve as an exchange session promoting the active discussion among key panellists and with the audience on hot topics on a particular theme(s). The detailed programme of this session will be available very soon.*

**VISUAL PRESENTATIONS 4BV.3**

**13:30 – 15:00 Integrated PV and Emerging Synergistic Applications**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**ORAL PRESENTATIONS 1BO.4**

**15:15 – 16:45 Towards Sustainable Manufacturing, Progress in HJT Cell and Advanced Module Manufacturing**

**Chairpersons:**

Invited

Invited

**1BO.4.1 Silver-Lean Metallization for Sustainable PV Manufacturing at the TW Scale**
Y. Chang, L. Wang, Y. Zhang, H. Wang, C.-Y. Huang, R. Chan, C. Chan & B. Hallam
UNSW, Sydney, Australia

**1BO.4.2 A Roadmap for Silver-, Copper-, Lead-, Solder- and Adhesive-Free PV Modules – Based on TOPCon-IBC Technology and More Than 15 Years of Successful Laser Process Development in the Field of "Aluminum Joining"**
J.-F. Nekarda, G. Emanuel, O. John, J. Paschen, M. Melati Menegassi, A. Nägele, S. Nold, A.A. Brand, J.D. Huyeng & R. Preu
Fraunhofer ISE, Freiburg, Germany

**1BO.4.3 Aging Tests of Mini-Modules with Copper Plated Heterojunction Solar Cells**
A. Lachowicz, A. Barrou, B. Paviet-Salomon & C. Ballif
CSEM, Neuchâtel, Switzerland
S. Harrison & V. Barth
CEA INES, Le Bourget-du-Lac, France
M. Galiazzo & N. Frasson
Applied Materials, Treviso, Italy

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**1BO.4.4 Progresses on the Design of a Tool for the Post-Treatment of HJT Cells: from Prototype to In-Line Industrial Tool**
A. Voltan
Applied Materials, Olmi di San Biagio di Callalta, Italy
J. Veirman, J.S. Caron, D. Pelletier, M. Albaric, P. Jeronimo & A.-S. Ozanne
CEA, Le Bourget-du-Lac, France
M. Sciuto
3Enel Green Power, Catania, Italy

**1BO.4.5 Shingle Cell IV Characterization Based on Spatially Resolved Host Cell Measurements via Machine Learning**
P. Kunze, N. Wöhrle, A. Krieg, M. Demant & S. Rein
Fraunhofer ISE, Freiburg, Germany

**ORAL PRESENTATIONS 2BO.9**

**15:15 – 16:45 Stability and Advanced Characterisation of Perovskite Solar Cells**

**Chairpersons:**

Invited

Yinghuan Kuang
imec, Leuven, Belgium

**2BO.9.1 Outdoor Performance Monitoring, Characterization, and Degradation Analysis of Novel Perovskite Solar Cells**
J. Chakar
Ecole Polytechnique, Palaiseau, France
F. Oswald & E. Stéphan
University of Paris-Saclay, Gif-sur-Yvette, France
S. Narbey
Solaronix, Aubonne, Switzerland
A. Migan-Dubois
GeePs, Gif-sur-Yvette, France
J. Parra
Sorbonne University, Palaiseau, France
K. Medjoubi & J.-B. Puel
IPVF, Palaiseau, France
J. Posada
EDF R&D - IRDEP, Palaiseau, France
Y. Bonnassieux
LPICM-CNRS, Palaiseau, France

**2BO.9.2 Reality Check for Perovskite Photovoltaics: Performance and Stability in Outdoor Environment**
M. Khenkin, M. Remec, U. Erdil, Q. Emery, J. Kurpiers, J. Dagar, E. Unger, H. Köbler, A. Abate, F. Scheler, B. Stannowski, S. Albrecht, R. Schlatmann & C. Ulbrich
HZB, Berlin, Germany
S. Tomšic
University of Ljubljana, Slovenia

**2BO.9.3** **9 Different ISOS Protocols for Accelerated Aging of a Perovskite Solar Cell: Comparison and Analysis of Indoor and Outdoor Tests**
U. Erdil, M. Khenkin, Q. Emery, H. Köbler, A. Abate, R. Schlatmann & C. Ulbrich
HZB, Berlin, Germany
E.A. Katz
BGU, Ben-Gurion, Israel

**2BO.9.6** **Surface Saturation Current Densities of Perovskite Thin Films from Suns-Photoluminescence Quantum Yield Measurements**
R. Lee Chin, A.M. Soufiani, J. Zheng, A. Pusch, E. Choi, A. Ho-Baillie, T. Trupke & Z. Hameiri
UNSW, Sydney, Australia
P. Fassl & U. Paetzold
KIT, Karlsruhe, Germany

## ORAL PRESENTATIONS 3BO.14

**15:15 – 16:45** **Reliability and Degradation of Module Packaging**

**Chairpersons:**

Sagarika Kumar
DEWA, Dubai, United Arab Emirates

Stefan Mitterhofer
NIST, Gaithersburg, USA

**3BO.14.1** **On the Status and the Evaluation of Modules in the Field**
I.M. Peters, J. Denz, C. Buerhop-Lutz, B. Doll, J. Hepp, J. Hauch & C. Brabec
HI ERN, Erlangen, Germany

**3BO.14.2** **Effect of Partial Shadow on Reliability in Residential PV Modules**
E. Ozkalay, M. Caccivio & G. Friesen
SUPSI, Mendrisio, Switzerland
A. Virtuani
CSEM, Neuchâtel, Switzerland
C. Ballif
EPFL, Neuchâtel, Switzerland

**3BO.14.3** **Test and Evaluation of Combinations of Encapsulant Materials towards a Long Service Lifetime of PV Modules: PV 40 Plus**
R. Einhaus, J. Kriening, M. Engel & D. Geyer
ZSW, Stuttgart, Germany
G. Oreski & C. Barretta
PCCL, Leoben, Austria
A. Brandstaetter
Lenzing Plastics, Austria
A. Gok
Gebze Technical University, Kocaeli, Turkey
H. Krebs
CS Wismar, Germany

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**3BO.14.4** **Photovoltaic Encapsulant Aging in Dependence of Different Light Spectra**
R. Heidrich, A. Mordvinkin & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
C. Barretta, M. Bredács & G. Oreski
PCCL, Leoben, Austria

**3BO.14.5** **Near-Infrared Spectroscopy of EVA Encapsulants as a Tool for Probing Degradation Status of Silicon PV Modules**
O. Stroyuk, C. Buerhop-Lutz, J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany

**3BO.14.6** **Design of Experiment for Degradation Modelling of PV Modules**
G. Oreski & E. Helfer
PCCL, Leoben, Austria
K. Berger
AIT, Vienna, Austria
G.C. Eder & Y. Voronko
OFI, Vienna, Austria
B. Brune & I. Ortner
TÜV Austria, Vienna, Austria
K. Knöbl
FHTW, Vienna, Austria
L. Neumaier
Silicon Austria Labs, Villach, Austria
M. Feichtner
Kioto Solar, St. Veit/Glan, Austria

## VISUAL PRESENTATIONS 4BV.4

**15:15 – 16:45** **PV and Buildings / Managing Local Fluctuations with Storage / Concentrators; Space Applications**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 4BO.5

**17:00 – 18:30 BIPV Modelling and Testing of Temperature, Performance and Reliability**

**Chairpersons:**

Gabriele C. Eder
OFI, Vienna, Austria

Simon Boddaert
CSTB, Sophia Antipolis, France

**4BO.5.1 Fluid Dynamic and Experimental Analyses of Ventilated Bifacial Photovoltaic Facades**
R. Arena, S. Aneli, G.M. Tina & A. Gagliano
University of Catania, Italy

**4BO.5.2 Validation of Three Module Temperature Models (Faiman, Sandia and Ross) Using Measurement Data from Multiple Outdoor Research Facilities**
T. Sheremet
FHTW, Viena, Austria
M. Tabakovic
FHTW, Vienna, Austria
R.M.E. Valckenborg
TNO, Eindhoven, The Netherlands

**4BO.5.3 Assessment of Thermally Induced Stress in BIPV Modules Using FEM Simulations**
A.J. Beinert, A. Mahfoudi, F. Ensslen & P. Romer
Fraunhofer ISE, Freiburg, Germany
C. Erban
Sunovation, Elsenfeld, Germany

**4BO.5.4 Bifacial PV Systems in High Latitude: Modelling and Validation with Monitoring Data**
H.E. Huerta, S. Ranta, S. Wang & A. Heinonen
TUAS, Turku, Finland
S. Jouttijärvi & K. Miettunen
University of Turku, Finland
A. Driesse
PV Performance Labs, Freiburg, Germany

**4BO.5.5 Maximum Temperatures of BIPV Components: Proposal of a New Testing Procedure to Evaluate the Thermal Behaviour of BIPV Products in Non-Conventional Shading Scenarios**
G. Bellenda, M. Caccivio, F. Parolini, P. Bonomo & F. Frontini
SUPSI, Mendrisio, Switzerland

**4BO.5.6 Defining Standard Test Conditions for Indoor PV Power Rating**
J.C. Blakesley, D.E. Parsons & G. Koutsourakis
NPL, Teddington, United Kingdom

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## ORAL PRESENTATIONS 2BO.10

**17:00 – 18:30 Novel Materials and Process Innovations for Perovskite PV**

**Chairpersons:**

Francesco Di Giacomo
University of Rome Tor Vergata, Italy

Angelika Harter
HZB, Berlin, Germany

**2BO.10.1 Ammonia-Assisted Chemical Vapor Deposition of Formamidinium Cations and Sym-Triazine for Perovskite Layers**
F. Sahli & Q. Jeangros
CSEM, Neuchâtel, Switzerland
Q. Guesnay, A. Kuba, N. Salsi, C.M. Wolff & C. Ballif
EPFL, Neuchâtel, Switzerland
L. Duchêne
EMPA, Dübendorf, Switzerland

**2BO.10.2 All-Vacuum Processed Methylammonium-Free Perovskite Solar Cells in P-I-N Architecture via a Sequential Layer Deposition Process**
A. Diercks, D.B. Ritzer, T.J. Feeney, J. Petry, A. Farag, R. Singh,
U.W. Paetzold & P. Fassl
KIT, Karlsruhe, Germany

**2BO.10.3 Two-Dimensional Dion-Jacobson CsPbI3 with Enhanced Interlayer Coupling for Stable and Efficient Photovoltaics**
Y. Lei, G. Peng & Z. Jin
Lanzhou University, China
H. Wang
Delft University of Technology, The Netherlands

**2BO.10.4 Compositional and Interfacial Engineering for Highly Efficient Wide Bandgap Sn-Based Perovskite Photovoltaics**
S. Cho, P. Pandey, S. Lee, S. Yoon, J. Ryu, D.-G. Lee & D.-W. Kang
Chung-Ang University, Seoul, Republic of Korea

**2BO.10.5 Achieving High Efficiency and Thermal Stability in Germanium Encapsulated Tin-Lead Based Perovskite Solar Cells via Doping and Interlayer Engineering**
S.R. Sahamir, G. Kapil, Q. Shen & S. Hayase
The University of Electro-Communications, Tokyo, Japan
T. Bessho & H. Segawa
University of Tokyo, Japan

**2BO.10.6 Analysis of Electron Transport Layers in Semitransparent P-I-N Perovskite Solar Cells**
T. Wahl, J. Hanisch, E. Ahlswede & J.-P. Becker
ZSW, Stuttgart, Germany

**ORAL PRESENTATIONS 3BO.15**

**17:00 – 18:30 Durability Testing, Modelling, and In-Situ Characterisation**

**Chairpersons:**

Sona Ulicna
NREL, Golden, USA

Oleksandr Stroyuk
HI ERN, Erlangen, Germany

**3BO.15.1 A Finite Element Model to Simulate Photovoltaic Backsheet Cracking After Aging**
S. Mitterhofer & X. Gu
NIST, Gaithersburg, USA
M. Kempe
NREL, Golden, USA

**3BO.15.2 Student Awards Finalist Presentation: Non-Destructive Monitoring of Mechanical and Chemical Changes in PV-Mini-Modules Produced Using Variable Lamination Times**
P. Wessel & R. Gottschalg
Anhalt University of Applied Sciences, Köthen, Germany
A. Mordvinkin
Fraunhofer IMWS, Halle (Saale), Germany

**3BO.15.3 Influence of External Stresses on Degradation Pathways of Photovoltaic Modules**
E. Helfer & G. Oreski
PCCL, Leoben, Austria
G.C. Eder & Y. Voronko
OFI, Vienna, Austria
B. Brune & I. Ortner
TÜV Austria, Vienna, Austria
K.A. Berger
AIT, Vienna, Austria
K. Knöbl
UAS Technikum Wien, Vienna, Austria
L. Neumaier
Silicon Austria Labs, Villach, Austria

**3BO.15.4 In-Laminate Sensing Technology for Validation of Thermo-Mechanical Analysis of Interconnections**
M. Casasola Paesa, J. Govaerts, J. Poortmans &
H. Sivaramakrishnan Radhakrishnan
imec, Genk, Belgium
T. Engelen, N. Kyranaki & M. Daenen
Hasselt University, Belgium
B. Luo
KU Leuven, Belgium

**3BO.15.5 Microscopic Model Describing Potential-Induced Degradation in Silicon Heterojunction Solar Cells and EVA-Based Modules**
O. Arriaga Arruti, L. Gnocchi & C. Ballif
EPFL, Neuchâtel, Switzerland
A. Virtuani & A. Faes
CSEM, Neuchâtel, Switzerland

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**3BO.15.6 Design and Testing of PV Modules Based on Glass/Glass Configuration to Achieve Extended Lifetime**
C. Barretta, L. Meinhart & G. Oreski
PCCL, Leoben, Austria
H. Krebs & J. Wittfoth
CS Wismar, Germany
A. Brandstaetter
Lenzing Plastics, Austria
D. Geyer & R. Einhaus
ZSW, Stuttgart, Germany
A. Gok
Gebze Technical University, Kocaeli, Turkey

**VISUAL PRESENTATIONS 1BV.5**

**17:00 – 18:30 Silicon Material for Solar Cells and its Defects / Fabrication and Production of c-Si Silicon Solar Cells and Related Tools and Processes**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**Wednesday, 20 September 2023**

## PLENARY SESSION CP.1

**08:30 – 10:00 Multiple Aspects of PV Rollout**

**Chairpersons:**

Teresa Barnes
NREL, Golden, USA

David Moser
Eurac Research, Bolzano, Italy

**CP.1.1** **Special Introductory Presentation: Raising the Limits to PV Penetration: Why We Need Battery Swapping for the Future Energy and Transport Systems**
A. Vallera
University of Lisbon, Portugal

**CP.1.2** **Mapping the Relevance and Implications of Digitalisation for PV**
P.-J. Alet
CSEM, Neuchâtel, Switzerland
V. Efthymiou
University of Cyprus, Nicosia, Cyprus
G. Arrowsmith
EUREC, Brussels, Belgium
I.A. Tsanakas
CEA, Le Bourget-du-Lac, France
J. Leloux
LuciSun, Sart-Dames-Avelines, Belgium
G. Barchi
Eurac Research, Bolzano, Italy
S. de Vito, G. Adinolfi & G. Graditi
ENEA, Portici, Italy
T. Garabetian
SolarPower Europe, Brussels, Belgium

**CP.1.3** **Degradation Pathways in Bifacial PV Module Packaging Designs with Emerging Encapsulants and Half-Cut Cells**
S. Ulicna, D.M. Roberts, M. Owen-Bellini, P. Ndione, H. Moutinho, K. Terwilliger, S. Johnston, B. McDanold, T.J. Silverman, L.T. Schelhas & D.B. Kern
NREL, Golden, USA

**CP.1.4** **Invited**

Wednesday, 20 September 2023

## PLENARY SESSION CP.2 / CP.3

**10:30 – 12:30 Developments in Single and Multijunction Devices: Wafer and Thin Film Technologies**

**Chairpersons:**

Stefan W. Glunz
Fraunhofer ISE, Freiburg, Germany

Marko Topic
University of Ljubljana, Slovenia

**CP.2.1** **Indium-Free Silicon Heterojunction Solar Cells with the Conversion Efficiency Beyond 26%**
S. Yin, C. Hong, C. Li, M. Yang, X. Ru, F. Peng, M. Qu, J. Lu, L. Fang & X. Xu
LONGi Green Energy, Xi'an, China

**CP.2.2** **The Impact of Measurement Conditions on Solar Cell Efficiency**
M. Rauer, A. Fell, W. Wöhler, M.C. Schubert & J. Hohl-Ebinger
Fraunhofer ISE, Freiburg, Germany
D. Hinken & K. Bothe
ISFH, Emmerthal, Germany

**CP.3.1** **Roadmap for Perovskite/Silicon Tandem Solar Cells: from Lab Records to Next Generation Modules**
E. Köhnen, L. Korte, A. Abate, E. Unger, B. Stannowski, S. Albrecht & R. Schlatmann
HZB, Berlin, Germany

**CP.3.2** **Invited**

**CP.3.3** **Comprehensive Analysis of the Interactions between a Concentrating Photovoltaics (CPV) Module and 5-Junction Solar Cells**
R.F. Löckenhoff & P. Schroth
Azur Space, Heilbronn, Germany
M. Steiner
Fraunhofer ISE, Freiburg, Germany

**CP.3.4** **Opportunities for thin-film PV in the next decade in Europe**
A. Lange
First Solar, Krefeld, Germany
M. Glöckler
First Solar, Perrysburg, USA

## ORAL PRESENTATIONS 2CO.1

**13:30 – 15:00 High-Efficiency Pervoskite Silicon Tandems**

**Chairpersons:**

Ivan Gordon
imec, Leuven, Belgium

Invited

**2CO.1.1 Student Awards Finalist Presentation: Highly Efficient Perovskite/Silicon Tandem Solar Cells on Thin Nano-Textured Cz-Silicon Bottom Cells**
A. Harter, S. Albrecht, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany
K. Artuk, D. Turkay, C. Ballif & C.M. Wolff
EPFL, Neuchatel, Switzerland
Q. Jeangros
CSEM, Neuchatel, Switzerland

**2CO.1.2 Student Awards Finalist Presentation: Recent Progress, Loss Analysis and Prospects for High-Efficiency (>30%) Two-Terminal Perovskite-Si Solar Cells**
D. Turkay, K. Artuk, M. Boccard, C.M. Wolff & C. Ballif
EPFL, Neuchatel, Switzerland
X.Y. Chin, S.-J. Moon, A. Walter & Q. Jeangros
CSEM, Neuchatel, Switzerland
D.A. Jacobs
EPFL, Lausanne, Switzerland

**2CO.1.3 Efficient Double-Side Textured Perovskite Silicon Tandem Solar Cells: Controlled Processing and Understanding of Perovskite Formation**
O. Er-Raji, M.M. Abdelaziz Abdelnaby, H. Nagel, B. Kore, O. Schultz-Wittmann, M. Bivour, M. Hermle, S.W. Glunz, J. Borchert & P.S.C. Schulze
Fraunhofer ISE, Freiburg, Germany

**2CO.1.4 Monolithic Perovskite/Silicon Tandem Solar Cell with Certified 29.11% Efficiency using Industrial Silicon Bottom Cells**
B. Li, K. Sveinbjörnsson, L. Korte & S. Albrecht
HZB, Berlin, Germany
E. Jarzembowski, L. Kegelmann, A. Wirtz, F. Frühauf, A. Weihrauch, R. Niemann, F. Fertig & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**2CO.1.5 Monolithic Perovskite Silicon Tandem Solar Cells with High Short-Circuit Currents of 20 mA/cm2 by Optimizing the ITO Interconnection Layer**
O.S. Kabakli, K. McMullin, L. Tutsch, M. Bivour, O. Fischer, A.J. Bett, M. Hermle, S.W. Glunz, J. Borchert & P.S.C. Schulze
Fraunhofer ISE, Freiburg, Germany
J.C. Goldschmidt
Philipps University of Marburg, Germany

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**2CO.1.6 Modelling Performance and Degradation of Perovskite-Silicon Tandem Devices under Outdoor Operating Conditions**
S. Tomšic, M. Jošt, B. Lipovšek & M. Topic
University of Ljubljana, Slovenia
M. Remec, F. Scheler, M. Khenkin, C. Ulbrich, R. Schlatmann & S. Albrecht
HZB, Berlin, Germany

## ORAL PRESENTATIONS 5CO.4

**13:30 – 15:00 Solar Hydrogen and P2X**

**Chairpersons:**

Ingrid Weiss
WIP Renewable Energies, Munich, Germany

Bruno Gaiddon
HESPUL, Lyon, France

**5CO.4.1 Limits of Solar-to-Hydrogen Efficiency and Loss Analysis in Photovoltaic-Driven Water Electrolyzers**
O. Astakhov & T. Merdzhanova
Forschungszentrum Jülich, Germany
U. Rau
RWTH Aachen University, Germany

**5CO.4.2 Evaluation of the Influence of Different Energy Usage Behavior, Component Dimensionings and PV Orientations on the Suitability and Lifetime of a Hybrid, Hydrogen-Based PV Energy System for a Private Household**
M.C. Möller & S. Krauter
Paderborn University, Germany

**5CO.4.3 True Cost of Green Hydrogen: a Dynamic Simulation**
G. Borz, G. Barchi & D. Moser
Eurac Research, Bolzano, Italy
C. Breyer
LUT University, Lappeenranta, Finland
E. Vartiainen
Fortum Growth, Finland

**5CO.4.4 Modelling One Year of Operation of PV Supported Electric Supply of a District with H2 Storage**
M. Mostafa, M. Rennhofer, B. Kubicek & S. Zamini
AIT, Vienna, Austria
P. Colbertaldo
Politecnico di Milano, Italy

**5CO.4.5** **GIS-based Multi-Criteria Decision Support for Large-Scale Integration of Solar Photovoltaic Energy: Towards Competitive Green Hydrogen Production in Morocco**
F.-Z. Ouchani, O. Jbaihi & A. Ghennioui
Green Energy Park, Benguerir, Morocco
A. Alami Merrouni
Mohammed First University, Oujda, Morocco
M. Maaroufi
EMI, Rabat, Morocco

**5CO.4.6** **Coupling Efficiency and Performance of the PV-Driven "Artificial Leaf" for CO2 Conversion under Variable Irradiance and Temperatures**
T. Cibaka, T. Merdzhanova, O. Astakhov, V. Smirnov, U. Chime, K. Zhang, M. Heggen & U. Rau
Forschungszentrum Jülich, Germany
A.J. Martín & J. Pérez-Ramírez
ETH Zurich, Switzerland
P. Strasser
Technical University of Berlin, Germany

## PANEL DISCUSSION CO.7

**13:30 – 15:00** **PV Manufacturing Ecosystem in Europe**

*The aim of this round table is to serve as an exchange session promoting the active discussion among key panellists and with the audience on hot topics on a particular theme(s). The detailed programme of this session will be available very soon.*

## VISUAL PRESENTATIONS 4CV.1

**13:30 – 15:00** **Performance and Monitorisation of PV Systems**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*



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## ORAL PRESENTATIONS 2CO.2

**15:15 – 16:45** **Perovskite Top-Cell Development and All Perovskite Tandems**

**Chairpersons:**

Gianluca Coletti
TNO Energy Transition, Petten, The Netherlands

Invited

**2CO.2.1** **Compositional and Additive Engineering Towards High Open-Circuit Voltage (~~1.27V) Inverted Perovskite Solar Cells and (>1.975V) Perovskite/c-Si Tandems**
K. Artuk, D. Turkay, M.R. Golobostanfard, M. Othman, A.M. Jaffrès, D.A. Jacobs, C. Ballif & C.M. Wolff
EPFL, Neuchatel, Switzerland
X.Y. Chin, A. Walter, S.J. Moon, F. Saenz & Q. Jeangros
CSEM, Neuchatel, Switzerland

**2CO.2.2** **Study of Sputter Damage on Triple-Cation Perovskite Layer in Monolithic Perovskite/Silicon Tandem Solar Cells**
Q. Yang, W. Duan, A. Lambertz, B. Klingebiel, T. Kirchartz, Y. Wang, K. Bittkau, S. Vitusevich, Y. Zhang, U. Rau & K. Ding
Forschungszentrum Jülich, Germany

**2CO.2.3** **Single Source Vapor Deposition of Halide Perovskites: from a Solid Target to Thin Films and Solar Cells**
T. Soto-Montero, W. Soltanpoor, S. Kralj, J..S. Solomon & M. Morales-Masis
University of Twente, Enschede, The Netherlands
R. Azmi, E. Ugur, E. Aydin & S. De Wolf
KAUST, Thuwal, Saudi Arabia

**2CO.2.4** **Monolithic Inorganic Perovskite/ Silicon Tandem Solar Cells with an Approximate Efficiency of 23%**
S. Wang, P. Wang, B. Chen, R. Li, N. Ren, Y. Li, B. Shi, Q. Huang, Y. Zhao & X. Zhang
Nankai University, Tianjin, China
M. Grätzel
EPFL, Lausanne, Switzerland

**2CO.2.5** **Advanced Materials and Processes for All-Perovskite Tandem Photovoltaics**
D.B. Ritzer, H. Hu, B.A. Nejand, S. Moghadamzadeh, T. Feeney, F. Laufer, P. Fassl & U.W. Paetzold
KIT, Karlsruhe, Germany

**2CO.2.6** **Simulation-Based Loss Analysis & Optimization of All-Perovskite Tandem Solar Cells & Modules**
U. Aeberhard, S.J. Zeder & S. Jenatsch
Fluxim, Winterthur, Switzerland
H. Lai, R. Kothandaraman & F. Fu
EMPA, Duebendorf, Switzerland
K. Datta, J. Wang & R. Janssen
Eindhoven University of Technology, The Netherlands
B. Ruhstaller
ZHAW, Winterthur, Switzerland

## ORAL PRESENTATIONS 5CO.5

**15:15 – 16:45 PV + Storage and Grid Integration**

**Chairpersons:**

Rui Pestana
R&D Nester, Sacavém, Portugal

Annick Anctil
Michigan State University, East Lansing, USA

**5CO.5.1 Development of Concepts for Site Optimization and Improvement of the Technical Concept Using the Example of the Project Idea "PHES-Rio"**
A. Blinn, K. Kreitzer & H. te Heesen
Trier University of Applied Sciences, Neubrücke, Germany

**5CO.5.2 Ground-Breaking Approach to Renewable Energy Community**
M. Pierro, D. Moser, S. Zambotti & G. Barchi
Eurac Research, Bolzano, Italy
C. Cornaro
University of Rome Tor Vergata, Italy
R. Perez
State University of New York, Albany, USA

**5CO.5.3 Absorption of PV Power Prediction Errors with Headroom Control by Variable Importance-Considering Svr Model with Different Initial Values**
J. Cui, X. Fang & Y. Ueda
Tokyo University of Science, Japan
T. Oozeki
AIST, Koriyama, Japan

**5CO.5.4 On the Effects of Nodal PV Power Forecasting Errors on the Operation of Power Systems**
J.G. da Silva Fonseca Jr., T. Takeuchi, T. Saito, S. Shuhei & K. Ogimoto
University of Tokyo, Japan

**5CO.5.5 Hybrid Battery Sizing Design Tool**
A.C. Neves Foles, L.A. Fialho, L. Fava & P.A. Horta
University of Evora, Portugal
P. Matos & P. Mota
Capwatt Services, Maia, Portugal

**5CO.5.6 Development of Energy Management System for PV-Bess System for Non-Interconnected Areas**
D.E. Melliti, D.L. Ha, M. Riou, F. Al-Shakarchi & F. Araya
Entech, Quimper, France

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## ORAL PRESENTATIONS 4CO.8

**15:15 – 16:45 Solar Forecasting**

**Chairpersons:**

Jan Remund
Meteotest,Bern, Switzerland

Ana Maria Gracia Amillo
CENER, Sarriguren-Navarra, Spain

**4CO.8.1 Student Awards Finalist Presentation: Probabilsitic Short-Term Forecasting of Cloudiness with SolarSTEPS**
A. Carpentieri, D. Folini & M. Wild
ETH Zurich, Switzerland
D. Nerini
MeteoSwiss, Locarno-Monti, Switzerland
S. Pulkkinen
Finnish Meteorological Institute, Helsinki, Finland
A. Meyer
BFH, Bern, Switzerland

**4CO.8.2 Evaluation of ECMWF HRES IFS and CAMS IFS Intra- and Day-Ahead Forecasts with Respect to Surface Solar Irradiances**
J. Lezaca & M. Schroedter-Homscheidt
DLR, Oldenburg, Germany
Y.M. Saint-Drenan
MINES ParisTech, Sophia Antipolis, France

**4CO.8.3 Combination of a Novel All Sky Imager Based Approach for Highresolution Solar Irradiance Nowcasting with Persistence and Satellite Nowcasts for Increased Accuracy**
N. Straub, W. Herzberg, A. Dittmann & E. Lorenz
Fraunhofer ISE, Freiburg, Germany

**4CO.8.4 Hybrid Solar Nowcasts by Combining an All-Sky Imager Based Physical and Deep Learning Model**
Y. Fabel, B. Nouri, S. Wilbert, N. Blum & R. Pitz-Paal
German Aerospace Center, Almería, Spain
D. Schnaus & R. Triebel
TUM, Munich, Germany
L.F. Zarzalejo & E. Ugedo
CIEMAT, Madrid, Spain
J. Kowalski
RWTH Aachen University, Germany

**4CO.8.5 Dynamic Graph Machine Learning for Mult-Site Solar Forecasting**
RE. Carrillo, B. Schubnel, R. Langou & P.-J. Alet
CSEM, Neuchatel, Switzerland

**4CO.8.6 Hybrid Artificial Intelligence-Based Prediction Model for Irradiance Nowcasting Using Sky-Images**
V.A. Martinez Lopez, G. van Urk, P.J.F Doodkorte, M. Zeman, O. Isabella & H. Ziar
TU Delft, The Netherlands

## ORAL PRESENTATIONS 3CO.10

**15:15 – 16:45 Optical and Electrical Characterisation of PV Modules**

**Chairpersons:**

Invited

Carolin Ulbrich
HZB, Berlin, Germany

**3CO.10.1 Two-Dimensional Representation of the Bidirectional Reflection Distribution Function of Photovoltaic Modules**
C. Bucher, S. El Hassani & M. Hügi
BFH, Burgdorf, Switzerland
A. Bohren
OST, St. Gallen, Switzerland

**3CO.10.2 Evaluation of the Glare Function of PV-Modules and Description of Relevant Measurement Procedures**
R. Trattnig
Joanneum Research, Weiz, Austria
J. Zehndorfer
Zehndorfer Engineering Consulting, Klagenfurt, Austria
L. Plessing
TPPV, Vienna, Austria

**3CO.10.3 Test Requirements for Angular Response Measurement of Encapsulated Solar Cell Coupons**
W. Herrmann & G. Bardizza
TÜV Rheinland, Cologne, Germany
M. Hsian Saw & M. Pravettoni
SERIS, Singapore, Singapore
N. Riedel-Lyngskær & M. Babin
DTU, Roskilde, Denmark
I. Kröger
PTB, Braunschweig, Germany

**3CO.10.4 Characterization of Curved Modules for VIPV**
I. Antón Hernández, R. Herrero, F.J. Martín, S. Askins, J. Macías Rodríguez, L.J. San José, G. Vallerotto, R. Núñez & C. Domínguez
UPM, Madrid, Spain

**3CO.10.5 The Effect of Irradiance Non-Uniformity on the Performance Parameters of State-of-the-Art PV-Module Designs**
Y. Zhang, Q. Gao, W. Xu & C. Monokroussos
TÜV Rheinland, Shanghai, China
G. Bardizza & W. Herrmann
TÜV Rheinland Solar, Cologne, Germany

**3CO.10.6 Advanced Analysis of Spectral and Spatial Non-Uniformity of an LED Sun Simulator with Double-Side Illumination for Bifacial PV Module Power Rating**
S. Dittmann & G.L. Martins
Anhalt University of Applied Sciences, Köthen, Germany
R. Gottschalg
Fraunhofer CSP, Halle, Germany

Wednesday, 20 September 2023

## VISUAL PRESENTATIONS 2CV.2

**15:15 – 16:45 Compound and Organic Semiconductors**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 2CO.3

**17:00 – 18:30 Perovskite-based Tandem Upscaling and Industrialisation**

**Chairpersons:**

Invited

Juliane Borchert *(i)*
Fraunhofer ISE, Freiburg, Germany

**2CO.3.1 Large-Scale Monolithic Perovskite/Silicon Tandem Solar Cell on Commercially Textured Silicon**
Q. Xu, B. Shi, J. Liu, P. Liu, Z. SunLi, Y. Li, L. Yan, W. Duan, Y. Li, R. Li, N. Ren, W. Han, Q. Huang, D. Zhang, H. Ren, S. Xu, C. Zhang, H. Zhuang, A. Lambertz, K. Ding, Y. Zhao & X. Zhang
Nankai University, Tianjin, China

**2CO.3.2 Industrial Processes for Scaling Monolithic Perovskite Silicon Tandem Solar Cells**
J. Kurpiers, S. Severin, T. Bertram, A.M. Soufiani, B. Li, P.I Reyes-Figueroa, J.N. Kleesiek, K. Mayer-Stillrich, A. Cruz Bournazou, M. Roß, A. Al-Ashouri, A. Harter, S. Albrecht, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany

**2CO.3.3 Dual-Functional Molecule Passivation for Efficient Monolithic Perovskite/ Silicon Tandem Solar Cells**
Y. He, H. Zhang, J. Li, X. Dong, L. Ding, M. Yang, X. Ru, J. Liu, B. He & X. Xu
LONGi Green Energy Technology, Xi'An, China

**2CO.3.4 Lamination: Alternative Fabrication Method for Monolithic Perovskite/Silicon Tandem Solar Cells**
J. Roger, A. Farag, T.J. Feeney, D. Baumann, H. Hu, P. Fassl, M. Worgull & U.W. Paetzold
KIT, Karlsruhe, Germany

**2CO.3.5** **2T Perovskite Based Tandem PV: from Lab Scale Small Area Cell towards Large Area Devices on Commercial CIGS and c-Si Bottom Cells**
V. Zardetto, M. Simor, G. Lucarelli, V. Gevaerts & S.C. Veenstra
TNO, Eindhoven, The Netherlands
N. Phung, J. Wang, K. Datta, K. Mukherjee, S. Prunte, A. Bracesco, P. Proceya, R. Janssen & M. Creatore
Eindhoven University of Technology, The Netherlands
Y. Wu, B.J. Geerligs & G. Coletti
TNO, Petten, The Netherlands
O. Isabella
Delft University of Technology, The Netherlands

**2CO.3.6** **3-Terminal Perovskite-Silicon Tandems: from a Peculiar Research Device to a Potential Module Level Solution for the Future?**
M. Kikelj, B. Lipovšek & M. Topic
University of Ljubljana, Slovenia
L.-L. Senaud, J. Geissbühler, F. Sahli, C. Ballif, Q. Jeangros & B. Paviet-Salomon
CSEM, Neuchâtel, Switzerland
D. Lachenal & D.L. Bätzner
Meyer Burger Research, Hauterive, Switzerland

## ORAL PRESENTATIONS 5CO.6

**17:00 – 18:30** **Energy System Integration; Climate Change / Environmental Sustainability of PV**

**Chairpersons:**

Invited

Garvin Heath
NREL, Golden, USA

**5CO.6.1** **Flexible Electricity Demand Forecasting Based on mRMR Feature Selection and WT-LSTM**
K. Iwabuchi, D. Watari, Z. Dafang, I. Taniguchi & T. Onoye
Osaka University, Suita, Japan

**5CO.6.2** **Impact of Time Resolution of Solar and Meteorological Data on Clipping Losses and Energy Yield Simulation**
J. Rusnak, B. Schnierer, M. Suri & M. Opatovsky
Solargis, Bratislava, Slovakia
G. Srinivasan
Solargis Americas, Toronto, Canada

**5CO.6.3** **Sensitivity of Global Warming Potential of PERC Solar Cells to Production Electricity Mix, Installation Location and System Lifetime**
A.A. Khan, C. Reichel, L. Friedrich, D.M. Subasi, P. Molina, H. Neuhaus & S. Nold
Fraunhofer ISE, Freiburg, Germany

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**5CO.6.4** **Ground-Mounted or Rooftop Photovoltaic Plant - European Production or Chinese Production: Which Is the Most Environmentally Sustainable System?**
E. Brivio, A. Danelli & P. Girardi
RSE, Milan, Italy

**5CO.6.5** **Student Awards Finalist Presentation: Processes of CO2 Capture and Reduction to Solar Fuels Compatible with Photovoltaics**
A. González del Valle, P. Garcia-Linares & A. Martí Vega
UPM, Madrid, Spain

**5CO.6.6** **Student Awards Finalist Presentation: More Than Recycling: How Should We Define Circularity Goals for PV in a Global Energy Transition?**
H. Mirletz
Colorado School of Mine, Golden, USA
S. Ovaitt, M. Mendez Ribo & T.M. Barnes
NREL, Golden, USA
S. Sridhar
Arizona State University, USA

## ORAL PRESENTATIONS 4CO.9

**17:00 – 18:30** **Solar Resource Assessment and Modelling**

**Chairpersons:**

Vicente Lara-Fanego
Solargis, Bratislava, Slovakia

Invited

**4CO.9.1** **Advances in the NSRDB**
M. Sengupta, A. Habte, G. Buster, Y. Xie & B. Benton
NREL, Golden, USA
M. Foster
University of Wisconsin, Madison, USA

**4CO.9.2** **Evaluation of Irradiance Decomposition Models and Their Predictors**
J.K. Thorning & S.V. Spataru
DTU, Roskilde, Denmark

**4CO.9.3** **A Benchmark of Simple Diffuse and Direct Irradiance Measurement Systems**
N. Blum, F. Maas, J. Stührenberg, R. Broda, M. Meinel, B. Nouri & L. Campos Guzmán
DLR, Almeria, Spain
A. Kazantzidis
University of Patras, Greece
M. Abraim & A. Ghennioui
Green Energy Park, Benguerir, Morocco
M. Calais
Murdoch University, Australia
A. Habte
NREL, Golden, USA
J.M. Pó
EKO Instruments, Den Haag, The Netherlands
L.F. Zarzalejo
CIEMAT, Madrid, Spain
S. Wilbert
DLR, Tabernas, Spain

**4CO.9.4** **Aerosols Estimation in Arid Region, for Solar Resource Applications**
D.A. Bachour & D. Perez-Astudillo
HBKU/ Qatar Foundation, Doha, Qatar

**4CO.9.5** **Using OpenStreetMap Data for Topography and Irradiance Modelling for Integrated PV**
E. Sovetkin, M. Gordon, A. Gerber & B. Pieters
FZ Jülich, Germany

**4CO.9.6** **Effect of Urban Development on Local Albedo Based on LiDAR Data**
Y. Zhou, S. Marathe, M. Zeman, O. Isabella & H. Ziar
TU Delft, The Netherlands

## ORAL PRESENTATIONS 3CO.11

**17:00 – 18:30** **Outdoor Performance and Energy Rating**

**Chairpersons:**

Hartmut Nussbaumer
ZHAW, Winterthur, Switzerland

Juan Lopez-Garcia
QEERI, Doha, Qatar

**3CO.11.1** **Student Awards Finalist Presentation: Impact of Coloured Interlayers on Modelling Module Temperature of Vertically Mounted Glass-Glass BIPV Modules**
M. Babin, I.H. Jóhannsson, M.L. Jakobsen & S. Thorsteinsson
DTU, Roskilde, Denmark

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**3CO.11.2** **Quantification of Operating Temperatures and Thermomechanical Stress for Modules in BIPV-Relevant Configurations**
H. Quest, A. Fairbrother & C. Ballif
EPFL, Neuchâtel, Switzerland
A. Virtuani
CSEM, Neuchâtel, Switzerland

**3CO.11.3** **Predicting Outdoor Performance of Perovskite-Silicon Tandem Modules with New Accelerated Indoor Reliability Testing**
P. Manshanden, L.J. Geerligs, V. Rosca, M.J. Jansen, M. Späth & G. Coletti
TNO Energy Transition, Petten, The Netherlands
V. Zardetto, I. Dogan & S.C. Veenstra
TNO Energy Transition, Eindhoven, The Netherlands

**3CO.11.4** **Energy Rating of PV Modules - Uncertainties Associated with (G-T) Power Matrix Measurements in Accordance with IEC 61853-1**
G. Bardizza, W. Herrmann & H. Maaroufi
TÜV Rheinland Solar, Cologne, Germany
A. Schmid & M. Rauer
Fraunhofer ISE, Freiburg, Germany
B. Provost & L. Prieur
Certisolis, Le Bourget-du-Lac, France
G. Bellenda & G. Friesen
SUPSI, Mendrisio, Switzerland
C. Xu
ISFH, Emmerthal, Germany
S. Riechelmann, H. Sträter & S. Winter
PTB, Braunschweig, Germany
T. Sample, H. Müllejans & D. Pavanello
European Commission JRC, Ispra, Italy
J. Dubard
LNE, Trappes, France

**3CO.11.5** **How Accurate Are Temperature Measurements of PV Modules to Estimate the Cell Temperature?**
R. Aninat, D. Out, M. Theelen & R. Valckenborg
TNO/Solliance, Eindhoven, The Netherlands
D. Mann
BMC, Geleen, The Netherlands
P. Nivelle
University of Hasselt, Belgium

**3CO.11.6** **On the Review of Incidence Angle Modifier Issues for Photovoltaic Energy Predictions**
L. Barrutia, U. Bueno & E. Lorenzo
UPM, Madrid, Spain
M. Muñoz
ACCIONA-ENERGIA, Navarra, Spain

## VISUAL PRESENTATIONS 1CV.3

**17:00 – 18:30** **High Temperature Routes for Si Cells / Heterojunction Solar Cells / Recent Advances in Silicon Solar Cell Characterisation**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**Thursday, 21 September 2023**

## ORAL PRESENTATIONS 4DO.1

**08:30 – 10:00 PV System Design and Optimisation**

**Chairpersons:**

Invited

Kari Lappalainen
Tampere University, Finland

**4DO.1.1 Student Awards Finalist Presentation: Lab Measurements of Power Optimizer Efficiency and Performance Simulation of Partially Optimized Systems Affected by Shading**
C. Allenspach, F. Carigiet & F. Baumgartner
Zurich University of Applied Sciences, Winterthur, Switzerland

**4DO.1.2 Light and Shade – A Hemicube Approach for Efficient Shading Calculations in Utility-Scale PV Plants**
A. Neubert
DNV Maritime Software, Oldenburg, Germany
M. Hamer
DNV Services, Bristol, United Kingdom
J. Lopez-Lorente
DNV, Arnhem, The Netherlands

**4DO.1.3 Investigating the Temperature Distribution of a PV Module under Various Environmental Factors and Exploring Novel Module Geometries for the Reduction of Thermal Losses**
G. du Boullay, M.G. Chowdhury & J. Poortmans
imec, Leuven, Belgium

**4DO.1.4 Module Type Impacting Electromagnetic Emissions from PV Systems**
D. Kroner
Dalarna University, Falun, Sweden
U. Lundgren
RISE, Gothenburg, Sweden

**4DO.1.5 Cleaning Optimization for Photovoltaic Powerplants: a Novel Approach Combining Techno-Economic Modelling with Historic Rain and Soiling**
F. Clandestino, T. Müller & K. Pogorelov
Virtuous-Re, Ebersberg, Germany

**4DO.1.6 Mitigation of Soiling by Understanding and Control of Dust Particle Cementation**
G. Willers, M.Z. Khan, V. Naumann & K. Ilse
Fraunhofer CSP, Halle, Germany
R. Gottschalg
Anhalt University of Applied Sciences, Koethen, Germany

Thursday, 21 September 2023

## ORAL PRESENTATIONS 2DO.6

**08:30 – 10:00 Chalcogenide Solar Cells, Devices and Back Contacts**

**Chairpersons:**

Bart Vermang
Imec, Genk, Belgium

Mirjam Theelen
TNO Energy Transition, Eindhoven, The Netherlands

**2DO.6.1 Special Introductory Presentation: Opportunities with Bifacial Chalcogenide Thin Film PV**
R. Carron
EMPA, Dübendorf, Switzerland

**2DO.6.2 Study of Different Approaches to Fabricate CdSeTe/CdTe Devices by Thermal Evaporation**
E. Artegiani, N. Torabi, O.K. Simya & A. Romeo
University of Verona, Italy

**2DO.6.3 Epitaxial Growth of Cu(In,Ga)S2 Thin Films on GaP/Si(001) Pseudo-Substrate: towards Cu(In,Ga)S2/Si Tandem Solar Cells**
E. Bertin, R. Gautheron-Bernard, C. Cornet, A. Létoublon, M. Julien & O. Durand
INSA Rennes, France
E. Gautron, L. Choubrac, L. Arzel, F. Pineau, T. ALOUI, S. Harel & N. Barreau
University of Nantes, France
A. Crossay
IPVF, Palaiseau, France

**2DO.6.4 Photon Management by Functional Back Contacts for Ultrathin CIGSe Solar Cells: Insight from Experiment and Simulation**
M. Demir, A.N. Sprafke, B. Fuhrmann, T. Schneider, T. Hölscher, H. Kempa & R. Scheer
Martin Luther University, Halle, Germany

**2DO.6.5 Theoretical and Experimental Optimization of Back Junction for Cu(In,Ga)Se2 Solar Cells**
T. Nishimura & A. Yamada
Tokyo Institute of Technology, Japan

## ORAL PRESENTATIONS 5DO.11

**08:30 – 10:00** **Broadening the PV Markets: Tools and Results for Better Analysis, Modelling and Forecasting**

**Chairpersons:**

Stefan Nowak
NET Nowak Energy & Technology, St. Ursen, Switzerland

Nives Della-Valle *(i)*
European Commission JRC, Ispra, Italy

**5DO.11.1** **Student Awards Finalist Presentation: On the Full Potential and Role of Different Solar Photovoltaic System Technologies in the Iberian Energy Transition**
M. ElSayed, D. Bogdanov, D. Keiner, R. Satymov & C. Breyer
LUT University, Lappeenranta, Finland
L. Walter
OTH Regensburg, Germany
J.C. Osorio-Aravena
Universidad Austral de Chile, Coyhaique, Chile

**5DO.11.2** **Advanced Solar PV Market Forecasting with High Granularity for 33 European Countries**
A. van Rechem, P. Macé, E. Bosch & G. Masson
Becquerel Institute, Brussels, Belgium

**5DO.11.3** **Towards a Scoreboard for the Benchmarking of Solar Policies and Regulations**
P. Malbranche
CEA, Le Bourget-du-Lac, France

**5DO.11.4** **Firm PV Power Generation – Overview and Outlook**
J. Remund
Meteotest, Bern, Switzerland
R. Perez
State University of New York, Albany, USA
M. Perez
Clean Power Research, Napa, USA

**5DO.11.5** **PV Opportunities Are More Than Reducing the Generation Cost**
C. Honsberg, A. Barnett, C. Miller, B. Dauksher & S.M. Goodnick
Arizona State University, Tempe, USA
I. Sellers
University of Oklahoma, Norman, USA
D.M. Kammen
University of California Berkeley, USA
S. Kurtz
University of California Merced, USA
H. Atwater
California Institute of Technology, Pasadena, USA

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**5DO.11.6** **Impact of Climate Change on Future Solar Resource Variability and Intermittency across Australia**
S. Poddar, M. Kay, A. Prasad, J.P. Evans & S.P. Bremner
UNSW, Sydney, Australia

## ORAL PRESENTATIONS 3DO.16

**08:30 – 10:00** **Shading Effects and Imaging Techniques**

**Chairpersons:**

Christos Monokroussos
TÜV Rheinland, Shanghai, China

Eszter (Esther) Voroshazi
CEA, Le Bourget-du-Lac, France

**3DO.16.1** **Performance Gain of Shading Tolerant PV Modules in Different Electrical PV System Setups**
F.P. Baumgartner & C. Allenspach
ZHAW, Winterthur, Switzerland

**3DO.16.2** **Comparison of Indoor Characterization and Outdoor Energy Yield Measurement of Shade-Resistant and Standard PV Modules under Partial Shading Conditions**
T. Siquera, S. Dittmann, H. Sánchez Ortiz, C. Meza & R. Gottschalg
Anhalt University of Applied Sciences, Köthen, Germany
A. Bakhtiari, W. Maier & H. Hanifi
AE SOLAR, Königsbrunn, Germany

**3DO.16.3** **Calculation Tool to Determine the Shading Tolerability of PV Modules**
A. Alcañiz, N. Rukhshi, R. Koutarapu, A. Astigarraga, O. Isabella & H. Ziar
TU Delft, The Netherlands

**3DO.16.4** **A Measure for PV Module Performance under Partial Shading and Its Application to CIGS and cSi Technologies for Realistic Shading Scenarios**
J. Moereke, S. Grünsteidl, P. Borowski & T. Dalibor
Avancis, Munich, Germany

**3DO.16.5** **Improvements in the Acquisition of Daylight Electroluminescence Images Using High Speed Cameras: Comparison of Square and Sinusoidal Waves Excitations**
C. Terrados, D. González Francés, J. Anaya, V. Gómez-Alonso, M.A. González & O. Martínez
University of Valladolid, Spain

**3DO.16.6** **Quantifying the Impact of Solar Variation on Daylight Electroluminescence-Imaging**
T. Kari, G.A. dos Reis Benatto, R. del Prado Santamaría & S.V. Spataru
DTU, Roskilde, Denmark

**VISUAL PRESENTATIONS 2DV.1**

**08:00 – 10:00 Perovskite-based Tandem Devices**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**ORAL PRESENTATIONS 4DO.2**

**10:30 – 12:00 Agrivoltaics: Advances in Design, Modelling and Performance Analysis**

**Chairpersons:**

Ioannis (John) Tsanakas
CEA, Le Bourget-du-Lac, France

Miriam Di Blasi *(i)*
Enel Green Power, Rome, Italy

**4DO.2.1 Agrivoltaic Approaches to Minimize Light Competition between Plants and Solar Cells**
C. Honsberg
Arizona State University, Tempe, USA
G. Barron-Gafford
University of Arizona, Tucson, USA
R. Sampson
Pegasus Technologies, Phoenix, USA
S.G. Bowden
Solestial Solar, Tempe, USA

**4DO.2.2 Comparison of Different AgriPV Layouts in Terms of Photovoltaic Energy Yield Output**
H. Sánchez Ortiz, S. Dittmann & C. Meza
Hochschule Anhalt University of Applied Sciences, Köthen, Germany
R. Gottschalg
Fraunhofer CSP, Halle, Germany

**4DO.2.3 3D Modelling of Light-Sharing Agrivoltaic Systems for Orchards, Vineyards and Berries**
I. El Boujdaini, J.R. Bueno & J. Leloux
LuciSun, Villers-la-Vill, Belgium
R. Bruhwyler & F. Lebeau
University of Liège, Gembloux, Belgium
B. Sarr
LuciSun, Villers-la-Ville, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, USA

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**4DO.2.4 Optimal PV Array Layout of Agrivoltaic Systems Based on Vertical Bifacial PV Modules**
R. Arena, S. Aneli, A. Gagliano & G.M. Tina
University of Catania, Italy

**4DO.2.5 Field Results and Simulation of a New Generation Dynamic Agrivoltaic Solution**
M. Duchemin, G. Nardin & M. Ackermann
Insolight, Renens, Switzerland
D. Petri, J. Levrat, D. Chudy, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland
M. Baumann, J.N. Widmer, B. Christ, A. Ançay & C. Carlen
Agroscope, Conthey, Switzerland

**4DO.2.6 SYMBIOSYST: From the Design to the Implementation, a Symbiosis Where PV and Agriculture Can Have a Mutually Beneficial Relationship**
D. Moser
Eurac Research, Bolzano, Italy
M. Thalheimer
Laimburg, Vadena/ Ora, Italy
A. Scognamiglio
ENEA, Portici, Italy
P. Vullo
Farmer's Union of South Tyrol, Bolzano, Italy
G. Demofonti
Valmont Solar, Rome, Italy
H. Häberlein
Aleo Solar, Prenzlau, Germany
M. Macarulla
Polytechnic University of Catalonia, Barcelona, Spain
A.S.H. van der Heide
imec, Genk, Belgium
H. Ziar
Delft University of Technology, The Netherlands
J. Moschner
KU Leuven, Belgium
A. Pignatelli
EF Solare Italia, Trento, Italy
J. Macdonald
ENGIE Laborelec, Linkebeek, Belgium
N. Groen
KUBO Greenhouse Projects, Monster, The Netherlands
J. Leloux
LuciSun, Sart-Dames-Avelines, Belgium
M.G. Chowdhury
3E, Brussels, Belgium
J. Porter
Above Surveying, Colchester, United Kingdom
S. van Overbeek
PHYSEE, Delft, The Netherlands
P. Picchi
ETA Florence, Italy

## ORAL PRESENTATIONS 2DO.7

**10:30 – 12:00 CIGS and Related Materials, Buffer Layers and Interfaces**

**Chairpersons:**

Romain Carron
EMPA, Dübendorf, Switzerland

Invited

**2DO.7.1 Double Buffer Layer for over 15%-Efficient Wide Bandgap Cu(In,Ga)Se2 Solar Cells**
Y. Yao, Y. Liu, J. Ma, X. Yang, F. Liu, Z. Zhou, Y. Sun & W. Liu
Nankai University, Tianjin, China

**2DO.7.2 Comparison and Assessment of ALD-ZnMgO, ZnSnO and ZnTiO as CdS-Free Buffer Layers in Cu(In,Ga)Se2 Solar Devices**
D. Bagrowski, S. Spiering, N. Krämer, T. Helder, M. Zinßer,
T. Magorian Friedlmeier & J.-P. Becker
ZSW, Stuttgart, Germany

**2DO.7.3 Student Awards Finalist Presentation: Industrial Compatible Methodologies for Composition Assessment in Zn(O,S) Thin Films by Means of Raman Scattering Spectroscopy**
V. Rotaru, A.J. Lopez-Garcia, G. Alvarez, A. Pérez-Rodríguez,
V. Izquierdo Roca & M. Guc
IREC, Sant Adrià del Besòs, Spain
D. Hariskos
ZSW, Stuttgart, Germany

**2DO.7.4 The Path to 20 % Aperture Efficiency of CIGSSe 30x30 cm² Laminated Modules with Cd-Free Sputtered ZnOS Buffer Layer**
M. Stölzel, H. Aboulfadl, H. Elanzeery, S. Oueslati, A. Lomuscio,
D. Helmecke, J. Röder, C. Schubbert, J. Moereke, S. Grünsteidl, M. Hála,
P. Borowski, P. Eraerds & T. Dalibor
AVANCIS, Munich, Germany

**2DO.7.5 Voc Advantage of Zn(O,S) Buffer over CdS in Low-Gap (Ag,Cu)(In,Ga)Se2**
R. Gutzler, A. Kanevce, D. Hariskos, J.-P. Becker & S. Paetel
ZSW, Stuttgart, Germany

**2DO.7.6 Chemical Bath Deposition of Zn1-xSnxOy Films as Buffer Layers for Cd-Free Cu(In,Ga)Se2 Solar Cells**
D.A. Garzon & S. Sadewasser
INL, Braga, Portugal
C. Rossi, F. Soggia & D. Colombara
University of Genova, Italy

Thursday, 21 September 2023

## ORAL PRESENTATIONS 4DO.12

**10:30 – 12:00 Design and Optimisation of Bifacial PV Systems**

**Chairpersons:**

Daniel Mugnier *(i)*
Planair, Villeurbanne, France

Invited

**4DO.12.1 Albedo and the Performance of Bifacial Modules in Fixed Mounted Structures at Utility Scale Sites**
L. Rodrigues & C. Buckland
Lightsource, London, United Kingdom

**4DO.12.2 IEA PVPS Task 13 Techno-Economic Study of Bifacial Photovoltaic Systems on Single Axis Trackers**
J.S. Stein & D Riley
Sandia National Laboratories, Albuquerque, USA
G. Maugeri
RSE, Milano, Italy
S. Ovaitt
NREL, Golden, USA
N. Riedel-Lyngskær & J. Vedde
European Energy, Søborg, Denmark

**4DO.12.3 Quantifying the Bifacial Gain Improvement under Optimized Mounting Systems: Comparison of Experimental and Simulated Data**
D. Berrian & J. Linder
Belectric, Kolitzheim, Germany

**4DO.12.4 Optimizing Vertically Oriented Solar PV in Northern Climates**
C. Pike
University of Alaska Fairbanks, USA
D.S. Riley & L. Burnham
Sandia National Laboratories, Albuquerque, USA

**4DO.12.5 Photovolatic and Green Roof –Enery Yield per Area of Vertically Installed Bifacial Moduls in Dense Arrangements**
H. Nussbaumer, R. Hiltebrand, S. Pfyffer & M. Klenk
ZHAW, Winterthur, Switzerland

**4DO.12.6 Quantifying Sources of Electrical Mismatch in Bifacial Systems**
K.R. McIntosh, M.D. Abbott & B.A. Sudbury
PV Lighthouse, Coledale, Australia

## ORAL PRESENTATIONS 3DO.17

**10:30 – 12:00 Advances in Cell Interconnections**

**Chairpersons:**

Silvia Maria Pietralunga *(i)*
CNR, Rome, Italy

Antonin Faes
CSEM, Neuchâtel, Switzerland

**3DO.17.1 Towards Silver Consumption Reduction in HJT Modules Using ECA Bonding and Soldering**
R. Monna, C. Lucas, G. Rey, V. Barth, B. Hladys, J. Jourdan, F. Pernoud & E. Voroshazi
CEA, Le Bourget-du-Lac, France
X. Hernandez & J.-P. Aguerre
Mondragon Assembly, Aretxabaleta, Spain

**3DO.17.2 Reliable Interconnections of Long PV Strings by Using Aluminum Foil: a Step Towards Full Automation of FoilMet Interconnect Shingling**
J. Paschen, A. Brand, O. John, G. Emanuel & J. Nekarda
Fraunhofer ISE, Freiburg, Germany

**3DO.17.3 The Effects of Increasing Filler Loading on the Contact Resistivity of Interconnects Based on Silver Epoxide Conductive Adhesives and Silver Metallization Pastes**
M. Ignacia Devoto Acevedo, K. Wienands, D. Rudolph, A. Halm & D. Tune
ISC Konstanz, Germany
R. Wells
Nagase ChemteX America LLC, Delaware, USA
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

**3DO.17.4 Student Awards Finalist Presentation: Impact of String Connection and Contact Degradation on Electrical Current Distribution on Solar Cell and Photovoltaic Module Level: a Magnetic Field Imaging Validated Model**
A. Tummalieh, M. Mittag, D. Yucebas, L. Schäfer & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany
R. Quay
University of Freiburg, Germany

**3DO.17.5 On the Characterization and Validation of Accurate Contact Resistances for Sustainable Industrial Solar Modules**
B. Sesli, J. Sala, T. Borgers, M. Meuris, J. Poortmans, M. Daenen & B. Vermang
UHasselt - IMO IMOMEC, Genk, Belgium

**3DO.17.6 Local Resolution of Currents through Electrical Joints Consisting of Materials with Different Conductivity**
S. Grosser, M. Pander, U. Zeller & B. Jaeckel
Fraunhofer CSP, Halle (Saale), Germany

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## VISUAL PRESENTATIONS 5DV.2

**10:30 – 12:00 Energy System Integration; Resilience and Security of Supply; Solar Fuels, Storage / Sustainability and Recycling of Photovoltaics**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 4DO.3

**13:30 – 15:00 Floating PV**

**Chairpersons:**

Thomas Reindl
NUS, Singapore

Invited

**4DO.3.2 Quantifying Module Level Stressors in Floating PV Systems**
T. Kjeldstad, D. Lindholm, C. Seiffert, N. Roosloot, H. Fjær, S. Brattheim, E.S. Marstein, J.H. Selj & G. Otnes
Institute for Energy Technology, Kjeller, Norway
F. Clayer
Norwegian Institute for Water Research, Oslo, Norway

**4DO.3.3 Towards Light-Weight and Mechanically Durable Photovoltaic Modules for Floating Applications**
N. Kyranaki, P. Nivelle, M. Casasola Paesa, R. De Jong, A.S.H. van der Heide, I. Kaaya, S. Bouguerra & M. Daenen
UHasselt - IMO IMOMEC, Diepenbeek, Belgium
L. Spannan & J. Moschner
KU Leuven, Belgium

**4DO.3.4 Student Awards Finalist Presentation: Modeling and Validation of Heat Transfer Effects in Floating PV Systems**
M. Nicola, M. Berwind & S. Wieland
Fraunhofer ISE, Freiburg, Germany

**4DO.3.6 Offshore Floating PV DC and AC Yield Analysis Considering Wave Effects**
A. Alcañiz, N. Monaco, O. Isabella & H. Ziar
TU Delft, The Netherlands

## ORAL PRESENTATIONS 2DO.8

**13:30 – 15:00 CIGS and Related Materials, Device Concepts and Stability**

**Chairpersons:**

Marika Edoff
Uppsala University, Sweden

Invited

**2DO.8.1 Chalcogenide Thin Film Materials for Tandem PV: Present and Future**
B. Vermang
imec, Genk, Belgium

**2DO.8.2 Verification of Large Area GaAs//CuIn1-yGaySe2-Based Multijunction Solar Cells Using Modified Smart Stack Technology**
K. Makita, Y. Kamikawa, H. Mizuno, R. Oshima, Y. Shoji, S. Ishizuka & T. Sugaya
AIST, Tsukuba, Japan
T. Takamoto
Sharp, Nara, Japan

**2DO.8.3 Analysis of EBIC Time Variation with VSe–VCu Vacancy Complex in Cu(In, Ga)Se2 Solar Cells**
R. Fukuda, T. Nishimura & A. Yamada
Tokyo Institute of Technology, Japan

**2DO.8.4 Analysis of the Early-Stage of Reverse Bias Defects in CIGS Solar Cells**
A. Gerber, T.S. Vaas, S. Nofal, M. Hülsbeck, C. Zahren, B.E. Pieters & U. Rau
Forschungszentrum Jülich, Germany

**2DO.8.6 Study of Uniqueness of Highly Flexible CIGS Solar Cells on Mica Substrate of One Step Deposition Process**
M. Syabriyana, P.-Y. Huang & C.-H. Lai
NTHU, Hsinchu, Taiwan

## PANEL DISCUSSION DO.13

**13:30 – 15:00 Securing a Diverse and Resilient Supply Chain**

*The aim of this round table is to serve as an exchange session promoting the active discussion among key panellists and with the audience on hot topics on a particular theme(s). The detailed programme of this session will be available very soon.*

Thursday, 21 September 2023

## ORAL PRESENTATIONS

**13:30 – 15:00 NEWS**

## VISUAL PRESENTATIONS 5DV.3

**13:30 – 15:00 PV Deployment: Realising the Full Potential of PV in Various Markets and World Regions / Markets, Cost, Economics of PV / Energy Communities and PV Capacity Building**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

## ORAL PRESENTATIONS 4DO.4

**15:15 – 16:45 Transport / Vehicle Integrated Photovoltaics (VIPV)**

**Chairpersons:**

Bonna Newman *(i)*
Lightyear, Helmond, The Netherlands

Roland M. E. Valckenborg
TNO, Eindhoven, The Netherlands

**4DO.4.1 Analysis of Climate Conditions Upon the Driving Distance of Photovoltaics-Powered Vehicles**
M. Yamaguchi, K. Nakamura, R. Ozaki, N. Kojima & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
T. Masuda, T. Nakado, K. Yamada, K. Okumura & A. Satou
Toyota Motor, Susono, Japan
T. Tanimoto & Y. Tomita
Nissan Motor, Yokosuka, Japan
Y. Ota, K. Araki & K. Nishioka
University of Miyazaki, Japan
C. Thiel, A. Tsakalidis & A. Jäger-Waldau
European Commission JRC, Ispra, Italy
T. Takamoto
Sharp, Nara, Japan
Y. Zushi
Miyazaki University, Japan

**4DO.4.2** **I-V Curve Simulation of Curved PV Modules for Vehicle Integration under Various Irradiation Conditions**
F. Mujovi, J. Levrat, A. Faes, P. Duvoisin, S. Prabhudesai, G. Cattaneo, L. Jacques & M. Despeisse
CSEM, Neuchâtel, Switzerland
C. Ballif
EPFL, Neuchâtel, Switzerland
G. Arnoux, N. Bassi & R. Ambigapathy
Pasan, Neuchâtel, Switzerland

**4DO.4.3** **Solar Energy Harvesting for a Custom Sailing Yacht, a Case Study for Project Zero**
A. Krul & E. Shirazi
University of Twente, Enschede, The Netherlands
H. Wieggers
Vitters Shipyard, Zwartsluis, The Netherlands

**4DO.4.4** **Systems Analysis of an Onboard PV System on a Demonstrator Light Commercial Vehicle**
N. Patel, K. Bittkau, B.E. Pieters, E. Sovetkin & K. Ding
Forschungszentrum Jülich, Germany
R. Peibst & H. Fischer
ISFH, Emmerthal, Germany
A.H.M.E. Reinders
Eindhoven University of Technology, The Netherlands

**4DO.4.5** **Stress Tolerance of Novel, Lightweight, Curved PV Modules for Vehicle Integration**
K. Kleber, S. Prabhudesai, G. Cattaneo, L. Jacques, F. Mujovi, M. Despeisse, A. Faes & C. Ballif
CSEM, Neuchâtel, Switzerland
J. Robin & V. Leite
Simoldes Plastics, Oliveira de Azémis, Portugal
J. Silva
CEiiA, Matosinhos, Portugal
U. Desai
EPFL, Neuchâtel, Switzerland

**4DO.4.6** **In with the Electrons, out with the Heat: Evaluation of a Spectrally-Selective Foil in Sunroof-Integrated PV**
A. Bakovasilis, J. Govaerts, A. Tuomiranta & A. van der Heide
imec, Genk, Belgium
K. Strijckmans
GroupMAM, Zele, Belgium
G.H. Yordanov
EnergyVille, Genk, Belgium

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## ORAL PRESENTATIONS 2DO.9

**15:15 – 16:45** **III-V and Related Compound Semiconductors**

**Chairpersons:**

Gianluca Timò
RSE, Milan, Italy

Rüdiger Löckenhoff
Azur Space, Heilbronn, Germany

**2DO.9.1** **HVPE-Grown GaInP/GaInAsP Dual-Junction Solar Cells for Two-Terminal III-V//Si Triple-Junction Structures**
Y. Shoji, R. Oshima, K. Makita & T. Sugaya
AIST, Tsukuba, Japan
A. Ubukata & S. Koseki
TNSC, Minato City, Japan

**2DO.9.2** **III-V//Si Triple-Junction Solar Cell with GaInAsP-Rear-Heterojunction Middle Cell**
P. Schygulla, R. Müller, O. Höhn, M. Schachtner, D. Chojniak, M. Klitzke, B. Bläsi, F. Dimroth & D. Lackner
Fraunhofer ISE, Freiburg, Germany
A. Cordaro & A. Polman
AMOLF, Amsterdam, The Netherlands

**2DO.9.3** **Low-Cost Front Metallization for High-Efficiency III-V-on-Silicon Tandem Solar Cells**
J. Schube, O. Höhn, M. Jahn, G. Mikolasch, F. Predan, J. Bartsch & R. Keding
Fraunhofer ISE, Freiburg, Germany

**2DO.9.4** **Gallium Nanoparticles as Antireflection Coating for III-V Solar Cells**
S. Catalán-Gómez, M. Martinez Castellano, A. Gallego Carro, A. Gonzalo, L. Dorado Vargas, A. Perez Fernandez, A. Hierro & J.M. Ulloa
UPM, Madrid, Spain
A. Redondo-Cubero
UAM, Madrid, Spain

**2DO.9.5** **Approaches for III-V/Si Tandem Solar Cells and Comparative Studies on Si Tandem Solar Cells**
M. Yamaguchi, K. Nakamura, R. Ozaki, N. Kojima & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
T. Takamoto
Sharp, Nara, Japan

**2DO.9.6** **Single-Junction Bifacial Sb2(S,Se)3 Solar Cells**
C. Qian, K. Sun, M.A. Green, B. Hoex & X. Hao
UNSW, Sydney, Australia

## ORAL PRESENTATIONS 5DO.14

**15:15 – 16:45 Circularity and Recycled Material Supply of PV**

**Chairpersons:**

Karsten Wambach
Wambach-Consulting, Petersdorf, Germany

Paula Sánchez-Friera
Solkeys, Gijón, Spain

**5DO.14.1 Low-Carbon Manufacturing Increases Climate Benefit of Renewables, by up to 75% for Photovoltaics**
D. Ravikumar & G. Heath
NREL, Golden, USA

**5DO.14.2 Towards a Recyclability Index for Photovoltaic Modules: Methodology, Challenges and Policy Implications**
D. Polverini
European Commission DG GROW, Brussels, Belgium
F. Alfieri, C. Spiliotopoulos & A. Arcipowska
European Commission JRC, Sevilla, Spain

**5DO.14.3 Evaluating the Impact of Reshoring and Friendshoring on PV Material Supply Risks**
E. Gervais & S. Nold
Fraunhofer ISE, Freiburg, Germany
R. Kleijn & E. van der Voet
Leiden University, The Netherlands

**5DO.14.4 A Tool for Sustainable European PV: Case Study with the Silicon Heterojunction Technology**
A. Barrou, L.-L. Senaud, C. Ballif & B. Paviet-Salomon
CSEM, Neuchâtel, Switzerland

**5DO.14.5 Life Cycle Assessment of PV Module Backsheets**
P. de Wild & M. de Wild-Scholten
SmartGreenScans, Groet, The Netherlands
I. Goudswaard
Endurans Solar, Urmond, The Netherlands

**5DO.14.6 Delamination of End-of-Life PV Modules by Controlled Pyrolysis**
V. Iwaszko, F. Marchitto, J. Moenne & G. Chichignoud
ROSI Solar, Saint Martin d'Hères, France

Thursday, 21 September 2023

## ORAL PRESENTATIONS 3DO.18

**15:15 – 16:45 Shingle and Tandem Cell Interconnection and Front Glass Optimisation**

**Chairpersons:**

Invited

Philipp Kratzert
SOLARWATT, Dresden, Germany

**3DO.18.1 Design, Manufacturing and Reliability of Shingle Matrix Modules**
D. von Kutzleben, J. Markert, S. Birnkammer, N. Abdel Latif, T. Rößler, J. Weber, A. Kraft & D.H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

**3DO.18.2 Performance of Electrically Conductive Adhesive with Shingled Si Heterojunction Technology Cells**
P. Hacke & D.C. Miller
NREL, Golden, USA

**3DO.18.3 Improvement Options for PV Modules by Glass Structuring**
M. Hofmann, L. Stevens, P. Hör, P. Barth, B. Bläsi, S. Riepe, S. Kalthoff, B. Kafle, M. Zimmer, M. Mittag & S. Nold
Fraunhofer ISE, Freiburg, Germany
I. Sen
Gebr. Schmid, Freudenstadt, Germany
J. Reck
SENTECH, Berlin-Adlershof, Germany
N. Schröer
ICB, Dahlewitz, Germany
L. Clochard
Nines Photovoltaics, Dublin, Ireland
S. Ihlow & C. Horch
GMB Glasmanufaktur Brandenburg, Tschernitz, Germany

**3DO.18.4 Multifunctional Coatings for Solar Module Glass**
N. Song, N. Chang, Y. Zeng, Y. Jiang, Y. Wu, Z. Zhou, M. Keevers, R. Egan & M. Green
UNSW, Sydney, Australia
A. Gentle
UTS, Sydney, Australia

**3DO.18.5 Bio-Replicating and Artificially Textured Glasses for Maximized Energy Yield in Bifacial and Building-Integrated PV**
D. Yoo, P. Tillmann, K. Jäger & C. Becker
HZB, Berlin, Germany
T. Kraus & H. Hauser
temicon, Freiburg, Germany

**3DO.18.6** **Advanced Understanding of Multi-Terminal Tandems: Potential Efficiency, Interconnection, and Energy Yield**
E. Warren, B. McMahon, R. Witteck & J. Geisz
NREL, Golden, USA

**VISUAL PRESENTATIONS 4DV.4**

**15:15 – 16:45** **Solar Resource Assessment, Modelling and Forecasting / PV System Engineering**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**ORAL PRESENTATIONS 4DO.5**

**17:00 – 18:30** **"PV Everywhere": Infrastructure Integrated Photovoltaics (I2PV) and New Applications**

**Chairpersons:**

Tadanori Tanahashi
AIST, Koriyama, Japan

Angele Reinders
Eindhoven University of Technology, The Netherlands

**4DO.5.1** **Solar for Railways - Investigation of the PV Potential on the German Rail Infrastructure**
M. Herz, A. Sepanski, U. Hupach, B. Schönauer, S. Ulrich & J. van der Weem
TÜV Rheinland Energy, Cologne, Germany

**4DO.5.2** **Photovoltaic Noise Barriers as Energy Generating Infrastructure: Functional Overview about Five Solutions**
J. Forster, G. Tsutzkiridze, C. Herr, J. Huyeng, F. Basler, L.C. Rendler, M. Heinrich & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany
R. Kohlhauer
R. Kohlhauer, Gaggenau, Germany

**4DO.5.3** **New Precision Pressure Point Test Method to Detect Si Cell Breakage in PV Modules – Application to the Solar Road**
M. Vite, P. Messaoudi, R. De Bettignies, D.R. Heslinga & E. Voroshazi
CEA, Le Bourget-du-Lac, France

**4DO.5.4** **Night Time Atmospheric Water Generation on PV Modules - A Novel Method for Generating Water and Electricity from PV Modules**
J.J. John, N. Najeeb & G. Mathiak
DEWA, Dubai, United Arab Emirates

Thursday, 21 September 2023

**4DO.5.5** **URBANBOX the Lightweight Retractable PV Plant**
A. Büchel
iWorks, Ruggel, Liechtenstein
F.P. Baumgartner, R. Fehr, S. Metzger, M. Loup, F. Carigiet & R. Eberlein
ZHAW, Winterthur, Switzerland

**4DO.5.6** **Infrastructure Integrated Photovoltaics: Realization and Validation of PV Panels Integrated in Road Elements and Noise Barriers**
F. Colberts, J. Boumans, C. Mass-Prötzen, E. Hamers, L. Boumans, J. Simons, W. Brand & Z. Vroon
Zuyd University, Heerlen, The Netherlands
A. de Bondt
SolaRoad, Den Haag, The Netherlands
W. van de Wall
Wallvision, Heeze, The Netherlands
A. Kingma & D. Roosen
TNO/Solliance, Eindhoven, The Netherlands

**ORAL PRESENTATIONS 5DO.10**

**17:00 – 18:30** **Acceleration of PV Deployment in Europe and beyond / PV as an Energy Justice Enabler**

**Chairpersons:**

Philippe Malbranche
CEA, Le Bourget-du-Lac, France

Maria Getsiou
European Commission DG RTD, Brussels, Belgium

**5DO.10.1** **Unlocking the Potential of Photovoltaic Energy Communities in the Public Sector: Action for the PV Community**
C. Sanz-Cuadrado, L.M. Carrasco, L. Narvarte & A.B. Cristóbal
UPM, Madrid, Spain
M. Victoria & Z. Zhang
Aarhus University, Denmark
M. Topic & M. Bokalic
University of Ljubljana, Slovenia
A. Cavaco & P.A. Horta
University of Évora, Portugal
A. North
Centre for Sustainable Energy, Bristol, United Kingdom

**5DO.10.2 Shining Light on European BIPV: A Survey of Dependence and Fragmentation in the Emerging European Value Chain for Building Integrated Photovoltaics**
G. Lopez Pinto, F. Ozaras & B. Sandén
Chalmers University of Technology, Göteborg, Sweden
J. Andersson
Uppsala University, Sweden
A. Oller Westerberg
ESMC, Knivsta, Sweden
J. Lindahl
Becquerel Sweden, Knivsta, Sweden

**5DO.10.3 Comparison of BIPV Innovation System Structures in Multiple Countries**
M. van Noord
RISE, Stockholm, Sweden
N. Martín-Chivelet
CIEMAT, Madrid, Spain
M. Tabakovic
UAS Technikum Wien, Vienna, Austria
R. Yang
RMIT University, Melbourne, Australia
O. Bernsen
Netherlands Enterprise Agency, Den Haag, The Netherlands
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
F. Tilli
GSE, Rome, Italy
A. Baggini
University of Bergamo, Pavia, Italy

**5DO.10.4 Development and Piloting of a Novel Decentralized Solar PV Charging System for Sustainable E-Mobility in Rural Africa**
K. Götz, C. Pizzinini & M. Lienkamp
Technical University of Munich, Germany
I.A. Tsanakas
CEA, Le Bourget-du-Lac, France
J. Giliomee, M. Meli, L. Smith, A. Rix & T. Booysen
Stellenbosch University, South Africa
T. Abera
Adama Science and Technology University, Ethiopia

**5DO.10.5 Assessing Energy Access and Poverty in Cities: the Role of PV as Driver for Action**
V. Palermo & M. Pittalis
European Commission JRC, Ispra, Italy

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**5DO.10.6 Photovoltaics and Citizens' Participation as Key Enablers of the Global Warming Mitigation**
S. Caneva & D. Celik
WIP Renewable Energies, Munich, Germany
I. Lizarralde, M. Hamwi & B. Samir
ESTIA Institute of Technology, Cote Basque, France
V. Kromrey & D. Vedel
Bodensee-Stiftung, Radolfzell, Germany
L. Lentzen
Bodensee-Stiftung, Konstanz, Germany
A. Schneller, J. Fjornes & K. Anger
Adelphi, Berlin, Germany
A. De Ferrari & C. Crippa
FONDAZIONE ICONS, Lodi, Italy
E. Denny & I. Petrov
Trinity College Dublin, Ireland
S. Mulero & A. Hernández Serrano
CARTIF, Valladolid, Spain
I. Lacoste
I-ENER, Saint-Jean-Pied-de-Port, France
M. Regidor & R. Ruiz
ENERGETICA, Valladolid, Spain
R. Oliveira & N. Brito
Power Parity, Lisbon, Portugal
K. Harder
Abundance, London, United Kingdom
V. Segon & T. Šimek
REGEA, Zagreb, Croatia
A. Costeniuc
Tractebel Engineering, Munich, Germany

## ORAL PRESENTATIONS 5DO.15

**17:00 – 18:30 Environmental Profile and Life Cycle Analysis**

**Chairpersons:**

Paul de Wild
SmartGreenScans, Groet, The Netherlands

Estelle Gervais
Fraunhofer ISE, Freiburg, Germany

**5DO.15.1 Dynamic LCA of Perovskite-Silicon Tandem PV in Different Market Penetration Scenarios**
C. Polacchi, A. Louwen & D. Moser
Eurac, Bolzano, Italy
C. Cornaro
University of Rome II, Italy

**5DO.15.2 Human Health Risk Assessment for Improper Landfill Disposal of End-of-Life CdTe PV**
E. Kupets & G. Heath
NREL, Golden, USA

**5DO.15.3** **HighLite H2020: Improving the Environmental Profile of High-Performance Low-Cost Modules for a Competitive Manufacturing Industry**
A. Binani, F. Lenzmann, A.W. Weeber & J.C.P. Kester
TNO Energy Transition, Petten, The Netherlands
S. Lindfors & V. Lampinen
Valoe, Mikkeli, Finland
T. Radavicius
SoliTek, Vilnius, Lithuania
T. Regrettier
VOLTEC SOLAR, Dinsheim-sur-Bruche, France
S. Harrison
CEA, Le Bourget-du-Lac, France
L. Tous & I. Gordon
imec, Leuven, Belgium

**5DO.15.4** **Comparing the Carbon Footprint of Future Silicon Photovoltaics Manufacturing in North America and China**
L. Yuan, A. Farina, C. Deng & A. Anctil
Michigan State University, East Lansing, USA

**5DO.15.6** **Progress in Standardisation Concerning the Re-Use of PV Modules**
A. van der Heide
imec, Genk, Belgium
S. Noels & J. Clyncke
PV Cycle, Brussels, Belgium
D.M. Godinho Ariolli & G.O. Hernandez
BayWa r.e. Operation Services, Rome, Italy

## ORAL PRESENTATIONS 3DO.19

**17:00 – 18:30** **Encapsulants, Light-Weight and Eco-Designed Modules**

**Chairpersons:**

Tudor Timofte
ISC Konstanz, Germany

Veronica Bermudez Benito
QEERI, Doha, Qatar

**3DO.19.1** **Techno-Economical Analysis of Biopolymers for Potential Implementation in PV Modules**
S. Feldbacher & G. Oreski
PCCL, Leoben, Austria
K. Resch-Fauster & A. Klein
Montanuniversität Leoben, Austria

**3DO.19.2** **Standardized Cross-Linking Determination Methods Applied to POE Encapsulants in Lamination Recipe Emphasizing**
M. Landa - Pliquet, M. Sérasset, T. Bejat, E. Mofakhami & E. Voroshazi
CEA, Le Bourget-du-Lac, France
A. Auger
CEA, Grenoble, France

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**3DO.19.3** **Challenges for Quality Control Posed by New PV Encapsulation Materials**
S. Lust, N. Schnitzler, A. Brendler, S. Wendlandt & T. Weber
PI Berlin, Germany

**3DO.19.4** **Lightweight Solar Modules Implementing Advanced Polymer Materials and Next Generation Back-Contacted Silicon Heterojunction Solar Cells**
M. Despeisse, H. Li, J. Champliaud, P. Duvoisin, M. Roten, L. Baume, C. Charriere, B. Paviet-Salomon, C. Ballif & L. Barraud
CSEM, Neuchatel, Switzerland
T. Kössler, L. Andreetta & D. Lachenal
Meyer Burger Research, Hauterive, Switzerland

**3DO.19.5** **Light as Heaven, Strong as Hell(?): Testing Honeycomb-Based Laminates for Laminates for Light-Weight C-Si PV Applications**
J. Govaerts, P. Dufke, B. Luo, R. Van Dyck, T. Borgers & J. Poortmans
imec, Genk, Belgium
A. Derluyn, J. Saelens & W. Winant
EconCore, Leuven, Belgium
M. Caliskan Arslan
KalyonPV, Ankara, Turkey
U. Desai, F. Lisco, A. Faes & C. Ballif
EPFL, Neuchâtel, Switzerland
G. Oreski & N. Pervan
PCCL, Leoben, Austria
G. Eder
OFI, Vienna, Austria

**3DO.19.6** **Design for the Environment: HJT Module with Ultra-Low Carbon Footprint**
T. Bejat, A. Boulanger, N. Gazbour, R. Monna, R. Varache, J. Francois, W. Favre, C. Roux, A. Derrier & E. Voroshazi
CEA, Le Bourget-du-Lac, France

## VISUAL PRESENTATIONS

**17:00 – 18:30** **POSTER AWARDS WINNERS SESSION**

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.*

**Friday, 22 September 2023**

## ORAL PRESENTATIONS 3EO.1

**08:30 – 10:00 Innovations in PV Modules and BOS Components**

**Chairpersons:**

Miguel-Ángel Muñoz-Garcia
UPM, Madrid, Spain

Invited

**3EO.1.1 Novel Asynchronous Shade Detection Algorithms for Reconfigurable PV Modules**
M.R. Vogt, D. Salokhe, A. Calcabrini, M. Muttillo, O. Isabella, R. Santbergen & P. Manganiello
Delft University of Technology, The Netherlands

**3EO.1.2 PV Microinverters: Latest Efficiency Rankings, Energy Yield Assessments, Firmware Issues**
S. Krauter & J. Bendfeld
Paderborn University, Germany

**3EO.1.3 Medium Voltage String Inverter for Future Utility-Scale PV Power Plants**
M. Geiss, A. Hensel, D. Derix, J. Thoma & D. Kranzer
Fraunhofer ISE, Freiburg, Germany

**3EO.1.4 Evaluation of Horizontal Single-Axis Sun Tracker Algorithms in Terms of Energy Production and Operational Performance**
I. Munoz, A. Guinda, L. Casajùs, G. Olivares, S. Diaz & A. Gracia Amillo
CENER, Sarriguren, Spain

**3EO.1.5 Student Awards Finalist Presentation: Combined Fabrication of IBC TOPCon PV Cells and Lateral Power MOSFETs on a Single c-Si Substrate**
D.A. van Nijen, T. Stevens, Y. Mercimek, G. Yang, R.A.C.M.M. van Swaaij, M. Zeman, O. Isabella & P. Manganiello
Delft University of Technology, The Netherlands

**3EO.1.6 Effect of Wind Turbine Induced Shadow Flicker on the Reliability of IGBTs in PV Converters in Hybrid Wind-Solar Systems**
L. Van Cappellen & M. Daenen
IMO-IMOMEC, Diepenbeek, Belgium
M. Deckers
Energy Ville, Genk, Belgium

Friday, 22 September 2023

## ORAL PRESENTATIONS 4EO.2

**08:30 – 10:00 Managing the Variability of PV Power on Different Scales / Concentrators and Space Applications**

**Chairpersons:**

Stephen Taylor
European Space Agency, Noordwijk, The Netherlands

Ignacio Antón *(i)*
UPM, Madrid, Spain

**4EO.2.1 A Reinforcement Learning HEMS Strategy for Residential PV+battery Self-Consumption Systems**
C. Crespo & M Centeno Brito
University of Lisbon, Portugal

**4EO.2.2 Smoothing of Power Output Fluctuations in Three Utility Scale PV Plants Located in Different Continents**
J. Lehmann & Q. van Nieuwenhoven
ENGIE Laborelec, Linkebeek, Belgium

**4EO.2.3 Controlling Pools of PV and Wind Power Plants Connected to the Distribution Grid to Provide Local Ancillary Services**
A. Oudjedi & V. Krakowski
HESPUL, Lyon, France

**4EO.2.4 Application of Nowcasting to Reduce the Impact of Irradiance Ramps on PV Power Plants**
J. Schaible, K. Jäger & C. Becker
HZB, Berlin, Germany
B. Nouri & N. Blum
DLR, Almería, Spain
T. Kotzab & M. Loevenich
DLR, Stuttgart, Germany
A. Hammer
DLR, Oldenburg, Germany
S. Wilbert
DLR, Almeira, Spain

**4EO.2.5 (Al)InGaP Structures for Luminescent Concentrators**
E. Achilli, M. Calicchio, N. Armani, F. Annoni, M. Cornelli, E. Malvisi, F. Trespidi, A. Minuto, E. Celi, G. Abagnale, S. Rizzi & G. Timò
RSE, Piacenza, Italy

**4EO.2.6 Effect of Electron and Proton Radiation on Ultra-Thin GaAs Solar Cells with Different Doping Concentrations**
A. Barthel, L. Sayre & L.C. Hirst
University of Cambridge, United Kingdom
S. Sato & T. Ohshima
QST, Takasaki, Japan

## ORAL PRESENTATIONS 5EO.3

**08:30 – 10:00 Markets for PV Systems and New Manufacturing**

**Chairpersons:**

Michael Woodhouse
NREL, Golden, USA

Invited

**5EO.3.1 A Snapshot of the Global PV Market - 2022**
G. Masson
IEA PVPS, Brussels, Belgium
A. Jäger-Waldau
European Commission JRC, Ispra, Italy
I. Kaizuka
RTS Corporation, Chuo-ku, Japan
J. Lindahl
Becquerel Sweden, Knivsta, Sweden
J. Donoso
UNEF, Madrid, Spain

**5EO.3.2 Enabling Firm Renewable Power Generation the Critical Importance of Timing**
M. Perez
Clean Power Research, Napa, USA
R. Perez
State University of New York, Albany, USA
J. Remund
Meteotest, Bern, Switzerland
T. Hoff
State University of New York, USA
M. Pierro
Eurac Research, Bolzano, Italy

**5EO.3.3 Attractiveness of PV Prosumerism in the European Electricity Market**
E. Vartiainen
Fortum Renewables, Finland
C. Breyer
LUT University, Lappeenranta, Finland
D. Moser
Eurac Research, Bolzano, Italy
E. Román Medina
Tecnalia, Derio, Spain
C. Busto
Eni, Novara, Italy
M. Topic
University of Ljubljana, Slovenia
D. Mugnier
PLANAIR, Perpignan, France

Friday, 22 September 2023

**5EO.3.4 The Role of Digital Operation Technology for Photovoltaic Mini-Grids in Sub-Saharan Africa: Impact and Benefits of Advanced Remote Monitoring Systems**
M. Pittalis, S. Szabó & M. Moner Girona
European Commission JRC, Ispra, Italy
A. Sancho
Trama TecnoAmbiental, Barcelona, Spain
M. Zopoulou
SE4ALL, Vienna, Austria

**5EO.3.5 Re-Establishing a PV Ecosystem in Europe**
P. Fath, W. Jooss, M.C. Raval, J. Reichle & H. Gross
RCT Solutions, Konstanz, Germany
R. Harney, R. Kopecek & J. Libal
ISC Konstanz, Germany
J. Trube & P. Baliozian
VDMA, Frankfurt am Main, Germany

**5EO.3.6 Prospective Techno-Economic Analysis of 4T and 2T Perovskite on Silicon Tandem Photovoltaic Modules at GW-Scale Production**
M. Hull, L. Oberbeck, J. Rousset & V.-S. Nguyen
IPVF, Palaiseau, France

## PLENARY SESSION EP.1

**10:30 – 12:00 Enabling Multi Terawatt PV Deployment: Technical and Social Dimensions**

**Chairpersons:**

Invited

Invited

**5EP.1.1 Using On-Line PV Inverter Measurements to Determine the Hosting Capacity of Distribution Grid**
N. Etherden
Vattenfall R&D/ Luleå University of Technology, Stockholm, Sweden
M. Alhamwi
Luleå University of Technology, Skelleftea, Sweden

**5EP.1.2 Roofs, Roads, Reservoirs - The Potential for Applied PV in Europe**
G. Kakoulaki, D. D'Agostino, C. Maduta & R.P. Kenny
European Commission JRC, Ispra, Italy

**5EP.1.3 Collective Self-Consumption: The Next Step in PV Prosuming Policy to Foster Citizen Engagement?**
W.L. Schram
University of Twente, Enschede, The Netherlands
L.R. Visser & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

**5EP.1.4** **Invited**

**5EP.1.5** **Photovoltaics at Multi Terawatt Scale: Waiting is not an option**
N.M. Haegel
NREL, Golden, USA

**12:10 – 13:10 CONFERENCE CLOSING**

Highlights of the Conference week, Key note, Winners of Student Awards, Ceremony of Poster Awards



**VISUAL PRESENTATIONS**

**Monday, 18 September 2023**

**VISUAL PRESENTATIONS 3AV.1**

**13:30 – 15:00 PV Module Design and Manufacturing/ Electronic Systems for BOS**

**3AV.1.1** **Computational Simulation and Experimental Verification of Non-Destructive Testing of Encapsulant Cross-Linking in Photovoltaic Modules**
M. Pander, M. Wendt, P. Wessel, A. Mordvinkin & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
E. Malguth, J. Hepp, A. Adrian & C. Camus
LayTec, Berlin, Germany

**3AV.1.2** **Results and Sensitivity Assessments from a Cross-Technological Round-Robin Verification of Destructive and Non-Destructive Test Methods for Determining the Degree of Cross-Linking of Photovoltaic Module Encapsulants**
C. Camus, A. Adrian, J. Hepp & E. Malguth
LayTec, Berlin, Germany
A. Linsenmeyer
Sunset Energietechnik, Adseldorf, Germany
S. Lust
PI Photovoltaik-Institut Berlin, Germany
A. Mordvinkin & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
R. Schüler
IBC Solar, Bad Staffelstein, Germany
P. Wessel
Hochschule Anhalt, Köthen, Germany

**3AV.1.3** **Structured Backside Glass for Improved Efficiency in Solar Modules**
L. Stevens, B. Bläsi & M. Mittag
Fraunhofer ISE, Freiburg, Germany
C. Horch & S. Ihlow
GMB Glasmanufaktur Brandenburg, Tschernitz, Germany

**3AV.1.4** **Intermetallic Phase Growth and Microhardness of Sn42Bi58 Solder Joints on Silicon Solar Cells**
D. Güldali, A. De Rose & A. Kraft
Fraunhofer ISE, Freiburg, Germany
S. Oeser
Fraunhofer IWM, Freiburg, Germany
U. Tetzlaff
THI, Ingolstadt, Germany

**3AV.1.5** **Temperature Distribution during the Lamination Process of PV Modules and Its Influence on the Degree of Cross-Linking for EVA and POE Simulation vs Test Results**
A.K. Öz, J. Vasani, C. Reichel, C. Wellens & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

**3AV.1.6** **Development of a Novel Non-Destructive Lamination Control of PV Modules using Magnetic Resonance Sensors**
A. Mordvinkin & P. Wessel
Fraunhofer CSP, Halle (Saale), Germany

**3AV.1.7** **Thermomechanical Reliability Study of Thermoplastic Foil-Foil Lightweight Photovoltaic Modules**
D. Habans, E. Mofakhami & A. Derrier
CEA, Le Bourget-du-Lac, France
J.-L. Bouvard & N. Billon
MINES Paris, Sophia Antipolis, France

**3AV.1.8** **IBC4EU Project - Piloting Novel Cost-Competitive Bifacial IBC Technology for Vertical Integrated European GW Scale PV Production Value Chain**
F. Buchholz, D. Tune, T. Messmer & J. Linke
ISC Konstanz, Germany
J. Ulbikas
Protech, Vilnius, Lithuania
C. Rohr
NorSun, Oslo, Norway
D. Kujik
Energyra, Westknollendam, The Netherlands
D.W.K. Eikelboom, L. Hirvonen, F. Fabris & A. Barin
FuturaSun, Cittadella, Italy
T. Borgers, R. Van Dyck & H. Sivaramakrishnan Radhakrishnan
imec, Genk, Belgium
S. Harrison & T. Bejat
CEA, Le Bourget-du-Lac, France
J.M. Kroon
TNO, Petten, The Netherlands
V. Mertens & T. Dullweber
ISFH, Emmerthal, Germany
I. Rosen
COPPRINT, Jerusalem, Israel
W. Palitzsch
LuxChemtech, Freiberg, Germany
Y. Zaror & I. Weiss
WIP Renewable Energies, Munich, Germany
P. Lukinskas & J. Denafas
Valoe Cells, Vilnius, Lithuania
T. Vanhanen & T. Savisalo
Valoe, Mikkeli, Finland
M. Pospischil & T. Müller
HighLine Technology, Freiburg, Germany
O. Coskun
KalyonPV, Ankara, Turkey
P. Macé
Becquerel Institute, Brussels, Belgium
H. Minamiyama
Toyal, Osaka, Japan

**3AV.1.9** **Analysis of Optical Coupling Gains from Cell Interconnection Ribbons for the Energy Rating of PV Modules**
A. Protti, A. Welpulwar, J. Shahid & M. Mittag
Fraunhofer ISE, Freiburg, Germany

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**3AV.1.10** **Laser Structuring and Wet Chemical Etching for Anti-Glare Properties of Photovoltaic Module Glass**
L. Bienkowski, M. Hofmann, M. Zimmer, J. Willmann, B. Bläsi, A. Brand & J.-F. Nekarda
Fraunhofer ISE, Freiburg, Germany
B.-U. Sander, M. Schneider & C. Schmitt
RENA, Gütenbach, Germany

**3AV.1.11** **Development of a Non-Isothermal Curing Kinetics Model for Encapsulants in PV Modules**
G. Riedl, M. Wolfslehner & G.M. Wallner
University of Linz, Austria

**3AV.1.12** **Honeycomb Structures as Backsheets for Light Weight PV Modules**
N. Pervan, G. Oreski & N.M. Hochrainer
PCCL, Leoben, Austria
Y. Voronko & G.C. Eder
OFI, Vienna, Austria
F. Lisco & D. Bhupatrai
EPFL, Neuchâtel, Switzerland
A. Derluyn
EconCore, Heverlee, Belgium
B. Luo
KU Leuven, Belgium
J. Govaerts
imec, Genk, Belgium

**3AV.1.13** **Measurement of Encapsulant Thermal Expansion: Impact of Residual Stresses**
V. Meslier & B. Chambion
INES, Le Bourget-du-Lac, France
J.-L. Bouvard & P.O. Bouchard
CEMEF, Sophia-Antipolis, France

**3AV.1.14** **Flexible Transparent Polymeric Front Encapsulation as Finish Layer for CIGS PV Cells Using Additive Manufacturing**
S. Feldbacher, N. Pervan & G. Oreski
PCCL, Leoben, Austria
M. Harnisch, T. Tettenborn & A. Zimmermann
Sunplugged, Wildermieming, Austria

**3AV.1.15** **Crack Analysis of Interconnect-Shingled Half-Cell Solar Modules**
C. Xu, B. Wolpensinger, I. Kunze, H. Schulte-Huxel & M. Köntges
ISFH, Emmerthal, Germany

**3AV.1.17** **Design of Distributed Bragg Reflectors for Highly Transparent Photovoltaic Modules**
Y. Kim, M. Shin & M.-J. Lee
Korea Aerospace University, Goyang, Republic of Korea
G. Kang & H. Ko
KIST, Seoul, Republic of Korea
J.-D. Kwon
KIMS, Changwon, Republic of Korea

**3AV.1.18** **Long-Term Stability of Transparent Polypropylene Backsheets**
E. Helfer, J. Petro, M. Lang & G. Oreski
PCCL, Leoben, Austria
I. Devoto & A. Halm
ISC Konstanz, Germany
M. Klenk
ZHAW, Winterthur, Switzerland

**3AV.1.19** **Simulation of Heat Flow and Novel Manufacturing Design of PVT Modules**
R. Koepge, P. Sheela & H. Schwabe
Fraunhofer CSP, Halle (Saale), Germany

**3AV.1.20** **Bifacial Module Characterization Analysis with Current Mismatched Cells**
S. Hwang, H.-S. Lee & Y. Kang
Korea University, Seoul, Republic of Korea
D. Suh
Hoseo University, Chungnam, Republic of Korea

**3AV.1.22** **Solder Pastes in Shingled Modules**
K. Wienands, J. Stanulla, E. Kurtovic, A. Halm & D. Tune
ISC Konstanz, Germany
N. Kopp & C. Hallensleben
TAMURA ELSOLD, Ilsenburg (Harz), Germany

**3AV.1.23** **New Developments of Black Backsheets with Improved Reflectivity and Circular Economy**
A. Anderlini
Coveme, San Lazzaro di Savena, Italy

**3AV.1.24** **Performance Optimization of Shingled modules**
D. Tune, K. Wienands, J. Stanulla, R. Farneda, E. Kurtovic & A. Halm
ISC Konstanz, Germany

**3AV.1.25** **Honeybee Hive Structured 3D Concave Photovoltaic Modules Supported by 3D Mechanical Metamaterials Enhanced Light Recapturing Effect**
M.J. Yun, Y.H. Sim, D.Y. Lee & S.I. Cha
KERI, Changwon, Republic of Korea

**3AV.1.26** **A "New" PV Generator at the IES-UPM with Bifacial PV Modules Manufactured in 1987**
F. Martinez-Moreno, P. Merodio & E. Lorenzo
IES-UPM, Madrid, Spain

**3AV.1.27** **Cell/Module Integration Process Using Electrode Sheet**
D. Lim
Korea National University of Transportation, Chungju, Republic of Korea

**3AV.1.28** **Influence of Back Sheet Thermal Insulator on Operational Temperature of Photovoltaic – Thermal (PVT) Modules**
R.R. Vardanyan, N.K. Badalyan & M.G. Travajyan
NPUA, Yerevan, Armenia

**3AV.1.29** **Analysis of the Effects of Faster Lamination Process during PV Module Manufacturing**
B. Aydogan, B. Sekertekin, C. Egin & M.C Arslan
KalyonPV, Ankara, Turkey

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**3AV.1.30** **Optimization of Module Rear Side Self-Shading with Respect to Bifacial Gain**
N. Polat, A. Kumtepe & M. Günöven
Kalyon PV, Ankara, Turkey

**3AV.1.31** **Developement of Light Weight Silicon PV Module with a Weight Reduction of 40% or More and Structure for Fatm Building Application**
H.-M. Hwang, H.-J. Bang, S.-W. Ko, Y.-C. Ju & W.-G. Shin
KIER, Daejeon, Republic of Korea

**3AV.1.32** **Power Increase Effect by Reflection on Backsheet in Photovoltaic Module**
J.-S. Hwang & D. Kim
Korea University, Seoul, Republic of Korea
H.-S. Lee & Y. Kang
KU-KIST, Seoul, Republic of Korea

**3AV.1.33** **Design, Development, and Fabrication Process of Solar Palm**
C. Egin & M. Caliskan
Kalyon PV, Ankara, Turkey

**3AV.1.34** **Anti-Glare Bifacial Module Designs with Structured Glass for Façade Application**
M. Hofmann, B. Bläsi, J. Willmann, L. Bienkowski, M. Zimmer, D. Reinwand, F. Ensslen, S. Riepe, S. Nold, A. Brand & T.E. Kuhn
Fraunhofer ISE, Freiburg, Germany

**3AV.1.35** **Polyethylene Copolymers as Solar Cell Encapsulants: a Critical Overview**
G. Oreski & C. Barretta
PCCL, Leoben, Austria
P. Gebhardt & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany
D.C. Miller, S. Ulicna & M. Kempe
NREL, Golden, USA
L. Bruckman
Case Western Reserve University, Cleveland, USA
L. Gnocchi
EPFL, Neuchâtel, Switzerland
H.-Y. Li
CSEM, Neuchâtel, Switzerland
B. Habersberger
DOW, Houston, USA
K. Proost
IP Fab, Mechelen, Belgium
M. Kühne
Hanwha Q-Cells, Bitterfeld-Wolfen, Germany

**3AV.1.36** **Improving AllBlack Module Efficiencies**
B. Jaeckel & M. Pander
Fraunhofer CSP, Halle (Saale), Germany
M. Evertz, M. Brandenburg & M. Robertz
Feron, Düren, Germany
A. Linsenmeyer
SUNSET, Adelsdorf, Germany

**3AV.1.45** **Directly Coupled PV-Battery Module under Realistic Cycling**
U. Chibuko, T. Merdzhanova, D. Weigand, S.N. Agbo, U. Rau & O. Astakhov
Forschungszentrum Jülich, Germany
F. Ezema
University of Nigeria, Nsukka, Nigeria

**3AV.1.46** **Development of an Electronic Interface for Advanced Diagnostics of Photovoltaic System**
E. Celi, A. Minuto & G. Timò
RSE, Piacenza, Italy

**3AV.1.47** **Horizontal Single Axis Tracker for Agri-PV: Solutions at Low LCOE and LCA , Optimized for Different Crops**
A. Ricci, A. La Mura, C. Tarisciotti, G. Demofonti & A. Timidei
Valmont Solar, Rome, Italy

**3AV.1.48** **Reliability Analysis and Energy Yield of a String Inverter for a BIPV Application Considering the Cavity Temperature Measurements**
S. Bouguerra, R. De Jong, N. Kyranaki, A. Morlier & M. Daenen
IMO IMOMEC, Diepenbeek, Belgium
O. Alavi, I. Kaaya & L. Van Cappellen
imec, Heverlee, Belgium
F. Poormohammadi, M. Deckers & J. Moschner
Energy Ville, Genk, Belgium

**3AV.1.49** **Optimal PV Module Topologies for High Speed Optical Wireless Communication**
M. Muttillo, O. Isabella & P. Manganiello
Delft University of Technology, The Netherlands

**3AV.1.50** **Solar Energy Potential and Hybrid Maximum Power Point Tracking; (Case of Ethiopia)**
E. Gedefaye & T. Tadiwose
Bahir Dar University, Ethiopia
S. Lakeou
University of the District of Columbia, Washington DC, USA
T. Terefe
Adama Science and Technology University, Arada, Ethiopia

**3AV.1.51** **Validation of Declared Efficiency in Commercial PV Inverters' Datasheets**
G.P. de Lima, A.C. Ribeiro, P.R.D.R. da Silva, G.C.S. Prym, J.F.S. de Paula, J.L. de Souza Silva, T.A.S. Barros & M.G. Villalva
State University of Campinas, São Paulo, Brazil
H. da S. Alvarez & R.M. Garcia
BYD, São Paulo, Brazil

**3AV.1.52** **Central Inverter Testing Under Real Outdoor Conditions. A Controllable Analysis under Non-Controllable Conditions Using Statistics. A Real Case Study**
S. Suarez, J.M. Rivas, G. Navas, I. Fernandez & S. Rodríguez-Conde
Enertis Applus, Madrid, Spain

**3AV.1.53** **Design and Implementation of a Power DC/DC Converter for Application in Photovoltaic Panels**
P. Valdivia-Lefort, A. Sanchez & R. Barraza
Federico Santa Maria Technical University, Santiago, Chile

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**3AV.1.54** **A Virtual Bus Parallel Differential Power Processing Configuration for Photovoltaic/Battery Applications**
A. Nazer, O. Isabella & P. Manganiello
Delft University of Technology, The Netherlands

## VISUAL PRESENTATIONS 3AV.2

**15:15 – 16:45** **Module Reliability**

**3AV.2.1** **Can We Accelerate the Damp Heat Test?**
J.P. Rakotoniaina, R. Couderc & J. Aimé
CEA, Le Bourget-du-Lac, France

**3AV.2.3** **Increased Reliability for PV in Alpine Environment (R&D Project PV-DETECT)**
A. Gassner & G.C. Eder
OFI, Vienna, Austria
E. Özkalay & G. Friesen
SUPSI, Mendrisio, Switzerland
M. Feichtner
KIOTO, Sankt Veit an der Glan, Austria
M. Babin
Technical University of Denmark, Roskilde, Denmark
F. Bleicher
TU Wien, Vienna, Austria

**3AV.2.4** **Developing Highly Accelerated Stress Tests for PV Modules: Pressure Cooker Test Versus Damp Heat Test**
A. Beinert, C. Biedermann, S. Mujumdar, J. Erb, P. Gebhardt, D. Philipp & B.I. Hädrich
Fraunhofer ISE, Freiburg, Germany

**3AV.2.5** **Influence of the Material Combination on the UV Fluorescence of Films for Photovoltaic Modules**
Z. Jiang, P. Wessel, S. Dittmann, C. Meza & R. Gottschalg
Hochschule Anhalt University of Applied Sciences, Köthen, Germany

**3AV.2.6** **Backsheet Degradation in Moderate and Desert Climate**
A.A. Abdallah, H.M. Abufares, M. Abdelrahim, M. Elgaili, K. Mroue, A. Samara & M. Pasha
QEERI, Doha, Qatar
O. Stroyuk & C. Buerhop-Lutz
HI ERN, Erlangen, Germany

**3AV.2.7** **Damp Heat and UV Ageing Behavior of Double Glass Laminates Based on UV-Transparent EVA and POE**
M. Tiefenthaler, G.M. Wallner & R. Pugstaller
University of Linz, Austria

**3AV.2.8** **Evaluation of Cell Cracks in Crystalline Silicon Photovoltaic Modules Using Imaging Techniques – First Steps towards Preparing an Evaluation Guideline**
C. Buerhop-Lutz, T. Winkler & I.M. Peters
HI ERN, Erlangen, Germany
S. Rupp & M.B. Koentopp
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany
A. Linsenmeyer
Sunset Energietechnik, Adelsdorf, Germany
B. Jaeckel
Fraunhofer CSP, Halle, Germany
A. Shirgupe & R. Gottschalg
Hochschule Anhalt – APOLLO, Köthen, Germany
G. Kleiss
8.2 Arp & Kleiss, Berlin, Germany

**3AV.2.9** **Reliability of Lightweight PV Laminations under Harsh Environmental Conditions**
A. Buceta, A.B. Cueli & J. Bengoechea
CENER, Sarriguren (Navarra), Spain

**3AV.2.10** **Equivalent Damp Heat Testing Time Map for Service Lifetime of Photovoltaic Modules**
A. Gok
Gebze Technical University, Kocaeli, Turkey
C. Barretta & G. Oreski
PCCL, Leoben, Austria
A. Brandstaetter
LP, Lenzing, Austria
D. Geyer & R. Einhaus
ZSW, Stuttgart, Germany

**3AV.2.11** **Characterization of Decomissioned PV Modules Coming from Spanish PV Plants**
M.C. Alonso-García, F.G. Rosillo, E. Mejuto & M.B. Nieto-Morone
CIEMAT, Madrid, Spain
M.A. Muñoz
ETSIAAB UPM, Madrid, Spain

**3AV.2.12** **Analysis of the Effects of Leakage Current Produced by Potential Induced Degradation (PID) in Photovoltaic Modules with PERC and Topcon Technology**
M.R.M. Neves, A.M.C. Silveira, J.F.S. de Paula & M. Gradella Villalva
UNICAMP, Campinas, Brazil
H. Franca Santos, T. Crestani, L. S. Costa & R.M. Moreno Garcia
BYD Energy R&D, Campinas, Brazil

**3AV.2.13** **The Influence of Salinity on Potential-Induced Degradation (PID) in Monocrystalline Silicon Photovoltaic Modules**
T. Crestani, H.F. Santos, E. Mendes, G.S. de Souza Carvalho,
M.S. Sanches de Oliveira, R.M. Moreno Garcia & C.G. Miranda
BYD Energy R&D, Campinas, Brazil
M. Rainier
UNICAMP, Campinas, Brazil

**3AV.2.14** **The Influence of Photovoltaic Module Technology against Light-Induced Degradation (LID) and Potential-Induced Degradation (PID)**
H. Franca Santos, E. Mendes, G. de Souza Carvalho,
M. Sanches de Oliveira & R. Moreno Garcia
BYD Energy do Brasil, Campinas, Brazil

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**3AV.2.15** **Characterization of Electrical Leakage Circuit within a PV Module Installed in Outdoor**
T. Tanahashi & T. Oozeki
AIST, Koriyama, Japan

**3AV.2.16** **Benchmarking of Thin-Film PV Module Long-Term Outdoor Stability**
M. Bokalic, K. Brecl & M. Topic
University of Ljubljana, Slovenia

**3AV.2.17** **Evaluating the Impact of Encapsulant Color on the Performance and Reliability of PV Modules in Different Climates**
S. Hamed & B.S. Aldalali
Kuwait University, Kuwait
I. Kaaya
imec, Genk, Belgium
S. Bouguerra
Hasselt University, Belgium

**3AV.2.18** **Numerical Design Study for Desert Climate Applications of Bifacial PV Modules**
M. Pander, B. Jaeckel & S. Grosser
Fraunhofer CSP, Halle (Saale), Germany
A.A. Abdallah
QEERI, Doha, Qatar

**3AV.2.19** **Influence of Front and Rear Covers of the PV Module on the Degradation Modes of SHJ Solar Cells under Damp Heat Condition**
L. Pirot-Berson & R. Bodeux
EDF R&D, Palaiseau, France
R. Couderc
CEA, Le Bourget-du-Lac, France
P. Lefillastre
EDF Renewables, Paris La Defense, France
J. Dupuis
EDF R&D, Moret Loing et Orvanne, France

**3AV.2.20** **Quantification and Mitigation of the PV-Soiling in Bifacial Modules Configuration**
B. Aissa, A.A. Abdallah, B.W. Figgis, M.M. Kivambe & J. Lopez-Garcia
QEERI, Doha, Qatar

**3AV.2.21** **PV Module and Glass Sample Sand Abrasion Testing**
G. Mathiak, N. Najeeb, H. Alshanquiti, P. Gabbadi, Y. Kumar, J.J. John & V. Alberts
DEWA R&D Center, Dubai, United Arab Emirates
M. Mirza
Fraunhofer ISC, Würzburg, Germany

**3AV.2.22** **Proposal for Hot Desert Test Cycle**
G. Mathiak, S. Kumar, B. Adothu, P. Gabbadi, Y. Kumar, J.J. John & V. Alberts
DEWA R&D Center, Dubai, United Arab Emirates
B. Jaeckel & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

**3AV.2.23** **Field Degradation Study of Bifacial Photovoltaic Modules in Northern Europe**
M. Bartholomäus, N. Riedel-Lyngskær, L. Morino, R. A. Galan, P. Poulsen & S.V. Spataru
Technical University of Denmark, Roskilde, Denmark

**3AV.2.24** **Performance and Reliability of PV Modules in Indonesia**
O.A. Rosyid, N.M. Lande, A. Priyadi, H. Hartadhi, A. Faradilla, F.M.R. Nulhaq, L. Sapinah & A. Sudrajat
BRIN, Banten, Indonesia
H. Sträter
PTB, Braunschweig, Germany

**3AV.2.25** **A Methology for Measuring Degradation on Real PV Power Plant Exposed to Extreme High UV Solar Radiation: the Experience in Northern Chile**
P. Valdivia-Lefort, V. Navarro & R. Barraza
Federico Santa Maria Technical University, Santiago, Chile

**3AV.2.26** **Investigating the Phenomenon of Backsheet Chalking in a Multi-MW Plant in South Africa**
F.J. Vorster, E.E. van Dyk & J.L. Crozier McCleland
Nelson Mandela University, Port Elizabeth, South Africa
C. Buerhop-Lutz, O. Stroyuk, E. Wittmann & I.M. Peters
HI ERN, Erlangen, Germany
M. Vumbugwa
Nelson Mandela Univerity, Port Elizabeth, South Africa

**3AV.2.27** **Defects and Degradations in Photovoltaic Modules from Hot Middle East Deserts**
S. Kumar, B. Adothu, Z. Shekason, K. Chapaneri, A. Baloch, P. Gabbadi, Y. Kumar, A. Alheloo, A. Almheiri, J.J. John, G. Mathiak & V. Alberts
DEWA, Dubai, United Arab Emirates
B. Jaeckel, D. Daßler & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

**3AV.2.29** **Identification and Investigation of Materials Degradation in Photovoltaic Modules from Middle East Hot Desert**
B. Adothu, S. Kumar, N. Lyka Muttumthala, Z. Shekason, K. Chapaneri, P. Gabbadi, Y. Kumar, A. Alheloo, A. Almheiri, J.J. John, G. Mathiak & V. Alberts
DEWA, Dubai, United Arab Emirates
B. Jaeckel, D. Daßler & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

**3AV.2.30** **Classification of EL Failure Catalogs**
G. Kleiss
8.2 Arp & Kleiss, Berlin, Germany
B. Jaeckel, M. Pander & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
A. Reuter
DKE, Offenbach, Germany
C. Buerhop-Lutz
HI ERN, Erlangen, Germany
M.B. Koentopp
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany
J. Kirch
Ing.-Büro Jochen Kirch, Leeder, Germany
A. Linsenmeyer
Sunset, Adelsdorf, Germany

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**3AV.2.31** **Linking Module Design, Indoor Accelerated Testing with Outdoor Desert Energy Yield Measurements**
A. Elamim, S. Elhamaoui, A. Benazzouz, K. Tijani & A. Ghennioui
Green Energy Park, Benguerir, Morocco
M. Pander & B. Jaeckel
Fraunhofer CSP, Halle (Saale), Germany

**3AV.2.32** **Open Fault Detection Technology of Bypass Circuit of PV Module with IR Camera - Reducing of Reflection Effect by Clouds**
S. Nishikawa & H. Kubota
Nihon University, Tokyo, Japan

**3AV.2.33** **Accelerated Aging Study of Backsheet Repair with Flowable Silicone Sealant**
G. Beaucarne, J. Lima Garcia & E. Jadot
Dow Silicones, Seneffe, Belgium

**3AV.2.34** **Methodology of UV Accelerated Test in Photovoltaic Modules**
V. Arias & R. Barraza
Federico Santa María Technical University, San Joaquín, Chile
J. Garcia Garcia
Universidad Austral de Chile, Coyhaique, Chile

**3AV.2.35** **Long Term Reliability Investigation for Liquid and Non-Liquid Encapsulation Environment for IBC Zebra Solar Cell**
T. Timofte, R. Farneda & A. Halm
ISC Konstanz, Germany
C. Erban
Sunovation, Elsenfeld, Germany

**3AV.2.36** **Determination of Activation Energy for the Degradation of Encapsulant (EVA/TPO) in c-Si Photovoltaic Modules**
M. Avula, K. Patel, S. Singh & S. Mallick
IIT Bombay, Mumbai, India
B. Adothu
DEWA Research and Development Center, Dubai, United Arab Emirates

**3AV.2.37** **Micro-Cracking Evaluation Criteria Analysis on Solar Photovoltaic Panel by Numerical and Experimental Methods**
H. LIU
EDF, Beijing, China
Y. Xiong & T. Chen
EDF R&D, Beijing, China
Y. Yu, Y. Wu, Q. Wang, M. Sun & T. Xu
Canadian Solar, Suzhou, China
E. Boyère, G. Kwiatkowski & J. Dupuis
EDF R&D, Moret-sur-Loing, France

**3AV.2.55** **Simulation of Electrical Losses in Bifacial PV and Validation with Real Vertical System in Germany**
O. Boldbaatar, D. Castillo, E.M. Grommes & U. Blieske
University of Applied Science Cologne, Germany

**VISUAL PRESENTATIONS 3AV.3**

**17:00 – 18:30 PV Module Performance**

**3AV.3.1 Study on Field Test of PV Modules and Supporting Devices in Tropical Coastal Atmospheres**
Y.-J. Qiu, S.-Y. Ting, Y.-T. Li, K.-W. Lu, C.-F. Hsieh & M.-A. Tsai
ITRI, Hsinchu, Taiwan
Y.-H. Pai
HDHU, Hualien, Taiwan
F.-H. Yeh
Taipei First Girls High School, Taiwan

**3AV.3.2 Solar Panel Rooftop Testing, Performance and Optimization in Desert Climate of Abu Dhabi, United Arab Emirates**
L. Nayfeh & L. Nayfeh
Dunecrest American School, Dubai, United Arab Emirates
A. Nayfeh
Khalifa University, Abu Dhabi, United Arab Emirates

**3AV.3.3 Characterization Analysis on Monofacial Modules with Bifacial Cells at Carport**
S. Hwang, H.-S. Lee & Y. Kang
Korea University, Seoul, Republic of Korea
D. Suh
Hoseo University, Republic of Korea

**3AV.3.4 Performance Evaluation of Anti-Reflection Encapsulated Mono-Silicon PV Module under Indoor Lighting Simulator by Using RTOS Method**
Y.-S. Long, M.-A. Tsai, C.-F. Wu, C.-H. Chou, T.-C. Wu & S.-Y. Ting
ITRI, Hsinchu, Taiwan
F.-H. Yeh
Taipei First Girls High School, Hsinchu, Taiwan

**3AV.3.5 Detailed Analysis of Loss Distribution in Bifacial Perovskite/Silicon Tandem PV Systems**
Y. Blom, C.M. Ruiz Tobon, O. Isabella, M.R. Vogt & R. Santbergen
TU Delft, The Netherlands

**3AV.3.6 A Case Study of Developing SEMI Standards for Emerging PV under Solar/Indoor Lighting Application**
Y.-S. Long, M.-A. Tsai, T.-C. Wu & S.-Y. Ting
ITRI, Hsinchu, Taiwan
F.-H. Yeh
Taipei First Girls High School, Hsinchu, Taiwan

**3AV.3.7 Measurement Uncertainty Analysis for Large Area High-Efficiency Modules**
K. Ramspeck, C. Böhmer & M. Meixner
halm elektronik, Frankfurt am Main, Germany

**3AV.3.8 Short-Term Outdoor Energy Rating vs Climate Specific Energy Rating (CSER)**
M.J. Rivera & C. Reise
Fraunhofer ISE, Freiburg, Germany

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**3AV.3.9 Investigation and Classification of Performance of PV Modules under Partial Shading Scenarios**
S. Meric, H. Ihan, G. Yakın & O. Bazkir
TUBITAK UME, Kocaeli, Turkey

**3AV.3.10 Optical Characterization of Indoor PV Devices**
H. Ihan, G. Yakın, S. Meric & O. Bazkir
TUBITAK UME, Kocaeli, Turkey

**3AV.3.11 Thermal Management of Photovoltaic Modules with Optical Filters: Effects on Performance and Reliability**
J.C. Ortiz Lizcano, H. Ziar, M. Zeman & O. Isabella
TU Delft, The Netherlands
I. Kaaya
imec, Genk, Belgium

**3AV.3.12 Hyperbolic Metamaterials for Enhancing Energy Yield of Photovoltaic Modules**
B. Fetlinski, B. Janaszek & M. Kieliszczyk
Warsaw University of Technology, Poland

**3AV.3.13 Ideal Surface Structures from Nature for Photovoltaics**
K. Shanks
University of Exeter, Cornwall, United Kingdom

**3AV.3.14 Limits and Possible Extensions of the Single Diode Model in View of its Application to the Latest PV Cell Technologies**
B. Wittmer, A. Mermoud, M. Oliosi & A. Bridel-Bertomeu
PVsyst, Satigny, Switzerland

**3AV.3.15 PV Modules Outdoor Performance: Temperature Coefficient Variation with Irradiance Level**
M.I. Torres Aguilar & J. Badosa
École Polytechnique, Palaiseau, France
V. Bourdin
LIMSI, Orsay, France
A. Migan-Dubois
GeePs, Gif-sur-Yvette, France

**3AV.3.16 Do We Correctly Define the Nominal Power of Thin-Film Modules? Determination of Power Stabilization Coefficients for Thin-Film PV Modules to Reflect the Location Dependent Influence**
M. Boruah
Oldenburg University, Germany
T. Weber, N. Pongthanacharoenkul, N. Murali, S. Lust, B. Lippke & S. Xuereb
PI Berlin, Germany
J. Kemnitz
Signum Energy Analytics, Durham, USA

**3AV.3.17 Development and Validation of Coupled Thermal-Electric Transient Model of a Photovoltaic System**
S. Pereira, P. Canhoto & R. Salgado
University of Évora, Portugal
T. Oozeki
AIST, Koriyama, Japan

**3AV.3.18** **Determining the Spectral Responsivity of PV Modules with a Tunable Laser Light Source**
K. Ladner, H. Sträter & S. Winter
PTB, Braunschweig, Germany

**3AV.3.19** **Thermal Issues on Half- Cell Bifacial Modules. A Way Through Albedo and Mismatch Voltage**
S. Suarez, J.M. Rivas, G. Navas, I. Fernandez & S. Rodríguez-Conde
Enertis Applus, Madrid, Spain

**3AV.3.20** **Experimental Study of Temperature and Performance in BIPV Elements and Comparison with Numerical Simulation**
P. Schenk, J. Froebel, S. Schindler, M. Pander & B. Jaeckel
Fraunhofer CSP, Halle (Saale), Germany

**3AV.3.21** **Technology and Location-Invariant Models for Detecting Partial Shading in Outdoor PV Modules**
G.M. Whyte & B.E. Pieters
Forschungszentrum Jülich, Germany

**3AV.3.22** **Improving Parameter Determination for PV Module Models**
C.W. Hansen, A.R. Jones, T. Transue & M. Theristis
Sandia National Laboratories, Albuquerque, USA

**3AV.3.23** **Variation in Power Temperature Coefficients of Fielded Modules**
B. Figgis, A. Abdallah, M. Kivambe, B. Aissa & J. Lopez-Garcia
QEERI, Doha, Qatar

**3AV.3.24** **Optimal Design and Experimental Test of a Solar Simulator for Solar Photovoltaic Modules**
P. Valdivia-Lefort, R. Cortés, C. Cárdenas-Bravo & R. Barraza
Federico Santa Maria Technical University, Santiago, Chile

**3AV.3.25** **Impact of Soiling on Transparency of Different Glass Types: A Comparative Study**
S. El Hassani, M. Hügi & C. Bucher
BFH, Burgdorf, Switzerland

**3AV.3.26** **Power Rating Procedure for Hybrid CPV/PV Modules with Integrated Trackers**
G. Timò, A. Minuto & E. Celi
RSE, Piacenza, Italy

**3AV.3.28** **Module External Quantum Efficiency Measurements as a Method for Defects Analysis in Bifacial PV Modules**
A. Alheloo, A. Almheiri, S. Kumar, B. Adothu & G. Mathiak
DEWA, Dubai, United Arab Emirates

Monday, 18 September 2023

**3AV.3.29** **Ultra-High Efficiency Hybrid Solar Modules Based on CPV Microtracking: Demonstration of the Pilot Production Line and Field Results of the Commercial Pilot Sites**
J. Levrat, D. Petri, M. Despeisse & D. Chudy
CSEM, Neuchâtel, Switzerland
C. Ballif & X. Niquille
EPFL, Neuchâtel, Switzerland
G. Nardin, M. Ackermann, M. Duchemin & J.M. Sanchis Ronda
Insolight, Renens, Switzerland
S. Askins, C. Domínguez, G. Vallerotto & I. Antón Hernández
UPM, Madrid, Spain
G. Siefer, M. Steiner & J.F. Martinez Sanchez
Fraunhofer ISE, Freiburg, Germany
A. Valor, A. Apraiz & J.-P. Aguerre
Mondragon Assembly, Aretxabaleta, Spain

**3AV.3.30** **Reliability and Degradation Analysis of Photovoltaic Modules under Harsh Environmental Conditions**
D. Hassan Daher & D. Mouhoumed
Centre d'Etudes et de Recherche de Djibouti, Djibouti
D. Diallo & A. Migan-Dubois
CNRS, Gif-sur-Yvette, France
P.-O. Iogerais
CERTES, Lieusaint, France
C. Ménézo
INES, Le Bourget-du-Lac, France

**3AV.3.31** **Do We Need Light to Stabilize PV Modules?**
R. Couderc & L. Chaput
CEA, Le Bourget-du-Lac, France
B. Provost & L. Prieur
CERTISOLIS, Le Bourget-du-Lac, France

**3AV.3.32** **Encapsulant-Free Full-Size N.I.C.E. Modules in Outdoor Performance Test: First Year Results and Roadmap towards Higher Efficiency**
C. Pönisch, L. Schanz, J. da Costa Fernandes, M. Schmidt & D. Kray
University of Applied Sciences Offenburg, Germany

**3AV.3.33** **Assessing Uncertainties from Reflected Irradiance in Bifacial PV Simulations through a 3D View Factor Model and Rear Sensor Measurements**
S. Mollier & I.A. Tsanakas
CEA, Le Bourget-du-Lac, France

**3AV.3.34** **Robust Self-Referencing Module Temperature under Partial Shading Conditions**
B.E. Pieters & A. Gerber
Forschungszentrum Jülich, Germany

**3AV.3.35** **Performance Verification of Electrical Models for Bifacial Photovoltaic Modules Using Experimental Data under Controlled Conditions of Temperature and Irradiance**
V. Gonzalez, P. Valdivia-Lefort & R. Barraza
Federico Santa Maria Technical University, Santiago, Chile

**3AV.3.36** **Mask for Routine Testing Using Time Domain Reflectometry on Solar Modules: Measures to Investigate Non-Visible Failures**
A. Silveira, M.R.M. Neves, M. Villalva & L.C. Kretly
UNICAMP, Campinas, Brazil
R. Garcia & H. da S. Alvarez
BYD, Campinas, Brazil



**Tuesday, 19 September 2023**

**VISUAL SESSION 2BV.1**

**08:30 – 10:00** **Modelling, New Materials, Devices and Characterisation Techniques / New Modelling and Characterisation Techniques**

**2BV.1.1** **Construction of Novel BaSi2 Solar Cells by Applying an a-SiC Electron Transport Layer**
R. Du, S. Aonuki, H. Hasebe, K. Kido, H. Takenaka, K. Toko & T. Suemasu
University of Tsukuba, Japan
M. Mesuda
Tosoh Corporation, Ayase, Japan

**2BV.1.2** **Effect of Substrate Temperature on Structure, Morphology and Optical Properties of Sb2Se3 Thin Films Fabricated by CMBD from Sb and Se Precursors for Solar Cells**
T.M. Razykov, R. Yuldoshev, R. Khurramov, K.M. Kouchkarov & Sh.B. Utamuradova
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan
A. Bosio & N. Romeo
University of Parma, Italy
A. Romeo
University of Verona, Italy
M.S. Tivanov & D.S. Bayko
Belarusian State University, Minsk, Belarus

**2BV.1.3** **Growth of Sb2Se3 by Ionized Jet Deposition for Thin Film Solar Cells Application**
N. Torabi, E. Artegiani, O.K. Simya & A. Romeo
University of Verona, Italy

**2BV.1.4** **Iron Pyrite and Its Application in Photovoltaics**
A. Zaka, A. Nayfeh & S. Alhassan
Khalifa University, Abu Dhabi, United Arab Emirates

**2BV.1.5** **Synthesis of SnZrSe3 Thin Films by Pulsed Laser Deposition and Post-Annealing**
R. Kondrotas, V. Pakštas, R. Juskenas & A. Krotkus
Center for Physical Sciences and Technology, Vilnius, Lithuania
S. Bereznev, K. Muska & O. Volobujeva
Tallinn University of Technology, Estonia

**2BV.1.6** **Measurement of Electron Gas Temperature in Bi2Te3 by Thermal Noise**
I. Konovalov, T. Nickel & E. Mehnert
University of Applied Sciences Jena, Germany

**2BV.1.7** **Effect of Substitution on the Properties of the Cu2Fe1-xCoxSnS4 Thin Films**
S. Drissi, A. El Kissani, A. Abali, D. Ait Ihaj, S. El Massi, L. Amiri, L. Nkhaili, K. El Assali & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

**2BV.1.9** **Efficient Narrowband Photovoltaic Optical Energy Receivers**
I.O. Sokolovskyi, V.P. Kostylyov & A. Sachenko
NAS ISP, Kyiv, Ukraine
A.I. Shkrebtii-Chkrebtii
Ontario Tech University, Oshawa, Canada

**2BV.1.10** **Peculiarities of Hot Carrier Effect in GaAs P-N Junction**
J. Gradauskas, S. Ašmontas, A. Sužiedelis, A. Silenas, A. Cerškus, A. Rodin & I. Zharchenko
CPST, Vilnius, Lithuania
O. Masalskyi
Vilnius Gediminas Technical University, Lithuania

**2BV.1.11** **Synthesis and Characterizations of Cu2ZnSnS4 (CZTS) Powder Prepared by Sol Gel Technique for Applications Photovoltaique**
M. Bousseta, L. Nkhaili, A. Narjis, K. El Assali & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

**2BV.1.12** **Some Features of Charge Carriers Injection in Nanocomposite Solar Cells Based on CLONIDINE/Si Heterojunction with Plasmonic Au Nanoparticles**
S.V. Mamykin, V.R. Romanyuk, I.B. Mamontova, O.S. Kondratenko, N.V. Kotova, T.R. Barlas, N.M. Roshchina & P.S. Smertenko
NAS ISP, Kyiv, Ukraine

**2BV.1.14** **Manganese-Substituted Kesterite for Earth-Abundant Thin Films Photovoltaics**
V. Trifiletti, L. Frioni, G. Tseberlidis, E. Vitiello, M. Acciarri & S. Binetti
University of Milano - Bicocca, Italy
M. Danilson & M. Grossberg
Tallinn University of Technology, Estonia
S. Marchionna
RSE, Milan, Italy

**2BV.1.15** **Research of Boron and Oxygen Related Defects in Barium Disilicide Thin Films by Density Functional Theory Method**
Y. Cao, J.-M. Mouesca & S. Gambarelli
University of Grenoble Alpes, France
T. Suemasu
University of Tsukuba, Japan

**2BV.1.16** **Alumium Doped Zinc Oxide Prapared by Mist Chemical Vapor Depositon Applying for Dye Sensitized Solar Cells**
C. Li & H.S. Wai
Kochi University of Technology, Japan

**2BV.1.17** **Low-Temperature Atomic Layer Deposited Magnesium Oxide as a Passivating Electron Contact for Ion Implanted c-Si Solar Cells**
G. Kökbudak Baldan
METU, Ankara, Turkey
G. Bektaşs, H. Asav, H.H. Canar, A.E. Keçeci, B. Arıkan & R. Turan
ODTÜ-GÜNAM, Ankara, Turkey
C Akgün
ASELSAN, Ankara, Turkey

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**2BV.1.18** **Device Modeling of HTL/BaSi2 Heterojunction Solar Cells by Optical Simulations**
S. Aonuki & T. Suemasu
University of Tsukuba, Japan
C.M. Ruiz Tobon, R. Santbergen & O. Isabella
Delft University of Technology, The Netherlands

**2BV.1.19** **Cd-Free Kesterite Solar Cells Featuring Titania as Buffer Layer**
G. Tseberlidis, V. di Palma, V. Trifiletti, M. Acciarri & S. Binetti
University of Milano - Bicocca, Italy
M. Valentini, C. Malerba & A. Mittiga
ENEA, Rome, Italy

**2BV.1.20** **Optimization of BiOI/HTL Heterojunction for Efficient Charge Extraction from Solar Cell: for Indoor Light Harvesting**
S. Manjhi, N. Chatterji & V. Garg
SVNIT, Surat, India
B.S. Sengar
IIT Indore, India

**2BV.1.31** **Using Machine Learning to Predict Module Performance from Cell and Module Parameters**
H. Wagner-Mohnsen, S. Wasmer & B. Klöter
WAVELABS Solar Metrology Systems, Leipzig, Germany
P.P. Altermatt
Trina Solar, Jiangsu, China
M. Ernst
ANU, Canberra, Australia

**2BV.1.32** **An Electro-Thermal Model to Study Hot-Spot Formation in Thin-Film Solar Cells**
S. Nofal, B.E. Pieters & U. Rau
Forschungszentrum Jülich, Germany

**2BV.1.33** **On the Accuracy of Spectral Adjustment for Performance Measurements of Multijunction Solar Cells**
N. Kopidakis, T. Song, J. Geisz & D. Friedman
NREL, Golden, USA

**2BV.1.34** **The Extraction of the Spatial External Luminescence Efficiency for High Resolution Mapping of Charge Recombination**
T. Yeshurun, M. Fiegenbaum-Raz & G. Segev
Tel Aviv University, Israel

**2BV.1.35** **Frequency Dependence of Modulated SPV to Characterize Surface Defects**
D. Regaldo, J.-B. Puel & P. Schulz
IPVF, Palaiseau, France
V. Donchev, S. Georgiev & K. Kirilov
Sofia University, Bulgaria
J.P. Connolly & J.-P. Kleider
GeePs-CentraleSupelec, Gif sur Yvette, France

**2BV.1.36** **Bifacial and Anuglar-Resolved JV-Measurements on the Example of Ultra-Thin CIGSe Solar Cells**
T. Koehler, J. Kruip, Y. Li & M. Schmid
University of Duisburg-Essen & CENIDE, Germany

**2BV.1.37** **Ohmic Shunt Imaging of the Top Cell in Silicon / Perovskite Tandem Solar Cells**
J. Wyttenbach, M. Matheron & O. Dupré
CEA, Le Bourget du Lac, France

**2BV.1.38** **Reviewing the Definition of Solar Cell Generations**
M. Schmid
University of Duisburg-Essen, Germany

**2BV.1.39** **Numerical Simulation of Perovskite Solar Cells under Light Soaking Degradation with Silvaco Atlas**
E. Zugasti, A. Murillo, I. Cornago, A. Buceta, C. Pinto & J. Bengoechea
CENER, Sarriguren-Navarra, Spain

**2BV.1.40** **Prospective Performance Enhancement of Cu2BaSn(S,Se)4 Based Solar Cell by Optimizing Buffer Layer and Metal Contact**
H. Patel, R.K. SHARMA, D. Joshi & V. Garg
SVNIT, Surat, India

**2BV.1.41** **Impact of Cu2O Back Buffer on Modeling Bifacial Ge-Incorporated Sb2Se3 Devices**
S. Lee
University of Kentucky, Lexington, USA
K. Price
Morehead State University, USA

**2BV.1.42** **New Ab-Initio Calculations of Combined Tunneling and Thermionic Field Emission Processes in Graphene/Oxide/n-GaAs Schottky Barrier Solar Cells**
A.C. Varonides
University of Scranton, USA

**2BV.1.43** **InGaAs-Based MQWs Photovoltaic under Concentration**
G. Siddharth
National Institute of Technology Calicut, Kozhikode, India
R. Singh & M. Dubey
IIT Indore, India
R. Bhardwaj
Dr. B R Ambedkar NIT Jalandhar, India
V. Garg
S.V. National Institute of Technology Surat, India

**2BV.1.44** **Principles for Construction of Solar Cells Using Terrestrial Counter-Radiation**
C. Graf von Westarp
University of Applied Sciences Hamburg, Germany

**2BV.1.45** **In-situ Microscopy Characterization of Light-induced Phase Segregation in Wide-Bandgap Perovskite Materials**
F. Cao, M. Li, J. Ye & C. Xiao
Ningbo Institute of Materials Technologies and Engineering, China
L. Du
Northwestern Polytechnical University, Xi'an, China
Z. Gao, C. Chen & D. Zhao
Sichuan University, Chengdu, China
C. Li & Z. Li
Northwestern Polytechnical University, Xi´an, China

Tuesday, 19 September 2023

**VISUAL SESSION 2BV.2**

**10:30 – 12:00 Perovskite Photovoltaics**

**2BV.2.1** **Electron Transport Layer and Hole Transport Layer-Free Perovskite Solar Cells**
L. Wang & Q. Han
Kyushu Institute of Technology, Kitakyushu, Japan
C. Zhang
China Jiliang University, Hangzhou, China
T. Ma
Kyushu Institute of Technology, KItakyushu, Japan

**2BV.2.2** **A Journey to High-Efficiency, Low-Cost Perovskite Solar Cells/Modules**
C.-G. Wu
National Central University, Jhong-Li, Taiwan

**2BV.2.3** **Upscaling of Solution Processed Perovskite Photovoltaics: Drying and Crystallization Dynamics of Slot-Die Coated Perovskite Solar Cells during Gas Quenching**
K. Geistert, S. Ternes, B. Hacene & U.W. Paetzold
KIT, Karlsruhe, Germany
D.B. Ritzer
KIT, Eggenstein-Leopoldshafen, Germany

**2BV.2.4** **Effect of Extremely High Voltage on Perovskite Solar Cells**
J. Park & J. Byeon
Seoul National University, Republic of Korea
M. Ko, H. Lee & H.-J. Song
Seoul National University of Science and Technology, Republic of Korea
J.Y. Kim
Gyeongsang National University, Jinju, Republic of Korea

**2BV.2.5** **Characterization of Perovskite Mini-Modules**
R. Ebner, G. Ujvári & A. Mittal
AIT, Vienna, Austria
M. Hadjipanayi, V. Paraskeva & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
A. Hadipour, A. Aguirre & T. Aernouts
imec, Genk, Belgium
T. Fontanot & S. Pechmann
Fraunhofer IKTS, Forchheim, Germany
S. Christiansen
Max Planck Institute for the Science of Light, Erlangen, Germany

**2BV.2.6** **Effect of ETL, and MAPbBrI3 Quantum Dots at HTL/absorber Interface on the Performance of (Sn,Ge) Based Perovskite Solar Cells**
R.V.N. Sai, S.S.R. Reddy, A. Mantri & V. Garg
SVNIT, Surat, India
B.S. Sengar
NIT Srinagar, India

**2BV.2.7** **Hybrid Vapor-Solution 2-Step Deposition of FAPbI3-Based Medium Bandgap Perovskite for Efficient P-I-N Solar Cells and Modules**
C.A. Villalobos Meza & T. Aernouts
imec, Genk, Belgium
T. Merckx, Y. Kuang & J. Poortmans
imec, Leuven, Belgium

**2BV.2.9** **Testing EVA, PMMA and PVDF under UV Irradiation for a New Low Temperature Encapsulation Method for Perovskite Solar Cells**
L. Ocaña, C. Montes & E. Llarena
ITER, Granadilla de Abona, Spain
B. González-Diaz & S. González-Pérez
ULL, La Laguna, Spain

**2BV.2.10** **Analysis of Local Variations in Transient Electroluminescence Images of Perovskite Solar Cells**
E.L. Comi, M. Battaglia, C. Kirsch, B. Ruhstaller & E. Knapp
ZHAW, Winterthur, Switzerland
S. Jenatsch, B. Blülle & R. Hiestand
Fluxim, Winterthur, Switzerland

**2BV.2.11** **Efficient and Thermally Stable P-I-N Perovskite Solar Cells with Electron Transport Layers Containing Phenanthroline Derivatives and Lithium Complexes**
T. Mochizuki, S. Araki, H. Takato & K. Tanahashi
AIST, Koriyama, Japan
Y. Okuyama & T. Sano
INOEL-EN, Yamagata, Japan

**2BV.2.12** **Perovskite Solar Cells Prepared in a Hybrid Process That Makes Use of Ambient and Moisture-Free Conditions to Produce HTM-Free Architectures with Back Contacts Based on Carbon and MAI in PVDF Compounds**
C. Montes, L. Ocaña & E. Llarena
ITER, Granadilla de Abona, Spain
B. González-Diaz & S. González-Pérez
ULL, Laguna, Spain

**2BV.2.13** **Bottlenecks in Perovskite Solar Cell Recycling**
E.S. Akulenko, M. Esmaeilzadeh, M. Hadadian & K. Miettunen
University of Turku, Finland

**2BV.2.14** **Monolithic Perovskite Solar Modules Enabled by Stable Device Architecture with Industrially Scalable Processes**
T. Merckx, A. Aguirre, Y. Kuang, A. van der Heide, A. Krishna, J. Poortmans & T. Aernouts
imec, Genk, Belgium
A. Haijiah & Y. Abdulraheem
Kuwait University, Safat, Kuwait

**2BV.2.15** **Reaching Long-Term Indoor Operation of Self-Sustained IoT Devices with Perovskite Solar Cells**
D. Uršic, M. Pirc, M. Jošt, M. Topic & M. Jankovec
University of Ljubljana, Slovenia

**2BV.2.16** **Systematization of the Co-Evaporation Process of MAPbI3 Absorbers for Perovskite Solar Cells**
L.V. Mercaldo, M. Ferrara, C. Ponti, G.V. Sannino, C. Diletto & P. Delli Veneri
ENEA, Portici, Italy

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**2BV.2.17** **Iodine-Induced Phase Segregation in the Controlled Growth of Large Grains of Perovskites**
M.-H. Kuo, B. Dzurnak, L. Landová & J. Holovsky
CTU, Prague, Czech Republic
K. Ridzoňová
ASCR, Prague, Czech Republic
A.P. Amalathas
University of Jaffna, Sri Lanka

**2BV.2.18** **Long-Term Monitoring System for Perovskite Solar Cells under Realistic Indoor Conditions**
M. Pirc, M. Jošt, Z. Ajdic & M. Topic
University of Ljubljana, Slovenia

**2BV.2.19** **Towards Sustainable and Efficient Indoor PV Using Perovskite Solar Cells**
M. Jošt, D. Uršic, M. Pirc, Z. Ajdic, M. Jankovec & M. Topic
University of Ljubljana, Slovenia

**2BV.2.20** **A Lateral Heterojunction Device as a Tool to Study Perovskite-Based Solar Cells**
D. Regaldo, P. Lopez-Varo, N. Mallik, J. Hajhemati, V. Dufoulon, G. Vidon, S. Cacovich, J. Alvarez, J.-B. Puel, J.-P. Kleider & P. Schulz
IPVF, Palaiseau, France

**2BV.2.21** **Fully Inorganic CsPbI3 Towards Tandem Application**
E. Nonni, F. Matteocci & A. Di Carlo
C.H.O.S.E, Rome, Italy

**2BV.2.23** **The Innovation and Strategy Brought by the H2020 Viperlab Project in Communication and Dissemination**
F. Roca & D. Casaburi
ENEA, Portici, Italy
N. Maticiuc & E. Unger
HZB, Berlin, Germany
M. Sytnyk
HIERN, Erlagen, Germany
E. Zugasti
CENER, Sarriguren-Navarra, Spain

**2BV.2.24** **Measuring Perovskite Solar Cells Fast and Slow**
B. Mihaylov, H. Müllejans, T. Sample & E.D. Dunlop
European Commission JRC, Ispra, Italy

**2BV.2.26** **New Paradigm for Hole-Selective Materials**
A. Ullah
KIER, Daejon, Republic of Korea
Y. Jo, C.-H. Han, S. Ahn, I. Jeong & S. Hong
KIER, Daejeon, Republic of Korea

**2BV.2.27** **Effect of Antisolvents in Ambient Air on Perovskite Solar Cells**
T. Negami, K. Sawaki, A. Mavlonov, Y. Kawano & T. Minemoto
Ritsumeikan University, Kusatsu, Japan

**2BV.2.28** **Numerical Investigation of Lead Free Halide Perovskite with All-Inorganic Transport Layer**
S. Kumar, V. Vinturaj & S.K. Pandey
National Institute of Technology Karnataka, Surathkal, India
V. Garg
S.V. National Institute of Technology, Surat, India

**2BV.2.29** **Evaluation of Thermal Stability of BiI3 Thin Films**
N. Coutinho, T. Crestani, O. Oliveira, A.P.M.M. Modesto, M. Gradella Villalva & F.C. Marques
UNICAMP, Campinas, Brazil

**2BV.2.30** **Hyperspectral Imaging of Laser Patterned Perovskite Solar Cells - An Investigation of the Spatially Resolved Electrical Properties**
C. Schultz, M. Fenske, A. Bartelt & B. Stegemann
HTW Berlin, Germany
G. Gélinas, S. Marcet & L.I. Dion-Bertrand
Photon etc, Montreal, Canada
J. Dagar, R. Schlatmann & E. Unger
HZB, Berlin, Germany

**2BV.2.31** **Investigation of ETL/Absorber Heterojunction for Efficient Charge Extraction from Formamidinium Tin-Based Perovskite Solar Cell**
S. Gupta, V. Garg & J. Sarvaiya
SVNIT, Surat, India

**2BV.2.32** **Investigation of ASnI2Br Perovskite/C60 Heterojunction for Improved Charge Extraction from Solar Cell**
R.K. SHARMA, H. Patel, S. Yadav & V. Garg
SVNIT, Surat, India

**2BV.2.33** **Development of Photovoltaic Cells Based on Ferroelectric Inorganic Perovskites for Indoor Application**
N.A.. Diop, D. Kobor & R. Ndoukane
LCPM, Ziguinchor, Senegal
M. Diale
SARCHI, Pretoria, South Africa

**2BV.2.43** **Setting the Baseline for the Modelling of Kesterite Solar Cells: the Case of Study of Tandem Application**
A. Gon Medaille, A. Jimenez Arguijo, K.J Tiwari & Z. Jehl Li Kao
IREC, Barcelona, Spain
A. Navarro Güell, M. Jimenez Guerra, M. Placidi, E. Saucedo & S. Giraldo
UPC, Barcelona, Spain

## VISUAL PRESENTATIONS 4BV.3

**13:30 – 15:00** **Integrated PV and Emerging Synergistic Applications**

**4BV.3.1** **Heat Loss Coefficients for a Floating PV Pilot Plant in Kilinochchi, Sri Lanka**
D. Lindholm, V.S. Nysted, T. Kjeldstad & J. Selj
Institute for Energy Technology, Kjeller, Norway

**4BV.3.2** **Lessons Learnt and Best Practices for the Installation of Floating PV Islands on Inland Lakes**
M. Ikhennicheu, B. Danglade & F. Gorintin
INNOSEA, Nantes, France

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**4BV.3.3** **Heat-Rates for Solar Arrays: a Morphometry Study Applied to Floating Photovoltaics**
B. Amiot & S. Giroux-Julien
CETHIL, Villeurbanne, France
M. Ferrand
CEREA, Marne la Vallee, France
R. Le Berre
EDF R&D, Ecuelles, France

**4BV.3.4** **Analysis of Effect for Bifacial Module in Floating Photovoltaic**
J. Lee & H.-J. Kim
K-Water Research Institute, Yuseong-gu, Republic of Korea
H. Jo & J. Him
Korea Water Resources, Daejeon -Si, Republic of Korea

**4BV.3.5** **Proposal of Solar Cell Modules for Reducing Partial Shading Loss**
K. Nakamura, R. Ozaki, Y. Ohshita & M. Yamaguchi
Toyota Technological Institute, Nagoya, Japan
C. Okamoto
SHARP, Nara, Japan

**4BV.3.6** **Evaporation Reduction and Energy Generation Potential Using Floating Solar on Hydropower Reservoirs – Case Study Lake Nasser, Egypt**
K. Ilgen & A. Armbruster
Fraunhofer ISE, Freiburg, Germany
D. Schindler & J. Lange
University of Freiburg, Germany
R. Ladwig
University of Wisconsin - Madison, USA

**4BV.3.7** **Modeling of Bifacial AgriPV Greenhouses in Southern Spain**
A. Kujawa, N. Hanrieder, S. Wilbert & M. Blanco
DLR, Almeria, Spain
J.A. Carballo, F. Ferrera-Cobos & J. Polo
CIEMAT, Madrid, Spain
M. Perez & J. Sanchez
UAL ARM, Almeria, Spain
R. Pitz-Paal
DLR, Cologne, Germany

**4BV.3.8** **Assessment of Remaining Underwater Irradiance in PV on Water Systems**
B.B. Van Aken & J.M. Kroon
TNO, Petten, The Netherlands
P. Boderie
Deltares, Delft, The Netherlands
W. Koops & M. Mosterman
GroenLeven, Leeuwarden, The Netherlands
M. Roohe & O. Huizing
Van Oord, Rotterdam, The Netherlands

**4BV.3.9** **Assessment of Olivoltaic's Potential to Improve Land Use**
E. Mouhib, A. Fernández-Solas, F. Almonacid-Cruz & E.F. Fernández
University of Jaen, Spain
L. Micheli
University of Rome, Italy

**4BV.3.10** **Predicting Cultivation and Power Generation of Agri-PV**
T. Toyoda, D. Yajima, K. Araki & K. Nishioka
University of Miyazaki, Japan

**4BV.3.11** **A Study on Cell Cracks of Shingled Photovoltaic Modules Applied to Floating Photovoltaic**
C.-S. Won, D.-C. Kim, M. Gang & M. Kim
SCOTRA, Songpa-gu, Republic of Korea
J. Lee & H. Jo
K-water, Yuseong-gu, Republic of Korea
S. Shin
Korean Rural Community Corporation, Gyeonggi-do, Republic of Korea

**4BV.3.12** **Optimal Simulation-Based Design of a Photovoltaic System for Integration into an Agrivoltaic Field**
J. Ancousture, P. Leglize & E. Benizri
INRAE, Nancy, France
Y.B. Assoa
CEA, Grenoble, France

**4BV.3.13** **Autonomous Multi-Objective Optimization of a Dual-Use System with Vertical Bifacial PV Panels and the Grass Crop Timothy**
E. Hustad Honningdalsnes, E. Stensrud Marstein & H. Nygard Riise
Institute for Energy Technology, Kjeller, Norway
H. Bonesmo
Norwegian Institute of Bioeconomy Research, Kjeller, Norway

**4BV.3.14** **Solar@sea: a Concept for PV on Flexible Floaters for off-Shore Application**
W. Soppe, M. Koetse, D. Roosen, A. vd Brink & M. Hoogeland
TNO, Eindhoven, The Netherlands
B. vd Berg & C. vd Nat
Bluewater Energy Services, Hoofddorp, The Netherlands
A. di Fino
Endures, Den Helder, The Netherlands
C. Hendriks & C. Scheerder
Genap, Amsterdam, The Netherlands
A. Bottger & L. vd Akker
Avans University Applied Sience, Breda, The Netherlands
W. Otto
Marin, Wageningen, The Netherlands

**4BV.3.15** **Assessment of Stresses Induced by Personnel Standing on PV Modules Mounted on a Floating Elastic Membrane**
H.G. Fjær, V.S. Nysted, N. Roosloot, D. Lindholm, T. Kjeldstad & J. Selj
Institute for Energy Technology, Kjeller, Norway

**4BV.3.16** **Comparative Analysis of Two Agrivoltaic Systems for Nighttime Irrigation of Plain Vegetable Plots**
G.P. Moreda, M.A. Muñoz-Garcia & R. Sánchez-Calv
UPM, Madrid, Spain
M.B. Nieto-Morone & M.C. Alonso-García
CIEMAT, Madrid, Spain

**4BV.3.17** **The Comparison Analysis of Photovoltaic Systems Using with the Pivotless Sun Tracking Floating System**
H. Jee & J. Lee
Sungkyunkwan University, Suwon, Republic of Korea

**4BV.3.18** **How does Module Array Design affect the Food-Energy Productivity & Economic Performance of Agrivoltaic Systems?**
H. Alam, Z. Tahir & N. Butt
LUMS, Lahore, Pakistan

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**4BV.3.19** **Assessment and Guidelines for an Agrivoltaic Pilot in Alentejo**
L. Bunge, L.A. Fialho & P.A. Horta
University of Évora, Portugal

**4BV.3.20** **PV along Motorways for Electric Vehicles Charging - Case Study Portugal**
T. Neves, G. Gaspar, C. Catita & M Centeno Brito
University of Lisbon, Portugal

**4BV.3.21** **Effect of Rapidly Varying Partial Shading on Maximum Power Tracking of Vehicle Integrated Photovoltaics**
B.J. K Naga, S. Jain & N. Shiradkar
IIT Bombay, Mumbai, India

**4BV.3.22** **Analysis and Modeling of Heat Transfer and Psychrometric Processes for Radiation-Driven Frost Protection in Agrivoltaics Systems**
E.-M. Stollenwerk & M. Berwind
Fraunhofer ISE, Freiburg, Germany
F. Al-Sibai
RWTH Aachen, Germany

**4BV.3.23** **YESPV-NIGBEN PROJECT: Yield Analysis and Socio-Economic Impact Assessment of Photovoltaic and Photovoltaic-Supported Food and Energy Hybrid Systems in Tropical Nigerian Climate**
E.I. Obetta, S.N. Agbo, O. Muller, O. Astakhov, T. Merdzhanova, M. Meier, C. Jedmowski, B.E. Pieters, A. Gerber, U. Schurr & U. Rau
Forschungszentrum Jülich, Germany
U. Ukwu, P. Ugwoke, M.I. Uguru, F.I. Ezem & C.M.I. Okoye
University of Nigeria, Nsukka, Nigeria

**4BV.3.24** **Sky View Factor Estimation from Lidar Scenes for Vehicle Integrated Photovoltaics**
J. Macías Rodríguez, R. Herrero, I. Antón Hernández & R. Núñez
UPM, Madrid, Spain

**4BV.3.25** **GIS-Based Solar Irradiance Simulation for VIPV Applications in a Complex Urban Environment**
D. Pera, C. Braun, P. Pinheiro & U. Leopold
Luxembourg Institute of Science and Technology (LIST), Esch-sur-Alzette, Luxembourg

**4BV.3.26** **Agrivoltaic Systems Utilizing a Novel Deep Learning Metamodel and Parameter Selection by Optimization Algorithms**
M. Berwind, K. Amelung, L. Kurumundayil, L.J. Gfüllner & M. Demant
Fraunhofer ISE, Freiburg, Germany

**4BV.3.27** **Modelling Performance and Availability of Solar Streetlights in Shaded Environments**
L. Morino, M. Bartholomäus, S.V. Spataru & P.B. Poulsen
DTU, Roskilde, Denmark

**4BV.3.28** **Landscape Integrated PV: A Case Study**
C. Pires, L. Bunge, L. Fialho & P. Horta
University of Évora, Portugal

**4BV.3.29** **APV Gives Shelter to Crops**
F. Gross, R. Martinez & M. Bohn
sbp sonne, Stuttgart, Germany
S. Gayler & F. Späth
University of Hohenheim, Stuttgart, Germany
T. Weber
University of Kassel, Germany

**4BV.3.30** **Inland Floating Photovoltaic Potential of Portugal**
D. Duarte, L.A. Fialho, M.P.I. Collares-Pereira & P.A. Horta
University of Évora, Portugal

**4BV.3.31** **Distributed Photovoltaic Booster Pumping for the Management of the Pressure Irrigation Units in the Hydrant for Maximizing the Probability of Meet the Crop Water Needs**
R. Sánchez-Calv, M.A. Muñoz-Garcia, G.P. Moreda & L. Juana
UPM, Madrid, Spain

**4BV.3.32** **A Comparison Study of Field Demonstration Data of Power Generation and Crops Products between Multi-Row Vertical Agrivoltaics and Normal Agrivoltaics**
B. Kim & J.H. Jung
Yeungnam University, Gyeongsan, Republic of Korea

**4BV.3.33** **Fabrication of Micro-Stripped Cu(In,Ga)Se2 Solar Cells for Semi-Transparent Building-Integrated PV**
J. Fonseca, P. Anacleto & S. Sadewasser
INL, Braga, Portugal

**4BV.3.34** **Comparison of the Temperatures of Bifacial and Monofacial Photovoltaic Modules for Different Floating System Configurations**
G. Mannino & G.M. Tina
University of Catania, Italy
G. Jiménez-Castillo
University of Jaén, Spain
A. Cucuzza
ENEL, Catania, Italy
A. Canino
3Sun, Catania, Italy
F. Bizzarri
ENEL, Roma, Italy

**4BV.3.35** **Experimental Measurement and Modelling of Solar Irradiation on the Roof of a PV-Powered Urban Bus**
T. Santos
NOVA, Lisbon, Portugal
M Centeno Brito
University of Lisbon, Portugal
M.J. Geca
Lublin University of Technology, Poland

**4BV.3.36** **Quantified Potential Contribution of Agrivoltaics to the EU PV Market**
C. Plaza
Becquerel Institute, Lyon, France
A. Penas, P. Macé & G. Masson
Becquerel Institute, Brussels, Belgium

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**4BV.3.37** **Blockchain-Based Local Energy Trading Markets**
A. Boumaiza
QEERI, Doha, Qatar
A. Sanfilippo
HBKU/ Qatar Foundation, Doha, Qatar

**4BV.3.38** **Experimental Investigation of an Agrivoltaic PV Panel under Symmetric Filterd Illumination**
I. Krasilnikov & A. Kribus
Tel Aviv University, Israel
H. Vitoshkin
ARO, Rishon LeZion, Israel
G. Mittelman
Afeka Tel-Aviv Academic College of Engineering, Tel Aviv, Israel

**VISUAL PRESENTATIONS 4BV.4**

**15:15 – 16:45** **PV and Buildings / Managing Local Fluctuations with Storage / Concentrators; Space Applications**

**4BV.4.1** **The Development of Building-Integrated Photovoltaics (BIPV) from 2000 to 2022 – What Can We Learn from Nine Competitions?**
G. Becker, F. Flade, B. Schiebelsberger & W. Weber
Bavarian Association for the Promotion of Solar Energy, Munich, Germany
R. Krippner
Nuremberg Institute of Technology, Germany

**4BV.4.2** **Simulation-Assisted Outlook for Luminescent Solar Concentrators with >5% Power Conversion Efficiency and Appropriate Transmission**
T.A de Bruin & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

**4BV.4.3** **Rings-BIPV Project: Analysis of PV Solutions for Retrofitting Buildings under Mediterranean Climate Conditions**
N. Martín-Chivelet, M. Alonso-Abella, C. Sanz-Saiz, J. Cuenca,
M. de la Cruz, A. Marcos-Castro & J. Polo
CIEMAT, Madrid, Spain
F. Olivieri, E. Caamaño-Martín & L. Olivieri
UPM, Madrid, Spain

**4BV.4.4** **3D Glare Assessment Tool for Photovoltaic (PV) Deployment in High-Density Urban Environments**
H. Sun
National University of Singapore, Singapore
T. Reindl
SERIS, Singapore, Singapore

**4BV.4.5** **Thou Shall Not Shadow Thy Neighbour: Developing an Urban Planning Tool for the H2020 E-Shape Project**
R. Amaro e Silva, R. Jolivet, B. Gschwind, L. Menard & P. Blanc
MINES Paris, Sophia Antipolis, France

**4BV.4.6** **Performance of PV Array Configurations Under Dynamic Partial Shadings on BIPV System**
C. Shao, A. Migan-Dubois & D. Diallo
Centralesupelec-GeePs, Gif-sur-Yvette, France

**4BV.4.7** **Experimental Performance Evaluation of a BIPVT Roof Tile System**
L. Clasing, C. von Holst, J. Muenzberg, C.P. Dick & U. Blieske
Cologne University of Applied Sciences, Germany
P. Hakenberg
paXos Consulting & Engineering, Langenfeld, Germany
S. Leyer & J.-R. Hadji-Minaglou
University of Luxembourg, Luxembourg

**4BV.4.8** **Post-Mortem Analysis of Corrugated Flexible CIGS Modules**
R. Aninat, A. Kingma, H. Kirchner, L. Simeonov, H. Mallet,
A. Vandenbroucke, S. Villa, D. Roosen & M. Theelen
TNO/Solliance, Eindhoven, The Netherlands

**4BV.4.10** **Vertical Bifacial PV for Flat Rooftops - Energy Yields from Prototypes and Pilots in Europe**
S.E. Foss, S. Petroncini, A. Yadmelat & T. Mongstad
Over Easy Solar, Oslo, Norway
C. Seiffert
IFE, Kjeller, Norway

**4BV.4.11** **Performance Analysis and Optimization of Vertical Building Integrated Photovoltaic Multi-Skin Facade (BIPV-MSF) Based on Decision-Making Approach to Enhancing Power Generation and Ventilation Efficiency**
J.-H. Yoon, D. Kim, H.-M. Lee & M. Choi
Hanbat National University, Daejeon, Republic of Korea
H. Choi
MaCK Architecture Firm, Sejong-si, Republic of Korea

**4BV.4.13** **Field Experimental Performance Evaluation of an All-Electric-Based Plus-Energy Residential Building Based on 3-Year Operational Data in South Korea**
H.-M. Lee, J.-H. Yoon, D. Kim & M. Choi
Hanbat National University, Daejeon, Republic of Korea
R.-D. Lee
Hanbat National University, Daejoen, Republic of Korea

**4BV.4.14** **Heating of Urban Environments by Photovoltaic Modules**
M. Mittag
Fraunhofer ISE, Freiburg, Germany

**4BV.4.15** **Towards Highly Efficient Multifunctional Photovoltaic Windows**
S. Villa & R. Valckenborg
TNO, Eindhoven, The Netherlands
N. Guillevin
TNO, Petten, The Netherlands
D. Out
TNO, Den Haag, The Netherlands
M. Ribberink
Pilkington Netherlands, Enschede, The Netherlands

**4BV.4.16** **Long-Term Large-Scale Performance Testing and Comparison of Plasmonic Luminescent Solar Concentrator Devices**
A. Glenn, S. Chandra & S. McCormack
Trinity College Dublin, Ireland

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**4BV.4.17** **A Study on the Development of Building Photovoltaic Information Modeling (PIM) Algorithm for BIPV Design and the Establishment of Open Library**
H. Jeon & K. Choi
BIMS, Seoul, Republic of Korea

**4BV.4.19** **Indications of Early Climate Change Impacts Revealed within Weather Files for Predicting Photovoltaic System Performance in Europe**
D. D'Agostino
European Commission JRC, Ispra, Italy
D. Parker
Florida Solar Energy Center, Cocoa, USA

**4BV.4.20** **Development of Technical Guidelines and Rules for Building-Integrated PV Systems (BIPV)**
R. Haselhuhn, J. Sting & B. Müller
DGS, Berlin, Germany

**4BV.4.21** **Examining the Applicability of End-of-Life (EoL) Photovoltaic (PV) Panels as a Building Material**
R.R. Rao & M. Mani
Indian Institute of Science, Bangalore, India

**4BV.4.22** **Studying Interventions to Regulate Indoor Hygrothermal Comfort in Building Integrated with End-of-Life (EoL) PV Panels**
S. Priyadarshani, R.R. Rao & M. Mani
Indian Institute of Science, Bangalore, India

**4BV.4.23** **Color Properties and Cell-to-Module (CTM) Losses of Colored Building-Integrated Photovoltaic Modules**
D. Reinwand, A. Wessels, L.E. Alanis, M. Antonios, T. Kroyer & M. Heinrich
Fraunhofer ISE, Freiburg, Germany

**4BV.4.24** **Power Flow Algorithm to the Optimization of On-Grid PV Buildings with or without Backup Storage**
K. Alves e Silva, L.M. Carrasco & A.L. Mata
UPM, Madrid, Spain

**4BV.4.25** **Bifacial BIPV Balustrades - Shadowing, Performance and Benefits**
F. Parolini, G. Friesen, E. Özkalay, P. Bonomo & F. Frontini
SUPSI, Mendrisio, Switzerland
T. Del Caño, E. Rico & J. Jimenez
Onyx Solar Energy, Avila, Spain

**4BV.4.26** **BIPV Elements for Prefabricated Prefinished Volumetric Construction**
C. Clement, T.S. Liang & S.W. Leow
SERIS, Singapore, Singapore

**4BV.4.27** **Simulation of the Performance of a PV-Façade by Different Shading Varations – a Study by the Stagimo-Project**
J. Sting, R. Haselhuhn & B. Müller
DGS, Berlin, Germany

**4BV.4.28** **Comparative Analysis of Fireproof Performance According to the Type of BIPV Module (GtoG, GtoB)**
E. Ryu, K.-J. Kim, D. Kim, B. Cho & J.-J. Choi
KCL Korea Conformity Laboratories, Chungbuk, Republic of Korea

**4BV.4.46** **Design of Highly Luminescent BBeta-Diketonate-Based Europium Complexes for Luminescence Solar Concentrators**
O. Essahili, M. Ilsouk, M. Ouafi & O. Moudam
Mohammed VI Polytechnic University, Ben Guerir, Morocco

**4BV.4.47** **Reliability of High Efficiency PERC Solar Cells for Space Applications**
M.-A. Tsai, Y.-S. Long, C.F. Hsieh & T.-C. Wu
ITRI, Hsinchu, Taiwan

## VISUAL PRESENTATIONS 1BV.5

**17:00 – 18:30** **Silicon Material for Solar Cells and its Defects / Fabrication and Production of c-Si Silicon Solar Cells and Related Tools & Processes**

**1BV.5.1** **Student Awards Finalist Presentation: Investigation of OH Distribution in Fused Quartz Crucibles for Czochralski Silicon Ingots by IR-Microscopy**
G.K. Warden, A. Erbe & M. Di Sabatino
Norwegian University of Science and Technology, Trondheim, Norway
P. Ebbinghaus & M. Rabe
MPI, Düsseldorf, Germany
M. Juel
SINTEF, Trondheim, Norway
B.A. Gaweł
The Quartz Corp, Drag, Norway

**1BV.5.2** **Simultaneous Optimization of Crystal Growth Furnace and Process Using Crystal Growth Simulation and Machine Learning**
H. Tanaka, X. Liu, T. Kojima & N. Usami
Nagoya University, Japan
K. Kutsukake
RIKEN, Tokyo, Japan

**1BV.5.3** **Investigation of Process Parameters on the Distribution of the Specific Resistivity in Ga-Doped Cz-Crystals**
F. Mosel, K. Hess & B. Klipp
PVA Crystal Growing Systems, Wettenberg, Germany

**1BV.5.4** **Characterization and Hydrometallurgical Treatment of Industrial Si-Kef**
T. Mubaiwa & J. Safarian
NTNU, Trondheim, Norway

**1BV.5.5** **Development and Improvement of Methods for Reducing Contamination of Silicon-Kerf from Wafer Slicing**
R. Riva, M. Landa - Pliquet & F. Coustier
CEA, Le Bourget du Lac, France

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**1BV.5.6** **Towards Highly Efficient Low Carbon Footprint Solar Cells: Impact of High Temperature Processing on Epitaxially Grown p-Type Silicon Wafers**
C. Rittmann, P. Messmer, M. Drießen, A. Richter, C. Weiss, M.C. Schubert, S. Janz & F. Schindler
Fraunhofer ISE, Freiburg, Germany
Y.P. Botchak, S. Sanz-Alonso & B. Terheiden
University of Konstanz, Germany
T. Niewelt
The University of Warwick, Coventry, United Kingdom

**1BV.5.7** **Influence of Surface Texturing on Three-Dimensional Flexibility of c-Si Wafer**
K. Ide, T. Nishihara & A. Ogura
Meiji University, Kawasaki, Japan
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
T. Kawatsu & T. Nagai
Komatsu NTC, Nanto, Japan
N. Yamada & H. Kobayashi
Nagaoka University of Technology, Japan

**1BV.5.8** **Determination of Bulk Carrier Lifetime of Silicon Ingots Using Photoconductance Decay Measurement**
D. Krisztián, F. Korsós & K. Szöke
SEMILAB, Budapest, Hungary
S. Fu
SEMILAB, Shanghai, China

**1BV.5.9** **Impact of Hydrogen in Ga-Doped Silicon on Maximum LeTID Defect Density**
R. Zerfaß, J. Simon, A. Herguth & G. Hahn
University of Konstanz, Germany

**1BV.5.10** **Influence of Different Aluminum Concentrations in Cz-Si Wafers on LeTID**
M. Mehler, A. Zuschlag & G. Hahn
University of Konstanz, Germany
M. Trempa
Fraunhofer IISB, Erlangen, Germany
T. Buck
ISC Konstanz, Germany

**1BV.5.11** **Effects of Carbon and Oxygen in Si on Degradation of Carrier Selective Contact Cell Performance**
Y. Ohshita, K. Kimura & T. Hara
Toyota Technological Institute, Nagoya, Japan
T. Nishihara & A. Ogura
Meiji University, Kawasaki, Japan

**1BV.5.12** **Minority Carrier Trapping Effects in Mono-Crystalline Silicon**
V.P. Markevich, T.O. Abdul Fattah, M.P. Halsall & A.R. Peaker
University of Manchester, United Kingdom

**1BV.5.13** **“Solar Wafer Inspection- What for?” or “The Real Impact of Wafer Defects on Cell Lines Yield”**
A. Schlezinger
Applied Materials, Santa Clara, USA

**1BV.5.14** **Development of Low-Cost High-Efficient and Reliable UMG PV Cells**
C. del Cañizo, D. Fuertes Marrón & N. Dasilva-Villanueva
UPM, Madrid, Spain
B. Arıkan, H.H. Canar, R. Turan, H. Asav & A.E. Keçeci
ODTÜ-GÜNAM, Ankara, Turkey
G. Sánchez-Plaza
UPV, Valencia, Spain
L. Mendez, M. Funes & E. Forniés
Aurinka PV Group, Madrid, Spain

**1BV.5.15** **Assessing the Potential of TOPCon Solar Cells Architecture using Industrial n-Type Cast-Mono Silicon Material**
B. Bazer-Bachi, S. Williatte & G. Goaer
Photowatt, Bourgoin-Jallieu, France
P. Saint-Cast, C. Teßmann & S. Mack
Fraunhofer ISE, Freiburg, Germany
J. Posada & R. Bodeux
EDF R&D, Palaiseau, France

**1BV.5.24** **Half-Cell Product Characterization on Laser Dicing Process**
S. Hwang, H.-S. Lee & Y. Kang
Korea University, Seoul, Republic of Korea
D. Suh
Hoseo University, Chungnam, Republic of Korea

**1BV.5.25** **Progress on Screen-Printed Metallization by Improving the Screen Manufacturing Process with Laser Technology**
A. Nair, A. Nägele, M. Linse, D. Witt, A.A. Brand, A. Lorenz, S. Kühnhold-Pospischil, S. Tepner & F. Clement
Fraunhofer ISE, Freiburg, Germany
A. Künkele & S. Wagner
Kissel and Wolf, Wiesloch, Germany

**1BV.5.26** **Influence of Hydrogen During Sputtering of Aluminum-Doped Zinc Oxide for Silicon Heterojunction Solar Cells**
M.A. Yaqin, W. Duan, A. Lambertz, K. Bittkau & K. Ding
Forschungszentrum Jülich, Germany
K. Zhang & U. Rau
RWTH Aachen University, Germany

**1BV.5.27** **Deposition of Alternative Materials for Selective Contacts of Novel Heterojunction Solar Cells by High-Pressure Sputtering**
F. Pérez-Zenteno, E. San Andrés Serrano, E. Garcia-Hemme, R. Benítez, G. Godoy, D. Caudevilla, S. Duarte, R. García-Hernansanz, J. Olea, D. Pastor & A. del Prado
UCM, Madrid, Spain
I. Torres & R. Barrio
CIEMAT, Madrid, Spain

**1BV.5.28** **Enabling Thermal Laser Separation of Silicon Wafers While Interconnected with Aluminum Foil**
M. Melati Menegassi, J. Paschen, A. Brand, G. Emanuel, O. John & J. Nekarda
Fraunhofer ISE, Freiburg, Germany

**1BV.5.29** **Investigation of the PERC Solar Cell Performance from the Perspective of the Dark Saturation Current Densities: J0e and J0e-met**
H. Asav, S. Aslan, H.H. Canar, A.E. Keçeci, V. Ünsür, B. Arıkan & R. Turan
ODTÜ - GÜNAM, Ankara, Turkey

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**1BV.5.30** **Production PERC Solar Cell Loss Analysis and Efficiency Improvement up to 22.8%**
M. Kahraman, O. Yigit, B. Gümüs Çiftci & M. Aslan
Kalyon Günes Teknolojileri, Ankara, Turkey
E. Han
Kalyon Günesş Teknolojileri, Ankara, Turkey
M. Raval
RCT Solutions, Konstanz, Germany

**1BV.5.31** **High-Rate Spatial Atomic Layer Deposition for Perovskite Based Solar Cell Production**
B. van de Loo, F. Souren, H. de Vries & E. Kremers
SALD, Eindhoven, The Netherlands

**1BV.5.32** **Elaboration and Characterization of Silicon Nanostructures for Photovoltaic Applications**
I. Ngom & D. Kobor
UASZ, Ziguinchor, Senegal

**1BV.5.33** **Investigation on Encapsulated Graphene/Silicon Solar Cells**
L. Lancellotti, E. Bobeico, V. Fiandra, L. Sannino, C. Andreozzi & P. Delli Veneri
ENEA, Portici, Italy
R. Chierchia & N. Lisi
ENEA, Rome, Italy

**1BV.5.34** **Metallization of Solar Cells by the Lift-Induced Forward Transfer Technique**
C. Munoz-Garcia, D. Canteli, J.M. Molla & C. Molpeceres
UPM, Madrid, Spain
I. Torres & J.J. Gandía
CIEMAT, Madrid, Spain

**1BV.5.35** **Impact of the Front Side Multi Anti-Reflection Coating Layer on PERC Solar Cells**
C.-W. Kuo, T.-M. Kuan, Y.C. Li, C.-W. Lee, W.-L. Chueh, L.-G. Wu, S.-C. Lin & C.-Y. Yu
TSEC, Hsinchu, Taiwan

**1BV.5.36** **High Power Impulse Magnetron Sputtering for Large Area Hard Transparent Coatings**
A.W. Oniszczuk, P. Rozanski & W. Gajewski
TRUMPF Hüttinger, Zielonka, Poland
A.P. Ehiasarian & P.E. Hovsepian
HIPIMS, Sheffield, United Kingdom
D. Loch
TRUMPF Hüttinger, Freiburg, Germany

**1BV.5.37** **Investigation of Contact Formation on Locally Laser-Doped Surfaces on a Microscopic Scale**
D. Wurmbrand, H. Plagwitz, G. Hahn & B. Terheiden
University of Konstanz, Germany

**1BV.5.38** **New Prototype Intense Pulse Light Device with Full Solar Cell Area Illumination for Drying and Curing of Silicon Heterojunction Solar Cells**
D. Ourinson, D. Erath, A. Lorenz & F. Clement
Fraunhofer ISE, Freiburg, Germany
M. Lion
Botest Systems, Kreuzwertheim, Germany
M. Drews
ASYS, Dornstadt, Germany

**1BV.5.39** **Plasma Texturing of Multiple Kerf-Less Separated Ultra-Thin Silicon Layers**
A. Okhorzina, R. Schalinski & N. Bernhard
Anhalt University of Applied Sciences, Köthen, Germany
S.L. Schweizer
Martin Luther University Halle-Wittenberg, Halle (Saale), Germany

**1BV.5.40** **Using the Enhanced Oxidation Rates under Locally Laser-Doped N+ Regions for Self-Masking and Patterning the IBC Solar Cells**
V.V. Kuruganti & V.D. Mihailetchi
ISC Konstanz, Germany
O. Isabella
Delft University of Technology, The Netherlands

**1BV.5.41** **A Sustainable and Fast Silicon Texturization Process Driven by Lignosulfonates**
R. Barrio, I. Torres & N. González
CIEMAT, Madrid, Spain
G. Godoy
UCM, Madrid, Spain
R. Ellis
BORREGARD, Sarpsborg, Norway

**1BV.5.42** **Challenges and Advantages for Cut Solar Cells for Shingling and Half-Cell Modules**
J.D. Huyeng, E. Lohmüller, T. Rößler, B. Shabanzadeh, C. Reichel, J. Weber, M. Hofmann, D. von Kutzleben, N. Abdel Latif, A. Kraft, D.H. Neuhaus, F. Clement & R. Preu
Fraunhofer ISE, Freiburg, Germany

**1BV.5.44** **Numerical and Experimental Investigation of Sustainable Rinsing Processes for Silicon Solar Cell Manufacturing**
L. Emmer, G. Isele, M. Zimmer & K. Krieg
Fraunhofer ISE, Freiburg, Germany

**1BV.5.45** **Gas-Immersion Laser-Doped Silicon Tunnel Junctions for Multi-Junction Solar Cells**
G. Gaspar, F. Serra, J.M. Almeida Serra & K. Lobato
IDL, University of Lisbon, Portugal
F. Geml & G. Hahn
University of Konstanz, Germany
J. Kern & M. Müller
Technical University Bergakademie Freiberg, Germany
L. Vines
University of Oslo, Norway
A. Fave
INSA Lyon, Villeurbanne Cedex, France



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**VISUAL PRESENTATIONS 4CV.1**

**13:30 – 15:00** **Performance and Monitorisation of PV Systems**

**4CV.1.1** **Making Equation-Based Thermal Models Dynamic: The Filter-EWM-MBE (FEM) Correction Approach**
B. Herteleer, A. Kladas & J. Cappelle
KU Leuven, Ghent, Belgium

**4CV.1.2** **PCS Unit Based Faulty Modules Detection Using Poisson Distribution of PCS Current Frequency Distribution in a Large-Scale PV Power Plants**
K. Takino
Tokyo Univeristy of Science, Japan
A. Sadono
Looop, Tokyo, Japan
Y. Ueda
Tokyo University of Science, Japan

**4CV.1.3** **Data-Driven Detection and Comparison of Soiling Losses for Commercially Operated Roof-Top Power Plants in Germany**
D. Melgar, N. Holland, A. Heimsath & K. Kiefer
Fraunhofer ISE, Freiburg, Germany
E. Sarquis Filho & B. Müller
Enmova, Freiburg, Germany
B. Kollosch
Pohlen Solar, Geilenkirchen, Germany

**4CV.1.4** **Evaluating the Accuracy of Inverter-Based String IV Measurements**
M. Bartholomäus, L. Morino, P. Poulsen & S.V. Spataru
DTU, Roskilde, Denmark

**4CV.1.5** **Health Monitoring of Solar Photovoltaic Plants**
G. Anamiati, G. Guerra & P. Mercade Ruiz
DNV, Barcelona, Spain
L. Landberg
DNV, Hellerup, Denmark

**4CV.1.6** **Band-Pass Filter Optimization to Remove Sunlight Reflection in Daylight Electroluminescence Imaging of PV Modules**
G.A.D.R. dos Reis Benatto, T. Kari, R. del Prado Santamaría, P.B. Poulsen & S.V. Spataru
DTU, Roskilde, Denmark

**4CV.1.7** **Daylight Electroluminescence Imaging Methodology Comparison**
G.A.D.R. dos Reis Benatto, T.K. Hass, R. del Prado Santamaría & S. Spataru
DTU, Roskilde, Denmark
C. Terrados, D. González Francés, V. Gómez-Alonso, J. Anaya, M.A. González & O. Martínez
UVa, Valladolid, Spain

**4CV.1.8** **Impact of Adverse Weather Events on Photovoltaic Modules' Performance - Case Study of Polycrystalline Silicon Modules at Alice, Eastern Cape, South Africa**
O.A. Alimi, E.L. Meyer, O.I. Olayiwola & O.K. Overen
University of Fort Hare, Alice, South Africa

**4CV.1.9** **PV System Performance and Economic Analysis of PERC, HIT, and CIGS Module Technologies in Peru**
J. Angulo, A. Berastain, A. Carhuavilca, L. Conde, M. Cataño, L.C. Garcia & J.A. Palomino Töfflinger
PUCP, Lima, Peru
V. Pleshcheva
ESMT Berlin, Germany
E. Muñoz & J. de la Casa Higueras
University of Jaén, Jaen, Spain

**4CV.1.10** **Polymer Degradation in Different Climate Zones - Impact on Performance and Operation in South Africa and Germany**
C. Buerhop-Lutz, O. Stroyuk, E. Wittmann & I.M. Peters
HI ERN, Erlangen, Germany
E.E. van Dyk, M. Vumbugwa, F.J. Vorster & J.L. Crozier McCleland
NMU, Port Elizabeth, South Africa

**4CV.1.11** **Shadow Detection and Classification in Photovoltaic Installations with Learnable Neural Networks**
E. Wittmann, C. Buerhop-Lutz & J. Hauch
HI ERN, Erlangen, Germany
V. Christlein, C. Brabec & I.M. Peters
FAU, Erlangen, Germany

**4CV.1.12** **Towards Climate-Specific O&M for PV Plants: Guidelines and Best Practices**
I.A. Tsanakas
CEA, Le Bourget-du-Lac, France
B. Herteleer
KU Leuven, Belgium
U. Jahn
VDE Renewables, Alzenau, Germany

**4CV.1.13** **Unmanned Aerial Vehicle (UAV) Decision-Making for Photovoltaic (PV) Plant Diagnostics Using Image and Electrical Data Analysis**
A. Livera, A. Michail & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
J.L. Carús Candás & D. Fernández Martínez
TSK, Gijón, Spain
A. Antonopoulos, G. Petrakis, A. Tripolitsiotis, P. Partsinevelos & E. Koutroulis
Technical University of Crete, Chania, Greece

**4CV.1.14** **Towards a More Robust Performance Loss Rate Estimate: Minimising the Uncertainty in the Analysis of Photovoltaic System Degradation**
H. Quest & C. Ballif
EPFL, Neuchâtel, Switzerland
A. Virtuani
CSEM, Neuchâtel, Switzerland

**4CV.1.15** **Classification of Photovoltaic Faults Using a Novel Deep Learning Architecture**
E.J. Westraadt, C.M. Clohessy, W.J. Brettenny & E.E. van Dyk
Nelson Mandela University, Port Elizabeth, South Africa

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**4CV.1.16** **PV Module Temperature Estimations Using Inverter Data**
P. Raux & L. Sauvage
Ener-Pacte, Lyon, France

**4CV.1.17** **Electroluminescence in Multiple Modules on Tracker in the Field: Massive Efficient Polarization**
L.A. Carpintero Gómez
Cobra Instalaciones y Servicios, Madrid, Spain
C. Terrados, D. González Francés, O. Martínez, M.A. Gonzalez Rebollo & V. Gómez-Alonso
University of Valladolid, Spain

**4CV.1.18** **Fluorinated Multi-Layer Backsheets with Inner Crack Structures**
C. Buerhop-Lutz, O. Stroyuk, B. Doll & I.M. Peters
HI ERN, Erlangen, Germany
P. Stephan
Aquila Clean Energy, Hamburg, Germany

**4CV.1.19** **Image Quality Evaluation of Contactless Outdoor Photoluminescence Based on String Inverter's IV Curve Sweep**
G.A. dos Reis Benatto, R. del Prado Santamaría & S.V. Spataru
DTU, Roskilde, Denmark
M. Vukovic, M.S. Marjavara, E. Olsen & I. Burud
NMBU, Ås, Norway

**4CV.1.20** **Soiling Losses in Bifacial Technology Installations in the Atacama Desert Solar Platform**
A. Taquichiri, P. Ferrada, D. Olivares, J. Rabanal-Arabach, E. Fuentealba-Vidal & C. Portillo
University of Antofagasta, Chile

**4CV.1.21** **Smart Monitoring of Photovoltaic Plants with Cloud Computing and IoT Using Machine Learning**
M. Emamian, A. Eskandari, A. Nedaei & J. Milimonfared
Amirkabir University of Technology, Tehran, Iran
A.M. Moradi Sizkouhi
Concordia University, Montréal, Canada
M. Aghaei
University of Freiburg, Germany

**4CV.1.22** **Soiling and Irradiance Measurement for Bifacial PV Using In-Situ I-V**
M. Gostein & A. Marquis
Atonometrics, Austin, USA
M. Bila & R. Campbell
EDF Renewables, San Diego, USA

**4CV.1.23** **Verification of Photovoltaic System Configuration**
O. Osvald, M. Garaj, A. Skoczek & T. Cebecauer
Solargis, Bratislava, Slovakia

**4CV.1.24** **Solar Photovoltaic Array Operational Fault Analysis with Machine Learning Using Pretrained Deep Learning Models for Feature Selection**
T.M. Zenebe, O.-M. Midtgård, S. Völler & B.D. Dimd
NTNU, Trondheim, Norway

**4CV.1.25** **Degradation Analysis of Small-Scale PV Systems under Different Climatic Conditions**
G. Papageorgiou, D. Buß, R. Zimmermann, M. Queck & M. Koentopp
Hanwha Q Cells, Bitterfeld-Wolfen, Germany
M. Norton, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

**4CV.1.26** **On the Impact of PV Module Faults Observed by Infrared Thermography on Power Production of a Utility Scale Power Plant**
B.L. Aarseth, M.M. Nygård, G. Otnes & E.S. Marstein
Institute for Energy Technology, Kjeller, Norway

**4CV.1.27** **Fault Diagnosis of Grid-Connected Photovoltaic Systems Based on Semi-Supervised Ensemble Clustering and Multi-Layer Perceptron Model**
M. Zargarani
Espace-Dev, Cayenne, French Guiana
S. Zermani, C. Mahamat & L. Linguet
University of French Guiana, Cayenne, French Guiana

**4CV.1.28** **Aging Analysis of Si PV Modules Using Finite Element Model with Extracted Parameters**
J. Zhang, S. Cao & K. Ding
Hohai University, Changzhou, China
L. Feng & F. Hamelmann
University of Applied Sciences Bielefeld, Minden, Germany

**4CV.1.29** **PV String Fault Diagnosis Technology Using I-V Curve Images and Transfer Learning with Pre-Trained CNN**
W.-G. Shin, S.-H. Bae, Y.-C. Ju, H.-M. Hwang & S.-W. Ko
KIER, Daejeon, Republic of Korea

**4CV.1.30** **Analysis of the Thermal Behaviour of a Mismatched Module in a String**
M. Vumbugwa, E.E. van Dyk, F.J. Vorster & J.L. Crozier McCleland
NMU/ PVinsight, Port Elizabeth, South Africa

**4CV.1.31** **Modelling the Normal Operation of PV Inverters under the Absence of Maintenance Logs**
P. Mercade Ruiz, G. Guerra & G. Anamiati
GreenPowerMonitor, Barcelona, Spain
L. Landberg
DNV Denmark, Hellerup, Denmark

**4CV.1.32** **Design and Operation of the First Large Linear Vertical Bifacial PV Plant in France**
H. Colin
CEA, Le Bourget-du-Lac, France
A. Benefice
CNR, Lyon, France

**4CV.1.33** **Home Assistant: a Valuable Tool for Energy Management in Self-Consumption PV Systems**
M. Alonso-Abella
CIEMAT, Madrid, Spain

**4CV.1.34** **PV DC Array Fault Diagnosis Using Classification Machine Learning with k-NN Algorithm**
S.W. Ko, W.G. Shin, H.-M. Hwang & Y.-C. Ju
KIER, Daejeon, Republic of Korea

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**4CV.1.35** **Soiling Losses Modeling for PV Modules in the South of Spain**
S.P. Noelia & J. Alonso-Montesinos
University of Almeria, Spain
J. Polo
CIEMAT, Madrid, Spain
G. López Rodríguez
University of Huelva, Spain

**4CV.1.36** **Supervision of PV-Systems Composed of Similar Subsystems, Based on Cross-Check – Discussed for the Example of an Array of Subsystems in ΔTriangular-Type Configuration**
H.G. Beyer
University of the Faroe Islands, Torshavn, Faroe Islands

**4CV.1.37** **A GIS Application for Managing a Photovoltaic Plant: First Advances**
A. de Sousa Cardoso, M.I. Ramos Galán, J.M. Jurado Rodríguez &
F. Feito Higueruela
University of Jaen, Spain

**4CV.1.38** **Performance Differences of Individual Modules in a PV Array**
L. Feng & F.U. Hamelmann
Bielefeld University of Applied Sciences, Minden, Germany
N. Amin
National Energy University, Kajang, Malaysia
J. Zhang & K. Ding
Hohai University, Changzhou, China

**4CV.1.39** **PV Modules Electrical Parameters and Thermal Coefficient Degradation: Effects on Current Mismatch and Strings Perfomances for LCOE Calculation**
S. Licciardello, A. Di Stefano, D. Ferlito, S. Scalia, F. Bizzarri, L. Todaro &
A. Canino
ENEL Green Power, Catania, Italy

**4CV.1.40** **In-Operation Energy Audit to Support BIPV Sustainability and Reliability**
S. Boddaert, S. Thebault & A. Mathieu
CSTB, Sophia Antipolis, France
L. Prieur
CERTISOLIS, Le Bourget-du-Lac, France
D. Trebosc
BDPV, Castanet Tolosan, France

**4CV.1.41** **Artificial Neural Network Based Power Prediction Method for a Photovoltaic Power Plant**
H. Assem, N. Belhaouas, F. Hadjrioua & K. Bakria
CDER, Bouzareah-Algiers, Algeria
F. Bouachafa
UHSTB, Bouzareah-Algiers, Algeria
T. Azib
ESTACA, Montigny-le-Bretonneux, France

**4CV.1.42** **Photovoltaic Inspection Tool for Solar Panels Defects Detection in the Field**
D.J. Castillo Patton, A.B. del Pozo, F. García Fernández, L. Viani,
I.J. Fernández López & S. Rodríguez-Conde
Enertis Applus+, Madrid, Spain

**4CV.1.43** **Challenges of Aerial Drone Electroluminescence in Solar Photovoltaic Field Inspections**
R. del Prado Santamaría, G. dos Reis Benatto, T. Kari, L. Morino, P. Poulsen & S.V. Spataru
DTU, Roskilde, Denmark

**4CV.1.44** **Performance Analysis with Risk Identifications and its Economic Impact on PV Plant in Harsh Climates: Baghdad_Site Case**
M.A. Hameed
Ministry of Oil, Baghdad, Iraq
R. Scheer
Martin Luther University, Halle (Saale), Germany
Q.M. Alias
Retired Faculty Member Consultant Electrical Engineer, Baghdad, Iraq
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

**4CV.1.45** **A Two-Step Procedure to Assess Photovoltaic Module Performance**
A. Sabadus & M. Paulescu
West University of Timisoara, Romania

**4CV.1.46** **Analysis of the Tilt and Azimuth Angles Variations on Incident Solar Irradiance for Tropical Sites in Brazil**
E. Mahmoudi, M. Gradella Villalva, T.A. Barros & F.C. Marques
UNICAMP, Campinas, Brazil
H. da S. Alvarez & R. Moreno Garcia
BYD Energy R&D from Brazil, Campinas, Brazil

**4CV.1.47** **Artificial Intelligence for Photovoltaic Power Production Forecasting**
Y. Toughyaoui, H. Louahlia, R. Petrone, H. Obeid & H. Gualous
University of Caen Normandy, Saint-Lô, France

**4CV.1.48** **Intelligent Fault Diagnosis Algorithm for Photovoltaic Using Cross-Validation Based Selecting a Classification Method**
Y.H. Kim, J.-M. Moon, M.-J. Oh, S.W. Kim, S.-Y. Jang, D.Y. Chung, S.-I. PArk, J. Jeon, M. Kim & M. Son
Korea Photonics Technology Institute, Bukgu, Republic of Korea

**4CV.1.49** **Characterization of Micro-Converter on Partial Shading for the Operation and Maintenance of Photovoltaic Power Plant**
J. Kim & C. Kim
Green Energy Institute, Mokpo, Republic of Korea
J.-H. Kim
Chonnam National University, Gwangju, Republic of Korea
J. Lee
WP, Suncheon, Republic of Korea

**4CV.1.50** **Validation of Photovoltaic Plant Loss Estimation from Monitoring Data: String Faults, Shading and Degradation**
K. de Brabandere, M. Nikam, J. Deckx & G. Chowdhury
3E, Brussels, Belgium

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**4CV.1.51** **Potential of a Smart Residual Current Monitoring System for Electric Arc Recognition in PV Systems**
W. Dirksen
DLR Institute of Networked Energy Systems, Oldenburg, Germany
W. Weihs-Sedivy & D. Millinger
Twingz Development, Vienna, Austria
A. Javornik
Pointar, Skofja Loka, Slovenia
G. Roolfs
Doepke Schaltgeräte, Norden, Germany

**4CV.1.52** **Rear-side Irradiance Measurement for Bifacial PV Systems: A Case Study of Different Sensor Installation Setups**
L. Valverde, J. Muñoz, I. Meyer & C. Thawanyavitchajit
Mott MacDonald, Madrid, Spain

## VISUAL SESSION 2CV.2

**15:15 – 16:45** **Compound and Organic Semiconductors**

**2CV.2.1** **Effect of Ag-Ge Double Cation Substitution on Optoelectronic Properties of Cu2ZnSn(S,Se)4 Thin Film Solar Cell**
V.C. Karade & J.H. Yun
KIER, Naju, Republic of Korea
K. Kim
KIER, Daejeon, Republic of Korea
J.H. Kim
Chonnam National University, Gwangju, Republic of Korea

**2CV.2.2** **The Impact of Different Spin Coating Acceleration Indexes on the Properties of Cu2ZnSnS4 Nanocrystal Thin Films**
A. Alluhaybi, D.P. Halliday & M. Szablewski
Durham University, United Kingdom

**2CV.2.3** **Development of Fabrication Process for Electroplated CZTS Absorber**
I. Mizushima & P.T. Tang
IPU, Virum, Denmark

**2CV.2.4** **A Novel Two-Stage Hybrid Process towards Wide Spreading of CIGS Solar Cell Industry with Materially Efficient Fabrication**
S. Song, S. Lee, A. Cho, I.-C. Hwang, S.K. Ahn, K. Kim, I.-Y. Jeong, J.S. Yoo, J.S. Cho, S.J. Ahn, J.H. Park, D. Shin, A. Lee, J. Gwak & Y.-J. Eo
KIER, Daejeon, Republic of Korea

**2CV.2.5** **Application of Thin Film Organic Photovoltaics in Greenhouses**
M. Teitel, R. Grimberg, M. Friman-Peretz, S. Ozer, H. Vitoshkin & A. Levi
VOLCANI Center, Rishon LeZion, Israel
I. Yehia & E. Magadley
TRDC, Kfar-Qari, Israel
S. Gantz & R. Amir
Agricultural Extension Service, Ministry of Agriculture, Rishon LeZion, Israel
A. Levy
Ben-Gurion University of the Negev, Beer-Sheva, Israel
F. Geoola
ARO, Rishon LeZion, Israel

**2CV.2.6** **Influence of Oxygen Content on the Properties of Sputtered In2(OxS1-X)3 Used as Buffer Material in Cu(In,Ga)Se2-Based Solar Cells**
W. Witte, R. Menner & D. Hariskos
ZSW, Stuttgart, Germany
E. Ghorbani & K. Albe
Technical University of Darmstadt, Germany
X. Jin, R. Schneider & D. Gerthsen
Karlsruhe Institute of Technology, Germany

**2CV.2.7** **Fabrication of Thin Film Back-Contact GaAs Solar Cells with Indium Tin Oxide Transparent Electrode**
J.W. Jeong
Gwangju Institute of Energy Technology, Republic of Korea
H.-B. Shin & H.K. Kang
KANC, Suwon, Republic of Korea
J.-B. Kang & J.H. Jang
Korea Institute of Energy Technology, Naju-si, Republic of Korea

**2CV.2.8** **Revealing the Role of Ag Alloying in Metal Precursors in Kesterite Thin Films and Solar Cells**
M. He, J. Li & X. Hao
UNSW, Sydney, Australia
J.H. Kim
Chonnam National University, Gwangju, Republic of Korea

**2CV.2.9** **Electron and Hole Transport Oxide Layers Combined into All-Oxide Cells**
T. Dimopoulos, R.A. Wibowo & S. Edinger
AIT, Vienna, Austria

**2CV.2.10** **Patterned Epitaxial Lift-off Process for GaAs Solar Cells with High Under-Etching Rate**
J. Lee & S. Jo
Kyungpook National University, Daegu, Republic of Korea
H.-B. Shin & H.K. Kang
KANC, Suwon, Republic of Korea

**2CV.2.11** **Electrically Conductive Optical Notch Filters for Colorful Transparent Electrode Layers in Thin-Film Solar Cells**
D.-H. Cho, W.-J. Lee, T.-H. Hwang & Y.-D. Chung
ETRI, Daejeon, Republic of Korea

**2CV.2.12** **New Concept of Specific-Orientational WSe2 Layered Structure to Passivate Back Contact of Cu(In,Ga)Se2 Thin Film Solar Cell**
J.-N. Liu, C.-C. Chung, L.-H. Tu, T.-Y. Yang, Y.-L. Cheuh & C.-H. Lai
NTHU, Hsinchu, Taiwan

**2CV.2.13** **Design and Fabrication of Mesh-Type Transparent Cu2ZnSn(S, Se)4 Thin-Film Solar Cells Using Photolithography**
J.-S. Kim, K.-P. Kim & D.-S. Lee
GIST, Gwangju, Republic of Korea

**2CV.2.14** **Characterization of Germanium Based Thin Films Deposited by PECVD for Multijunction Solar Cell Fabrication**
P. Perez-Rodriguez, D. Sharma, G. Limodio & A.H.M. Smets
Delft University of Technology, The Netherlands

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**2CV.2.15** **Study of the Thermal Reliability of Copper Nitride Deposited by Magnetron Sputtering for the Next Generation of Eco-Friendly Solar Absorbers**
M.I. Rodríguez Tapiador, J.P. González & S. Fernández
CIEMAT, Madrid, Spain
M. Vazquez
Rey Juan Carlos University, Madrid, Spain
N. Gordillo
UAM, Madrid, Spain
J.M. Asensi & J. Bertomeu
University of Barcelona, Spain

**2CV.2.16** **Reducing Shading Effects in CPV Solar Cells with Advanced Contact Finger Design**
T. Schweigstill, L. Stevens, A. Lebowsky, M. Steiner, F.D. Heinz, R. Müller, F. Dimroth & O. Höhn
Fraunhofer ISE, Freiburg, Germany

**2CV.2.17** **Effects of the Sulfur-Incorporated Mo(S, Se)2 Formed During the Sulfurization Process at the Mo/Cu(In, Ga)(S, Se)2 Interface**
Y.L. Chang, L.-H. Tu, C.-C. Chung, S.-K. Lin, J.H. Siew, T.-Y. Yang & C.-H. Lai
NTHU, Hsinchu, Taiwan

**2CV.2.18** **The Effect of CdCl2 Treatment on the Performance of TiO2/Sb2Se3 Solar Cells**
A. Naujokaitis & R. Kondrotas
Center for Physical Sciences and Technology, Vilnius, Lithuania
M. Kauk-Kuusik
Tallinn University of Technology, Estonia
P. Zabierowski & P. Spiewak
Warsaw University of Technology, Poland

**2CV.2.19** **Alternative Preconditioning by Utilization of a Thin Film Module's Dark Diode Fingerprint**
B. Friedel & S. Winter
PTB, Braunschweig, Germany

**2CV.2.20** **Enhance Performance of CZTSSe Solar Cells through Chlorine-Based Impurity Inclusion Process**
O.K. Simya, P. Punathil, E. Artegiani, S. Zanetti, N. Torabi & A. Romeo
University of Verona, Italy

**2CV.2.21** **Post Deposition Annealing Treatment Impact on Optimized Transparent Conductive Oxide Bi-Layer Front Contact for Multijunction Thin-Film Silicon Solar Cells**
F. Saitta, P. Kalpoe, G. Padmakumar, P. Perez-Rodriguez, G. Limodio, R. Santbergen & A.H.M. Smets
Delft University of Technology, The Netherlands

**2CV.2.22** **On the Growth of Industrially Relevant CIGS Thin Films for Flexible Substrates**
S. Hamtaei, G. Brammertz, J. Poortmans & B. Vermang
imec, Genk, Belgium

**2CV.2.23** **Use of Germanium in Multi-Junction Solar Cells for High Spectral Utilization: a Case Study**
G. Padmakumar, F. Saitta, G. Limodio, S. Pullayikkodi, P. Perez Rodriguez, T. de Vrijer & A.H.M. Smets
TU Delft, The Netherlands
E.A.G. Hamers
HyET Solar, Arnhem, The Netherlands

**2CV.2.24** **Na Doping Optimization for CIGS Ultrathin Solar Cells**
A.F. Violas, J.P. Teixeira, T.S. Lopes, M.A. Curado, P.A. Fernandes & P.M.P. Salomé
INL, Braga, Portugal

**2CV.2.25** **Breakthroughs in Three Terminal Band Offset Barrier Organic/Si Tandem Solar Cells**
M.E. Gueunier-Farret, S. Chambon, G. Wantz, L. Hirsch & L. Vignau
IMS-CNRS, Talence, France
J.P. Connolly & J.-P. Kleider
CentraleSupelec, Gif sur Yvette, France
P. Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France

**2CV.2.26** **Development of Monolithically Integrated AlGaAs on Silicon for Tandem Solar Cells**
C. Renard, G. Chau, G. Hallais, F. Hamouda, L. Vincent & D. Bouchier
CNRS, Palaiseau, France
J.P. Connolly, A. Jaffre & D. Mencaraglia
CNRS - GeePs, Gif-sur-Yvette, France

**2CV.2.27** **Synthesis of High-Crystalline Germanium Monosulfide Films for Optoelectronics**
A. Drabavicius, R. Kondrotas, A. Naujokaitis, V. Pakštas & M. Franckevicius
Center for Physical Sciences and Technology, Vilnius, Lithuania

**2CV.2.28** **Micro-Concentrator Solar Cells: Matching Modeling and Experiments**
J. Lucaßen, S. Kidane, T. Koehler, I. Kardosh & M. Schmid
University of Duisburg-Essen, Germany

**2CV.2.29** **Highly Stable Photoactive Materials and Their Large Area Application for Organic Solar Cells**
F. Arshad, M. Haris, M. Jahankhan, C.E. Song, H.K. Lee & W. S. Shin
KRICT, Daejeon, Republic of Korea

**2CV.2.30** **Strategies to Improve the Performance of Type-II GaAsSb/GaAsN Superlattice Solar Cells: Controlling Band Alignment and Carrier Transport**
A. Gallego Carro, L. Stanojevic, M. Schwarz, S. Catalán-Gómez, D.F. Marrón, A. Guzman, A. Hierro, Z. Gacevic & J.M. Ulloa
UPM, Madrid, Spain
V. Braza, S. Flores, D. Fernández Reyes, T. Ben & D. González
UCA, Puerto Real, Spain
G. Barbieri & J.M. Llorens
IMN-CNM, Madrid, Spain
B. Alén
IMN-CNM, Tres Cantos, Spain
U. Aeberhard
Fluxim, Winterthur, Switzerland

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**2CV.2.31** **Optoelectronic Properties of Cu(In,Ga)Se2 Solar Cells with Varying Back Contacts and Functional Layers at the Rear Interface**
T. Hölscher, F.J. Prien & R. Scheer
Martin Luther University, Halle (Saale), Germany
M. Placidi, A. Thomere & A. Pérez-Rodríguez
IREC, Barcelona, Spain

**2CV.2.32** **Atmospheric Corrosion of CIGS-Based Solar Cells**
A. Debono & P. Volovitch
PSL Research University, Paris, France
A. Rebai, N. Schneider & J.-F. Guillemoles
IPVF, Palaiseau, France

**2CV.2.33** **Magnetron Sputtering of Indium-Tin Oxide (ITO) Thin Films and Investigation of Their Optical Characteristics**
A.V. Stanchik & V.F. Gremenok
NASB, Minsk, Belarus
I.I. Tyukhov
San Jose State University, USA
V.V. Khoroshko
BSUIR, Minsk, Belarus

**2CV.2.34** **Investigating the Role of Joule Heat Generation from Reverse and Forward Currents on CZTSSe Kesterite Thin Film Solar Cell by COMSOL Simulations**
A.T. Hajjiah & A.T. Haijiah
Kuwait University, Safat, Kuwait

**2CV.2.35** **ZnMgO Buffer Layer for Cu(In,Ga)Se2 Solar Cell Prepared Trough Chemical Bath Deposition**
C. Rossi & F. Soggia
University of Genoa, Italy
D.A. Garzon, S. Sadewasser & D. Colombara
INL, Braga, Portugal

**2CV.2.36** **Understanding Transient Photoluminescence in CIGS Solar Cells**
S. Güler, U. Rau & T. Kirchartz
Forschungszentrum Jülich, Germany

**2CV.2.37** **2D Phosphorene based Counter Electrode for Dye Sensitized Solar Cells**
S. Derbali
Mohammed VI Polytechnic University (UM6P), Ben Guerir, Morocco
O. Moudam
Mohammed VI Polytechnic University, Ben Guerir, Morocco

**2CV.2.38** **Role of Substrate Temperature on the Stoichiometry and Performance of Copper Nitride as an Eco-Friendly Solar Absorber**
M.I. Rodríguez Tapiador
CIEMAT, MADRID, Spain
N. Gordillo
CMAM, Madrid, Spain
J.M. Asensi & J. Bertomeu
University of Barcelona, Spain
G. Del Rosario & J. Merino
URJC, Madrid, Spain
S.M. Fernandez
CIEMAT, Madrid, Spain

**VISUAL PRESENTATIONS 1CV.3**

**17:00 – 18:30 High Temperature Routes for Si Cells / Heterojunction Solar Cells / Recent Advances in Silicon Solar Cell Characterisation**

**1CV.3.1 Localized Bifacial Passivated Contacts Solar Cell with 23.5% Efficiency**
S.-P. Hsu, C.-P. Huang, B.-C. Kung, S.-Y. Chen, M.-T. Kuo & H.-C. Chang
ITRI, Tainan, Taiwan
K.-C. Lai & C.-C. Li
Motech Industries, Tainan, Taiwan

**1CV.3.2 All-Aluminum Screen-Printed POLO Back Junction Solar Cells**
B. Min, F. Haase, T. Brendemühl, R. Peibst & R. Brendel
ISFH, Emmerthal, Germany
K. Tsuji & M. Dhamrin
Toyo Aluminium, Shiga, Japan

**1CV.3.3 Progress in Development of polyZEBRA IBC Solar Cells**
J. Linke, F. Buchholz, S. Sharbaf, J. Hoß, J. Lossen & R. Kopecek
ISC Konstanz, Germany

**1CV.3.4 Student Awards Finalist Presentation: Investigation of Ultra-Thin Solar Cells with Polysilicon Based Passivated Contacts on Both Front and Rear**
Y. Lan, P. Padhamnath, J.D. Arcebal, G. De Luna & A. Danner
National University of Singapore, Singapore

**1CV.3.5 Rear Junction Tunnel Oxide Passivated Hole Contacts Silicon Solar Cells with Selective Front Surface Field**
V.D. Mihailetchi, V.V. Kuruganti, T. Buck, S. Veerman & R. Kopecek
ISC Konstanz, Germany
C. Ebert & S. Seren
SCHMID, Freudenstadt, Germany

**1CV.3.6 Effect of Dopant Activation by Rapid Thermal Annealing or Pulsed Laser Annealing in Interdigitated Back-Contacted Solar Cells**
F.J. Pérez-Zenteno, R. Benítez, G. Godoy, D. Caudevilla, S. Duarte, R. García-Hernansanz, J. Olea, D. Pastor, A. del Prado, E. San Andrés Serrano & E. Garcia-Hemme
UCM, Madrid, Spain
I. Torres & R. Barrio
CIEMAT, Madrid, Spain

**1CV.3.7 Investigation of Wafer Quality on IBC Cell Fabrication by Using Cz Phosphorus Doped n-Type Mono-Si Ingots**
N. Yıldırım, O. Coskun, F.S. Yıldırım, E. Çamkara, B.K. Cihan, A. Parlak & K. Görgişsen
Kalyon PV, Ankara, Turkey

**1CV.3.8 Investigation of Laser Doping on the Formation of Selective Emitter Solar Cells**
S. Meziani, A. Moussi, S. Chaouchi, O. Djema & A. Guendouzi
CRTSE, Algiers, Algeria

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**1CV.3.9 Excellent Surface Passivation Quality on Full Size Crystalline Silicon Substrate Using PECVD N-a-Si:H Deposition and Thermal Annealing Process**
T. Tachibana, K. Shirasawa & K. Tanahashi
AIST, Koriyama, Japan
Y. Yuasa, N. Itou, T. Yamashita, K. Fukuchi, Y. Irie, H. Takahashi & K. Niira
Kyocera Corporation, Yasu, Japan

**1CV.3.10 Impact of SiOx Pinholes Induced by PECVD on Poly-Si Passivating Contacts**
W. Si, Z. Yao, P.A. Procel Moya, E. Özkol, M. Karaman, R. van der Kolk, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

**1CV.3.11 Aluminum Paste Metallization with Prior Local Laser Contact Opening for TOPCon Solar Cells**
D. Ourinson, A. Brand, A. Lorenz, J. Huyeng & F. Clement
Fraunhofer ISE, Freiburg, Germany
M. Dhamrin
Osaka University, Japan

**1CV.3.12 Improved P+poly-SI/SIOx Passivating Quality Enabled by Tuning Ex-Situ BBr3 Diffusion and Hydrogenation Overlayer Recipes**
Y.M. Kaplan, B. Uygun, H.H. Canar, E.H. Ciftpınar, G. Altiner, R. Turan & H. Nasser
ODTÜ-GÜNAM, Ankara, Turkey

**1CV.3.14 Impact of Alkaline Texturing Additives on Pyramid-Size, -Distribution and Cell Efficiency, for TOPCon and SHJ Cell Concepts**
B. Straub, T. Harders, D. Brunner, T. Dannenberg, J. Vollmer, A. Eljaouhari, F. Dorn & H. Kühnlein
RENA, Gütenbach, Germany

**1CV.3.15 Variation of Carrier Bulk Lifetime in n-Type Czochralski Silicon Wafers with Annealing Temperature**
S. Seyrek, G. Bektaşs, S. Aslan & R. Turan
Middle East Technical University, Ankara, Turkey

**1CV.3.16 Formation of the Spikes between Ag/Al Electrodes and c-Si Wafers Interface with Varied Firing Condition**
K.T. Jeong, J.S. Park, H.-E. Song, Y.A. Cho & M.G. Kang
KIER, Daejeon, Republic of Korea

**1CV.3.25 Light Soaking Effects in Silicon Carbide-Based Transparent Passivating Contact Solar Cells**
B. Xu, A. Eberst, W. Duan, M.A. Yaqin, K. Bittkau, A. Lambertz, U. Rau & K. Ding
Forschungszentrum Jülich, Germany

**1CV.3.26 Microdoping of Layers for High Efficiency Silicon Heterojunction Solar Cells**
I. Vulcanean, J. Seif, A. Steinmetz, S. Pingel, I. Koc, M. Bivour & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

**1CV.3.28** **Lithium-Doped Nickel Oxide Grown by Different PVD Methods for Hole-Selective Contacts in Silicon-Based Heterojunctions**
F. Menchini, S. Rakhshani, L. Serenelli, L. Martini, E. Salza, P. Mangiapane, M. Izzi & M. Tucci
ENEA, Rome, Italy
A. Latini
Sapenza University, Rome, Italy

**1CV.3.29** **Epitaxially Grown Crystalline Silicon as Electron Selective Contact Layer for Crystalline Germanium TPV Cells**
M. Gamel, G. López & M. Martín
UPC, Barcelona, Spain
T. Jawhari
CCiTUB, Barcelona, Spain
P. Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France
I. Garin
UVIC-UCC, Spain

**1CV.3.30** **Role of Oxygen Flow Rate during Indium Tin Oxide Deposition in the ITO/p-a-Si:H Stack Contact Resistance Optimization for Silicon Heterojunction Solar Cells Application**
A. Pandey, S. Mandal, S. Alam, S. Bhattacharya & V.K. Komarala
IIT Delhi, New Delhi, India

**1CV.3.32** **Self Assembled Monolayer Templating for Passivated Contact Solar Cells**
W. Nemeth, D.L. Young, M.R. Page, S. Theingi & P. Stradins
NREL, Golden, USA

**1CV.3.33** **Investigating the Passivation Potential of Thermal Evaporation Grown Vanadium Sub-Oxide Films for Silicon Heterojunction Solar Cells**
N. Bandaru, R. Kanakala, N. Dsouza & J.K. Rath
ITT Madras, Chennai, India
R. Madaka
Woxsen University, Hyderabad, India

**1CV.3.34** **Evolution upon Annealing of Electrical and Structural Properties of p-Type nc-SiOx:H Films Deposited at 130°C**
A.J. Olivares-Vargas & P. Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France

**1CV.3.35** **Dopant-Free Base Contacts for Silicon Heterojunctions**
F. Menchini, L. Martini, L. Serenelli, E. Salza, M. Izzi & M. Tucci
ENEA, Rome, Italy

**1CV.3.36** **Effect of Alkaline Concentration and Additives on Pyramidal Distribution for Crystalline Silicon Substrate Preparation for SHJ Solar Cell**
S. Bhattacharya, A. Pandey, S. Mandal & V.K. Komarala
IIT Delhi, New Delhi, India

**1CV.3.37** **Selective Laser Ablation of Transition Metal Oxide Thin Films for SHJ Solar Cells**
C. Munoz-Garcia, D. Canteli, S. Lauzurica, M. Morales & C. Molpeceres
UPM, Madrid, Spain
T. Tom, J.M. Asensi & J. Bertomeu
University of Barcelona, Spain
E. Ros, P.R. Ortega, J.M. López-González & C. Voz Sánchez
UPC, Barcelona, Spain

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**1CV.3.38** **Synthesis of Nanoporous Black Silicon by Aluminium-Assisted Chemical Etching**
S. Uddin, Md.R. Hashim & M.Z. Pakhuruddin
University Sains Malaysia, Gelugor, Malaysia

**1CV.3.39** **Low Temperature Plasma Processes for Selective Contacts**
L. Xu, P. Bulkin, M. Poplawski, A.D.J. Olivares-Vargas & P. Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France

**1CV.3.50** **Low Temperature Degradation Issues in a-Si:H/c-Si Heterojunction Solar Cells: Simulations and Experimental Case Study**
M.Y. Ghannam
Kuwait University, Safat, Kuwait

**1CV.3.51** **Relationship between Efficiency and Temperature Coefficients in Industrial PERC Solar Cells**
H. Duman & M. Günöven
KalyonPV, Ankara, Turkey

**1CV.3.52** **Investigation of Oxide Passivation for Dopant-Free Selective Contacts for Silicon Solar Cells**
A. Deep Pakki, R. Kumar Sharma & J. Holovsky
CTU, Prague, Czech Republic
K. Ridzoňová
ASCR, Prague, Czech Republic
F.-J. Haug & J.A. Spitznagel
EPFL, Neuchâtel, Switzerland

**1CV.3.53** **Evaluating the Performance of DNNs for Iron Concentration Prediction in Silicon Solar Cells Using Photovoltaic Parameters**
O.V. Zavhorodnii
Taras Shevchenko National University of Kyiv, Ukraine

**1CV.3.54** **Optimizing an N-PERT Solar Cell to Atacama Desert Solar Spectrum Using a Genetic Algorithm**
P. Ferrada
University of Antofagasta, Chile
A. Marzo
University of Granada, Spain
B. Ivorra
UPM, Madrid, Spain
M.R. Ferrández
University of Almeria, Spain
F. Araya Rojas
CEA, Le Bourget-du-Lac, France
E. Ruiz Reina
University of Malaga, Málaga, Spain

**1CV.3.55** **Effective Hole-Selective Contact Using MoOx Layer for Rear Emitter P-TOPCon Solar Cells**
D. Kang, H.-S. Lee, Y. Kang & D. Kim
Korea University, Seoul, Republic of Korea

**1CV.3.56** **Minimum Bandgap Criteria for Carrier Selective Layers in Si Solar Cells**
N. Chatterji
SVNIT, Surat, India
P.R. Nair
IITB, Mumbai, India

**1CV.3.58** **Accurate Crystallite Size Determination in Poly-Si/SiOx Passivating Contacts**
T. Okker, R. Glatthaar, F. Huster, G. Hahn & B. Terheiden
University of Konstanz, Germany
S. Seren
Schmid Group, Freudenstadt, Germany
T. Pernau
Centrotherm International, Blaubeuren, Germany

**1CV.3.59** **Depth Distribution XPE Reveals Phospho-Oxygen Bonds in Polysilicon Films of TOPCon Devices**
Z.Q. Ma, Y.L. Wang, Z.X. Lan, L. Zhao, F. Xu & F. Hong
Shanghai University, China

**1CV.3.60** **Microscopic Image Analysis of Printed Structures Without a Microscope – A Deep Learning Approach**
L. Kurumundayil, S. Rein & M. Demant
Fraunhofer ISE, Freiburg, Germany

**1CV.3.61** **Full Spectrum Inline External Quantum Efficiency Measurements of Solar Cells in Less than 100 ms**
S. Wasmer, S. Bergemann, B. Klöter & P. Fuss-Kailuweit
WAVELABS Solar Metrology Systems, Leipzig, Germany

**1CV.3.62** **IV-Measurements of Shingle Solar Cells**
A. Krieg, N. Wöhrle, P. Kunze, M. Rauer, J. Greulich & S. Rein
Fraunhofer ISE, Freiburg, Germany
K. Ramspeck
h.a.l.m. elektronik, Frankfurt am Main, Germany

**1CV.3.63** **Extracting Parasitic Absorption and Layer Thickness from Reflection Spectra by Combining Simulation and Machine Learning Techniques**
A. Wörnhör, A. Fell, S. Rein & M. Demant
Fraunhofer ISE, Freiburg, Germany

**1CV.3.64** **Rapid Quantification of Light Trapping in Bifacial Silicon Solar Cells Based on Inline Reflection Measurements**
W. Wöhler, A. Fell, S. Rein & J. Greulich
Fraunhofer ISE, Freiburg, Germany



**Thursday, 21 September 2023**

**VISUAL SESSION 2DV.1**

**08:30 – 10:00** **Perovskite-based Tandem Devices**

**2DV.1.1** **Upscaling Processes for Perovskite-Silicon Tandem Solar Cells**
O. Schultz-Wittmann, P.S.C. Schulze, O. Er-Raji, B. Kore, R. Efinger, U. Heitmann, M. Kohlstädt, S. Pingel, T. Wenzel, H. Nagel, M. Bivour, J. Borchert, M. Hermle & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

**2DV.1.2** **Optical Simulation-Assisted Design and Optimization of SHJ Bottom Subcells for High-Efficiency Monolithic Perovskite-Silicon Tandem Solar Cells**
Y. Zhao, M. Fardousi, R. Santbergen, A. Weeber, M. Zeman, L. Mazzarella & O. Isabella
Delft University of Technology, The Netherlands
K. Datta, A. Bracesco, M. Creatore & R.A.J. Janssen
Eindhoven University of Technology, The Netherlands
D. Zhang
TNO, Eindhoven, The Netherlands

**2DV.1.3** **Optical Design Strategies for High-Efficiency Monofacial and Bifacial Four-Terminal Perovskite-Silicon Tandem Modules**
Y. Zhao, R. Santbergen, M. Zeman, L. Mazzarella & O. Isabella
Delft University of Technology, The Netherlands
D. Zhang, M. Najafi, S.C. Veenstra & G. Coletti
TNO, Eindhoven, The Netherlands
A.W. Weeber
TNO, Petten, The Netherlands

**2DV.1.4** **Highly Efficient Tandem Perovskite Solar Cell Using Bandgap Tunable MAPbxSn1-xI3 Perovskites via Sandwich Evaporation Technique**
J.C. Jhou, H.-T. Lin & C.-F. Lin
NTU, Taipei, Taiwan

**2DV.1.5** **A Current-Matching Approach and Its Effectiveness for the Development of Highly Efficient Perovskite/Silicon Tandems**
K. Kamide & H. Takato
AIST, Koriyama, Japan

**2DV.1.6** **Perovskite-Silicon Tandem Solar Cell Processed by Scalable Spray Coating Process**
U. Heitmann, C. Vannaldeshi, O. Er-Raji, O. Schultz-Wittmann, B. Grübel, J. Bartsch & J. Borchert
Fraunhofer ISE, Freiburg, Germany

**2DV.1.7** **Electrical and Morphological Degradation of Si/PK Tandem Cells under Illumination: Impact of PK/ETL Interface and Cell Design**
A. Rivalland & C. Roux
INES, Le Bourget-du-Lac, France

**2DV.1.9** **Solution Processing of Semitransparent Perovskite Stack for 2-Terminal Monolithic Perovskite/Si Tandem Solar Cells**
F. Di Giacomo, S. Molagholi Pourmotlagh, H. Reddy Sathy & A. Di Carlo
University of Rome Tor Vergata, Italy
I. Usatii, E. Bobeico, M. Della Noce, L. Lancellotti, L.V. Mercaldo & P. Delli Veneri
ENEA, Portici, Italy

**2DV.1.10** **Study the Influences of Material and Tunneling Junction Quality to the Current Matching on 2T Perovskite/Silicon Tandem Solar Cell**
C.-H. Hsieh, J.-Y. Huang & Y.-R. Wu
NTU, Taipei, Taiwan

**2DV.1.11** **Direction for Optimizing Bottom Si Solar Cells by Structure in Monolithic Perovskite/Si Tandem Devices**
H. Song, Y. Kang, D. Kim & H.-S. Lee
Korea University, Seoul, Republic of Korea
S.-W. Lee
Stanford University, California, USA

**2DV.1.12** **Structuring of Perovskite-Silicon Tandem Solar Cells for Reduced Reflectance and Enhanced Absorptance at the Band Gap**
A. Callies, M. Hanser, B. Bläsi & O. Höhn
Fraunhofer ISE, Freiburg, Germany
J.C. Goldschmidt
Philipps-University Marburg, Germany

**2DV.1.13** **Alternative Interlayers for Shunt Mitigation on 2 Terminals Perovskite–Silicon Tandem Solar Cells**
T. Desrues, B. Marteau, E. Bruhat, G. Masmitja Rusinol, C. Bal & S. Dubois
CEA, Le Bourget du Lac, France

**2DV.1.14** **Numerical Simulations of Three Terminal Perovskite/Silicon Tandem Solar Cells Using Sentaurus TCAD**
P. Procel Moya, M. Al-Zoubi, M.R. Vogt, Y. Blom, R. Santbergen & O. Isabella
Delft University of Technology, The Netherlands

**2DV.1.15** **Optimization of Wide and Narrow Bandgap Absorbers for All-Perovskite Tandem Solar Cells**
J. Allegre, P. Tsoulka, M. Manceau, L. Champault, N. Lemaitre & S. Berson
CEA INES, Le Bourget-du-Lac, France

**2DV.1.16** **Levitrack Spatial ALD in Production for SnO2 Buffer Layers on M6 Perovskite Tandem Solar Cells**
M. Steltenpool, S.C. van der Linde & J.H.M. Beijersbergen
Levitech, Almere, The Netherlands

**2DV.1.17** **Three-Terminal Perovskite–Silicon Tandem Solar Cells: from Indoor Standard Test Condition Performance to Outdoor Energy Yield**
P. Wagner, P. Tockhorn, S. Hall, Q. Emery, M. Remec, M. Khenkin, S. Albrecht & L. Korte
HZB, Berlin, Germany

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**2DV.1.18** **Interaction of TCO and Low-Temperature Screen Printing Pastes for Upscaling of Perovskite-Silicon Tandem Solar Cells**
J. Kleesiek, A. Harter, P. Reyes-Figueroa, J. Kurpiers, A. Cruz Bournazou, M. Günther, C. Schröder, S. Janke, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany

**2DV.1.19** **Luminescence Imaging of Tandem Perovskite/Organic Solar Cells for Building Integrated Photovoltaics**
D. Ory & J. Posada
EDF R&D, Palaiseau, France
G. Vidon, K. Medjoubi & S. Cacovich
IPVF, Palaiseau, France
E. Jayaraman & M. Madsen
SDU, Sonderborg, Denmark
A. Di Carlo & F. Matteocci
C.H.O.S.E, Rome, Italy
C.J. Brabec & M. Wagner
FAU, Erlangen, Germany

**2DV.1.20** **Development of Indium Zinc Oxide TCOs Films Deposited from a Metallic Tube Target for Perovskite-Silicon Tandem Solar Cell Applications**
V. Sittinger, D. Stoll, A. Kaiser & S. Jung
Fraunhofer IST, Braunschweig, Germany
O.S. Kabakli, P.S.C. Schulze & J. Borchert
Fraunhofer ISE, Freiburg, Germany

**2DV.1.22** **In2O3-Based Front Electrodes Deposited at Low Process Temperatures for Monolithic Perovskite-Silicon Tandem Solar Cells**
P. Reyes-Figueroa, A. Cruz Bournazou, M. Bernardes, K. Mayer-Stillrich, S. Albrecht, R. Schlatmann, J. Kurpiers & B. Stannowski
HZB, Berlin, Germany

**2DV.1.23** **Laser Processes for Perovskite Modules in Glove Boxes: Faster and Cost-Effective Laser Process for P1 Patterning and Annealing of Layers**
S. Bergfeld
Aachen University of Applied Sciences, Germany
T. Merdzhanova
Bergfeld Lasertech, Aachen, Germany

**2DV.1.24** **Challenges for the Upscaling of the Tandem Si/PK Technology**
C. Roux, L. Champault, E. Fayard, S. Rousseau, C. Bal, N. Nguyen, M. Manceau, O. Dupré, S. Berson, A. Danel, H. Lignier, F. Jay & N. Lemaitre
CEA, Le Bourget-du-Lac, France

**2DV.1.25** **Monolithic 3-Terminal Perovskite/silicon HBT-Based Tandem Compatible with Industrial Silicon Bottom Cells: A Theoretical Study**
G. Giliberti, M. Cagnoni & F. Cappelluti
Polytechnic University of Turin, Italy

**2DV.1.26** **Perovskite-CuIn(Ga)Se2 2-Terminal Tandem Solar Modules with Industrially Scalable Processes**
R.K. Kothandaraman, M. Krause, H. Lai, S. Nishiwaki, S. Siegrist, R. Carron, A.N. Tiwari & F. Fu
EMPA, Duebendorf, Switzerland
M. Dussouillez, A. Walter & Q. Jeangros
CSEM, Neuchâtel, Switzerland

**2DV.1.27** **Investigation of Perovskite Layer Growth from Solution on Textured Substrates**
F. Riesebeck, F. Mathies, E. Unger, C. Becker & F. Yang
HZB, Berlin, Germany

**2DV.1.29** **Perovskite Top Solar Cell Development for Monolithic 2-Terminal Silicon-Based Tandem and Triple-Junction Solar Cell Application**
P.S.C. Schulze, O.S. Kabakli, M. Heydarian, M. Heydarian, O. Er-Raji, K. McMullin, J. Modes, R. Efinger, O. Schultz-Wittmann, C.A. Messmer, L. Restat, A.J. Bett, O. Fischer, L. Tutsch, M. Bivour, M.C. Schubert, M. Hermle, S.W. Glunz & J. Borchert
Fraunhofer ISE, Freiburg, Germany

**2DV.1.30** **Numerical Simulation: Design and Optimization of CsSnI3 and Cs3Sb2Br9 Based Multijunction Solar Cell**
A. Samanta & S. Yadav
SVNIT, Surat, India
S.K. Pandey & G. Siddharth
NIT, Kozhikode, India
V. Garg
NIT, Surat, India

**2DV.1.31** **Rapid Laser Annealing of Transparent Conductive Oxides for Temperature-Sensitive Solar Cell Structures**
A. Münzer, M. Bivour, L. Tutsch, F. Meyer & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany
F.D. Heinz
University of Freiburg, Germany

**2DV.1.32** **Efficient and Stable Inverted Wide-Bandgap Perovskite Solar Cells and Modules Enabled by Hybird Evaporation-Solution Method**
A. Zarean Afshord, B. Eren Uzuner, S.H. Sedani, G. Gunbas & S. Yerci
METU, Ankara, Turkey
W. Soltanpoor
University of Twente, Enschede, The Netherlands
Y. Kuang & T. Aernouts
imec, Genk, Belgium

**2DV.1.33** **Hybrid PERC Bottom Cells for Si/ Perovskite Tandem Solar Cells**
Y.-H. Kim, L. Aziz, H. Lee, D. Choi, J.-H. Choi, W.M. Kim, D.-K. Lee & I. Kim
KIST, Seoul, Republic of Korea
B.-K. Ju
Korea University, Seoul, Republic of Korea

**2DV.1.34** **Building Cost Models for Perovskite on Si Tandem Solar Cells**
J.J. Cordell, M. Woodhouse & E. Warren
NREL, Golden, USA

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## VISUAL SESSION 5DV.2

**10:30 – 12:00** **Energy System Integration; Resilience and Security of Supply; Solar Fuels, Storage / Sustainability and Recycling of Photovoltaics**

**5DV.2.1** **PV-Driven Energy-Saving Hydrogen Production via Noble Metal Exchanged Electrocatalysts**
H.H. Lee, D.S. Kim, S. Sarker, J.H. Choi & H.K. Cho
Sungkyunkwan University, Suwon-City, Republic of Korea

**5DV.2.2** **Comparison between Home Batteries and District Batteries in the Belgian Electricity Grid**
C. Lavaert, B. Herteleer & J. Cappelle
KU Leuven, Ghent, Belgium

**5DV.2.3** **Matching PV Production and Electricity Load on Household Level at High-Latitude Locations**
S. Jouttijärvi, L. Karttunen & K. Miettunen
University of Turku, Finland
S. Ranta
Turku University of Applied Sciences, Finland

**5DV.2.4** **Energy Sharing in Solar and Battery Off-Grid Systems with Advanced PV Generation Modelling: a Case Study of Norwegian Cabin Fields**
I. Fuchs, H.O. Torrisplass & S. Völler
NTNU, Trondheim, Norway

**5DV.2.5** **Flexibility in Solar and Battery Off-Grid Systems**
M. Bakken, R.E. Dihle & I. Fuchs
NTNU, Trondheim, Norway

**5DV.2.6** **Comparison between Decentralized and Centralized Energy Storage Systems for Power Ramp Rate Control of PV Systems**
K. Lappalainen
Tampere University, Finland
J. Kleissl
University of California, San Diego, USA

**5DV.2.7** **Large Scale AgriPV on Norwegian Farms with Flow Batteries as Seasonal Storage**
S. Völler & I.R. Brøndbo
NTNU, Trondheim, Norway
E. Loxley-Slåttsveen
Bryte Batteries, Trondheim, Norway
S. Preisig
Skjetlein VGS, Trondheim, Norway

**5DV.2.8** **Day-Ahead and Intra-Day Planning Method of PV Power Plant with Battery Energy Storage System for Securing Reserve Power**
Y. Kojima, J. Cui & Y. Ueda
Tokyo University of Science, Japan
T. Oozeki
AIST, Koriyama, Japan

**5DV.2.10** **Validation of a PV Production Model for Simulation of Wide Area Aggregated Distributed PV Power Production that Takes Individual Systems Location and Orientation into Account**
S. Ericson, L. Molin & J. Lindahl
Becquerel Sweden, Knivsta, Sweden

**5DV.2.11** **Energy Optimization for Companies with Digital Flex Twins**
J.S. da Costa Fernandes, A. Aamoume, J. Lottermoser, M. Schmidt, N. Hartmann & R. Gasper
Offenburg University of Applied Sciences, Germany

**5DV.2.12** **A Holistic Workflow for the Development of a Positive Energy District and its Operation as a Microgrid**
N. Skandalos & S. Kichou
CTU, Bustehrad, Czech Republic
M. Cenek
CTU, Prague, Czech Republic

**5DV.2.13** **Reliable Prosumer: Local Energy Management for Increased Reliability in Interruption-Prone Distribution Grids**
P. Ferreira Torres, J. Tavares Pinho & R. Zilles
University of São Paulo, Brazil
L. Souto & S. Williamson
University of Bristol, United Kingdom

**5DV.2.14** **Evaluating Flexibility Requirements of Prosumers in Energy Communities**
N. Vulic, Q. Li & H. Cai
EMPA, Duebendorf, Switzerland

**5DV.2.15** **Carbon-Based Hybrid Supercapacitors for High Power Photovoltaic Irrigation**
M. Horta, L.A. Fialho, A.C. Neves Foles & P.A. Horta
University of Evora, Portugal

**5DV.2.16** **Challenges of 10 Years of Photovoltaic Development in Chile**
E. Urrejola
Urrejola Ingenieros, Santiago, Chile

**5DV.2.17** **Demand Response Optimisation for a Prosumer with a Grid-Tied Photovoltaic System Through Genetic Algorithms**
D. Díaz-Bello, C. Vargas-Salgado, T. Gomez Navarro & D. Alfonso-Solar
Technical University of Valencia, Spain

**5DV.2.18** **On the Added Value of Probabilistic Forecasts Applied to the Optimal Scheduling of a PV Power Plant with Batteries in French Guiana**
R. Alvarenga & L. Linguet
University of French Guiana, Cayenne, France
H. Herbaux
Voltalia, Remire-Montjoly, France

**5DV.2.19** **Grid Integration Impacts of Vertical Bifacial Agri-Photovoltaics**
S. Lahr
Next2Sun, Dillingen, Germany
R. Fritz
Fraunhofer IEE, Kassel, Germany

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**5DV.2.20** **Energy Management Strategies and Their Effects on the Electricity Bill of a Building with Photovoltaic/Battery Systems**
S. Kichou, N. Skandalos & P. Wolf
CTU, Bustehrad, Czech Republic

**5DV.2.21** **Limiting Factors in Photovoltaic-Electrochemical Cell Development for Syngas Production**
S. Banerjee & J.K. Rath
IIT Madras, Chennai, India

**5DV.2.23** **Simulation and Management of PV System and Battery Storage in Providing Grid Support Adhering to Grid Code Requirements**
M.Z. Che Wanik
QEERI, Doha, Qatar

**5DV.2.24** **Effects of Control Strategy on Sizing of Energy Storage Systems for PV-Wind Power Systems**
M. Talvi & K. Lappalainen
Tampere University, Finland

**5DV.2.25** **Security Countermeasures for RansomwareAttacks on Energy Infrastructure**
J.-E. Lee, Y.-J. Lee, H.-Y. Kim, M.-G. Seo, B.-W. Han, J.-H. Hur & S. Yang
Far East University, Eumseong-gun, Republic of Korea

**5DV.2.34** **Solar Photovoltaic Waste and Resource Potential Projections in Australia, 2022-2050**
V. Tan, R. Deng & R. Egan
UNSW Australia, Sydney, Australia

**5DV.2.35** **Waste from Silicon Processing as a Source of Energy and Raw Materials**
W. Palitzsch, A. Killenberg & I. Röver
LuxChemtech, Freiberg, Germany

**5DV.2.36** **Experimental Characterisation of Photovoltaic Panels for Recycling in Australia**
O. Bowen & R. Deng
UNSW Australia, Sydney, Australia

**5DV.2.37** **Comparison of Experimental Separation Methods for Silicon Solar Panels**
S. Jech, N. Garg & A. Santasalo-Aarnio
Aalto University, Espoo, Finland
K. Miettunen
University of Turku, Finland

**5DV.2.38** **PV Glass - Challenges and Novel Solutions for the Recycling Process**
W. Palitzsch & I. Röver
LuxChemtech, Freiberg, Germany
R. de Almeida & O. Caulle
Mondragon Assembly, Orange, France
D. Timmers & W. Merket
Maltha, Lommel, Belgium

**5DV.2.39** **End-of-Life Solar Photovoltaic Management: a Comparison Between European Union and United States Approach**
P. Nain & A. Anctil
Michigan State University, East Lansing, USA

**5DV.2.40** **Pyrolysis Analysis of c-Si Photovoltaic Solar Module after End-of-Life (EOL) to Facilitate Recycling**
K.K. Patel, S. Arju & S. Mallick
IIT Bombay, Mumbai, India

**5DV.2.41** **Key Actors in the Circularity of Solar Panels in City of Helsinki**
B. Viriyaroj, S. Äärillä & P. Heikkinen
Aalto University, Espoo, Finland
E. Akulenko
University of Turku, Finland

**5DV.2.42** **Solar PV Sustainability and Circularity Roadmap for Europe**
D. Moser & A. Louwen
Eurac Research, Bolzano, Italy
D. Mugnier
PLANAIR, Lyon, France
D. Muñoz
CEA, Le Bourget-du-Lac, France
U. Jahn
VDE Renewables, Alzenau, Germany

**5DV.2.43** **Developing the Photovoltaic Circular Economy in South Africa Through Reuse, Repair and Resale of Modules**
J.L. Crozier McCleland & E.E. van Dyk
Nelson Mandela University, Port Elizabeth, South Africa
M.N. Crozier
University of Western Cape, Bellville, South Africa

**5DV.2.44** **Circular Water Strategies in PERC Solar Cells Manufacturing Industry**
P. Brailovsky, D. Subasi, M. Fischer, J. Rentsch & S. Nold
Fraunhofer ISE, Freiburg, Germany
J. Reich & S. Geißen
Technical University of Berlin, Germany
M. Held & A.-K. Briem
Fraunhofer IBP, Stuttgart, Germany
T. Dannenberg
RENA, Freiburg, Germany

**5DV.2.45** **Procedure Proposal to Determine PV Module Status for Its Second Life Application**
J. Rabanal-Arabach, E. Fuentealba-Vidal, J. Astudillo-Ledezma, S. Beltrán-Condori, A.A. Taquichiri, M.J. Riquelme-Zambrano & I. Jamett-Aranda
University of Antofagasta, Chile
J. Tapia-Jelcic
ATAMOSTEC, Providencia, Chile
A. Schneider
UASG, Gelsenkirchen, Germany
R. Couderc & D. Muñoz
CEA, Le Bourget-du-Lac, France

**5DV.2.46** **Characterisation of Partially Repaired PV Modules as a Previous Step for Their Reuse**
M.B. Nieto-Morone, F.G. Rosillo, E. Mejuto & M.C. Alonso-García
CIEMAT, Madrid, Spain
M. Camero & R. Tejedor
Solucciona Energy, Madrid, Spain
M.A. Muñoz-Garcia
ETSIAAB UPM, Madrid, Spain

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**5DV.2.47** **Environmental Impact of Mass-Customization Produced Roof Tiles with Integrated Flexible CIGS Devices**
M. Theelen & A. Kuypers
TNO, Eindhoven, The Netherlands
M. van der Hulst
Radboud University, Nijmegen, The Netherlands
L. de Simon & D. Bizarro
TNO, Utrecht, The Netherlands
J. Kester
TNO, Petten, The Netherlands
M. Hauck
Eindhoven University of Technology, The Netherlands

**5DV.2.49** **Life-Cycle Global Warming Impact of PV - Powered Hydrogen Supply Chains**
O. Kanz, K. Ding, K. Bittkau & U. Rau
Forschungszentrum Jülich, Germany
A. Reinders
Eindhoven University of Technology, The Netherlands

**5DV.2.50** **Photovoltaics Versus Negative Emissions Technologies**
S. Vadadkar
Albert-Ludwigs-Universität Freiburg, Germany
S. Agrawal & R. Preu
Fraunhofer ISE, Freiburg, Germany

**5DV.2.51** **Quantifying Material Demand for the Global Solar Photovoltaic Supply Chain in the Terawatt Era**
C. Xu, O. Isabella & M.R. Vogt
TU Delft, The Netherlands

**5DV.2.54** **Factories and Industrial Sites Impact on the Environmental Assessment of Silicon Wafers, Solar Cells and PV Modules**
P. Brailovsky, L. Sanchez, D. Subasi & S. Nold
Fraunhofer ISE, Freiburg, Germany

**5DV.2.55** **Generalizing a Parameterized Model Approach for Customized Life Cycle Assessment of Different Photovoltaic Technologies**
M. Marchand Lasserre, J. Schlesinger, R. Jolivet & P. Perez-Lopez
OIE Center MINES ParisTech, Sophia Antipolis, France
R. Besseau
JRC, Ispra, Italy

**5DV.2.56** **Modelling Recycling in Life Cycle Assessment of Perovskite/Silicon Tandem Modules**
L. Wang
TotalEnergies, Sophia Antipolis, France
P. Perez-Lopez & M. Marchand Lasserre
Mines Paris, Sophia Antipolis, France
L. Oberbeck
TotalEnergies, Paris, France

**5DV.2.57** **Cradle to Cradle Recycling of Perovskite Solar Cells**
Z. Wu, J. Zhang, M. Sytnyk, J. Hauch, C.J. Brabec & I.M. Peters
FZ Jülich, Erlangen, Germany
G. Babayeva
FAU, Erlangen, Germany

**5DV.2.58** **Synergies in the Recovery of Contact Materials from Solar Cell Scrap**
W. Palitzsch & I. Röver
LuxChemtech, Freiberg, Germany
C. Lemoine
CEA, Grenoble, France

**5DV.2.59** **Life Cycle Assessment of an Innovative High-Value c-Si PV Recycling Process**
H.-H. Fan & A. Chalaux
ROSI, Grenoble, France

**5DV.2.60** **How Circular Is the European Photovoltaic Industry? An Overview and Conceptualization**
T. Radavicius
SoliTek, Vilnius, Lithuania
A. Boukhatmi
TU Berlin, Germany
R. Nyffenegger
BFH, Biel, Switzerland

**VISUAL SESSION 5DV.3**

**13:30 – 15:00** **PV Deployment: Realizing the Full Potential of PV in Various Markets and World Regions / Markets, Cost, Economics of PV / Energy Communities and PV Capacity Building**

**5DV.3.1** **Floating Photovoltaics, a Solution to Smart Combination of Hydro- and Solar Power**
G. Kakoulaki, G. Rocio & S. Szabó
European Commission JRC, Ispra, Italy

**5DV.3.2** **Detection of PV Systems (Using AI) for Public Policy**
S.R. Freitas, M. Silva, F. Pacheco & E. Silva
Energy and Environment Agency of Lisbon, Portugal
A. Amicone, L. Marangoni & P. Gnatyuk
GFT, Genova, Italy

**5DV.3.3** **A Geographical Urban Digital Twin to Simulate PV Penetration Scenarios for the Decarbonization of Neighbourhoods and Cities in Luxembourg**
C. Braun, U. Leopold & P. Pinheiro
LIST, Esch-sur-Alzette, Luxembourg

**5DV.3.4** **Solar Power in Africa: Status, Markets and Future**
R. Leutz
TOMATO:GSL, Munich, Germany
T. Couture
E3 Analytics, Berlin, Germany

**5DV.3.5** **The Potential of Photovoltaics in the Future Electrical Power Supply of Bangladesh**
B. Loeffler & N. Bernhard
Anhalt University of Applied Sciences, Koethen, Germany

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**5DV.3.6** **Supporting PV Usage and Production to Reduce Fossil Fuel Use in European Agriculture – The AgroFossilFree Project**
C. Ma, D. Rutz, V. Hofmeier & R. Janssen
WIP Renewable Energies, Munich, Germany

**5DV.3.7** **An Urgent Call to Implement the Heat Transition in Europe: the Role of Coupling the Heating, Cooling, and Power Sectors**
D. Rutz, O. Birgi & R. Janssen
WIP Renewable Energies, Munich, Germany
A. Misech
ETIP RHC, Munich, Germany

**5DV.3.18** **Incentives and Disincentives for Floating Photovoltaics in Europe: A Sensitivity Analysis**
L. Micheli
Sapienza University of Rome, Italy
D. Lopez Talavera & F.A. Sepúlveda-Vélez
University of Jaén, Spain

**5DV.3.19** **Japanese Electricity Spot Market Price Forecasting by Using Neural Network**
X. Fang, J. Cui & Y. Ueda
Tokyo University of Science, Japan
T. Oozeki
AIST, Koriyama, Japan

**5DV.3.20** **The Optimal Azimuth and Tilt Angle of BIPV Panels Considering the Prices at Electricity Spot Market**
I. Batic
University of Belgrade, Serbia

**5DV.3.22** **Development of Machine Learning Techniques for Aggregated PV Production Forecasting in the Energy Market**
J. Baldacci, C. Lanzetta & A. Piazzi
I-EM, Livorno, Italy

**5DV.3.24** **The Value of Accurate PV Forecasts in the Past, Present and Future Scandinavian Energy Markets**
O.S. Klyve, H.N. Riise, J. Fagerström, E.S. Marstein & M.M. Nygård
Institute for Energy Technology, Kjeller, Norway

**5DV.3.25** **A Prospective Economic Analysis of Solar PV Costs in 2030 and in 2050**
H.J.J. Yu
CEA, Gif sur Yvette, France

**5DV.3.26** **Comparative Profitability Assessment of PV+BESS for Different Configurations and Business Models**
E. Bosch, P. Macé, G. Masson & A. Penas
Becquerel Institute, Brussels, Belgium

**5DV.3.27** **Trends of EU Research and Innovation in Photovoltaics**
A. Chatzipanagi & N. Taylor
European Commission JRC, Ispra, Italy

**5DV.3.28** **Rooftop PV on Apartment Buildings – How to Bring Simplicity and Benefits to Users**
C. von Friedeburg
CF Energy Research & Consulting, Berlin, Germany

**5DV.3.29** **Self Help Is the Best Help: Solar PV Cooperative Affordably Powers United Nations Refugee Camps**
M. Ray
University of Toronto, Canada

**5DV.3.30** **The Value of a Higher Flexibility on BIPV Module Assembly Lines**
P. Macé, E. Bosch, D. Gautier & G. Masson
Becquerel Institute, Brussels, Belgium

**5DV.3.40** **Social Content of Rural Electrification by Solar System a Case Study in Niger**
M.I. Rabiou
NGO CODDAE, Niamey, Niger

**5DV.3.41** **Supporting Energy Communities in Europe for a Fast Energy Transition**
R. Mergner, R. Janssen & D. Rutz
WIP Renewable Energies, Munich, Germany
A. Holzmann, K. Schilcher & A. Sahin
AEA, Vienna, Austria
N. Fenz & U. Höhne
OurPower, Vienna, Austria
M. Trifonova
BSERC, Sofia, Bulgaria
T. Heinel
BSU, Berlin, Germany
B. Dannemann & A. Mohr
DGRV, Berlin, Germany
E. Süle & N. Sumbadze
AYPEG, Tbilis, Georgia
S. Robićc & T. Šimek
REGEA, Zagreb, Croatia
B. Kovacs
MTVSZ, Budapest, Hungary
B. Lugosi
REXLEF, Budapest, Hungary

**5DV.3.42** **PROMISE: a Knowledge Transfer Platform to Study Reliability in Mediterranean PV Systems**
B. Azzopardi
The Foundation for Innovation and Research, Valletta, Malta
M. Rennhofer
AIT, Vienna, Austria
A. Mignonac
CEA, St. Paul lez Durance, France
I. Munoz
CENER, Sarriguren-Navarra, Spain
C. Meza
Hochschule Anhalt University of Applied Sciences, Köthen, Germany
M. de l'Epine
Becquerel Institute, Lyon, France
S. Zerafa
PIXAM, Valletta, Malta

**5DV.3.44** **All Hands on Deck: a Bundle of Strategies Aiming to Leverage Digital Media Content and Put Portugal's Solar PV on the Map**
R. Amaro e Silva & R. Jolivet
MINES Paris, Sophia Antipolis, France
M. Silva, A. Lavadinho & S.R. Freitas
Lisboa E-Nova, Lisbon, Portugal

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## VISUAL PRESENTATIONS 4DV.4

**15:15 – 16:45** **Solar Resource Assessment, Modelling and Forecasting / PV System Engineering**

**4DV.4.1** **A Scalable Method for Synthetic Irradiance Dataset Creation Based on Automated Feature Engineering and Markov Chain-Based Random Forest**
N. Holland
Fraunhofer ISE, Freiburg, Germany
J. Lopez-Lorente
DNV Netherlands, Arnhem, The Netherlands

**4DV.4.2** **Measuring Global, Direct, Diffuse, and Ground-Reflected Irradiance Using a Reference Cell Array**
M. Gostein
Atonometrics, Austin, USA
B.H. King
Sandia National Laboratories, Albuquerque, USA

**4DV.4.3** **NSRDB and PVGIS Validation Using Weather Stations Installed in Northeast Brazil**
L. Reis, L.C. Paiva, L. Castro & R. Santos
Casa dos Ventos Energias Renováveis, Fortaleza, Brazil

**4DV.4.4** **Bias Correction and Statistical Downscaling of Solar Radiation Using NA-CORDEX and the NSRDB**
M. Bailey, S. Bandyopadhyay, A. Habte, D. Nychka, M. Sengupta & Y. Xie
NREL, Golden, USA

**4DV.4.5** **Quality Control Methods and Gapfilling Rules for Rear-Side Irradiance Measurements on Large-Scale PV Power Plants**
G. Luchetta Martins, E. Koumpli, A. Panoui, S. Southern & J. Muller
Statkraft UK, London, United Kingdom

**4DV.4.6** **Albedo Measurements and Energy Yield Estimation Uncertainty for Bifacial Photovoltaic Systems**
P. Merodio, F. Martinez-Moreno & E. Lorenzo
IES-UPM, Madrid, Spain
R. Moreton
QPV, Madrid, Spain

**4DV.4.7** **Impact of Albedo Time Scale and Ephemeral Snow on the Estimated Energy Production of a Bifacial PV Plant**
V. Lara-Fanego
Solargis, Bratislava, Slovakia
C.A. Gueymard
Solar Consulting, Colebrook, USA

**4DV.4.8** **Comparative Study on Albedo Measurement and MODIS Satellite Data in Various Geographic Locations**
B. Song
DNV, Santiago, Chile
M. Guada
DNV, Madrid, Spain
N. Ferrari & C. Ruschel
DNV, Porto Alegre, Brazil
C. Hidalgo
DNV, Barcelona, Spain

**4DV.4.9** **Rotating Shadow Band for an ISO9060:2018 Class a Spectrally Flat and Fast Response Pyranometer**
M. Pó & K. Hoogendijk
EKO Instruments Europe, Den Haag, The Netherlands
E. Haverkamp
Radboud University, Nijmegen, The Netherlands
S. Nishikawa
EKO Instruments, Tokyo, Japan

**4DV.4.10** **Easy to Make Sensor Box for Monitoring Soiling of Photovoltaic (PV) Modules**
F.M. Mulei, A. Mertens, B.S. Richards & U.W. Paetzold
Karlsruhe Institute of Technology, Germany
R.J. Musembi & A.A. Ogacho
University of Nairobi, Kenya
S. Yaffa
University of The Gambia, Serrekunda, Gambia

**4DV.4.11** **Evaluation of the Duration of Albedo Measurement Campaigns**
S. Mau, A. Sharpe, C. Gertig, C. Campistron, J. Garcia & N. Chouleur
Everoze, Madrid, Spain

**4DV.4.12** **Cloud Regime Impact on Satellite-Based Irradiance Forecast**
S. Cros, J. Badosa, A. Szantai & M. Haeffelin
Ecole Polytechnique, Palaiseau, France

**4DV.4.13** **Cloud Cover Forecasting for Prediction of Short Term PV Power Generation Using Hybrid Models**
R. Korgaonkar & N. Shiradkar
IIT Bombay, Mumbai, India

**4DV.4.14** **Analysis of the Correlation between Cloud Properties and Solar Irradiance in Southern Germany Based on Meteorological Data of the DWD**
F. Pauls & M. Zehner
Rosenheim Technical University of Applied Sciences, Germany

**4DV.4.15** **Impact of Data Granularity on Nowcasting Solar Resource**
S.M. Hategan & M. Paulescu
West University of Timisoara, Romania

**4DV.4.16** **A Multi-Model Approach to Nowcasting Cloud Shadow**
M. Paulescu, S.-M. Hategan, E. Paulescu & A. Sabadus
West University of Timisoara, Romania
C. Dughir
Politehnica University Timisoara, Romania

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**4DV.4.17** **An Artificial Intelligence Approach for Cloud Identification in All Sky Images**
A. Boschert, M. Zehner, T. Estermaier & A. Brader
Technical University of Applied Sciences Rosenheim, Germany

**4DV.4.18** **Benchmarking of 3D Cloud Information and Detection Classification Methods for Solar Nowcasting Based on All-Sky Imagers for the City of Utrecht, The Netherlands**
K. Barhmi, S.Z. Mirbagheri Golroodbari & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

**4DV.4.19** **Impact of Variations in Albedo and Sensor Positions on Accuracy of Modelled Effective Rear-Side Irradiance for a Multi Megawatt Bifacial PV Plant with Tracking**
M.S. Wiig, M.M. Nygård, C.C. You & E. Marstein
IFE, Kjeller, Norway

**4DV.4.20** **McClear: a New Extended Version Estimating Tilted Irradiance Using Lookup Table of Radiance**
S. Bham, B. Gschwind & P. Blanc
MINES Paris - PSL Research University, Sophia Antipolis, France

**4DV.4.21** **Qatar Solar Atlas Web Application**
N. Mohandes, G. Scabbia, D. Perez-Astudillo, S. Jain, D. Bachour & A. Sanfilippo
HBKU/QEERI, Doha, Qatar

**4DV.4.22** **Method Development and Variability Class-Dependent Validation of the New CAMS Radiation Service V4.5**
M. Schroedter-Homscheidt, F. Azam, J. Betcke & J. Lezaca
DLR, Oldenburg, Germany
M. Lefevre & Y.-M. Saint-Drenan
MINES ParisTech, Sophia-Antipolis, France
L. Saboret
Transvalor, Sophia-Antipolis, France

**4DV.4.23** **Methodology for Calculating Rooftop Solar Photovoltaic Potential to Contribute to Forming Energy Communities and Analysis of their Environmental Impact**
A. Tro Cabrera
University of the Basque Country, Bilbao, Spain

**4DV.4.24** **Viability of the Faiman Temperature Model for Façade PV in Moderate Climates**
T. Ernst, B. Lim & F. Giovannetti
ISFH, Emmerthal, Germany
C. Schinke
Leibniz University Hannover, Germany
R. Puknat
ISFH, Hamelin, Germany

**4DV.4.25** **The Impact of Explicit Treatment of Atmospheric Aerosols in Forecasting Direct Normal Irradiance in a Dust-Rich Hot, Desert Climate**
C. Fountoukis, D. Perez-Astudillo, D. Bachour, V. Bermudez Benito & M. Ayoub
QEERI, Doha, Qatar

**4DV.4.26** **A Continuous Form of the Perez Diffuse Sky Model for Forward and Reverse Transposition**
A. Driesse
PV Performance Labs, Freiburg, Germany
A. Jensen
Technical University of Denmark, Risskov, Denmark
R. Perez
SUNY, Albany, USA

**4DV.4.30** **Evaluating 2D View-Factor Solutions to Estimate Ground-Reflected Irradiance in Large Bifacial PV Plants**
J. Santamaría & J.R. Ledesma
Universidad Politécnica de Madrid, Spain

**4DV.4.31** **Performance of PV Arrays with Bifacial PV Modules Installed in East-West Structures for Reliable Irrigation Applications**
L.M. Carrasco, F. Martinez-Moreno, R. Hogan Almeida & L. Narvarte
UPM, Madrid, Spain

**4DV.4.32** **New Approach to Define the Optimal Placement of Albedo Enhancing Materials to Optimize Bifacial Gains Considering Position, Length, Reflection Coefficient and Degradation**
S. Latella, M. Carbone & V. Sabatini
ENEL Green Power, Rome, Italy

**4DV.4.33** **Experimental and Theoretical Investigation of Fixed and Tracking PV Panel Performance in Tehran through Techno-Economic Aspects**
S. Eslami
University of Tehran, Iran
K. Rahbar, A. Golshanfard, A. Tadjik & R. Pouladian-Kari
Kirchner Solar Group, Alheim, Germany

**4DV.4.34** **Appropriate Configuration for PV System through Technical, Economic and Environmental Analysis**
M. Andam, J. El Alami & Y. Louartassi
Mohammed V University, Salé, Morocco
R. Zine
Al Akhawayn University, Ifrane, Morocco

**4DV.4.35** **Development of Design and Construction Guidelines for PV on Sloping Ground, Agrivoltaic, and Floating PV in Japan**
T. Oozeki
AIST, Koriyama, Japan
K. Takamori
Structural Performance Evaluation Institute, Osaka, Japan
K. Watanabe
Yachiyo Engineering, Tokyo, Japan
Y. Inoue
JPEA, Tokyo, Japan
T. Enomoto
Deloitte Tohmatsu Consulting, Hokkaido, Japan
T. Chiba
Hokkaido University of Science, Japan
S. Adachi
NIED, Tsukuba, Japan
T. Taniguchi
Osaka Metropolitan University, Japan
Y. Ohno
Kyoraku, Tokyo, Japan

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**4DV.4.36** **Automatic Layout and Bill of Quantities BIM-Oriented Optimizer for Solar Photovoltaic Plants with Advanced Constraints**
M. Carbone, S. Latella & V. Sabatini
ENEL Green Power, Rome, Italy

**4DV.4.37** **PV Self-Consumption Potential Along the Transport Infrastructure Such as Tunnels and EV Fast Charging Hubs**
A. Hensel
Fraunhofer ISE, Freiburg, Germany
O.S. Klyve
Institute for Energy Technology, Kjeller, Norway
M. Auerbach
Federal Highway Research Institute, Bergisch Gladbach, Germany

**4DV.4.38** **Battery Storage Analysis Demands Based on Novel High Temporal Resolution Weather Data Platform**
K.M. Paasch, H. Andersen & M. Nymand
University of Southern Denmark, Sønderborg, Denmark
S.B. Kjær
Danfoss Power Electronics and Drives, Gråsten, Denmark

**4DV.4.39** **Error Sources in PV Prognosis**
B. Kubicek, M. Steinbrecher & M. Rennhofer
AIT, Vienna, Austria

**4DV.4.40** **Database and Version Comparison of PVsyst Software in Different Installations in Brazil**
J.F.S. de Paula, J.L. de Souza Silva, G.C.S. Prym, G.P. de Lima, T.A. Barros & M.G. Villalva
University of Campinas, São Paulo, Brazil
H. da S. Alvarez, R. Moreno Garcia & F.C. Marques
BYD, São Paulo, Brazil

**4DV.4.41** **A Global Sensitivity Analysis Applied to a Photovoltaic Performance Tool**
K. Alvino & N. Zalachas
BBS Slama, Palaiseau, France
B. Ghannam & M. Nemer
Mines Paris, Palaiseau, France

**4DV.4.42** **Modeling of Inverter Derate Temperature and Clipping Using the Functions of the PVLIB Library**
L. Reis, L.C. Paiva, L.G. Castro & R. Santos
Casa dos Ventos Energias Renováveis, Fortaleza, Brazil

**4DV.4.43** **Improvement of a Model that Accounts for Sub-Hourly Clipping Losses in PV Performance Hourly Simulations**
A. Mermoud, B. Wittmer, M. Oliosi & A. Bridel-Bertomeu
PVsyst, Satigny, Switzerland

**4DV.4.44** **Proposed Criteria to Assess Swimmer Safety Near Large Floating Photovoltaic Installations**
P.H. Pretorius
TERRAETCH South Africa, Johannesburg, South Africa
R. Heuckelbach & J. Lemmens
DNV Netherlands, Arnhem, The Netherlands

**4DV.4.45** **On the Assessment of Swimmer Safety Near Large Floating Photovoltaic Installations – A Case Study**
R. Heuckelbach & J. Lemmens
DNV, Arnhem, The Netherlands
P.H. Pretorius
Terratech, Johannesburg, South Africa

**4DV.4.46** **IoT-Controlled Hall Ring Transmitters to Rapid Shutdown System of Fire Safety for Photovoltaic Modules**
C.-Y. Peng, S.-Y. Wu & Z.-H. Zhan
NCUT, Taichung, Taiwan
Y.T. Li, M.-A. Tsai, S.-Y. Ting, F.-Y. Yeh & T.-A. Liu
ITRI, Hsinchu, Taiwan

**4DV.4.47** **Experience Feedback on Preconstruction Energy Yield Assessments: Case Study on 134 PV Plants (1.3GWp)**
M. Jude
Eoltech, Toulouse, France

**4DV.4.48** **Accuracy Analysis of PV Modeling in IDA ICE 5.0 (beta): A Comparison to Measured Data in Unshaded and Shaded Conditions in High Latitudes**
M. Rynoson & C. Bales
University of Dalarna, Borlänge, Sweden
J. Munkhammar & J. Widén
Uppsala University, Sweden

**VISUAL PRESENTATIONS**

**17:00 – 18:30** **POSTER AWARDS WINNERS SESSION**