

## CONFERENCE PROGRAMME

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**Monday, 07 September 2020**

### OPENING

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

**8:30 – 09:50 INNOVATIONS IN PV TECHNOLOGIES**

#### Chairpersons:

Jozef (Jef) Poortmans  
imec, Belgium

Andreas Bett  
Fraunhofer ISE, Germany

#### AP.1.1 State of the Art in Perovskite Photovoltaics

A. Hagfeldt  
EPFL, Lausanne, Switzerland

#### AP.1.2 Student Awards Finalist Presentation: The Race for the Best Silicon Bottom Cell: Efficiency and Cost Evaluation of Perovskite-Silicon Tandem Solar Cells

C. Messmer, B.S. Goraya, S. Nold, J. Schön, J.C. Goldschmidt, M. Bivour & M. Hermle  
Fraunhofer ISE, Freiburg, Germany

#### AP.1.3 Intermediate Band Solar Cells: Present and Future

I. Ramiro & A. Martí  
UPM, Madrid, Spain

#### AP.1.4 High Performance Organic Photovoltaics

D. Baran  
KAUST, Jeddah, Saudi Arabia

### 10:00 – 10:30 Becquerel Prize Ceremony

#### Chaired by:

Joachim Luther  
Chair Becquerel Prize Committee

#### Prize delivered by:

Piotr Szymanski, European Commission, Director of the JRC Directorate C for Energy, Transport and Climate

#### Laudatio

Pierre Verlinden  
Becquerel Prize Winner 2019  
Managing Director, Amrock Pty Ltd, Australia  
Consultant, Non-Executive Director to PV companies, Visiting Professor at Sun Yat-sen University (Guangzhou)

#### Speech of the Becquerel Prize Winner 2020

Henry Snaith  
Professor of Physics in the Clarendon Laboratory,  
University of Oxford, united Kingdom

### 10:40 – 11:30 Opening Addresses

- Nicola Pearsall  
EU PVSEC General Chair  
Emerita Professor of Renewable Energy in the Faculty of Engineering and Environment of Northumbria University, United Kingdom
- Elias De Keyser  
Next Kraftwerke Belgium,  
"How aggregation can supply 100% renewable energies based on a B2B concept"



**11:40 – 12:35 Moderated Panel Discussion**
**Title:**

***The role of PV in the Green Deal and the EU Recovery Package - Perspectives and chances for a sustainable future?***

**Moderated by:**

Heinz Ossenbrink  
former European Commission Joint Research Centre

**Panellists**

- Walburga Hemetsberger,  
SolarPower Europe, Belgium
- Gunter Erfurt,  
CEO of Meyer Burger, Germany
- Marko Topič,  
Chair of ETIP PV, Vision of the ETIP PV
- Paolo Rossi,  
Director of AEM SA

Panellists are asked to present a three-minute intro statement, followed by a moderated panel discussion and Q&A with the audience

**ORAL PRESENTATIONS 1AO.1**
**13:30 – 15:00 Fundamentals: Novel Device and Module Concepts**
**Chairpersons:**

David Patrick  
Western Washington University, USA

Iñigo Ramiro  
UPM, Madrid

- 1AO.1.1 Nanowire Solar Cell Beating the Radiative Limit**  
K. Korzun, G. Castellanos Gonzalez, E.P.A.M. Bakkers, J. Gómez Riva & J.E.M. Haverkort  
Eindhoven University of Technology, Netherlands  
D. de Boer  
Solumineus, Amsterdam, Netherlands
- 1AO.1.2 4D Photoluminescence Imaging for Advanced Characterization of Photovoltaic Absorber**  
M. Legrand, A. Bercegol, L. Lombez & D. Ory  
EDF R&D, Palaiseau, France  
J.-F. Guillemoles  
IPVF, Palaiseau, France
- 1AO.1.3 High Resolution Linearity Measurements of Solar Cells Using Digital Light Processing Projection**  
G. Koutsourakis, T. Eales & J.C. Blakesley  
NPL, Teddington, United Kingdom  
I. Kröger  
PTB, Braunschweig, Germany
- 1AO.1.4 Complete Performance Model for Optimal Coloured Photovoltaic Module Design Based on Optic Filters for Building Integrated Applications**  
J.C. Ortiz Lizcano, G. Frantzi, G. Yang, H. Ziar, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands
- 1AO.1.5 Engineering the Reciprocal Space for Ultra Thin GaAs Solar Cells**  
J. Buencuerpo, M.A. Steiner & A.C. Tamboli  
NREL, Golden, USA  
J.M. Llorens & J.M. Ripalda  
IMM - CSIC, Tres Cantos, Spain
- 1AO.1.6 The Reduced Graphene Oxide/Au as Back Contacts for CdTe Solar Cells**  
G. Luo & W. Li  
Sichuan University, Chengdu, China



**ORAL PRESENTATIONS 2AO.4****13:30 – 15:00 Silicon Materials and Defect Engineering****Chairpersons:**

Noritaka Usami  
Nagoya University, Japan

Denis Bredemeier  
ISFH, Germany

**2AO.4.1 The Crystal Growth Explorer: Real-Time Navigable 3D Visualization of Silicon Grains and Defect Related Data in Cast-Mono and Multicrystalline Bricks**

J. Schönauer, T. Trötschler, A.S. Kovvali, M. Demant & S. Rein  
Fraunhofer ISE, Freiburg, Germany  
H. Schremmer  
Hennecke Systems, Zülpich, Germany

**2AO.4.2 What Is the Dislocation Sources in the Growth of High-Performance Multicrystalline Si Ingots?**

Y. Ohno  
Tohoku University, Sendai, Japan  
K. Tajima & N. Usami  
Nagoya University, Japan  
K. Kutsukake  
RIKEN, Tokyo, Japan

**2AO.4.3 Cast-Mono Silicon Wafers for a Sustainable PV Market Growth**

S. Riepe, S. Nold, P. Brailovsky, L. Friedrich, S. Janz & R. Preu  
Fraunhofer ISE, Freiburg, Germany

**2AO.4.4 Drop Test Method for Impact Loading on Silicon Wafer Edge: Damage and Breakage**

L. Carton, R. Riva, Y. Abidate & F. Coustier  
CEA, Le Bourget-du-Lac, France

**2AO.4.5 Student Awards Finalist Presentation: Doped Poly-Si/SiO<sub>x</sub> Passivating Contacts: Hydrogenation and Its Mechanisms**

T.N. Truong, D. Yan, A. Cuevas, D. Macdonald & H.T. Nguyen  
ANU, Canberra, Australia

**ORAL PRESENTATIONS 3AO.7****13:30 – 15:00 High Efficiency Tandem Solar Cells****Chairpersons:**

Christopher Case  
Oxford PV, United Kingdom

Benjamin Strahm  
Meyer Burger Research, Germany

**3AO.7.1 Introductory Oral: Perovskite/Silicon Tandem Cells: Self-Assembled Monolayer as HTL for 29.2% Efficiency and Progress in Upscaling to Large Areas**

E. Köhnen, A. Al-Ashouri, M. Roß, J.A. Marquez-Prieto, P. Caprioglio, A.B. Morales-Vilches, B. Li, B. Rech, R. Schlatmann, L. Korte, T. Unold, B. Stannowski & S. Albrecht  
HZB, Berlin, Germany  
A. Magomedov, E. Kasparavicius, T. Malinauskas & V. Getautis  
Kaunas University of Technology, Lithuania  
M. Stolterfoht & D. Neher  
University of Potsdam, Germany

**3AO.7.2 Silicon-Based Monolithic Triple-Junction Solar Cells with Conversion Efficiency >34%**

R. Müller, P. Schygulla, D. Lackner, O. Höhn, H. Hauser, B. Bläsi, F. Predan, J. Benick, M. Hermle, F. Dimroth & S.W. Glunz  
Fraunhofer ISE, Freiburg, Germany

**3AO.7.3 Research on Flexible Triple Junction Solar Cells with High Specific Power**

H. Wang, M. Jiang, P. Gao, R. Liu & Q. Sun  
Tianjin Institute of Power Sources, China

**3AO.7.4 High-Efficiency All-Perovskite Tandem Solar Cells via Vacuum-Assisted Growth Control**

B. Abdollahi Nejand, I.M. Hossain, M. Jakoby, S. Moghadamzadeh, U. Lemmer, B.S. Richards, I.A. Howard & U.W. Paetzold  
Karlsruhe Institute of Technology, Germany

**3AO.7.5 Fs-Laser Micro Machining for  $\mu$ -TLM Resistivity Test Structures in TCO Top Contact Multilayers for Perovskite Heterojunction Tandem Solar Cells**

S. Krause, S. Lange, V. Naumann, P.-T. Miclea & C. Hagendorf  
Fraunhofer CSP, Halle (Saale), Germany  
Q. Zhang, A. Richter, P.S.C. Schulze, O.S. Kabakli & J.C. Goldschmidt  
Fraunhofer ISE, Freiburg, Germany



**VISUAL PRESENTATIONS 4AV.1****13:30 – 15:00 Module Design Manufacture, Performance and Reliability (I)***Detailed information on this session is presented in the section entitled 'Visual Presentations'.***ORAL PRESENTATIONS 1AO.2****15:15 – 16:45 Advanced Solar Cell Architectures****Chairpersons:**Antonio Martí Vega  
UPM, SpainJames Patrick Connolly  
CNRS, France

- 1AO.2.1 Industrialization of Hybrid Si/III-V and Translucent Planar Micro-Tracking Modules**  
G. Nardin, A.F. Aguilar, L. Anglade, M. Duchemin, D. Schuppisser, F. Gerlich, M. Ackermann & L. Coulot  
Insolight, Ecublens, Switzerland  
D. Petri, J. Champlaud, A. Faes, N. Badel, A. Lachowicz, M. Despeisse & J. Levrat  
CSEM, Neuchâtel, Switzerland  
X. Niquille & C. Ballif  
EPFL, Neuchâtel, Switzerland  
S. Askins, N. Jost, G. Vallerotto, C. Domínguez & I. Antón Hernández  
UPM, Madrid, Spain
- 1AO.2.2 Back Surface Reflectors in Thinned III-V Gallium Arsenide Solar Cells**  
J. D'Rozario, S. Polly, G. Nelson & S.M. Hubbard  
Rochester Institute of Technology, USA  
R. Tatavarti  
MicroLink Devices, Niles, USA
- 1AO.2.3 Demonstration of GaAs-Based Energy-Transfer Ratchet Intermediate-Band Solar Cell**  
T. Sogabe, C.-Y. Hung, R. Tamaki & Y. Okada  
University of Tokyo, Japan  
S. Tomic  
University of Salford, Manchester, United Kingdom  
N. Ekins-Daukes  
UNSW Australia, Sydney, Australia
- 1AO.2.4 Flat Photonic Reflectors with Point Contact Approach for Cu(In,Ga)(S,Se)<sub>2</sub> Solar Cell Devices**  
M. Balestrieri & D. Lincot  
IPVF, Palaiseau, France  
S. Lakhdar Chaouche, C. Jimenez & D. Bellet  
CNRS, Grenoble, France  
M. Foldyna & P. Roca i Cabarrocas  
LPICM-CNRS, Palaiseau, France

- 1AO.2.5 Silicon Heterojunction Solar Cell Fabrication Using Nickel Oxide Hole-Selective Contact**  
M. Nayak, A. Pandey & V.K. Komarala  
IIT Delhi, New Dehli, India

**ORAL PRESENTATIONS 2AO.5****15:15 – 16:45 Defects in Silicon****Chairpersons:**Fabian Fertig  
Hanwha Q CELLS, GermanyJohn Murphy  
University of Warwick, United Kingdom

- 2AO.5.1 Disappearance of Hydrogen-Boron-Pairs in Silicon during Illumination and Its Relevance to Lifetime Degradation and Regeneration Effects in Solar Cells**  
D.C. Walter, D. Bredemeier & J. Schmidt  
ISFH, Emmerthal, Germany  
V.V. Voronkov  
Global Wafers, Merano, Italy  
R. Falster  
Scientist, Woodstock, United Kingdom
- 2AO.5.2 Defect Reactions Responsible for Boron Oxygen Degradation in Crystalline Silicon Photovoltaics**  
V. Markevich, A. Peaker, J.A. De Guzman, I. Crowe, I. Hawkins, S. Hammersley & M. Halsall  
University of Manchester, United Kingdom  
M. Vaquero-Contreras  
UNSW Australia, Sydney, Australia  
J. Coutinho & P. Santos  
University of Aveiro, Portugal
- 2AO.5.3 LeTID- and (Extended) BO-Related Degradation and Regeneration in B- and Ga-Doped Monocrystalline Silicon during Dark and Illuminated Anneals**  
W. Kwapil  
University of Freiburg, Germany  
J. Dalke, T. Niewelt & M.C. Schubert  
Fraunhofer ISE, Freiburg, Germany
- 2AO.5.4 The Role of Dark Annealing in Light and Elevated Temperature Induced Degradation in p-Type Mono-Like Silicon: A New Insight to the Problem**  
H.C. Sio, D. Kang & D. Macdonald  
ANU, Canberra, Australia
- 2AO.5.5 Investigation of Areas with High D-Band Emission Lines D3 and D07 in Multi-Crystalline Silicon Wafers with EBSD, TEM, and Hyperspectral Photoluminescence Imaging**



A. Thøgersen, I.T. Jensen & J.S. Graff  
 SINTEF, Oslo, Norway  
 T. Mehl, I. Burud & E. Olsen  
 NMBU, Ås, Norway  
 J. Zhu, S.E. Foss & C.R. Søndena  
 Institute for Energy Technology, Kjeller, Norway

- 2AO.5.6 Reducing LeTID with an Adjustment of the AlOx-SiNy:H Layer System**  
 A. Schmid, C. Fischer, D. Skórka, A. Zuschlag & G. Hahn  
 University of Konstanz, Germany

## ORAL PRESENTATIONS 3AO.8

15:15 – 16:45 **Tandems: Material and Process Developments**

### Chairpersons:

Sylvain Nicolay  
 CSEM, Switzerland

Eric Schneiderlöchner  
 Von Ardenne, Germany

- 3AO.8.1 Analysis and Optimization of Perovskite-Silicon Tandem Solar Cells by Full Optoelectronic Simulation**  
 U. Aeberhard, R. Häusermann, A. Schiller, B. Blülle & B. Ruhstaller  
 Fluxim, Winterthur, Switzerland
- 3AO.8.2 Quantifying Bottlenecks in Open-Circuit Voltage of Perovskite-Si Tandem Solar Cells**  
 B.L. Williams  
 Oxford PV, Yarnton, United Kingdom
- 3AO.8.3 Student Awards Finalist Presentation: High Band Gap Absorber for Monolithic Perovskite Silicon Tandem Solar Cells Reaching 25.1% Certified Efficiency and Ways Beyond**  
 P.S.C. Schulze, A.J. Bett, O.S. Kabakli, K.M. Winkler, L.E. Mundt, F.M. Gerspacher, Q. Zhang, C.L.M. Hofmann, M. Bivour, M. Hermle, S.W. Glunz & J.C. Goldschmidt  
 Fraunhofer ISE, Freiburg, Germany  
 H. Hillebrecht  
 University of Freiburg, Germany
- 3AO.8.4 2D Surface Passivation for Semi-Transparent Perovskite Solar Cells with Engineered Bandgap for 4T Tandem Photovoltaics**  
 I.M. Hossain, S. Gharibzadeh, P. Fassel, A. Mertens, U. Lemmer, B.S. Richards & U.W. Paetzold  
 Karlsruhe Institute of Technology, Germany  
 S. Schäfer, M. Rienäcker, T. Wietler & R. Peibst  
 ISFH, Emmerthal, Germany
- 3AO.8.5 Investigation of the Junction Influence on the Top-Cell in Perovskite/Silicon Tandem Solar Cells**  
 A. Puaud, D. Saporì, M. Matheron, B. Marie, R. Couderc, C. Roux, N. Nguyen, M. Manceau, O. Dupré, S. Berson & D. Muñoz

CEA, Le Bourget-du-Lac, France  
 G. Condorelli, M. Foti & C. Gerardi  
 ENEL Green Power, Catania, Italy

- 3AO.8.6 Scaling Up Four-Terminal Bifacial Tandem**  
 G. Coletti, V. Rosca, L.J. Geerligns, A.R. Burgers, L.A.G. Okel, K.M. de Groot, N.J.J. Dekker & M.J. Jansen  
 TNO Energy Transition, Petten, Netherlands  
 M. Najafi, D. Zhang, V. Zardetto, I. Dogan, R.A.J.M. Andriessen & S.C. Veenstra  
 TNO Energy Transition, Eindhoven, Netherlands  
 T. Aernouts  
 imec, Genk, Belgium  
 J. Hüpkes  
 Forschungszentrum Jülich, Germany  
 C. Burgess & M. Creatore  
 Eindhoven University of Technology, Netherlands

## VISUAL PRESENTATIONS 4AV.2

15:15 – 16:45 **Module Design Manufacture, Performance and Reliability (II)**

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

## ORAL PRESENTATIONS 1AO.3

17:00 – 18:30 **Advanced Materials and Approaches for PV-Modules**

### Chairpersons:

Francesco Roca  
 ENEA, Italy

Igor Konovalov  
 University of Applied Sciences Jena, Germany

- 1AO.3.1 The Use of Copper in Solar Cells and Modules**  
 P. Panek, K. Gawlinska-Necek & Z. Starowicz  
 Polish Academy of Sciences, Cracow, Poland  
 R.P. Socha & G. Putynkowski  
 Research and Development Center of Technology for Industry, Warsaw, Poland  
 M.K. Stodolny & B.B. Van Aken  
 TNO Energy Transition, Petten, Netherlands
- 1AO.3.2 Low Temperature Lead Free Solder Pastes for Shingling Interconnection**  
 N.S. Pujari & S. Sarkar  
 Macdermid Alpha Electronics Solutions, Bangalore, India  
 C. Bilgrien



Macdermid Alpha Electronics Solutions, New Jersey, USA

- 1AO.3.3 Encapsulant-Integrated Interconnection of Bifacial Solar Cells for BIPV Applications: Latest Results in the Twill-BIPV Project**  
J. Govaerts, T. Borgers, R. Van Dyck, N. Andries, P. Meyers,  
A. van der Heide, L. Vastmans, R. Moors, G. Doumen, P. Nivelle, M. Daenen,  
E. Voroshazi & J. Poortmans  
imec, Genk, Belgium  
C. Arnett & R. Labie  
imec, Leuven, Belgium  
M. Van den Storme & G. Van den Storme  
VdS Weaving, Oudenaarde, Belgium  
M. Dekens, S. Vandebroek, P. Schroyen & K. Smeers  
IPTE, Genk, Belgium  
T. Vavilkin & S. Dewallef  
Soltech, Tienen, Belgium  
F. Abgrall & D. Jousset  
Arkema, Colombes, France
- 1AO.3.4 Enabling the In-Situ Stress and Temperature Measurement by Silicon Solar Cell Integrated Stress and Temperature Sensors for Photovoltaic Modules**  
A.J. Beinert, M. Imm, J. Benick, S. Seitz, M. Heinrich, S.W. Glunz, U. Eitner &  
H. Neuhaus  
Fraunhofer ISE, Freiburg, Germany  
F. Becker & O. Paul  
University of Freiburg, Germany  
J. Aktaa  
Karlsruhe Institute of Technology, Germany
- 1AO.3.5 Reconfigurable Modules for Higher Yields in Urban PV Systems – A Simulation Study**  
A. Calcabrini, R. Weegink, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands
- 1AO.3.6 Spray Coating – A Versatile Technique for Thin Film Deposition in PV**  
J. Bartsch, U. Heitmann, L. Jakob, R. Hermann, S. Kluska, L. Cojocar, L.  
J.C. Goldschmidt, B. Bläsi, H. Hauser, S. Janz & M. Glatthaar  
Fraunhofer ISE, Freiburg, Germany

**ORAL PRESENTATIONS 2AO.6****17:00 – 18:30 Poly-Silicon Passivated Contacts (I)****Chairpersons:**Giso Hahn  
University of Konstanz, GermanyRonald C.G. Naber  
Tempress, The Netherlands

- 2AO.6.1 Towards 24% Efficiency for Industrial n-Type Bifacial Passivating-Contact Solar Cells with Homogeneous Emitter**  
J. Bao, W. Wu, C. Chen, L. Ma, Z. Qiao, C. Huang, Q. Shao, C. Chen,  
S. Zhan, R. Liu, Z. Liu & J. Chen  
Jolywood, Taizhou, China
- 2AO.6.2 Fully Screen-Printed Silicon Solar Cells with Local Al-BSF Base Contact and a Voc of 711 mV**  
F. Haase, B. Min, C. Hollemann, R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany  
J. Krügener  
Leibniz University of Hannover, Germany
- 2AO.6.3 Industrial TOPCon Solar Cells Realized by a PECVD Tube Process**  
F. Feldmann, B. Steinhauser, H. Nagel, T. Fellmeth, S. Mack, D. Ourinson,  
E. Lohmüller, J. Polzin, A. Moldovan, M. Bivour, F. Clement, J. Rentsch,  
M. Hermle & S.W. Glunz  
Fraunhofer ISE, Freiburg, Germany  
T. Pernau  
centrotherm international, Blaubeuren, Germany
- 2AO.6.4 POLO Back Junction: An Elegant Way to Implement Electron-Collecting Passivating Contacts in p-Type Industrial Silicon Solar Cells**  
B. Min, A. Merkle, T. Brendemühl, N. Wehmeier, Y. Larionova, B. Beier,  
L. David, H. Schulte-Huxel, T. Dullweber, R. Peibst & R. Brendel  
ISFH, Emmerthal, Germany
- 2AO.6.5 Doping and Hydrogenation Processes for Passivating Contact Solar Cells Using Plasma Immersion Ion Implantation (PIII)**  
T. Desrues, C. Oliveau, C. Seron & S. Dubois  
CEA, Le Bourget-du-Lac, France  
G. Borvon & F. Torregrosa  
Ion Beam Services, Peynier, France  
Q. Rafhay & A. Kaminski-Cachopo  
IMEP-LAHC, Grenoble, France
- 2AO.6.6 Photocurrent Enhancement via Self-Aligned, Selective Area, Dry-Etching of Poly-Si/SiO<sub>2</sub> Passivated Contacts for High-Efficiency Silicon Solar Cells**  
K. Chen, A.S. Kale & S. Agarwal  
Colorado School of Mines, Golden, USA  
V. LaSalvia, W. Nemeth, S. Theingi, D. Findley, H. Guthrey, M. Page,  
P. Stradins & D.L. Young  
NREL, Golden, USA

**ORAL PRESENTATIONS 3AO.9****17:00 – 18:30 Organic PV: Efficiency, Stability, Scalability****Chairpersons:**Sjoerd Veenstra  
TNO Energy Transition, The Netherlands

Invited



- 3AO.9.1 New World Record Efficiency for Organic Photovoltaic Modules**  
A. Distler & H.-J. Egelhaaf  
ZAE Bayern, Nuremberg, Germany  
C.J. Brabec  
FAU, Erlangen, Germany
- 3AO.9.2 Roll Processed Organic Solar Cells Based on P3HT:O-IDTBR**  
M. Fernández Castro, E. Mazzolini, R.R. Søndergaard, M. Espindola-Rodriguez & J.W. Andreasen  
Technical University of Denmark, Kgs. Lyngby, Denmark
- 3AO.9.3 Performance of Four Different Organic PV Modules According to the Energy Rating Standard Series IEC 61853**  
G. Bardizza, E. Salis, A.M. Gracia Amillo & E.D. Dunlop  
European Commission JRC, Ispra, Italy
- 3AO.9.4 Thermal Analysis of Organic Photovoltaic Modules as Building Elements in Long Term Outdoor Operating Conditions**  
C.A. Toledo Arias, J. Abad & A. Urbina  
UPCT, Cartagena, Spain  
G. Bardizza & A.M. Gracia Amillo  
European Commission JRC, Ispra, Italy
- 3AO.9.5 Challenges to Fully Roll-to-Roll Processed Organic Photovoltaic Devices**  
M. Bertrand, D. Hau & F. Allais  
ARMOR, Nantes, France
- 3AO.9.6 Extended Lifetime of Organic Solar Cells with New Non-Fullerene Acceptors**  
R. López Vicente, J. Abad & A. Urbina  
UPCT, Cartagena, Spain  
M. Espindola-Rodriguez, M. Fernández Castro & J.W. Andreasen  
Technical University of Denmark, Lyngby, Denmark

**VISUAL PRESENTATIONS 4AV.3**

**17:00 – 18:30 Inverters, Micro-Inverters and BOS Components / Sustainability and Circular Economy**

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

**Tuesday, 08 September 2020**

**ORAL PRESENTATIONS 2BO.1**

**08:30 – 10:00 Poly-Silicon Passivated Contacts (II)**

**Chairpersons:**

Martin Hermle  
Fraunhofer ISE, Germany

Thorsten Dullweber  
ISFH, Germany

- 2BO.1.1 Plating on TOPCon as a Way to Reduce the Fabrication Costs of i-TOPCon Solar Cells**  
B. Steinhäuser, B. Grübel, S. Nold, V. Arya, C. Schmiga, S. Kluska, A.A. Brand, F. Feldmann & M. Glatthaar  
Fraunhofer ISE, Freiburg, Germany  
N. Bay, X. Gay & M. Passig  
RENA, Gütenbach, Germany
- 2BO.1.2 Formation of p-Type Passivating Contacts by Short Annealing**  
S. Libraro, F.-J. Haug & C. Ballif  
EPFL, Neuchâtel, Switzerland  
J.J. Diaz Leon, C. Allebé, S. Nicolay & A. Ingenito  
CSEM, Neuchâtel, Switzerland
- 2BO.1.3 Fired-Only Passivating Poly-Si on Oxide Contacts with DC-Sputtered In-Situ Phosphorous-Doped Silicon Layers**  
L. David, B. Min, C. Hollemann, R. Peibst & R. Brendel  
ISFH, Emmerthal, Germany  
S. Hübner, T. Dippell & P. Wohlfart  
Singulus Technologies, Kahl am Main, Germany
- 2BO.1.4 Influence of Dielectric Films on the Passivation Quality of Phosphorus Doped Polysilicon Passivating Contacts Upon Firing**  
D. Kang, H.C. Sio, D. Yan, J. Stuckelberger, W. Chen & D. Macdonald  
ANU, Canberra, Australia
- 2BO.1.5 Assessing Performance and Limitations of Different Technologies for Poly-Si Based Passivating Contacts**  
A. Ingenito, C. Allebé, J.J. Diaz Leon, G. Nogay, A. Descoedres & S. Nicolay  
CSEM, Neuchâtel, Switzerland  
S. Libraro & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 2BO.1.6 Development of Poly-Si Passivating Contacts on Textured Si Surface for Bottom c-Si Solar Cell Application**  
G. Yang, S.K. Senthil Kumar, P.A. Procel Moya, Y. Zhao, C. Han, M. Singh, G. Limodio, L. Mazzarella, A.W. Weeber, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands



**ORAL PRESENTATIONS 5BO.6****08:30 – 10:00 Solar Radiation Modelling and Instrumentation****Chairpersons:**

Elke Lorenz  
Fraunhofer ISE, Germany

Ana Maria Gracia Amillo  
European Commission JRC, Italy

- 5BO.6.1 Accurate Irradiance Simulation Approach Combining Ray Tracing and View Factors Models**  
A. Calcabrini, R. Cardose, P. Manganiello, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands
- 5BO.6.2 Student Awards Finalist Presentation: Quantification of the Effect of Albedo Modeling for a Floating PV System on the North Sea**  
S.Z. Mirbagheri Golroodbari & W.G.J.H.M. van Sark  
Utrecht University, Netherlands
- 5BO.6.3 Method for Solar Potential Mapping of the Intra-Building over the Street Unoccupied Urban Volume**  
T. Santos  
CICS.NOVA, Lisbon, Portugal  
J. Rocha & K. Lobato  
University of Lisbon, Portugal
- 5BO.6.4 Imputation of Missing Values in Irradiance Datasets**  
A. Louwen, S. Lindig & D. Moser  
Eurac Research, Bolzano, Italy
- 5BO.6.5 The Impact of Albedo Measurements on Power Density Calculations of Bifacial Modules**  
E. Grommes, U. Blieske & J. Müller-Ost  
Cologne University of Applied Sciences, Germany
- 5BO.6.6 Simulation and Validation of Bifacial Irradiance Sensor Mounting Position**  
M. Korevaar, P. Babal, S. van Nieuwkerk, K. Wilson & J. Mes  
Kipp & Zonen, Delft, Netherlands

**ORAL PRESENTATIONS 4BO.11****08:30 – 10:00 Backsheet and Encapsulation Materials****Chairpersons:**

William J. Gambogi  
DuPont, USA

Gernot Oreski  
PCCL, Austria

- 4BO.11.1 Comparability in the Ageing Behavior of Backsheets Exposed to Indoor and Outdoor Weathering**  
L. Castillon, C. Barretta & G. Oreski  
PCCL, Leoben, Austria  
D. Mansour  
Fraunhofer ISE, Freiburg, Germany  
S. Mitterhofer  
University of Ljubljana, Slovenia
- 4BO.11.2 Validating Advanced Stress Testing Protocols Using Analysis of Degraded Polyvinylidene Fluoride-Based Backsheet Films**  
M. Owen-Bellini, D.C. Miller, D.R. Jenket & P. Hacke  
NREL, Golden, USA  
S.L. Moffitt & L.T. Schelhas  
SLAC, Menlo Park, USA  
A. Sinha  
Arizona State University, Mesa, USA  
A.M. Maes & J.Y. Hartley  
Sandia National Laboratories, Albuquerque, USA  
T. Karin  
Lawrence Berkeley National Laboratory, USA  
J. Tracy  
DuPont, Wilmington, USA
- 4BO.11.3 Evolution of Microstructure in Polyvinylidene Fluoride-Based Backsheets After Aging**  
S.L. Moffitt, P.-C. Pan, L. Perry, D. Jacobs, L.-P. Sung, S. Watson & X. Gu  
NIST, Gaithersburg, USA  
M.D. Kempe  
NREL, Golden, USA  
J. Tracy & K. Roy Choudhury  
DuPont, Wilmington, USA
- 4BO.11.4 More Realistic Consideration of Backsheet Coefficient of Thermal Expansion on Thermomechanics of PV Modules**  
P. Romer, A.J. Beinert, H. Neuhaus & M. Mittag  
Fraunhofer ISE, Freiburg, Germany  
G. Oreski  
PCCL, Leoben, Austria
- 4BO.11.5 Optimisation of the Frontsheet Encapsulant for Increased Resistance of Lightweight Solar PV Modules**  
F. Lisco, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland





- 4BO.11.6 Effect of Encapsulant Storage Conditions on the Long-Term Photo-Induced Degradation of EVA in Double-Glass Solar PV Modules**  
L. Gnocchi, A. Fairbrother, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland  
H.-Y. Li  
CSEM, Neuchâtel, Switzerland

- V.D. Mihailetchi  
ISC Konstanz, Germany  
P. Baranek  
EDF R&D, Palaiseau, France  
O. Isabella & R. Santbergen  
Delft University of Technology, Netherlands

**ORAL PRESENTATIONS 1BO.16**

**08:30 – 10:00 Development and Characterization of New Solar Cell Architectures**

**Chairpersons:**

Marin Rusu  
HZB, Germany

Jean-Paul Kleider  
CNRS/GeePs, France

- 1BO.16.1 Student Awards Finalist Presentation: Luminescent Characteristics of Wire-on-Well Nanostructure Solar Cells**  
M. Asami, R. Yokota, K. Watanabe, Y. Nakano & M. Sugiyama  
University of Tokyo, Japan
- 1BO.16.2 Measurements of Hot Carrier Temperature by Thermal Noise**  
I. Konovalov & N. Bhattacharjee  
University of Applied Sciences Jena, Germany
- 1BO.16.3 Tailoring Band Gap in 2D Nanolayers for Photovoltaic Applications: In<sub>2</sub>Se<sub>3</sub> Films**  
A.I. Shkrebtii / Chkrebti, R. Minnings & G. Perinparajah  
Ontario Tech University, Oshawa, Canada  
N. Arzate, S. Anderson & B. Mendoza  
CIO, Guanajuato, Mexico
- 1BO.16.4 Formation of p-Type BaSi<sub>2</sub> Thin Film and its Application to Silicon-Based Heterojunction Solar Cells**  
Y. Kimura, M. Fujiwara, K. Takahashi, Y. Nakagawa, T. Yoshino, K. Gotoh, Y. Kurokawa & N. Usami  
Nagoya University, Japan
- 1BO.16.5 Wide-Bandgap UV-Selective Transparent Solar Cells Based on ZnO and Zn(O,S) Absorbers for BIPV Applications**  
A.J. Lopez-Garcia, R. Fonoll Rubio, V. Izquierdo-Roca, E. Saucedo & A. Perez-Rodriguez  
IREC, Barcelona, Spain
- 1BO.16.6 Recent Results on Carrier Selective Three Terminal Perovskite on Silicon-IBC Tandem Solar Cells**  
J.P. Connolly, J.-P. Kleider & J. Alvarez  
CNRS/GeePs, Gif-sur-Yvette, France  
M.K. Nazeeruddin & H. Kanda  
EPFL, Sion, Switzerland

**VISUAL PRESENTATIONS 3BV.1**

**08:30 – 10:00 Perovskites**

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

**ORAL PRESENTATIONS 2BO.2**

**10:30 – 12:00 PERX: Processes and Technologies**

**Chairpersons:**

Barbara Terheiden  
University of Konstanz, Germany

Stefan Glunz  
Fraunhofer ISE, Germany

- 2BO.2.1 Comparison of LeTID in Monofacial and Bifacial Multi-Crystalline PERC Cells and Modules**  
D. Zhang, B. Wan, G. Yan, J. Wu, F. Jiang, J.-N. Jaubert & G. Xing  
Canadian Solar, Suzhou, China
- 2BO.2.2 Atmospheric Pressure Chemical Vapor Deposited Aluminum Oxide / Silicon Nitride Stacks for PERC and PERT Solar Cell Concepts with High Passivation Quality**  
F. Geml, B. Gapp, S. Sanz Alonso, J. Engelhardt & G. Hahn  
University of Konstanz, Germany
- 2BO.2.3 Simultaneous Boron Emitter Diffusion via Rapid Vapour-Phase Direct Doping and Crystallization of TOPCon Layers**  
M. Drießen, A. Richter, B. Steinhauser, F. Feldmann, J.-I. Polzin, F. Sahajad, M. Ohnemus, C. Weiss, J. Benick & S. Janz  
Fraunhofer ISE, Freiburg, Germany
- 2BO.2.4 Co-Plated Bifacial n-PERT Cells with 2-Sided Polysilicon Passivating Contacts**  
S. Singh, P. Choulat, F. Duerinckx, M. Recaman Payo, L. Tous & J. Poortmans  
imec, Leuven, Belgium  
R.C.G. Naber & M. Lenes  
Tempress, Vaassen, Netherlands



- 2BO.2.5 Firing-through Metallisation of PERT-Like Cells Using  $\mu$ -Si(n) as Thin Rear Side Full Area Passivating Contact**  
 P. Wyss, Q. Jeangros, F.-J. Haug, A. Ingenito & C. Ballif  
 EPFL, Neuchâtel, Switzerland  
 J.J. Diaz Leon, C. Allebé & S. Nicolay  
 CSEM, Neuchâtel, Switzerland
- 2BO.2.6 New Chemical Model for the Diffusion Mechanism of Phosphorus into the Silicon Wafer during POC13 Diffusion**  
 P. Jäger, V. Mertens, U. Baumann & T. Dullweber  
 ISFH, Emmerthal, Germany

**ORAL PRESENTATIONS 5BO.7**

**10:30 – 12:00 Forecasting Solar Radiation and PV Power**

**Chairpersons:**

Manajit Sengupta  
 NREL, USA

Jan Remund  
 Meteotest, Switzerland

- 5BO.7.1 Cross-Location Solar Irradiance Nowcasting by Metadata-Augmented CNN-LSTM Neural Networks from Satellite Images**  
 H.-F. Huang  
 Thingnario, Taipei, Taiwan  
 K.-Y. Lee  
 UIUC, Urbana, USA  
 W.H. Hsu  
 NTU, Taipei, Taiwan
- 5BO.7.2 Probabilistic Forecast of All-Sky Solar Radiation Using Enhanced WRF-Solar**  
 J.-H. Kim, P.A. Jimenez & J. Dudhia  
 National Center for Atmospheric Research, Boulder, USA  
 J. Yang, M. Sengupta & Y. Xie  
 NREL, Golden, USA
- 5BO.7.3 Ensemble Based 15 Days Ahead Aggregated Photovoltaic Power Generation Forecasting at Macro Area Level**  
 M. Moschella, E. Crisostomi & M. Tucci  
 University of Pisa, Italy  
 A. Betti, L. Gioni & C. Lanzetta  
 I-EM, Livorno, Italy
- 5BO.7.4 Minute Resolution Measurement Network for Global Horizontal and Tilted Solar Irradiance for a Transmission System Control Area in Southern Germany**  
 E. Lorenz, N. Holland, A. Dittmann, W. Herzberg, S. Karalus, W. Heydenreich & C. Braun  
 Fraunhofer ISE, Freiburg, Germany  
 P. Guthke & A. Semmig

TransnetBW, Stuttgart, Germany

- 5BO.7.5 Hybrid Modelling of PV Power Generation for Enhanced Forecasting**  
 S. Theocharides, G. Makrides, M. Kynigos & G.E. Georghiou  
 University of Cyprus, Nicosia, Cyprus  
 M. Theristis  
 Sandia National Laboratories, Albuquerque, USA
- 5BO.7.6 Using Analogs Ensembles and Genetic Algorithm to Handle Uncertainty in a Microgrid**  
 F. Calderon-Obaldia & A. Migan-Dubois  
 GeePs-UCR, Gif-sur-Yvette, France  
 J. Badosa  
 University Sorbonne, Palaiseau, France  
 V. Bourdin  
 LIMSI, Orsay, France

**ORAL PRESENTATIONS 4BO.12**

**10:30 – 12:00 Induced Degradation**

**Chairpersons:**

Christos Monokroussos  
 TÜV Rheinland, China

Henning Nagel  
 Fraunhofer ISE, Germany

- 4BO.12.1 The Challenge of PID with Bifaciality: Which Side Is Being Tested?**  
 J. Carolus, R. Breugelmans & M. Daenen  
 Hasselt University, Genk, Belgium  
 J.A. Tsanakas, A.S.H. van der Heide, E. Voroshazi & W. De Ceuninck  
 imec, Genk, Belgium
- 4BO.12.2 Optimized Module Packaging for Silicon Heterojunction Solar Cells and Increased PID Resistance**  
 O. Arriaga Arruti, L. Gnocchi, F. Lisco, A. Virtuani & C. Ballif  
 EPFL, Neuchâtel, Switzerland
- 4BO.12.3 Extreme Testing of PID Resistive c-Si PV Modules with 1500 V System Voltage**  
 P. Lechner, J. Schnepf, S. Hummel & D. Geyer  
 ZSW, Stuttgart, Germany  
 J. Wittfoth  
 CS Wismar, Germany  
 R. Merino Martínez  
 STRE, Llanera, Spain  
 P. Sánchez-Friera  
 IDONIAL, Gijón, Spain
- 4BO.12.4 Detecting and Understanding Sodium Movement in Solar Panel Encapsulant Polymers**  
 S.L. Moffitt, B.H. Hamadani & X. Gu



NIST, Gaithersburg, USA

**4BO.12.5 Illumination and Encapsulant Resistivity Are Critical Factors in Polarization-Type Potential Induced Degradation on n-PERT Cells**

B. Habersberger  
Dow Chemical, Lake Jackson, USA  
P. Hacke  
NREL, Golden, USA

**4BO.12.6 LeTID Impact on Bifacial and Monofacial Silicon Modules Using Accelerated Aging Tests, Quantitative Electroluminescence and PV Plant Modelling**

J. Dupuis, G. El Hajje, G. Plessis, E. Lajoie-Mazenc & P. Dupeyrat  
EDF R&D, Moret Loing et Orvan, France  
E. Sandré & K. Radouane  
EDF Renewables, Paris La Defense, France

**VISUAL PRESENTATIONS 3BV.2**

**10:30 – 12:00 CI(G)S, CdTe and Related Thin Films / Organic and Dye-Sensitised Devices / II-V and Related Compound Semiconductors / Tandems**

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

**ORAL PRESENTATIONS 2BO.3**

**13:30 – 15:00 Dopant Free Heterojunctions and TCOs**

**Chairpersons:**

Pere Roca i Cabarrocas  
CNRS, France

Jan Schmidt  
ISFH, Germany

**2BO.3.1 Development of Conductive SiCx:H as a New Hydrogenation Technique for Tunnel Oxide Passivated Contacts**

K. Qiu, M. Pomaska, A. Gad, S. Li, A. Lambertz, W. Duan, F. Finger, U. Rau & K. Ding  
Forschungszentrum Jülich, Germany  
Z. Liang  
Sun Yat-sen University, Guangzhou, China

**2BO.3.2 Interface Treatment to Improve the (I)a-Si:H/MoOx Stack for Passivating Contact Solar Cells**

L. Mazzarella, A. Alcañiz-Moya, E. Kawa, P.A. Procel Moya, Y. Zhao, C. Han, G. Yang, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands

**2BO.3.3 Design Rules for Novel Materials to Perform as Efficient Carrier-Selective Contacts for Silicon Solar Cell**

M. Boccard, A.N. Fioretti, J. Haschke & C. Ballif  
EPFL, Neuchâtel, Switzerland  
R. Woods-Robinson & K.A. Persson  
University of California, Berkeley, USA

**2BO.3.4 Student Awards Finalist Presentation: Enhancing Hole Selectivity of Passivated Contacts via Ultrathin Dielectric ALD-AIOx Tunnel Layer Exhibiting High Negative Interface Charge**

G. Kaur & A. Danner  
National University of Singapore, Singapore  
R. Sridharan, Z. Xin & R. Stangl  
SERIS, Singapore, Singapore

**2BO.3.5 Atomic Layer Deposited AIOx Tunnelling Interfacial Layer for p-Type Selective Contacts for c-Si Solar Cells**

M.T.S.K. Ah Sen, P.C.P. Bronsveld, E.G. Hoek, B.W.J. Kikkert & A.W. Weeber  
TNO Energy Transition, Petten, Netherlands

**2BO.3.6 Aiming for Fully Suitable High-Mobility TCOs for Silicon Heterojunction Solar Cells**

D. Erfurt, A. Cruz Bournazou, A.B. Morales-Vilches, E.C. Wang, R. Schlatmann & B. Stannowski  
HZB, Berlin, Germany  
M. Dimer, R. Köhler, U. Graupner & E. Schneiderlöchner  
Von Ardenne, Dresden, Germany

**ORAL PRESENTATIONS 3BO.8**

**13:30 – 15:00 Ways to Improve Perovskite Solar Cells**

**Chairpersons:**

Giorgio Bardizza  
European Commission JRC, Italy

Wolfgang Tress  
LMU Munich, Germany

**3BO.8.2 Inverted Perovskite Solar Cells: Original Optimization of a Mixed-Cation Mixed-Halide Perovskite Deposition Process Upon TFB as Hole Selective Layer**

T. Lemerrier, L. Perrin & E. Planès  
University Savoie Mont Blanc, Grenoble, France  
N. Lemaitre, S. Berson & L. Flandin  
CEA, Le Bourget-du-Lac, France

**3BO.8.3 Synergistic Modification for Efficient and Stable Perovskite Solar Cells**

B. Chen, P. Wang, R. Li, Y. Li, N. Ren, Q. Xu, L. Yan, Q. Huang, Y. Li, Y. Ding, D.K. Zhang, H. Ren, S. Xu, G. Hou, Y. Zhao & X. Zhang



Nankai University, Tianjin, China

**3BO.8.4 Acetic Acid Assisted Crystallization Strategy for High Efficiency and Long-Term Stable Perovskite Solar Cell**

Y. Li, J. Zheng, J. Bing, Y. Cho, S. Tang, M. Zhang, Y. Yao, C.F.J. Lau, D.S. Lee, C. Liao, M.A. Green, S. Huang & A.W.Y. Ho-Baillie  
 UNSW Australia, Sydney, Australia  
 J. Shi, J. Yuan & W. Ma  
 Soochow University, Suzhou, China

**3BO.8.6 Pb-Free Sn Perovskite Solar Cells with 13% Efficiency by Surface Passivation**

K. Nishimura, M.A. Kamarudin, D. Hirotsu, S. Qing & S. Hayase  
 University of Electro-Communications, Chofu, Japan  
 S. Iikubo  
 Kyushu Institute of Technology, Kitakyushu, Japan  
 T. Minemoto  
 Ritsumeikan University, Kisatus, Japan  
 K. Yoshino  
 University of Miyazaki, Japan

**ORAL PRESENTATIONS 4BO.13****13:30 – 15:00 Outdoor Performance and Energy Rating****Chairpersons:**

Stefan Winter  
 PTB, Germany

Juan Lopez-Garcia  
 European Commission JRC, Italy

**4BO.13.1 Annual Energy Yield Simulation of 3-Terminal Perovskite / Silicon Tandem Modules**

R. Santbergen, Z. Wang, A. Nour El Din, M.R. Vogt, M. Zeman & O. Isabella  
 Delft University of Technology, Netherlands

**4BO.13.2 Interlaboratory Comparison of the PV Module Energy Rating Standard IEC 61853-3 and Reference Parameter Set for the PV Community**

M.R. Vogt & K. Bothe  
 ISFH, Emmerthal, Germany  
 S. Riechelmann, E. Music & F. Plag  
 PTB, Braunschweig, Germany  
 A.M. Gracia Amillo  
 European Commission JRC, Ispra, Italy  
 A. Driesse  
 PV Performance Labs, Freiburg, Germany  
 A. Kokka & P. Kärhä  
 Aalto University, Espoo, Finland  
 C. Schinke  
 Leibniz University Hannover, Germany  
 J.C. Blakesley  
 NPL, Teddington, United Kingdom

G. Friesen & G. Corbellini  
 SUPSI, Canobbio, Switzerland  
 N. Riedel-Lyngskær  
 Technical University of Denmark, Roskilde, Denmark  
 R.M.E. Valckenborg  
 TNO, Eindhoven, Netherlands  
 M. Schweiger & W. Herrmann  
 TÜV Rheinland Energy, Cologne, Germany

**4BO.13.3 Uncertainty of PV Module Energy Rating Caused by Spectral Effects**

W. Herrmann, I. Nixdorf & J. Bonilla Castro  
 TÜV Rheinland Energy, Cologne, Germany

**4BO.13.4 Investigation of Field Irradiance Angular Profiles and Relation with Indoor IV Measurements for Accurate Energy Yield Predictions**

M. Mungra, Y. Li & A.J. Lennon  
 UNSW Australia, Sydney, Australia  
 M. Pravettoni  
 SERIS, Singapore, Singapore  
 E. Garcia Goma  
 Spire Solar - Eternal Sun, Den Haag, Netherlands

**4BO.13.5 Pearl TF PV: An In-Depth Investigation on the Prediction of Long Term Performance of Thin-Film Photovoltaic Modules**

M. Theelen, A. Kingma, R. Aninat & K. Bakker  
 TNO/Solliance, Eindhoven, Netherlands  
 T. Weber  
 PI Berlin, Germany  
 E.J. Achterberg, R. Verhagen & R. van Gestel  
 Solar Tester, Schinnen, Netherlands  
 B.E. Pieters, V. Huhn & E. Sovetkin  
 Forschungszentrum Jülich, Germany  
 A.W. Weeber  
 Delft University of Technology, Netherlands  
 K. Mack, M. Riedel & B. Rau  
 HZB, Berlin, Germany  
 M. Rennhofer  
 AIT, Vienna, Austria  
 L. Plessing  
 Crystalsol, Vienna, Austria

**4BO.13.6 Energy Yield Modeling of 2-D and 3-D Curved Photovoltaic Modules**

S. Neven-du Mont, C. Kutter, C. Reise, M. Heinrich & D.-H. Neuhaus  
 Fraunhofer ISE, Freiburg, Germany

**VISUAL PRESENTATIONS 5BV.3****13:30 – 15:00 Solar Resource and Forecasting**

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



## ORAL PRESENTATIONS 2BO.4

15:15 – 16:45 Si-Alloy Based Functional Layers and TCOs

## Chairpersons:

Matthieu Despeisse  
CSEM, Switzerland

Delfina Muñoz  
CEA, France

- 2BO.4.1 Multilevel Improvement in the Window Layers Stack of Silicon Heterojunction Solar Cell**  
L. Antognini, V. Paratte, M. Truong, J. Cattin, J. Haschke, J. Dréon, C. Ballif & M. Boccard  
EPFL, Neuchâtel, Switzerland  
L.-L. Senaud, G. Christmann, S. Nicolay, B. Paviet-Salomon & M. Despeisse  
CSEM, Neuchâtel, Switzerland
- 2BO.4.2 Design and Optimization of Positive-Charge Carrier Collectors Based on nc-SiOx:H for High-Efficiency Silicon Heterojunction Solar Cells**  
Y. Zhao, P.A. Procel Moya, L. Mazzarella, C. Han, G. Yang, A.W. Weeber, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands
- 2BO.4.3 Process Influences during Atmospheric Pressure Chemical Vapor Deposition of Passivating Si-Based Doping Glasses for PERT Solar Cell Concepts**  
F. Geml, J. Engelhardt, B. Gapp, L. Reinalter & G. Hahn  
University of Konstanz, Germany
- 2BO.4.4 The Sputter Deposition of Low Resistive and Broadband Transparent Cerium and Hydrogen Co-Doped Indium Oxide and Its Transfer to Silicon Heterojunction Solar Cells**  
L. Tutsch, M. Bivour & M. Hermle  
Fraunhofer ISE, Freiburg, Germany  
T. Koida, H. Sai & T. Matsui  
AIST, Tsukuba, Japan
- 2BO.4.5 Benchmarking TCOs for Silicon Heterojunction Solar Cells**  
A. Cruz Bournazou, D. Erfurt, E.-C. Wang, A.B. Morales-Vilches, R. Schlatmann & B. Stannowski  
HZB, Berlin, Germany  
B. Szyszka  
Berlin University of Technology, Germany
- 2BO.4.6 Effect of Process Sequence for nc-SiOx:H (n)/nc-Si:H (n) Double Layer in Silicon Heterojunction Solar Cells**  
D. Qiu, W. Duan, A. Lambertz, M. Pomaska, K. Bittkau, A. Gad & K. Ding  
Forschungszentrum Jülich, Germany

## ORAL PRESENTATIONS 3BO.9

15:15 – 16:45 Processing of Perovskite Solar Cells

## Chairpersons:

Shuzi Hayase  
University of Electro-Communications, Japan

Laura T. Schelhas  
SLAC, USA

- 3BO.9.1 Drying Dynamic of Solution-Processed Perovskite Thin-Films**  
S. Ternes, T. Börnhorst, J.A. Schwenzler, I.M. Hossain, H.M. Pham, T. Abzieher, T.J. Feeney, U. Lemmer, P. Scharfer, W. Schabel, B.S. Richards & U.W. Paetzold  
Karlsruhe Institute of Technology, Germany
- 3BO.9.2 In-Situ Monitoring of Perovskite Thin Film Formation by High-Speed Optical Reflectance Spectroscopy**  
C. Camus, C. Kaspari & V. Blank  
LayTec, Berlin, Germany  
J. Rappich & N. Nickel  
HZB, Berlin, Germany
- 3BO.9.3 2D Materials Enable 0.5 m<sup>2</sup> Perovskite Panel Fabrication for Solar Farm: Panel Efficiency Overcoming 10% and Stable Outdoor Performance**  
A. Agresti, S. Pescetelli, S. Razza, M. Pierro, C. Cornaro & A. Di Carlo  
University of Rome II, Italy  
E. Leonardi & L. Sorbello  
Greatcell Solar Italia, Rome, Italy  
S. Bellani & F. Bonaccorso  
Italian Institute of Technology, Genoa, Italy  
E. Kymakis  
Hellenic Mediterranean University, Heraklion, Greece
- 3BO.9.4 Towards 15% Efficient Semi-Transparent Stable p-i-n Perovskite Solar Modules**  
V. Zardetto, I. Dogan, L. Simurka, W. Verhees, D. Zhang, H. Fledderus, M. Najafi, Y. Galagan, P. Poodt, S.C. Veenstra & R.A.J.M. Andriessen  
TNO, Eindhoven, Netherlands  
A. Bracesco, A. Todinova & M. Creatore  
Eindhoven University of Technology, Netherlands  
A. Aguirre & T. Aernouts  
imec, Genk, Belgium
- 3BO.9.5 Slot Die Coating to Upscale Perovskite PV for Manufacturing**  
M. Friedrich, G. Gibson & A. Zakhidov  
nTact, Dallas, USA
- 3BO.9.6 Understanding the Ablation Mechanism in the P2 Patterning of Perovskite Solar Cells by Experimental and Numerical Analysis**  
C. Schultz, M. Fenske, A. Zeiser, A. Bartelt & B. Stegemann  
Berlin University of Applied Sciences, Germany  
J. Dagar, R. Schlatmann & E. Unger  
HZB, Berlin, Germany





**ORAL PRESENTATIONS 4BO.14****15:15 – 16:45      Module Design, Ageing and Degradation****Chairpersons:**

Tony Sample  
European Commission JRC, Italy

Mike Van Iseghem  
EDF R&D, France

**4BO.14.1    Assessing the Effects of Photovoltaic Modules Long-Term Performance Degradation on Lifetime Energy Yield Predictions**

I. Kaaya & K.-A. Weiß  
Fraunhofer ISE, Freiburg, Germany

**4BO.14.2    High Efficiency Silicon Module Degradation – from Atoms to Systems**

D.C. Jordan, D.B. Sulas-Kern, S. Johnston, H.R. Moutinho, C.-S. Jiang,  
C. Xiao, M. Young, A.G. Norman, C. Deline & I. Repins  
NREL, Golden, USA  
R. Bhoopathy, O. Kunz & Z. Hameiri  
UNSW Australia, Sydney, Australia  
C.L. Sainsbury  
Sinton Instruments, Boulder, USA

**4BO.14.4    Hotspot Susceptibility in Shingled Modules**

C.E. Clement, J.P. Singh, E. Birgersson, Y. Wang & Y. S. Khoo  
SERIS, Singapore, Singapore

**4BO.14.5    Correlation of Peel Forces to EVA Degree of Cross Linking and Accelerated Weathering**

P. Schenk, M. Pander, U. Zeller, B. Jäckel & M. Ebert  
Fraunhofer CSP, Halle (Saale), Germany

**4BO.14.6    Loss Analysis and Efficiency Potentials for CIGS Thin-Film PV Modules without and with Metal Grid: Experimental Results Analyzed by Simulation**

R. Wächter, G. Kaune, T. Repmann & K. Orgassa  
NICE Solar Energy, Schwäbisch Hall, Germany

**VISUAL PRESENTATIONS 1BV.4****15:15 – 16:45      Novel Photovoltaic Conversion Systems, Characterization Approaches and Device Designs / New Materials and Concepts for Cells and Modules**

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

**ORAL PRESENTATIONS 2BO.5****17:00 – 18:45      Full Silicon Heterojunction Solar Cells****Chairpersons:**

Arthur W. Weeber  
TNO Energy Transition, The Netherlands

William Dauksher  
Arizona State University, USA

**2BO.5.1    A Simple Litho-Free Approach to Processing High Efficiency Silicon Heterojunction (SHJ) Interdigitated Back-Contacted (IBC) Solar Cells**

H. Sivaramakrishnan Radhakrishna, I. Gordon & J. Poortmans  
imec, Leuven, Belgium  
M. Xu  
Jinko Solar, Shangrao, China  
M.G. Uddin  
Aalto University, Finland

**2BO.5.2    Improved Layer Properties Combined with Light Soaking Enabling for 23% Silicon Heterojunction Solar Cells**

A. Moldovan, S. Pingel, S. Roder, L. Tutsch, J. Temmler, L. Bodlak,  
A. Fischer, M. Bivour, J.-F. Nekarda & J. Rentsch  
Fraunhofer ISE, Freiburg, Germany  
A. Wendel, S. Hübner, T. Dippell & P. Wohlfart  
Singulus Technologies, Kahl am Main, Germany

**2BO.5.3    Student Awards Finalist Presentation: Illuminated Contact Resistance Measurements to Investigate the Properties of Contact Stacks in Silicon Heterojunction Solar Cells**

L.-L. Senaud, G. Christmann, A. Descoeurdes, J. Geissbühler, N. Badel,  
P. Wyss, C. Allebé, S. Nicolay, M. Despeisse & B. Paviet-Salomon  
CSEM, Neuchâtel, Switzerland  
P.A. Procel Moya, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands  
M. Boccard  
EPFL-STI-IMT-PVLAB, Neuchâtel, Switzerland  
C. Ballif  
EPFL, Neuchâtel, Switzerland

**2BO.5.4    Can a Front-Side Tunnel Layer Passivated Contact Beat a Heterojunction Contact?**

D. Fracasso, P. Wang, R. Tabajonda, J. Epistola, D. Perez, R. Sridharan,  
M.E. Delos Santos, G. De Luna, R. Stangl & T. Mueller  
SERIS, Singapore, Singapore

**2BO.5.5    Challenges for Efficient Integration of SHJ Based Solar Cells in Shingle Module Configuration**

S. Harrison, A. Bettinelli, B. Portaluppi, V. Giglia, P. Lefillastre & V. Barth  
CEA, Le Bourget-du-Lac, France

**2BO.5.6    Novel Patterning Techniques for Copper Electroplated Metallization of Heterojunction Solar Cells**



A. Lachowicz, G. Andreatta, N. Blondiaux, A. Faes, C. Allebé, L. Ding,  
S. Nicolay & M. Despeisse  
CSEM, Neuchâtel, Switzerland  
C. Fontaine & P.-H. Haumesser  
CEA-Leti, Grenoble, France  
J. Jourdan & D. Muñoz  
CEA / INES, Le Bourget-du-Lac, France  
M. Godard & M. Darnon  
University of Sherbrooke, Canada  
C. Ballif  
EPFL, Neuchâtel, Switzerland

- 2BO.5.7 First European 25% Efficient Large Area Silicon Solar Cell: Path for European Premium PV Manufacturing is Open**  
W. Favre, A. Danel, R. Varache, L. Sicot, V. Barth, A. Derrier, Y. Veschetti,  
D. Muñoz, C. Roux  
CEA, Le Bourget-du-Lac, France  
M. Sciuto, A. Ragonesi, A. Di Mateo, D. Nicotra, F. Rametta, D. Iuvara,  
M. Foti, C. Gerardi  
ENEL Green Power, Catania, Italy

#### ORAL PRESENTATIONS 3BO.10

**17:00 – 18:30 Characterizing Perovskite Solar Cell Performance and Stability**

#### Chairpersons:

Valerio Zardetto  
TNO/Solliance, The Netherlands

Xiaodan Zhang  
Nankai University, China

- 3BO.10.1 Negative Capacitance in Perovskite Solar Cells**  
F. Ebadi, A. Hagfeldt & W. Tress  
EPFL, Lausanne, Switzerland
- 3BO.10.2 Universal Measurement Protocol for Perovskite Based Photovoltaic Devices**  
G. Bardizza, H. Müllejans, D. Pavanello & E.D. Dunlop  
European Commission JRC, Ispra, Italy
- 3BO.10.3 Improving Perovskite Solar Cell Stability through Modification of the p-Type Contact**  
M. Dussouillez, A. Paracchino, L. Ding, S.-J. Moon, B.A. Kamino, A. Walter,  
L. Lauber, G. Christmann, S. Rafizadeh, C. Ballif & S. Nicolay  
CSEM, Neuchâtel, Switzerland
- 3BO.10.4 Experiences of Continuous On-Sun Performance Measurements of Perovskite Mini-Modules**  
M. Norton, M. Hadjipanayi, V. Paraskeva & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
M. Kohlstädt & U. Würfel

Fraunhofer ISE, Freiburg, Germany

- 3BO.10.5 Perovskite Solar Cells Subjected to Realistic Operating Conditions: Temperature Dependence, Outdoor Monitoring, Energy Yield Modelling**  
B. Lipovsek, S. Tomsic, K. Brecl & M. Topic  
University of Ljubljana, Slovenia  
M. Jost, A. Al-Ashouri & S. Albrecht  
HZB, Berlin, Germany
- 3BO.10.6 Report of Highly Stable Perovskite Minimodules Passing Key Ageing Tests in IEC61646**  
B. Yan & J. Yao  
Microquanta Semiconductor, Hangzhou, China

#### ORAL PRESENTATIONS 5BO.15

**17:00 – 18:30 Concentrators and PV for Space Applications**

#### Chairpersons:

Ignacio Antón Hernández  
UPM, Spain

Stephen Taylor  
European Space Agency, Netherlands

- 5BO.15.1 ALFAMA Project: Development of a Flexible and Laminated Space Photovoltaic Array**  
T. Guerin, R. Cariou, S. Noël, C. Jamin, Y. Roujol, P. Voarino & F. Chabuel  
CEA, Grenoble, France  
V. Khorenko  
Azur Space, Heilbronn, Germany
- 5BO.15.2 Benchmark and Irradiation Tests of Terrestrial Solar Cells for Low Cost Space Solar Array**  
S. Duzellier & T. Nuns  
University of Toulouse, France  
R. Cariou, P. Voarino & F. Chabuel  
CEA-Liten, Grenoble, France  
C. Aicardi  
CNES, Toulouse, France
- 5BO.15.3 Optics Development and Demonstration of Line-Focus Space Concentrator Prototype Using III-V/Si Cells**  
A. Bermudez-Garcia, P. Voarino, F. Chabuel & O. Raccurt  
CEA, Grenoble, France
- 5BO.15.4 Understanding the Reverse Bias Behaviour of Multijunction Solar Cells**  
J.R. Gonzalez, C. Baur & E. Fernández Lisbona  
ESA-ESTEC, Noordwijk, Netherlands  
I. Rey-Stolle  
UPM, Madrid, Spain



- 5BO.15.5 Development of an External Quantum Efficiency Method to Characterize Solar Cells with a Micro Spot: Applied to Micro-Concentrated Systems**  
P. Voarino, A. Bermudez-Garcia, R. Couderc & O. Raccurt  
CEA, Grenoble, France
- 5BO.15.6 Liquid Luminescent Solar Concentrator Based on Green Emission Carbon Quantum Dots**  
F. Mateen & S.-K. Hong  
Dongguk University, Seoul, Republic of Korea

**VISUAL PRESENTATIONS 6BV.5**

**17:00 – 18:30 Industrial Applications / PV Driven Energy Management and System Integration**

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

**Wednesday, 09 September 2020**

**ORAL PRESENTATIONS 4CO.1**

**08:30 – 10:00 Interconnections**

**Chairpersons:**

Sebastian Dittmann  
Anhalt University of Applied Sciences, Germany

Sener Oktik  
Sisecam, Turkey

- 4CO.1.1 Introductory Oral: Toward Shingling Interconnection with SHJ Solar Cells**  
V. Barth, A. Bettinelli, S. Harrison, C. Carrière & A. Derrier  
CEA, Le Bourget-du-Lac, France  
M. Galiazzi, A. Fecchio, A. Magon & L. Cerasti  
Applied Materials, Olmi di San Biagio di Callalta, Italy
- 4CO.1.2 Investigation of Failure Modes, Mechanisms and Driving Forces for Electrically Conductive Adhesives as Interconnects in PV Modules**  
N. Bosco & M. Springer  
NREL, Golden, USA
- 4CO.1.3 Thermomechanical Fatigue of Solder Joint and Interconnect Ribbon: A Comparison between Glass-Glass and Glass-Foil Modules**  
D. Lindholm, G. Otnes, H. Fjær & S.E. Foss  
Institute for Energy Technology, Kjeller, Norway  
G. Cattaneo & H.-Y. Li  
CSEM, Neuchâtel, Switzerland
- 4CO.1.4 Identification of a Viable and Robust Process for BJ-BC Solar Cells Interconnection**  
T. Timofte & A. Halm  
ISC Konstanz, Germany  
M. Pander & S. Großer  
Fraunhofer CSP, Halle (Saale), Germany
- 4CO.1.5 Solderable PVD Al Back Contacts for the Module Integration of High-Efficiency c-Si Solar Cells**  
H. Nagel, S. Gledhill, T. Kroyer, D. Eberlein, A. Kraft, M. Glatthaar & S.W. Glunz  
Fraunhofer ISE, Freiburg, Germany  
T. Fischer  
teamtechnik Automation, Ludwigsburg, Germany  
A. Hain & P. Wohlfart  
Singulus Technologies, Kahl am Main, Germany



## ORAL PRESENTATIONS 3CO.5

08:30 – 10:00 III-V and Related Compound Semiconductor Solar Cell Devices

## Chairpersons:

Gerald Siefer  
Fraunhofer ISE, Germany

Giovanni Flamand  
imec, Belgium

- 3CO.5.1 Progress in the Development of III-V Multijunction Cells on Ge/Si Substrates**  
I. Garcia, L. Barrutia, A. González, G. Hou, M. Hinojosa, L. Cifuentes, C. Algora & I. Rey-Stolle  
UPM, Madrid, Spain  
A.D. Johnson  
IQE, Cardiff, United Kingdom
- 3CO.5.2 Next-Generation Lattice-Matched Multijunction Solar Cells Based on Dilute-Nitride III-V Compounds**  
A. Aho, R. Isoaho, M. Raappana, T. Aho, A. Tukiainen, J. Reuna, V. Polojärvi, E. Anttola & M. Guina  
Tampere University, Finland
- 3CO.5.3 Development of Dilute Nitride GaPN<sub>x</sub> as a Top Cell Candidate for Three Terminal Silicon-Based Multijunction Solar Cell**  
S. Murali, A. Chikhalkar, C. Zhang, M. Goryll, R.R. King & C.B. Honsberg  
Arizona State University, Tempe, USA
- 3CO.5.4 Epitaxial GaAs Lift-off from Si(111) Wafer via 2D-GaSe Buffer Layer**  
N. Kojima, Y.-C. Wang, Y. Ohshita & M. Yamaguchi  
Toyota Technological Institute, Nagoya, Japan
- 3CO.5.5 Photon Recycling Mechanisms in Thin-Film GaAs Solar Cells**  
N. Gruginskié, G.J. Bauhuis, P. Mulder, E. Vlieg & J.J. Schermer  
Radboud University, Nijmegen, Netherlands  
F. Cappelluti & A. Tibaldi  
Polytechnic University of Turin, Italy
- 3CO.5.6 Stringing Monolithic Three Terminal III-V Tandems**  
J. Buencuerpo, J.F. Geisz, T.R. Klein, W.E. McMahon, E.L. Warren & A.C. Tamboli  
NREL, Golden, USA

## ORAL PRESENTATIONS 5CO.9

08:30 – 10:00 Systems Design Using Bifacial Modules

## Chairpersons:

Franck Al-Shakarchi  
CEATECH-INES, France

Zakaria Naimi  
Green Energy Park, Morocco

- 5CO.9.1 Optimizing the Electrical Architecture of Linear Vertical PV Bifacial Plants**  
H. Colin, T. Le & Y. Nepal  
CEA, Le Bourget-du-Lac, France
- 5CO.9.2 Optimising the Utilisation of Reflective Materials for Bifacial Plants**  
O.L. Rhazi, M. Chiodetti, J. Dupuis & P. Dupeyrat  
EDF R&D, Moret-sur-Loing, France  
S. Benyakhlef & K. Radouane  
EDF Renewables, Courbevoie, France
- 5CO.9.3 Effective Spectral Albedo from Satellite Data for Bifacial Gain Calculations of PV Systems**  
J.C. Blakesley, G. Koutsourakis & S. Douglas  
NPL, Teddington, United Kingdom  
J.K.L. Holder, F.A. Mukadam & R.S.J. Abrams  
RINA Tech UK, Brighton, United Kingdom  
A. Schmid  
Fraunhofer ISE, Freiburg, Germany
- 5CO.9.4 Testbed Validation of Bifacial Performance Modelling Methodology Using Ray Tracing Methods**  
K. Phetdee  
Mott MacDonald, Bangkok, Thailand  
M. Donaldson-Balan, P. Dagres & S. Velez  
Mott MacDonald, London, United Kingdom  
I. Stylianou  
Mott MacDonald, Brighton, United Kingdom  
C. Ng & K. Larchet  
Mott MacDonald, Madrid, Spain
- 5CO.9.5 Design Optimization of Bifacial Module PV Power Plants Based on Simulations and Measurements**  
M. Guari Borrull & A. Scherl  
Enerparc, Hamburg, Germany  
T. Kampschulte  
Hamburg University of Applied Sciences, Germany
- 5CO.9.6 Estimation of Maximum Current Generated by Bifacial PV Arrays for System Design**  
J.S. Stein, D.S. Riley & C. Stark  
Sandia National Laboratories, Albuquerque, USA



**VISUAL PRESENTATIONS 2CV.1**

**08:00 – 10:00 Characterisation & Simulation of Si Cells / Fabrication and Production of c-Si Silicon Solar Cells and Related Processes**

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

**PLENARY SESSION CP.1**

**10:30 – 12:30 INNOVATIONS FOR PV INDUSTRY AND DEPLOYMENT**

**Chairpersons:**

Marko Topič  
University of Ljubljana, Slovenia

Walburga Hemetsberger  
SolarPower Europe, Belgium

**CP.1.1 Final Study of MoOx Thickness Variation Influence on Partial Dopant-Free Silicon Heterojunction Solar Cells**

J. Dréon, S. Zhong, J. Cattin, J. Haschke, L. Antognini, V. Paratte, C. Ballif & M. Boccard  
EPFL, Neuchâtel, Switzerland

**CP.1.2 Requirements of the Paris Climate Agreement for the Coming 10 Years on Investments, Technical Roadmap, and Expansion of PV Manufacturing**

P.P. Altermatt, Y. Yang, Y. Chen, X. Zhang, D. Chen & Z. Feng  
Trina Solar Energy, Changzhou, China

**CP.1.3 FlamingoPV Project: Recent Advances towards High-Efficiency, Reliable Lightweight and Flexible Thin-Film Silicon Solar Cells and Modules**

G. Limodio, D. Rajagop, S. Nawarante, E. Spaans & A.H.M. Smets  
Delft University of Technology, Netherlands  
D. Bartesaghi, M. Hietkamp & E.A.G. Hamers  
HyET Solar, Arnhem, Netherlands

**CP.1.4 Analyzing the Power Prediction by Deep Learning Algorithm Using EL-Images**

C. Buerhop-Lutz, T. Pickel, T. Winkler & J. Hauch  
HI ERN, Erlangen, Germany

**CP.1.5 Performance of New Photovoltaic System Designs - IEA PVPS Task 13 Subtask 1.3**

M. Littwin, M. Köntges, T. Ohrdes & F. Giovannetti  
ISFH, Emmerthal, Germany  
F.P. Baumgartner  
ZHAW, Winterthur, Switzerland  
C. Biba

HSR, Rapperswil, Switzerland  
B. Farnung & M. Trommsdorff  
Fraunhofer ISE, Freiburg, Germany  
R.H. French  
CWRU, Cleveland, USA  
D. Gfeller, U. Muntwyler & T. Schott  
BFH, Bern, Switzerland  
M. Green  
Lightning Electrical Engineering, Raanana, Israel  
U. Jahn  
TUV Rheinland Energy, Cologne, Germany  
C. Messner  
AIT, Vienna, Austria  
D. Riley  
SANDIA National Laboratories, Albuquerque, USA  
D. Rivola  
SUPSI, Canobbio, Switzerland  
J.S. Stein  
Sandia National Laboratories, Albuquerque, USA  
W.G.J.H.M. van Sark  
Utrecht University, Netherlands

**CP.1.6 Augmented Reality Supporting the Planning Processes in PV Plants**

F.P. Baumgartner, P. Staiger & F. Carigiet  
ZHAW, Winterthur, Switzerland  
F. Gundelsweiler  
Zühlke, Schlieren, Switzerland

**ORAL PRESENTATIONS 4CO.2**

**13:30 – 15:00 Bifacial PV Modules**

**Chairpersons:**

Christian Camus  
LayTec, Germany

Yoshihiro Hishikawa  
AIST, Japan

**4CO.2.1 Introductory Oral: Comprehensive Evaluation of IEC Measurement Procedures for Bifacial Solar Cells and Modules**

M. Rauer, A. Schmid, F. Guo, F. Neuberger & J. Hohl-Ebinger  
Fraunhofer ISE, Freiburg, Germany

**4CO.2.2 Results of the Bifacial PV Cell and PV Module Power Measurement Round Robin Activity of the PV-Enerate Project**

G. Koutsourakis & J.C. Blakesley  
NPL, Teddington, United Kingdom  
M. Rauer & A. Schmid  
Fraunhofer ISE, Freiburg, Germany  
G. Bellenda & R.R. Molinero



SUPSI, Canobbio, Switzerland  
 T.R. Betts & M. Bliss  
 Loughborough University, United Kingdom  
 J. Bonilla Castro & W. Herrmann  
 TÜV Rheinland Energy, Cologne, Germany  
 K. Bothe & D. Hinken  
 ISFH, Emmerthal, Germany  
 S. Dittmann  
 Anhalt University of Applied Sciences, Köthen, Germany  
 J. Lopez-Garcia, R.P. Kenny & D. Pavanello  
 European Commission JRC, Ispra, Italy  
 S. Riechelmann, H. Sträter & S. Winter  
 PTB, Braunschweig, Germany  
 A. Vegas  
 INTA, Madrid, Spain

**4CO.2.3 Energy Yield Measurements of Bifacial PV Modules Mounted on a Cold Façade**

S. Dittmann, H. Sánchez & J. Bagdahn  
 Anhalt University of Applied Sciences, Köthen, Germany  
 R. Gottschalg  
 Fraunhofer CSP, Halle (Saale), Germany

**4CO.2.4 Comparison of the Energy Yield of Vertical (E-W Orientation) and Tilted (Equator Facing) Bifacial PV Module Arrays**

J. Lopez-Garcia, R.P. Kenny & T. Sample  
 European Commission JRC, Ispra, Italy  
 R. Urraca  
 University of La Rioja, Logroño, Spain

**4CO.2.5 Interconnection Technologies for High Reliable Bifacial Heterojunction Glass/Glass Photovoltaic Modules**

G. Cattaneo, A. Faes, H.-Y. Li, J. Levrat & M. Despeisse  
 CSEM, Neuchâtel, Switzerland  
 V. Barth, A. Bettinelli & L. Sicot  
 CEA, Le Bourget-du-Lac, France  
 A. Richter  
 Meyer Burger Technology, Gwatt (Thun), Switzerland  
 F. Rametta  
 3SUN, Catania, Italy  
 C. Colletti  
 ENEL Green Power, Catania, Italy  
 M. Izzì  
 ENEA, Rome, Italy  
 C. Ballif  
 EPFL, Neuchâtel, Switzerland

**ORAL PRESENTATIONS 3CO.6**

**13:30 – 15:00 Characterization of High Efficiency CIGS Absorbers and Devices**

**Chairpersons:**

Ayodhya Nath Tiwari  
 EMPA, Switzerland

Stefan Paetel  
 ZSW, Germany

**3CO.6.1 Introductory Oral: Improvement of Interface Quality of Cd-free Cu(In,Ga)(S,Se)<sub>2</sub> Solar Cell by all-dry Process through Aged Absorber**  
 J. Chantana  
 Ritsumeikan University, Shiga, Japan

**3CO.6.2 Extended Oral: Design and In-Depth Characterization of Absorber/Buffer Interfaces of CIGS Solar Cells: Results of the EFFCIS Project**

W. Witte, D. Hariskos, W. Hempel, S. Paetel & M. Powalla  
 ZSW, Stuttgart, Germany  
 M. Maiberg, S. Zahedi-Azad, P. Pistor & R. Scheer  
 Martin Luther University, Halle, Germany  
 D. Hauschild, V. van Maris, L. Weinhardt, X. Jin, R. Schneider, D. Gerthsen,  
 J. Seeger, J. Grutke & M. Hetterich  
 Karlsruhe Institute of Technology, Germany  
 M. Blankenship  
 University of Nevada, Las Vegas, USA  
 C. Heske  
 Karlsruhe Institute of Technology, Eggenstein, Germany  
 J. Keutgen & O. Cojocaru-Mirédin  
 RWTH Aachen University, Germany  
 E. Ghorbani & K. Albe  
 Technical University of Darmstadt, Germany  
 A. Nikolaeva, J. Marquez-Prieto, M. Krause, S. Schäfer, D. Abou-Ras,  
 T. Unold & R. Mainz  
 HZB, Berlin, Germany  
 P. Eraerds, T.P. Niesen, R. Lechner, T. Dalibor & J. Palm  
 Avancis, Torgau, Germany  
 M. Schweiger & B. Dimmler  
 NICE Solar Energy, Schwäbisch Hall, Germany  
 T. Henke & P. Kratzert  
 Solibro, Bitterfeld-Wolfen, Germany

**3CO.6.3 Electronic Structure of the CdS/Cu(In,Ga)Se<sub>2</sub>-Interface of KF and RbF-Treated Samples by Kelvin Probe and Photoelectron Yield Spectroscopy**

M. Rusu, T. Kodalle, L. Choubac, C.A. Kaufmann, R. Schlatmann & T. Unold  
 HZB, Berlin, Germany  
 N. Barreau  
 University of Nantes, France

**3CO.6.4 Surface Characterization of Polycrystalline CuIn(Ga)Se<sub>2</sub> Absorbers**



C. Kameni Boumenou, F. Ehre, F.-S. Babbe, M. Melchiorre, S. Siebentritt & A. Redinger  
 University of Luxembourg, Belvaux, Luxembourg  
 A. Elizabeth & H. Mönig  
 University of Muenster, Germany

**ORAL PRESENTATIONS 5CO.10**

**13:30 – 15:00 System Modelling for Sizing and Performance**

**Chairpersons:**

Kari Lappalainen  
 Tampere University, Finland

Angele Reinders  
 University of Twente, Netherlands

**5CO.10.1 Generated kWh Value as Function of System Design and Daily Price Profile**

B.B. Van Aken, L.H. Slooff-Hoek & I. Cesar  
 TNO Energy Transition, Petten, Netherlands

**5CO.10.2 Simulation of Large PV Plants Using a Continuous Radiance Distribution Model and Cell-Resolution Mismatch Calculation**

M. Herrerías Azcué & H. Zhou  
 HLRS, Stuttgart, Germany  
 H. Capdevila  
 Capdevila ite, Stuttgart, Germany

**5CO.10.3 Benchmarking Yield Assessment Exercise in Different Climates within an International Collaboration Framework**

D. Moser  
 Eurac Research, Bolzano, Italy  
 M. Herz  
 TÜV Rheinland Energy, Cologne, Germany  
 B. Müller  
 Fraunhofer ISE, Freiburg, Germany  
 I.T. Horvath, A. Schils & S. Ramesh  
 imec, Genk, Belgium  
 M. Green  
 M.G. Lightning, Raanana, Israel  
 J. Vedde & D. Barnard  
 European Energy, Søborg, Denmark  
 B. Herteleer  
 KU Leuven, Gent, Belgium  
 J.A. Tsanakas  
 CEA-INES, Le Bourget-du-Lac, France

**5CO.10.4 Comparison of Large Scale Bifacial PV Test Field Performance to Commercially Available Software, Research-Based and Open Source Tools**

N. Riedel-Lyngskær, A.A. Protti, D. Alvarez Mira, S. Thorsteinsson & P.B. Poulsen  
 Technical University of Denmark, Roskilde, Denmark

D. Berrian & J. Libal  
 ISC Konstanz, Germany  
 D. Barnard & J. Vedde  
 European Energy, Søborg, Denmark

**5CO.10.5 AHP-GIS Suitable Sites Identification for Large Scale PV Installations: a Case Study in Marrakech-Safi Region, Morocco**

F.-Z. Ouchani, O. Jbahi & A. Ghennioui  
 IRESEN, Benguerir, Morocco  
 M. Maaroufi  
 Mohammed V University, Rabat, Morocco

**5CO.10.6 Characteristic Declination, a Useful Concept for Accelerating Solar Potential Calculations?**

M.C. Brito & R. Amaro e Silva  
 University of Lisbon, Portugal  
 S.R. Freitas  
 Lisboa E-Nova, Lisbon, Portugal

**ORAL PRESENTATIONS 2CO.13**

**13:30 – 15:00 Manufacturing & Production of Si Cells**

**Chairpersons:**

Peter Wohlfart  
 Singulus Technologies, Germany

Pierre J. Verlinden  
 Sun Yat-sen University, China

**2CO.13.1 A Roadmap to Reach 24% Efficiency PERC Cell Based on Screen Printing for Mass Production**

X. Zhang, W. Liu, Y. Chen, S. Chen, G. Xu, Y.Y. Hu, Y. Yang, D. Chen, Y. Chen, P.P. Altermatt & Z. Feng  
 Trina Solar Energy, Changzhou, China  
 P.J. Verlinden  
 AMROCK, Surfers Paradise, Australia

**2CO.13.2 Aspects of Gallium Doping for PERC Solar Cells**

G. Fischer  
 Zittau/Görlitz University of Applied Sciences, Germany  
 F. Wolny  
 SolarWorld, Freiberg, Germany  
 H. Neuhaus  
 Fraunhofer ISE, Freiburg, Germany  
 M. Müller  
 Freiberg University of Technology, Germany

**2CO.13.3 Laser Enhanced Contact Optimization – A Novel Technology for Metal-Semiconductor-Contact Optimization for Crystalline Silicon Solar Cells**

E. Krassowski  
 CE Cell Engineering, Kabelsketal, Germany  
 S. Großer & M. Turek





Fraunhofer CSP, Halle (Saale), Germany

- 2CO.13.4 TOPCon – Technology Options for Cost Efficient Industrial Manufacturing**  
B. Kafle, B.S. Goraya, S. Mack, S. Nold & J. Rentsch  
Fraunhofer ISE, Freiburg, Germany
- 2CO.13.5 Mastering the Defectivity: Prerequisite for High Efficiency Silicon Heterojunction Solar Cells**  
R. Varache, J. Hotel, J. Dahan, W. Favre, A. Danel & C. Roux  
CEA, Le Bourget-du-Lac, France
- 2CO.13.6 AMPERE: The European PV Manufacturing Ready to Compete in the Premium High Efficiency Market**  
C. Colletti & C. Gerardi  
ENEL Green Power, Catania, Italy  
F. Bizzarri  
ENEL Green Power, Rome, Italy  
B. Strahm  
Meyer Burger Research, Hauterive, Switzerland  
A. Richter  
Meyer Burger Technology, Gwatt, Switzerland  
D. Muñoz  
CEA, Le Bourget-du-Lac, France  
M. Izzi  
ENEA, Rome, Italy  
J. Levrat  
CSEM, Neuchâtel, Switzerland  
C. Ballif  
EPFL, Neuchâtel, Switzerland  
O. Nielsen  
NorSun, Oslo, Norway  
B. Hartlin  
ERM, London, United Kingdom  
B. Melzer  
Jonas & Redmann, Berlin, Germany  
M. Tallián  
SEMILAB, Budapest, Hungary  
S. Lombardo  
CNR, Catania, Italy  
M. Balucani  
RISE Technology, Ostia, Italy  
J. Rentsch  
Fraunhofer ISE, Freiburg, Germany

**VISUAL PRESENTATIONS 6CV.2**

**13:30 – 15:00 Integration of Photovoltaic in Buildings, Vehicle, Infrastructure and Landscape**

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

**ORAL PRESENTATIONS 4CO.3**

**15:15 – 16:45 Module Design and Qualification**

**Chairpersons:**

Ulrike Jahn  
TÜV Rheinland, Germany

Guy Beaucarne  
Dow Silicones, Belgium

- 4CO.3.1 Importance of BOM Control and IEC 61215 Scope of Application**  
G. Oreski, C. Barretta, L. Castillon & P. Christöfl  
PCCL, Leoben, Austria  
M. Köntges  
ISFH, Emmerthal, Germany
- 4CO.3.2 Standardization Work of Non-Uniform Wind Loads Test on PV Module**  
S.-T. Hsu  
ITRI, Hsinchu, Taiwan
- 4CO.3.3 Novel Accelerated Testing Methods for Faster Evaluation of PV Modules and Materials**  
A. Borne  
DuPont, Geneva, Switzerland  
W.J. Gambogi & K. Roy Choudhury  
DuPont, Wilmington, USA  
K.-A. Weiß  
Fraunhofer ISE, Freiburg, Germany
- 4CO.3.4 Embrittlement and Degradation of Polymeric PV Module Materials due to Lamination**  
C. Herzog, D.E. Mansour, L. Pita Bauermann, S.-J. Ernst & T. Geipel  
Fraunhofer ISE, Freiburg, Germany  
S. Sraisth  
Robert Bürkle, Freudenstadt, Germany
- 4CO.3.5 Student Awards Finalist Presentation: Loss Analysis and Optimization of PV Module Components and Design for Desert Applications**  
H. Hanifi, M. Pander, U. Zeller, K. Ilse, D. Daßler, B. Jäckel, C. Hagendorf & R. Gottschalg  
Fraunhofer CSP, Halle (Saale), Germany  
M. Mirza  
Fraunhofer ISC, Würzburg, Germany  
M.A. Bahattab  
KACST, Riyadh, Saudi Arabia  
J. Schneider  
Fraunhofer IMW, Leipzig, Germany
- 4CO.3.6 PV Module Soiling Monitoring and Cleaning Abrasion Testing**  
G. Mathiak, O. Soukari, J. Saal, L. Rimmelspacher, W. Herrmann, F. Reil & J. Althaus  
TÜV Rheinland Energy, Cologne, Germany



## ORAL PRESENTATIONS 3CO.7

15:15 – 16:45 **Advances in Growth Methods for CIGSe and Kesterite Absorbers**

## Chairpersons:

Alex Redinger  
University of Luxembourg, Luxembourg

Jakapan Chantana  
Ritsumeikan University, Japan

- 3CO.7.1 (Ag,Cu)(In,Ga)Se<sub>2</sub> Solar Cells Grown at Low Temperature with Ag Precursor Layer Method**  
S.-C. Yang, M. Ochoa, A.N. Tiwari & R. Carron  
EMPA, Dübendorf, Switzerland
- 3CO.7.2 How the Absorber Thickness Affects the Formation of Reverse Bias Induced Defects in CIGS Solar Cells**  
K. Bakker, A. Rasia, S. Assen, B. Ben Said Aflouat & M. Theelen  
Solliance - TNO, Eindhoven, Netherlands  
A.W. Weeber  
TNO Energy Transition, Petten, Netherlands
- 3CO.7.3 Fabrication of Cation and Anion Alloyed CZTSe Solar Cell by Using Spray-Based Deposition**  
T. Enkhbat, S. Hamim & J.H. Kim  
University of Incheon, Republic of Korea
- 3CO.7.4 Growth at High Deposition Rates: CIGS and Secondary Phases**  
S. Paetel  
ZSW, Stuttgart, Germany
- 3CO.7.5 How Is the Back-Contact in CIGSe Thin Film Devices Affected by Heavy Alkali Treatments?**  
T. Bertram, T. Kodalle, P. Reyes-Figueroa, J. Lauche, R. Klenk, R. Schlatmann & C.A. Kaufmann  
HZB, Berlin, Germany
- 3CO.7.6 Mitigation of Performance Losses Upon Reduction of Absorber Layer Thickness in CIGS Solar Cells**  
T. Schneider, H. Kempa, J. Tröndle, B. Fuhrmann, F. Syrowatka & R. Scheer  
Martin Luther University, Halle, Germany

## ORAL PRESENTATIONS 6CO.11

15:15 – 16:45 **System Integration**

## Chairpersons:

Ingrid Weiss  
WIP Renewable Energies, Germany

Stefan Krauter  
University of Paderborn, Germany

- 6CO.11.1 Energy Balance in a System Based on Photovoltaic-Electrochemical and Storage Cells for Water Splitting**  
T. Merdzhanova, S.N. Agbo, K. Welter, O. Astakhov, V. Smirnov & U. Rau  
Forschungszentrum Jülich, Germany
- 6CO.11.2 Urban Solar Potential for Onboard PV-Powered Electric Vehicles**  
M.C. Brito & D.M. Pera  
University of Lisbon, Portugal  
T. Santos  
CICS NOVA, Lisbon, Portugal  
F. Moura  
CERIS, Lisbon, Portugal
- 6CO.11.3 PV Hosting Capacity of Medium and Low Voltage Grids Using a Geographical Information Open-Source Tool**  
V. Krakowski, M. Joos & N. Lebert  
HESPUL, Lyon, France  
S. Poutrel & P.-E. Raoult  
BURGEAP, Lyon, France
- 6CO.11.4 Data Analysis and Modelling of PV – Heat Pump Systems for Residential Energy Scenarios in the Netherlands**  
C. Gerçek & A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands
- 6CO.11.5 The Setting-Up of a Large Collective Self-Consumption Project in Lyon, France**  
B. Gaiddon  
HESPUL, Lyon, France  
M. Valentin, E. Vignali & A. Manelli  
SPL Lyon-Confluence, France  
F. Marcos  
EDF, Paris, France  
A. Choffez & Y. Dessup  
EDF ENR, Limonest, France
- 6CO.11.6 Characteristics of Day-Ahead Residual Demand, PV Power and Demand Forecasts in a Scenario of Large Penetration of PV**  
J. Gari da Silva Fonseca Jr., Y. Udagawa & K. Ogimoto  
University of Tokyo, Meguro, Japan  
T. Oozeki  
AIST, Tsukuba, Japan



**ORAL PRESENTATIONS 2CO.14**

**15:15 – 16:45**      **Analysis of Wafers and Layers for Highly Efficient Crystalline Silicon Solar Cells**

**Chairpersons:**

Francesca Ferrazza  
eni, Italy

Karsten Bothe  
ISFH, Germany

- 2CO.14.1 Luminescence: Science and Applications in Silicon Photovoltaics**  
H.T. Nguyen & D. Macdonald  
ANU, Canberra, Australia
- 2CO.14.2 Review and Recent Development in Combining Photoluminescence and Electroluminescence Imaging with Carrier Lifetime Measurements via Modulated Photoluminescence at Variable Temperatures**  
H. Höfller, F. Schindler, A. Brand, D. Herrmann, R. Eberle, R. Post, J. Greulich & M.C. Schubert  
Fraunhofer ISE, Freiburg, Germany
- 2CO.14.3 Student Awards Finalist Presentation: In-Situ Modulated Photoluminescence of Passivated c-Si Wafers during Annealing**  
A. Desthieux & J. Posada  
EDF R&D, Palaiseau, France  
M. Sreng  
IPVF, Palaiseau, France  
E. Drahi  
TOTAL, Paris la Defense, France  
B. Bazer-Bachi  
EDF ENR PWT (Photowatt), Bourgoin Jallieu, France  
F. Silva, J.-C. Vanel & P. Roca i Cabarrocas  
CNRS, Palaiseau, France
- 2CO.14.4 Light and Elevated Temperature Induced Degradation in B-Ga Co-Doped Cast Mono Silicon PERC Solar Cells**  
C. Zhou, F. Ji, S. Cheng & W. Wang  
CAS, Beijing, China  
D. Hu  
Jiangsu GCL, Xuzhou, China
- 2CO.14.5 Detecting Multivalent Defect Levels Using Deep Level Transient Spectroscopy**  
Z. Zhou, M.K. Juhl & F.E. Rougieux  
UNSW Australia, Sydney, Australia
- 2CO.14.6 Analysis of Defect Densities in the Thin (i) a-Si:H Passivation Layer of a-Si:H/c-Si Heterojunction Solar Cells Using Temperature Dependent Planar Conductance Measurements**  
S. Le Gall, A. Levchenko, R. Brüggemann & J.-P. Kleider  
CNRS/GeePs, Gif-sur-Yvette, France

**VISUAL PRESENTATIONS 5CV.3**

**15:15 – 16:45**      **Operation, Performance and Maintenance of PV Systems**

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

**ORAL PRESENTATIONS 4CO.4**

**17:00 – 18:30**      **PV Module Characterization and Fault Detection**

**Chairpersons:**

Ana Rosa Lagunas  
CENER, Spain

Christian Thiel  
European Commission JRC, Italy

- 4CO.4.1 Eddy-Current Analysis Method for Non-Destructive Characterization of Electrical Contacts and Solder Joints in PV Modules**  
L. Neumaier, W. Mühleisen, M. Lenzenhofer, P. Malago & C. Hirschl  
SAL Silicon Austria Labs, Villach, Austria
- 4CO.4.2 Development of Daylight Photoluminescence Technique for Photovoltaic Modules and Investigation of Temperature Dependency**  
L. Koester, A. Astigarraga, S. Lindig & D. Moser  
Eurac Research, Bolzano, Italy
- 4CO.4.3 Interfacial Characterization of Positive Bias Voltage Degradation in PV Modules**  
A. Sinha, S.L. Moffitt & L.T. Schelhas  
SLAC, Menlo Park, USA  
K. Hurst, J. Qian, D.C. Miller & P. Hacke  
NREL, Golden, USA
- 4CO.4.4 Data Mining Field I-V and Weather Data for PV Module EQE and Sun-Voc**  
J.L. Braid & J.S. Stein  
Sandia National Laboratories, Albuquerque, USA  
M. Wang  
CWRU, Cleveland, USA
- 4CO.4.5 Fundamental Study on Open Fault Detection Technology of Bypass Circuit of PV Module with IR Camera**  
S. Nishikawa, N. Fujita & H. Kuroda  
Nihon University, Tokyo, Japan
- 4CO.4.6 Quantitative Electroluminescence Imaging of PV Modules: Case Study of a Multi MW Plant with 100% EL Coverage**  
K.G. Bedrich, Y. Wang, W. Luo & Y. S. Khoo  
SERIS, Singapore, Singapore  
J. Chai  
QE Labs, Singapore, Singapore



**ORAL PRESENTATIONS 3CO.8****17:00 – 18:30 CIGSe Modules & Advances in CdTe Technology****Chairpersons:**

Wiltraud Wischmann  
ZSW, Germany

Tobias Bertram  
HZB, Germany

- 3CO.8.1 Introductory Oral: Large Area Screen-Printed Front Contact Metallization for Thin-Film Solar Module Production**  
T. Freund, N. Zancan, G. Kaune, W. Bromenne, R. Wächter, T. Repmann & K. Orgassa  
NICE Solar Energy, Schwäbisch Hall, Germany  
S. Lin & H. Shan  
NICE, Beijing, China
- 3CO.8.2 Transparent Back Contacts for CdTe Solar Cells: Criteria and Investigation of Oxide Materials**  
R.S. Hall, D.A. Lamb, A. Pockett, S.K. Thomas, M.J. Carnie & S.J.C. Irvine  
Swansea University, St. Asaph, United Kingdom
- 3CO.8.3 Performance Evaluation and Parametrization of CIGS Thin Film Solar Modules through Multilinear Regressions**  
G.A. Farias Basulto, P. Reyes-Figueroa, C. Ulbrich, B. Szyszka, R. Schlatmann & R. Klenk  
HZB, Berlin, Germany
- 3CO.8.4 Effects of PDT on the Low Temperature Behavior of CIGS Thin-Film Solar Cells**  
D. Mücke, R. Vidal Lorbada & T. Walter  
Ulm University of Applied Sciences, Germany  
R. Schäffler  
NICE Solar Energy, Schwäbisch Hall, Germany
- 3CO.8.5 Dispensing Technology Meets CIGS Substrates: First IV-Results with Dispensed Metal Grid on CIGS Mini-Modules**  
K. Gensowski, A.M. Jimenez Cardozo, S. Tepner, M. Pospischil & F. Clement  
Fraunhofer ISE, Freiburg, Germany  
M. Kuchler & M. Breitenbücher  
HighLine Technology, Freiburg, Germany  
T. Freund, P. Köder, J. Müller & B. Dimmler  
NICE Solar Energy, Schwäbisch Hall, Germany

**ORAL PRESENTATIONS 2CO.15****17:00 – 18:30 Measurement and Analysis of Crystalline Silicon Solar Cells****Chairpersons:**

Makoto Konagai  
Tokyo City University, Japan

Ronald Sinton  
Sinton Instruments, USA

- 2CO.15.1 Inline Solar Cell Statistics Combining I-V and Quantum Efficiency**  
B. Mitchell, S. Esefelder & B. Mette  
Wavelabs Solar Metrology Systems, Leipzig, Germany  
J. Wong  
Aurora Solar Technologies, Vancouver, Canada  
B.S. Tjahjono  
UNSW Australia, Sydney, Australia  
K.B. Choi, M.X.C. Heng, T.H. Chuah & J.W. Ho  
SERIS, Singapore, Singapore
- 2CO.15.2 Contacting of Busbarless Solar Cells for Accurate I-V Measurements**  
K. Bothe, C. Kruse & D. Hinken  
ISFH, Emmertal, Germany
- 2CO.15.3 Impact of the Bulk Resistivity and Operation Temperature on Silicon Solar Cells**  
A. Augusto, A. Srinivasa & S.G. Bowden  
Arizona State University, Tempe, USA  
A.H.T. Le, J.P. Seif & Z. Hameiri  
UNSW Australia, Sydney, Australia
- 2CO.15.4 Student Awards Finalist Presentation: Influence of Edge Recombinations on the Performance of Half-, Shingled- and Full Silicon Heterojunction Solar Cells**  
V. Giglia, J. Veirman, R. Varache, B. Portaluppi & S. Harrison  
CEA, Le Bourget-du-Lac, France  
E. Fourmond  
INSA Lyon, Villeurbanne, France
- 2CO.15.5 Selective Contacts and Fill Factor Limitation in Heterojunction Solar Cells**  
L. Serenelli, L. Martini, F. Menchini, M. Izzi & M. Tucci  
ENEA, Rome, Italy  
G. de Cesare  
Sapienza University of Rome, Italy  
G. Condorelli & C. Gerardi  
ENEL Green Power, Catania, Italy  
D. Muñoz  
CEA, Le Bourget-du-Lac, France
- 2CO.15.6 Stress Induced Inhomogeneities in Crystalline Silicon Solar Cells: from Characterization to Advanced Electrical Modelling**  
M. Kikelj, B. Lipovsek, M. Bokalic & M. Topic  
University of Ljubljana, Slovenia



**VISUAL PRESENTATIONS 5CV.4**

**17:00 – 18:30**      **PV System Design and Modeling / Energy Storage / Concentrators and PV for Space Applications**

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

**Thursday, 10 September 2020****ORAL PRESENTATIONS 5DO.1**

**08:30 – 10:00**      **Soiling**

**Chairpersons:**

Benjamin Figgis  
QEERI, Qatar

Peter Hacke  
NREL, USA

- 5DO.1.1      The Impact of Photovoltaic Soiling on the LCOE in Desert Climates**  
A.A. Abdallah, A. Ali, A. Baloch, B. Figgis, M. Kivambe, N. Barth, A. Belaidi, M. Contestabile & C. Broussillou  
QEERI, Doha, Qatar  
K. Ali  
HBKU, Doha, Qatar
- 5DO.1.2      On the Impact of Soiling on Energy Production in the Atacama Desert, in the Frame of ATAMOSTEC**  
E. Pilat & M. Amhal  
CEA, Le Bourget-du-Lac, France  
D. Olivares  
University of Antofagasta, Chile  
E. Urrejola  
ATAMOSTEC, Santiago, Chile
- 5DO.1.3      An Iterative, Self-Consistent Method to Estimate Degradation and Soiling Loss in PV Systems**  
A. Skomedal, H. Haug & E.S. Marstein  
Institute for Energy Technology, Kjeller, Norway  
M.G. Deceglie  
NREL, Golden, USA
- 5DO.1.5      Electrodynamic Cleaning of PV Module**  
D. Petri, A. Faes, J. Escarré Palou, S. Pittet, J. Champliand, B. El Roustom, M. Despeisse & C. Ballif  
CSEM, Neuchâtel, Switzerland  
G. McKarris  
CleanFizz, Meyrin, Switzerland
- 5DO.1.6      Estimating Snow Losses for Many Sites Using Minimal Data Sources**  
M. van Noord  
RISE, Stockholm, Sweden  
T. Landelius & S. Andersson  
SMHI, Norrköping, Sweden



**ORAL PRESENTATIONS 4DO.6****08:30 – 10:00 Sustainability and Recycling****Chairpersons:**

Karsten Wambach  
Wambach-Consulting, Germany

Andreas Wade  
First Solar, Germany

- 4DO.6.1 A Systematic Approach to Assess the Environmental Impact of New Technologies: A Case Study for CIGS Photovoltaic Laminate**  
M. van der Hulst & M. Huijbregts  
Radboud University, Nijmegen, Netherlands  
N. van Loon & M. Theelen  
TNO/Solliance, Eindhoven, Netherlands  
L. Kootstra & M. Hauck  
TNO, Utrecht, Netherlands  
J. Bergesen  
University of California, Santa Barbara, USA
- 4DO.6.2 Merging Photovoltaic Panels and Solar Thermal Collectors – How Photovoltaic Thermal (PVT) Hybrid Collectors Boost Environmental Performance**  
R. Itten, S. Manatschal & M. Stucki  
ZAHW, Wädenswil, Switzerland  
L. Brottier  
DualSun, Marseille, France
- 4DO.6.3 Remanufacturing Silicon Photovoltaics: Feasibility, Affordability and Environmental Impact Analysis**  
R. Deng, M.M. Lunardi, N. Chang, J. Ji & C.M. Chong  
UNSW Australia, Sydney, Australia  
P. Dias  
UFRGS, Porto Alegre, Brazil
- 4DO.6.4 LCA of a Photovoltaic System with Hetero-Junction Modules and Mono-Axial Tracker**  
A. Danelli, A. Gargiulo & P. Girardi  
RSE, Milan, Italy
- 4DO.6.5 Technico-Environmental Study of an Innovative Recycling Process to Implement a Circular Economy across the PV Value Chain**  
C. Agraffeil, N. Gazbour, F. Coustier, M. Sérasset, N. Velet, A. Dégousée & M. Benmansour  
CEA, Le Bourget-du-Lac, France  
C. Thommen  
Easy-engineering, Bex, Switzerland
- 4DO.6.6 Single Crystalline Si Ingot by Use of Recycled Silicon as an Example for Circular Economy**  
W. Palitzsch  
LuxChemtech, Freiberg, Germany  
I. Röver  
Losser Chemie, Freiberg, Germany

Y.-J. Yook  
S-TECH, Daegu, Republic of Korea  
J.S. Lee  
KIER, Daejeon, Republic of Korea

**ORAL PRESENTATIONS 6DO.11****08:30 – 10:00 Vehicles and Infrastructures****Chairpersons:**

Bianca Lim  
ISFH, Germany

Heinz Ossenbrink  
Band Gap, Germany

- 6DO.11.1 Potential and Challenges of Vehicle Integrated Photovoltaics for Passenger Cars**  
M. Heinrich, C. Kutter, F. Basler, M. Mittag, C. Reise, T. Kroyer, H. Neuhaus & H. Wirth  
Fraunhofer ISE, Freiburg, Germany
- 6DO.11.2 Environmental Impacts of Integrating Photovoltaic Modules on Electric Light Utility Vehicles**  
O. Kanz & K. Ding  
Forschungszentrum Jülich, Germany  
J. May  
Cologne University of Applied Sciences, Germany
- 6DO.11.3 Vehicle Integrated Photovoltaics - Evaluation of the Energy Yield Potential through Monitoring and Modelling**  
A.J. Carr, A.R. Burgers & B.K. Newman  
TNO Energy Transition, Petten, Netherlands  
E. van den Tillaart & T. Köhler  
TNO Traffic & Transport, Helmond, Netherlands
- 6DO.11.4 Improving the Reliability of a Solar Road PV Module**  
M. Vite, A. Boulanger, D.R. Heslinga, R. De Bettignies, J. Gaume & F. Chabuel  
CEA, Le Bourget-du-Lac, France
- 6DO.11.5 Photovoltaic Potential of Highways in the Netherlands Including Traffic Effect**  
C. Ferri, H. Ziar, T. Nguyen, H. van Lint, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands
- 6DO.11.6 Integrated Lightweight, Glass-Free PV Module Technology for Box Bodies of Commercial Trucks**  
C. Kutter, F. Basler, M. Heinrich, L.E. Alanis & H. Neuhaus  
Fraunhofer ISE, Freiburg, Germany





**VISUAL PRESENTATIONS 7DV.1**

**08:00 – 10:00**      **Costs, Economics, Finance and Markets / Assessment, Policies and Scenarios for Renewables; Societal and Global Challenges**

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

**ORAL PRESENTATIONS 5DO.2**

**10:30 – 12:00**      **Performance Assessment**

**Chairpersons:**

Gerhard Mütter  
ALTESO, Austria

Marios Theristis  
Sandia National Laboratories, USA

**5DO.2.1**      **Student Awards Finalist Presentation: Geographical Approach for Weather Risk Identification and PV Performance Assessment**

J. Ascencio-Vásquez, K. Brecl & M. Topic  
University of Ljubljana, Slovenia

**5DO.2.2**      **Comparative Analysis of Module Temperature Measurements and Estimation Methods for Various Climate Zones across the Globe**

M. Braga, A.K. Vidal de Oliveira & R. Rütger  
UFSC, Florianópolis, Brazil  
L. Burnham  
Sandia National Laboratories, Albuquerque, USA  
S. Dittmann  
Anhalt University of Applied Sciences, Köthen, Germany  
R. Gottschalg  
Fraunhofer CSP, Halle (Saale), Germany  
B. Figgis  
QEERI, Doha, Qatar  
A. Benlarabi  
IRESEN, Rabat, Morocco  
T.R. Betts  
CREST, Loughborough, United Kingdom  
T. Reindl  
SERIS, Singapore, Singapore  
S.-Y. Oh  
Yeungnam University, Gyeongsan, Republic of Korea  
J.-H. Choi  
Korea Testing Labs, Gyeongsan, Republic of Korea  
K.S. Kim  
KIER, Daejeon, Republic of Korea

**5DO.2.4**      **Guidelines for Ensuring Data Quality for Photovoltaic System Performance Assessment and Monitoring**

A. Livera, G. Makrides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus

M. Theristis & J.S. Stein  
Sandia National Laboratories, Albuquerque, USA  
E. Koumpli  
Solarcentury, London, United Kingdom

**5DO.2.5**      **Improving the Quality of PV Plant Performance Analysis by Increasing Data Integrity and Reliability: a Data-Driven Approach Using Machine Learning Techniques**

G. Oviedo Hernández & P.V. Chiantore  
BayWa, Rome, Italy  
E. Capra  
BayWa, Chieti, Italy  
S. Lindig & D. Moser  
Eurac Research, Bolzano, Italy

**5DO.2.6**      **Evaluation of Provisional Acceptance Testing Procedures for Commercial PV Plants**

S. Mau, A. Sharpe, C. Campistron, F. Canto Teixeira & N. Chouleur  
Everoze, Madrid, Spain

**ORAL PRESENTATIONS 4DO.7**

**10:30 – 12:00**      **MPP-Tracking, Inverters, BOS**

**Chairpersons:**

Claudia Buerhop-Lutz  
Helmholtz Institute ERN, Germany

Nicola Pearsall  
Northumbria University, United Kingdom

**4DO.7.1**      **Quality Management Best Practice Guidelines**

R. Gottschalg  
Fraunhofer CSP, Halle (Saale), Germany

**4DO.7.2**      **Micro-Inverters: an Update of Comparison of Conversion Efficiencies and Energy Yields**

S. Krauter & J. Bendfeld  
University of Paderborn, Germany

**4DO.7.3**      **New Maximum Power Point Tracking MPPT Algorithm Based on Research of a Target Voltage Range and Its Implementation in a Commercial Inverter for Photovoltaic Systems**

A. Minuto, E. Celi & G. Timò  
RSE, Piacenza, Italy  
N. Panozzo  
BDF DIGITAL, Vicenza, Italy

**4DO.7.4**      **Selective Deployment of Power Optimizers: Effect of Shade on Performance and Hotspots in PV Modules**

N.J.J. Dekker, M.J. Jansen & A.R. Burgers  
TNO Energy Transition, Petten, Netherlands



M.S. Dörenkämper  
TNO Energy Transition, Eindhoven, Netherlands  
R. Jonkman  
Heliox, Best, Netherlands  
R. van der Ven  
Solned, Veldhoven, Netherlands  
E. Gramsbergen  
RE-Source Renewable Energy, Veldhoven, Netherlands

**4DO.7.5 Evaluation of the DC Bus Link Capacitors and Power Transistor Modules in the Qualification Testing of PV Inverters**

P. Hacke & R. Thiagarajan  
NREL, Golden, USA  
D. Clemens  
SMA Solar Technology, Niestetal, Germany  
J. Flicker  
Sandia National Laboratories, Albuquerque, USA  
H. Igarashi  
SolarEdge Technologies Japan, Yokohama, Japan

**4DO.7.6 Aiming at Resolving Limitation of Indian Standard (IS): 2911-1-2 Regarding Calculation of Lateral Load Capacity for Short Rigid Piles of Solar Module Mounting Structure**

S. Chatterjee  
RGM International, Kolkata, India  
S. Mukherjee  
Vikram Solar, Kolkata, India

**ORAL PRESENTATIONS 6DO.12**

**10:30 – 12:00 Building Envelope / Design, Customisation and Standardisation**

**Chairpersons:**

Miguel C. Brito  
University of Lisbon, Portugal

Michiel Ritzen  
ZUYD, The Netherlands

**6DO.12.1 IEC61853-Matrix Analysis of PVPS Task 15 BIPV Round-Robin for More Than One Year at Seven Test Sites over the World**

R.M.E. Valckenborg  
TNO, Eindhoven, Netherlands  
L. Gaisberger  
FH-OOE, Wels, Austria  
K.A. Berger & G. Ujvári  
AIT, Vienna, Austria  
G.C. Eder  
OFI, Vienna, Austria  
P. Illich  
UAS Technikum Wien, Vienna, Austria  
C.S. Polo López  
SUPSI, Canobbio, Switzerland

S. Boddaert  
CSTB, Sophia Antipolis, France  
M. Del Buono  
EURAC Research, Bolzano, Italy  
N. Martín Chivelet  
CIEMAT, Madrid, Spain  
A. Sanz Martínez  
Tecnalia, Derio, Spain  
J.T. Kim  
Kongju National University, Gongju-si, Republic of Korea

**6DO.12.2 Performance Assessment of BIPV Systems: Research on BIPV Characterization Methods**

P. Bonomo, F. Parolini, F. Frontini, M. Caccivio & G. Bellenda  
SUPSI, Canobbio, Switzerland  
J.M. Vega de Seoane & D. Valencia  
Tecnalia, San Sebastián, Spain  
S. Boddaert  
CSTB, Sophia Antipolis, France

**6DO.12.3 Customization of BIPV Modules' Appearance by Colored Textiles (CoTex) and Their Digital Prototypes**

T. Gewohn, M.R. Vogt, B. Lim & R. Brendel  
ISFH, Emmerthal, Germany  
C. Schinke  
Leibniz University Hannover, Germany

**6DO.12.4 Simulating Interior Radiant Energy for the Design and Prototyping of an Indoor Solar PV Lamp**

M. Verkou, H. Ziar, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands

**6DO.12.5 Assessment of Technical and Economical Photovoltaic Potential on Flat Roofs in Urban Area - Case of Casablanca, Morocco**

H. Saadaoui, A. Ghennioui, Z. Naimi & B. Ikken  
Green Energy Park, Benguerir, Morocco  
H. Rhinane & D. Saifaoui  
University of Hassan II, Casablanca, Morocco

**6DO.12.6 New Intelligent Solar Façade for Architectural Building Integration**

G. Mangherini, P. Bernardoni, M. Boschetti, A. Andreoli, M. Gjestila, M. Bottarelli & D. Vincenzi  
University of Ferrara, Italy  
M. Brocato & R. Zarcone  
ENSAPM, Paris, France  
M. Tonezzer & P. Decarli  
Powerglax, Vallelaghi, Italy

**VISUAL PRESENTATIONS 2DV.2**

**10:30 – 12:00 Silicon Wafer Technology / Thin Film and Foil-Based Si Cells**

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



**ORAL PRESENTATIONS 5DO.3****13:30 – 15:00 O&M and Failure Analysis****Chairpersons:**

Peter Lechner  
ZSW, Germany

Killian Lobato  
University of Lisbon, Portugal

- 5DO.3.1 The Influence of Thermal Signatures Observed with Infrared Thermography on Power Production in Utility Scale PV Plants**  
B.L. Aarseth & M.B. Øgaard  
University of Oslo, Kjeller, Norway  
A. Skomedal & E.S. Marstein  
Institute for Energy Technology, Kjeller, Norway
- 5DO.3.2 Machine Learning PV Module I-V Curve Predictions Based on Electroluminescence Images**  
S. Rodrigues, C. Buerhop-Lutz, J. Hauch & I.M. Peters  
HI ERN, Erlangen, Germany  
B. Doll & C.J. Brabec  
FAU Erlangen-Nürnberg, Germany
- 5DO.3.3 Student Awards Finalist Presentation: Contactless Outdoor Photoluminescence of Silicon Photovoltaic Modules with Inhomogeneous Excitation Source**  
B. Doll, J. Hepp, M. Hoffmann, A. Vetter, L. Lürer & C.J. Brabec  
FAU Erlangen-Nürnberg, Germany  
O. Stroyuk, C. Buerhop-Lutz, J. Hauch & I.M. Peters  
HI ERN, Erlangen, Germany  
M. Hemsendorf  
GP Inspect, Neuried, Germany  
D. Tegtmeyer  
Mencke & Tegtmeyer, Hameln, Germany  
F. Talkenberg & M. Menz  
greateyes, Berlin, Germany
- 5DO.3.4 Lessons from Operating Large-Scale Solar Generators in Australia**  
L. McLeod, G. Dickeson & L. Frearson  
Ekistica, Alice Springs, Australia  
M. Miller  
CEFC, Sydney, Australia  
J. Ryan  
ARENA, Canberra, Australia
- 5DO.3.5 Autonomous Monitoring and Analysis of PV Systems by Unmanned Aerial Vehicles, Internet of Things and Big Data Analytics**  
M. Aghaei & A.H.M.E. Reinders  
Eindhoven University of Technology, Netherlands  
A. Eskandari  
Amirkabir University of Technology, Tehran, Iran

**5DO.3.6 PV4.0: Combining Asset Management, PV Measurement Data and the Cost Priority Number Method in a Digital Infrastructure for PV Plant O&M**

A. Louwen, L. Koester, S. Lindig & D. Moser  
Eurac Research, Bolzano, Italy  
A. Astigarraga  
Accademia Europea Bolzano, Italy

**ORAL PRESENTATIONS 7DO.8****13:30 – 15:00 Accelerating Technology Innovation and Sustainable Deployment****Chairpersons:**

Nigel Taylor  
European Commission JRC, Italy

Maria Getsiou  
European Commission DG RTD, Belgium

- 7DO.8.1 Potential Regulatory Approaches on the Environmental Impacts of Photovoltaics: Expected Improvements and Impacts on Technological Innovation**  
D. Polverini  
European Commission DG GROWTH, Brussels, Belgium  
N. Dodd & N. Espinosa  
European Commission JRC, Seville, Spain
- 7DO.8.2 SOLAR-ERA.NET - European Network of National and Regional Research and Innovation Programmes - Latest Developments, Project Results, Lessons Learned and Outlook**  
S. Nowak, M. Gutschner & T. Biel  
NET Nowak Energy & Technology, St. Ursen, Switzerland  
S. Oberholzer  
Swiss Federal Office of Energy, Bern, Switzerland  
C. Hünnekes, K. Chakanga & R. Horbelt  
Forschungszentrum Jülich, Germany  
M. Schulte  
Project Management Organisation ETN, Jülich, Germany  
D. Ruiz  
FECYT, Coruña, Spain  
E. Fernández  
MINECO, Madrid, Spain  
B. Gómez  
Ministry of Science, Madrid, Spain  
H. González  
CDTI, Madrid, Spain  
P.-J. Rigole  
Swedish Energy Agency, Eskilstuna, Sweden  
O. Bernsen  
Netherlands Enterprise Agency, Den Haag, Netherlands  
L. Polain  
Public Service of Wallonia, Jambes, Belgium



G. Carchon  
VLAIO, Gent, Belgium  
E. Afentaki  
GSRT, Athens, Greece  
P. Leptos  
RIF, Lefkosia, Cyprus  
R. Peyronnet  
ADEME, Paris, France  
P. Bain  
ANR, Paris, France  
K. Karaösz  
TUBITAK, Gebze, Turkey  
A. Covello  
MIUR, Rome, Italy  
E. Lutter  
Climate and Energy Fund, Vienna, Austria  
A. Hipfinger  
FFG, Vienna, Austria  
G. Friedmann  
Ministry of Energy, Jerusalem, Israel

**7DO.8.3 Reviewing Global Projections for Long-Term Solar PV Adoption: a Data-Mining Approach**

M. Jaxa-Rozen & E. Trutnevyte  
University of Geneva, Switzerland

**7DO.8.4 Solar Roadmapping: The Way to Open up a Broad Range of Possible Options**

P. Malbranche  
International Solar Alliance, Gurugram, India

**7DO.8.5 Comprehensive Financial Modeling of Solar PV Systems**

D. Baschieri, C.A. Magni & A. Marchioni  
UNIMORE, Modena, Italy

**7DO.8.6 INES.2S - A French Institute for Multilateral Industrial Research on Solar Energy**

J. Merten & A. Jouini  
CEA, Le Bourget-du-Lac, France  
F. Lambert  
CEA, Grenoble, France  
F. Stork  
CNR, Lyon, France  
P. Raffin  
Colas, Paris, France  
G. Coma  
Renault, Boulogne Billancourt, France  
G. Duissard  
2CA, Arlanc, France  
F. Barruel  
PFE, Le Bourget-du-Lac, France  
C. Ménézo  
USMB-LOCIE, Le Bourget-du-Lac, France

**ORAL PRESENTATIONS 6DO.13**

**13:30 – 15:00 Building Envelope / Design, Simulation and Performance**

**Chairpersons:**

Maarten Dörenkämper  
TNO Energy Transition, Netherlands

Nuria Martín Chivelet  
CIEMAT, Spain

**6DO.13.1 BIM - A Driver for Cost Reduction within the BIPV Industry**

P. Alamy  
Enerbim, Seilh, France  
E. Saretta & P. Bonomo  
SUPSI, Canobbio, Switzerland  
J. Adami  
Eurac Research, Bolzano, Italy  
S. Pierret  
Optimal Computing, Mons, Belgium  
D. Valencia  
Tecnalia R&I, San Sebastian, Spain  
P. Alonso  
WIP Renewable Energies, Munich, Germany

**6DO.13.2 Artificial Intelligence Applied to the Thermal Characterization of Building Integrated Photovoltaic Technologies**

L. Serrano-Lujan & J.M. Colmenar  
Rey Juan Carlos University, Madrid, Spain  
C.A. Toledo Arias, J. Abad & A. Urbina  
UPCT, Cartagena, Spain

**6DO.13.3 Outdoor Operating Temperature of Modules in BIPV and BAPV Topologies**

A. Fairbrother, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland

**6DO.13.4 Low Concentration and Solar Control Photovoltaic System for Building Integration: Yearly Results and Analysis of Skylight System**

D. Valencia & E. Román Medina  
Tecnalia Research & Innovation, San Sebastian, Spain  
Y.B. Assoa & F. Burgun  
CEA, Le Bourget-du-Lac, France  
A. Sanz Martinez  
Tecnalia, Derio, Spain  
E. Rico, T. Del Caño & V. Velasco  
Onyx Solar Energy, Avila, Spain  
T. Reijenga  
BEAR-iD, Gouda, Netherlands  
P. Surguy  
Film Optics, Watchfield, United Kingdom  
P. Alonso & I. Weiss  
WIP Renewable Energies, Munich, Germany

**6DO.13.5 Development and Yearly Results of Framing System for c-Si Large Area Glass Prototype in Ventilated Facade Configuration**

Y.B. Assoa, F. Burgun, P. Thony & I.A. Tsanakas



CEA, Le Bourget-du-Lac, France  
 E. Rico, T. Del Caño & V. Velasco  
 Onyx Solar Energy, Avila, Spain  
 D. Valencia, E. Román Medina, M. Machado & A. Sanz Martinez  
 Tecnalia R&I, San Sebastián, Spain  
 P. Alonso & I. Weiss  
 WIP Renewable Energies, Munich, Germany

**6DO.13.6 Applying Wireless Power Transfer for Curtain Wall BIPV Elements**

S. De Meyere & B. Minnaert  
 Odisee University College of Applied Sciences, Ghent, Belgium  
 S. Ravyts & J. Driesen  
 KU Leuven, Genk, Belgium

**VISUAL PRESENTATIONS 2DV.3****13:30 – 15:00 Crystalline Silicon Solar Cell Technologies**

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

**ORAL PRESENTATIONS 5DO.4****15:15 – 16:45 Fault Detection****Chairpersons:**

João M. Almeida Serra  
 University of Lisbon, Portugal

Daniela Guida  
 ENEL Green Power, Italy

**5DO.4.1 A Data-Driven Model for Solar Inverters**

G. Guerra & P. Mercade Ruiz  
 GreenPowerMonitor, Barcelona, Spain  
 L. Landberg  
 DNV GL, Hellerup, Denmark

**5DO.4.2 Anomaly Detection at Inverter Level via Machine Learning Algorithms under the Absence of O&M Logbooks**

A.P. Talayero, N. Yildirim Yürüsen & A. Llombart Estopinan  
 CIRCE, Zaragoza, Spain  
 J.J. Meler Estela  
 University of Zaragoza, Spain

**5DO.4.3 Advanced Fault Detection and Diagnosis with AI Techniques**

M. Chang & K.H. Chen  
 Sinogreenenergy, Taipei, Taiwan  
 J.-L. Li, Y.-S. Chen & L. Wang

Reforecast, Taipei, Taiwan

**5DO.4.4 Early Detection of Potential Induced Degradation in the Field: Testing a New Methodology on Silicon PV Modules**

M. Florides, G. Makrides & G.E. Georghiou  
 University of Cyprus, Nicosia, Cyprus

**5DO.4.5 Early Casualties in Five PV Plants in France: A Sustainability Perspective on Complete PV Fault Diagnostics for Revamping**

J.A. Tsanakas, D.-L. Ha & F. Al-Shakarchi  
 CEA-INES, Le Bourget-du-Lac, France

**ORAL PRESENTATIONS 7DO.9****15:15 – 16:45 Energy System Modelling, Economic and Social Drivers****Chairpersons:**

Philippe Malbranche  
 CEA, France

Stefan Nowak  
 NET Nowak Energy & Technology, Switzerland

**7DO.9.1 Towards Country Scale Photovoltaic Energy Yield Modelling**

A. Schils, I.T. Horvath, F. Catthoor, E. Voroshazi & M. Meuris  
 imec, Genk, Belgium  
 W. Clymans & I. Uljee  
 Flemish Institute for Technological Research, Mol, Belgium  
 F. Duchêne  
 Royal Meteorological Institute of Belgium, Brussels, Belgium  
 F. Meinke-Hubeny  
 VITO, Genk, Belgium

**7DO.9.2 A Framework to Assess Local Grid Impacts of PV Deployment and Load Growth, and Cost-Effective Measures to Minimise Disruption across Great Britain**

S. Few, P. Djapic, G. Strbac, J. Nelson & C. Candelise  
 Imperial College London, United Kingdom

**7DO.9.3 Photovoltaics with Horizontal Tracking and Delta Configuration in a Decarbonized European Energy System**

M. Victoria  
 Aarhus University, Denmark

**7DO.9.4 A Multi-Objective Optimization to Assess Economic Benefit Distribution and Impact of Energy Communities**

V. Casalicchio, M.G. Prina & D. Moser  
 Eurac Research, Bolzano, Italy  
 G. Manzolini  
 Polytechnic University of Milan, Italy

**7DO.9.5 Open Database of Small-Scale Solar PV Installations: a Citizen Science Initiative**

A.B. Cristóbal & C. del Cañizo  
 UPM, Madrid, Spain  
 L. Barbosa & G. Revuelta  
 UPF, Barcelona, Spain  
 S. Haas  
 Reiner Lemoine Institut, Berlin, Germany  
 M. Victoria  
 Aarhus University, Denmark  
 M. Brocklehurst  
 KempleyGreen Consultants, Gloucester, United Kingdom

**7DO.9.6 SocialRES Project – Fostering Energy Democracy through Social Innovation**

S. Caneva & P. Alonso  
 WIP Renewable Energies, Munich, Germany  
 I. Lizarralde, I. Valentin, A. Abi Akle & M. Hamwi  
 ESTIA Institute of Technology, Bidart, France  
 V. Kromrey, D. Vedel & A. Wotjen  
 Bodensee-Stiftung, Radolfzell, Germany  
 A. Schneller & L. Domröse  
 Adelphi, Berlin, Germany  
 A. Ferrari & C. Crippa  
 Fondazione Icons, Lodigi, Italy  
 E. Denny & J. Carroll  
 Trinity College Dublin, Ireland  
 M. Regidor & S. Mulero  
 CARTIF Foundation, Valladolid, Spain  
 I. Lacoste  
 I-ENER, Saint-Jean-Pied-de-Port, France  
 R. Ruiz  
 ENERGETICA, Valladolid, Spain  
 N. Brito Jorge & M. Teixeira  
 GoParity, Lisbon, Portugal  
 K. Harder & T. Harwood  
 Abundance, London, United Kingdom  
 T. Simek  
 REGEA, Zagreb, Croatia  
 D. Leonte & M. Policarp  
 Tractebel, Bucharest, Romania

**ORAL PRESENTATIONS 6DO.14**

**15:15 – 16:45 AgroPV and EcoPV**

**Chairpersons:**

Alessandra Scognamiglio  
 ENEA, Italy

Rutger Schlatmann  
 HZB, Germany

**6DO.14.1 Dutch National Measurement Standard for Biodiversity in Solar Parks: First Practical Experience**

A. Schotman  
 Wageningen Environmental Research, Netherlands  
 M. Erberfeld  
 Rijkswaterstaat, Utrecht, Netherlands  
 I. Cesar  
 TNO Energy Transition, Petten, Netherlands

**6DO.14.2 Student Awards Finalist Presentation: Techno-Economic Study of Agrivoltaic Systems Focusing on High Value Crops**

B. Willockx, B. Herteleer & J. Cappelle  
 KU Leuven, Gent, Belgium

**6DO.14.3 Potential Use of Organic Photovoltaic (OPV) in Greenhouse Cultivation**

M. Friman-Peretz, F. Geoola, S. Ozer, A. Levi & M. Teitel  
 Agricultural Research Organisation, Rishon LeZion, Israel  
 I. Yehia & E. Magadley  
 Triangle Research and Development Center, Kafr Qara, Israel  
 S. Gantz  
 Ministry of Agriculture, Bet-Dagan, Israel

**6DO.14.4 Vertical Bifacial Solar Module Systems on Wild Flower Strips Combining Energy and Crops Production with Preservation of Biodiversity**

J. Schneider  
 Fraunhofer IMW, Halle, Germany  
 N. Pannicke  
 UFZ, Leipzig, Germany  
 H. Haufe  
 DBFZ, Leipzig, Germany  
 J. Birger  
 Stiftungs Kulturlandschaft Sachsen-Anhalt, Wanzleben, Germany  
 N. Zwosta  
 Next2Sun, Berlin, Germany  
 M. Mattiza  
 Terrawatt, Leipzig, Germany

**6DO.14.5 Development Process of Tailormade Smart Agri-Energy PVT Laminates**

R.M.E. Valckenborg, M. Koetse, B. Dai & B. van de Vorst  
 TNO, Eindhoven, Netherlands  
 H. den Besten  
 Den Besten Service, Hoevelaken, Netherlands  
 P. Happé  
 Expice, Zwaag, Netherlands  
 G. Verpaalen





Kameleon Solar Specials, Roosendaal, Netherlands  
 H. Visscher  
 Solarge, Eindhoven, Netherlands  
 A. Schiebroek  
 SolarTech, Eindhoven, Netherlands  
 H. Lootens  
 Stichting Gelijkspanning Nederland, Aalsmeer, Netherlands  
 M. Roelofs  
 Taylor, Eindhoven, Netherlands  
 T. Verhoeven  
 Van der Leegte Werkt, Eindhoven, Netherlands

#### 6DO.14.6 Improved Healthy Growth of Basil Seedlings under LSC Filtered Illumination

D. Vincenzi, P. Bernardoni, G. Mangherini, M. Boschetti & A. Andreoli  
 University of Ferrara, Italy  
 C. Samà, L. Gila & S. Palmery  
 Istituto Eni Donegani, Novara, Italy  
 M. Tonezzer & P. Decarli  
 Powerglax, Vallelaghi, Italy

### VISUAL PRESENTATIONS

15:15 – 16:45 POSTER AWARDS WINNERS SESSION

#### Chairperson:

Julio Cárabe  
 CIEMAT, Spain

Aiming to increase the visibility of poster awards winners and as a recognition to the quality of their presentation, the winners will be presented on this dedicated Poster Awards Winners session. This session will be composed of 2 parts: The above mentioned presentation of the winners, and a chat discussion in a dedicated virtual room together with the winners and interested audience.

### ORAL PRESENTATIONS 5DO.5

17:00 – 18:30 Performance and Yield Investigations

#### Chairpersons:

Franz P. Baumgartner  
 ZHAW, Switzerland

Sandy Rodrigues  
 University of Lisbon, Portugal

#### 5DO.5.1 Investigations on the Main Causes for Reduced Performances during the Early Stage of Life of Rooftop PV Systems

D. Chianese & M. Caccivio  
 SUPSI, Canobbio, Switzerland

#### 5DO.5.2 Challenges Associated with Inconsistent Photovoltaic Degradation Rate Estimations

M. Theristis, B.H. King & J.S. Stein  
 Sandia National Laboratories, Albuquerque, USA  
 J. Ascencio-Vásquez & M. Topic  
 University of Ljubljana, Slovenia

#### 5DO.5.3 28 Years of Operational Data for a Utility Scale 103 kWp PV Plant (1989-2017) Analysis of Degradation of PV Modules, Inverters and System Performance with Technical and Economical Comparison to the Repowered 260 kWp PV Plant (2017-2019)

T. Nordmann & T. Vontobel  
 TNC Consulting, Feldmeilen, Switzerland

#### 5DO.5.4 Performance of Roof-Top PV Systems in Selected European Countries from 2012 to 2019

J. Schardt & H. te Heesen  
 Trier University of Applied Sciences, Neubrücke (Nahe), Germany

#### 5DO.5.5 On the Impact of a Solar Eclipse across 100 PV Systems in India and Southeast Asia

A.M. Nobre, S. Karthik, R.S. Baker, A. Agarwal, S. Pranav, R. Malhotra & A. Khor  
 Cleantech Solar, Singapore, Singapore

#### 5DO.5.6 Bifacial Optical Model Validation and Performance of Static and Tracked Systems Installed in the Atacama Desert

F. Araya Rojas, T. Capelle, F. Haffner & H. Colin  
 CEA-INES, Le Bourget-du-Lac, France

### ORAL PRESENTATIONS 2DO.10

17:00 – 18:30 Thin Film and Foil-Based Si Cells

#### Chairpersons:

Paola Delli Veneri  
 ENEA, Italy

Michio Kondo  
 AIST, Japan

#### 2DO.10.2 Implementation of a Monolithic Bypass Diode Concept in Amorphous Silicon Thin-Film Solar Modules

J. Reifschneider, N. Hambach, B.E. Pieters & S. Haas  
 Forschungszentrum Jülich, Germany

#### 2DO.10.4 Plasma Enhanced Chemical Vapor Deposition (PECVD) and Catalytic CVD (Hot-Wire CVD) for High-Rate Fabrication of Thin-Film Silicon Layers

S. Leszczynski, B. Leszczynska, C. Strobel, M. Albert & J.W. Bartha  
 Technical University of Dresden, Germany  
 F. Stahr & J. Kuske  
 FAP, Dresden, Germany



- 2DO.10.5 Flexible Bifacial Amorphous Si Quintuple- and Sextuple-Junction Solar Cells for IoT Devices**  
M. Konagai, H. Noge & R. Ishikawa  
Tokyo City University, Setagaya-ku, Japan
- 2DO.10.6 Columnar a-Si:H Precursor Films for Laser Liquid Phase Crystallization**  
M. Nuys, H. Ali & S. Haas  
Forschungszentrum Jülich, Germany

## ORAL PRESENTATIONS 6DO.15

17:00 – 18:30 Floating Photovoltaics

## Chairpersons:

Urs Muntwyler  
BUAS, Switzerland

Roland M. E. Valckenborg  
TNO, The Netherlands

- 6DO.15.1 A Global Review of Hybrid Hydropower-Connected Floating PV Projects: Research, Status, Opportunities and Challenges**  
S. Merlet  
NTNU, Trondheim, Norway  
B. Thorud  
Multiconsult, Oslo, Norway  
C. Paton  
SERIS, Singapore, Singapore
- 6DO.15.2 Floating Photovoltaics – On-Site Measurements in Temperate Climate and Lake Influence on Module Behavior**  
B. Amiot, M. Chiodetti, R. Le Berre & P. Dupeyrat  
EDF R&D, Moret-sur-Loing, France  
S. Giroux-Julien  
INSA Lyon, Villeurbanne, France  
D. Boubilil & K. Radouane  
EDF Renewables, Paris La Defense, France  
K. Vermeyen  
EDF Luminus, Brussels, Belgium
- 6DO.15.3 Performance and Reliability of Ocean Sun's Floating PV Technology**  
J.H. Selj, I.H. Lereng, P. De Paoli, G. Otnes & E.S. Marstein  
Institute for Energy Technology, Kjeller, Norway  
M.B. Øgaard  
University of Oslo, Norway  
S. Patel  
Stellenbosch University, Cape Town, South Africa
- 6DO.15.4 Irradiation Analysis of Floating One-Axis Azimuthal Tracking PV Systems**  
M. Dörenkämper, M.M. de Jong & W. Folkerts

TNO, Eindhoven, Netherlands

- 6DO.15.5 Innovative Floating Bifacial Photovoltaic Solutions for In-Land Water Areas**  
H. Ziar, E. Garcia Goma, J. Garro Etxebarria, F. Fatih Sönmez, I. Narvaez Alavez, T. Stark, A. Calcabrin, R. Santbergen & O. Isabella  
Delft University of Technology, Netherlands  
B. Prudon  
Waterschap Rivierenland, Tiel, Netherlands  
V. Lin & B. Roeffen  
Blue21, Delft, Netherlands  
D. Heijkoop, D. van Tilborg, P. van der Linde & H. van Laar  
Hakkers, Werkendam, Netherlands
- 6DO.15.6 On Module Temperature in Floating PV Systems**  
I.M. Peters  
Forschungszentrum Jülich, Erlangen, Germany  
A.M. Nobre  
Cleantech Solar, Singapore, Singapore



Friday, 11 September 2020

**ORAL PRESENTATIONS 6EO.1****08:30 – 10:00 Industrial Application and Electric Mobility****Chairpersons:**

Hubert Aulich  
SC Sustainable Concepts, Germany

Bonna Newman  
TNO Energy Transition, The Netherlands

**6EO.1.1 Designing Innovative Solutions for PV-Powered Electric Mobility Applications**

A. Sierra & A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands

**6EO.1.2 VIPV: Process Development of Integrated Photovoltaic Cells in a Double-Curved Composite Structure for Automotive Application**

T. Duigou, F. Chabuel & J. Gaume  
CEA, Grenoble, France  
V. Boichon, X. Brancaz, P. Francescato & L. Tenchine  
IPC, Balignat, France  
M. Lagache & P. Saffre  
University Savoie Mont Blanc, Annecy, France

**6EO.1.3 Development of High-Efficiency and Low-Cost Solar Cells for PV-Powered Vehicles Applications**

M. Yamaguchi, K. Araki, D. Sato & N. Kojima  
Toyota Technological Institute, Nagoya, Japan  
T. Takamoto  
SHARP, Nara, Japan  
T. Masuda & A. Satou  
Toyota, Shizuoka, Japan  
K. Yamada & T. Nakado  
Toyota, Japan  
M. Yamazaki  
NEDO, Kawasaki, Japan

**6EO.1.4 PHOTOPUR-PV Powered Process Automation of an AOP Based Water Decontamination**

J. da Costa Fernandes, E. Bollin & M. Schmidt  
University of Applied Sciences Offenburg, Germany  
P. García-Muñoz & N. Keller  
University of Strasbourg, France

**6EO.1.5 An Innovative Multi-Axis Solar System for HCPV**

F. Bizzarri  
ENEL, Rome, Italy  
L. Merlo & A. Cucuzza  
ENEL, Catania, Italy  
G. Lanzara, F. Ponticelli, F. Crisi & A. D'Ottavio  
Solergy, Formello, Italy  
Y. Banin  
Solergy, Piedmont, USA

**ORAL PRESENTATIONS 5EO.2****08:30 – 10:00 Energy Storage****Chairpersons:**

Francesco Dolci  
European Commission JRC, The Netherlands

Florence Lambert  
CEA, France

**5EO.2.1 Vanadium Redox Flow Battery Modelling and PV Self-Consumption Management Strategy Optimization**

A.C. Neves Foles, L.A. Fialho, M.P.I. Collares-Pereira & P.A. dos Santos Ribeiro Horta  
University of Evora, Portugal

**5EO.2.2 Temporal Complementarity between Wind and Solar Generation and the Role of Storage for Hybrid Plants**

R.A. Campos & R. Rütger  
UFSC, Florianópolis, Brazil

**5EO.2.3 Student Awards Finalist Presentation: Increased PV Utilisation from DC Distribution: Quantification of Geographical Location Impact**

P. Ollas & C. Markusson  
RISE, Borås, Sweden  
T. Thiringer  
Chalmers University of Technology, Götheborg, Sweden

**5EO.2.4 From Room to Field: Solar-Battery Coupling Feasibility Study**

O. Astakhov, T. Merdzhanova, L.-C. Kin & U. Rau  
Forschungszentrum Jülich, Germany

**5EO.2.5 Influence of PV and Battery Degradations on Residential Solar Panel Systems**

O. Alavi, W. De Ceuninck, M. Meuris & M. Daenen  
Hasselt University, Diepenbeek, Belgium

**5EO.2.6 Efficient Solar Charging of Lithium Ion Batteries Using Perovskite Solar Cells**

L.-C. Kin, Z. Liu, O. Astakhov, S.N. Agbo, H. Tempel, S. Yu, H. Kungl, R.-A. Eichel, U. Rau, T. Kirchartz & T. Merdzhanova  
Forschungszentrum Jülich, Germany

## ORAL PRESENTATIONS 7EO.3

08:30 – 10:00 **Costs, Economics, Finance and Markets**

### Chairpersons:

Silvia Caneva  
WIP Renewable Energies, Germany

Thomas Nordmann  
TNC Consulting, Switzerland

#### 7EO.3.1 **A Snapshot of Global PV Markets - the Latest Survey Results on PV Markets and Policies from the IEA PVPS Programme in 2019**

G. Masson  
Becquerel Institute, Brussels, Belgium  
A. Jäger-Waldau  
European Commission JRC, Ispra, Italy  
I. Kaizuka  
RTS Corporation, Tokyo, Japan  
J. Lindahl  
Becquerel Sweden, Stockholm, Sweden  
J. Donoso Alonso  
UNEF, Madrid, Spain

#### 7EO.3.2 **The Value of Efficiency**

I.M. Peters  
HI ERN, Erlangen, Germany  
S. Sofia & T. Buonassisi  
MIT, Cambridge, USA  
C.D. Rodríguez-Gallegos  
SERIS, Singapore, Singapore  
J. Hepp  
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

#### 7EO.3.3 **Bottom-Up Analysis of Future PV System Cost Development**

E. Vartiainen  
Fortum Growth, Finland  
G. Masson  
Becquerel Institute, Brussels, Belgium  
C. Breyer  
Lappeenranta University of Technology, Finland  
D. Moser  
Eurac Research, Bolzano, Italy  
E. Román Medina  
Tecnalia R&D, Derio, Spain

#### 7EO.3.4 **Costs of Utility-Scale Photovoltaic Systems Integration in the Future Italian Energy Scenarios**

E. Veronese, M.G. Prina & D. Moser  
Eurac Research, Bolzano, Italy

G. Manzolini  
Polytechnic University of Milan, Italy

#### 7EO.3.5 **First Economic Benchmark of PV Technologies for ATAMOSTEC in the Atacama Desert, Chile**

N. Gazbour, P.-J. Ribeyron & D. Muñoz  
CEA, Le Bourget-du-Lac, France  
E. Urrejola & M.J. Riquelme  
ATAMOSTEC, Santiago, Chile  
C. Gonzalez & A.M. Ruz  
CORFO, Santiago, Chile

#### 7EO.3.6 **Holistic Evaluation of the Economic Competitiveness of BIPV Solutions in Europe**

P. Macé & E. Bosch  
Becquerel Institute, Brussels, Belgium

## PLENARY SESSION EP.1

10:30 – 12:10 **PV IN THE ENERGY SYSTEM**

### Chairpersons:

Wim C. Sinke  
TNO Energy Transition, The Netherlands

Julio Cárabe  
CIEMAT, Spain

#### EP.1.1 **Designing PV for the First Generation of Solar Electric Vehicles**

B.K. Newman, V. Rosca, N.J.J. Dekker, L.A.G. Okel & M.J.A.A. Goris  
TNO Energy Transition, Petten, Netherlands  
S. Regondi, D. Dijken & D. di Carlo  
Lightyear, Helmond, Netherlands  
A. Khabbaz Saberi, S. van Montfort & R.M.A.F. Verschuren  
TNO Traffic & Transport, Helmond, Netherlands

#### EP.1.2 **Storage for Residential Energy Systems**

J. Juergens  
LG Chem Europe GmbH, Frankfurt, Germany

#### EP.1.3 **Sustainability of PV for the TeraWatt Era**

G. Heath  
NREL, Golden, USA



**EP.1.4 Innovative Self-Consumption and Aggregation Concepts for PV****Prosumers: Results of the PV-Prosumers4Grid Project**

W.G.J.H.M. van Sark &amp; W. Schram

Utrecht University, Netherlands

J. Radl, A. Fleischhacker &amp; G. Lettner

Vienna University of Technology, Austria

A. Louwen

Eurac Research, Bolzano, Italy

L.A. Aguilar, M. Roos &amp; M. Battaglia

BSW - Solar, Berlin, Germany

C. Grundner &amp; M. Jimeno

eclareon, Berlin, Germany

D. Hendricks, J. Vollmer &amp; P. Bancourt

EREF, Brussels, Belgium

R. Battisti

Ambiente Italia, Rome, Italy

K. Moosdorf

APESF, Aljezur, Portugal

H. Kuittinen &amp; E. Román Medina

Tecnalia Research &amp; Innovation, Derio, Spain

A. Joyce

LNEG, Lisbon, Portugal

G. Masson &amp; G. Neubourg

Becquerel Institute, Brussels, Belgium

J. Donoso Alonso

UNEF, Madrid, Spain

C. Winter, N. Diewald &amp; U. Winter

Fronius, Wels, Austria

**EP.1.5 Only PV Can Deliver Enough Power to Decarbonize**

R. Nordmann

Swissolar, Zurich, Switzerland

**12:10 – 13:10****CONFERENCE CLOSING****Chaired by:**

Nicola Pearsall

EU PVSEC General Chair

Emerita Professor of Renewable Energy in the Faculty of Engineering and Environment, Northumbria University, UK

**Moderated by:**

Heinz Ossenbrink

former European Commission Joint Research Centre

**Highlights of the Conference**

Robert Kenny

EU PVSEC Technical Programme Chair

European Commission Joint Research Centre

**Ceremony of the Student Awards**

Arno Smets

EU PVSEC Student Awards Coordinator

Professor Solar Energy at Delft University of Technology

**Ceremony of the Poster Awards**

Julio Cárabe

EU PVSEC Poster Awards Coordinator,

CIEMAT, Spain

**Announcement upcoming PV events****Representative PV SEC**

Chinho Park,

Yeungnam University, South Korea

**Representative IEEE PVSC**

Sylvain Marsillac

Old Dominion University, USA

**Representative EU PVSEC**

João M. Almeida Serra

FCUL- University of Lisbon/IDL, Portugal

**What do we take home from the EU PVSEC? Farewell and Closing**

Nicola Pearsall

EU PVSEC General Chair

Emerita Professor of Renewable Energy in the Faculty of Engineering and Environment, Northumbria University, UK



## Visual Presentations

Monday, 07 September 2020

## VISUAL PRESENTATIONS 4AV.1

13:30 – 15:00 Module Design Manufacture, Performance and Reliability (I)

## Chairpersons:

Ralph Gottschalg  
Fraunhofer CSP, Germany

William Gambogi  
DuPont, USA

## 4AV.1.1 Repair Options for PV Modules with Cracked Polyamide Backsheets

Y. Voronko & G.C. Eder  
OFI, Vienna, Austria  
C. Breitwieser  
Rembrandtin Lack, Vienna, Austria  
W. Mühleisen & L. Neumaier  
Silicon Austria Labs, Villach, Austria  
S. Feldbacher & G. Oreski  
PCCL, Leoben, Austria

## 4AV.1.2 Investigating the Influence of Sample Configuration on EVA Degradation Modes

C. Barretta, L. Castillon & G. Oreski  
PCCL, Leoben, Austria  
N. Kyranaki & T.R. Betts  
CREST, Loughborough, United Kingdom  
D.E. Mansour & L. Pita Bauermann  
Fraunhofer ISE, Freiburg, Germany  
K. Resch-Fauster  
University of Leoben, Austria

4AV.1.3 Encapsulation of Flexible Cu(In,Ga)Se<sub>2</sub>-Based Mini-Modules by Atomic Layer Deposition

S.-T. Zhang & N. Schneider  
CNRS, Palaiseau, France  
M. Guc, V. Izquierdo-Roca & A. Perez-Rodriguez  
IREC, Barcelona, Spain  
O. Salomon & R. Würz  
ZSW, Stuttgart, Germany  
T. Hildebrandt  
EDF R&D, Palaiseau, France

## 4AV.1.4 Leakage Current Analysis in Respect to Potential Induced Degradation for Cadmium Telluride Thin Film Solar Modules

L. Gerstenberg, A. Oberdorfer, S. Voswinckel, P.K. Panda & V. Wesselak  
Nordhausen University of Applied Sciences, Germany

## 4AV.1.5 Single-Step Fabrication of a Photovoltaic Module Using Encapsulants with Low Melting Temperature Metal Ribbons Embedded

D.-Y. Shin  
Pukyong National University, Busan, Republic of Korea  
J.-R. Lim, W.G. Shin, C.-G. Lee & G.-H. Kang  
KIER, Daejeon, Republic of Korea

## 4AV.1.6 Delamination of c-Si Module Encapsulation: Insight into Causes and Long-Term Effects

A. Fairbrother, L. Gnocchi, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland

## 4AV.1.7 Combined Approach for a Better Definition of Perovskite Devices Encapsulation Protocols and the Achievement of Targeted Lifetime in Standardized Conditions

S. Cros, O. Ibraikulov, C. Bal, A. Levrot, M. Manceau, C. Roux & S. Berson  
CEA, Le Bourget-du-Lac, France

## 4AV.1.8 Encapsulant Selection for Increased PID Resistance in Modules Made with Heterojunction Solar Cells

O. Arriaga Arruti, L. Gnocchi, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland

## 4AV.1.9 Degradation of Fielded PV Modules in Three Climates After Eight Years

D.S. Riley, C. Robinson, B.H. King & J.S. Stein  
Sandia National Laboratories, Albuquerque, USA

## 4AV.1.10 Development of Film-Based Ultra-Compact GaAs Photovoltaic Module Using Laser-Assisted Bonding

J. Joo, G.-M. Choi, K.-S. Jang, Y.-S. Eom & K.-S. Choi  
ETRI, Daejeon, Republic of Korea  
H.K. Kang, S.H. Jung & H.-B. Shin  
KANC, Suwon, Republic of Korea

## 4AV.1.11 Reliability Evaluation of Photovoltaic Modules through Artificial Corrosion Test

C. Lien, S.-H. Chen, S.-Y. Ting, K.-W. Lu, W.-L. Yang, M.-F. Lin, C.-F. Hsieh, T.-C. Wu & S.-T. Hsu  
ITRI, Hsinchu, Taiwan

## 4AV.1.12 Investigation of Discolored Electrodes of Crystalline Silicon PV Mini-Module Degraded by High Temperature and Humidity Stress Test

Y. Ino, S. Asao, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan

## 4AV.1.14 Comparison of Long-Term Indoor and Outdoor Performance Measurement Techniques of Crystalline Silicon PV Modules to Validate Annual Degradation

F. Carigiet & F.P. Baumgartner  
ZHAW, Winterthur, Switzerland  
C.J. Brabec  
FAU, Erlangen, Germany

## 4AV.1.15 Experimental Characterization of PV Solar Module Components - towards Numerical Modeling of the Lamination Process

I. Rahmoun & A. Derrier  
CEA, Le Bourget-du-Lac, France  
P.-O. Bouchard  
CEMEF, Sophia-Antipolis, France  
J.-L. Bouvard  
CEMEF, Sophia Antipolis, France





- 4AV.1.16 Defect Investigation by ‘Coring’ for CIGS Solar Modules**  
P. Yilmaz & J. Schmitz  
University of Twente, Enschede, Netherlands  
R. Aninat, M.G. Ott Cruz & M. Theelen  
TNO/Solliance, Eindhoven, Netherlands  
T. Weber  
PI Berlin, Germany
- 4AV.1.17 High Refractive Index Encapsulants to Reduce Reflection Losses and Increase Cell Efficiencies in Crystalline Silicon PV**  
D. Mann, R. van Zandvoort, M. Xu & P. Buskens  
TNO, Eindhoven, Netherlands
- 4AV.1.18 Power Increase Benefits for Back-Contact Solar Modules Compared to Standard String Technologies**  
G.J.W. Meijers, I.J. Bennett, P. di Lorenzo & P. Pasmans  
DSM Advanced Solar, Geleen, Netherlands  
I. Suez  
Silfab Solar, Mississauga, Canada
- 4AV.1.19 Encapsulation Polymer Screening via Ultra-Fast Aging under High Irradiance UV LEDs**  
N. Pinochet, J.-F. Lelièvre, R. Couderc & A. Derrier  
CEA, Le Bourget-du-Lac, France
- 4AV.1.20 Studying the Impact of Infrared Spectrum on Submerged Amorphous, Mono-and Poly-crystalline Solar Cells**  
P.K. Enaganti & S. Goel  
BITS-Pilani, Hyderabad, India  
P.K. Dwivedi  
IIT Kanpur, India  
A.K. Srivastava  
DRDO, Kanpur, India
- 4AV.1.21 Monitoring the Moisture Ingress into PV Modules by Measuring Capacitive Characteristics**  
E. Fokuhl, H. Berg, S. Stecklum, D.E. Mansour, D. Philipp & P. Gebhardt  
Fraunhofer ISE, Freiburg, Germany
- 4AV.1.23 LeTID and PID Hardness of Silicon Heterojunction Modules**  
R. Couderc, L. Sicot, S. Dimachkie, A. Derrier & Y. Veschetti  
CEA, Le Bourget-du-Lac, France
- 4AV.1.24 Analysis of Field Aged PV Modules with PET Based Backsheets Regarding Their Mechanical Stability**  
J. Schnepf, P. Lechner, H. Wirth, S. Hummel & D. Geyer  
ZSW, Stuttgart, Germany
- 4AV.1.25 H2020: Solar Train MSCA Fellowship - Home-Made UV-Fluorescence Spectroscopy Measurement Device for Si-c Photovoltaic Modules**  
A. Nairi, J. Bengoechea, M.J. Rodriguez & A.R. Lagunas  
CENER, Sarriguren-Navarra, Spain
- 4AV.1.26 Measuring the Contact Resistivity of ECA-Based Joints**  
M.I. Devoto, T. Timofte, A. Halm & D. Tune  
ISC Konstanz, Constance, Germany
- 4AV.1.27 Correlation between EVA Degree of Crosslinking and Moisture Ingress into PV Laminates**  
D.E. Mansour, C. Herzog, E. Fokuhl, P. Gebhardt & D. Philipp

- Fraunhofer ISE, Freiburg, Germany  
S. Mitterhofer & M. Jankovec  
University of Ljubljana, Slovenia
- 4AV.1.29 PV Backsheet Failure Analysis by Scanning Acoustic Microscopy**  
D.E. Mansour, S. Kotterer, D. Philipp & P. Gebhardt  
Fraunhofer ISE, Freiburg, Germany
- 4AV.1.30 Prediction of PID-s on the Basis of Accelerated Module Testing and Weather Data**  
V. Naumann, L. Erichsen, M. Rumiantcev, B. Jäckel & C. Hagendorf  
Fraunhofer CSP, Halle (Saale), Germany
- 4AV.1.31 Potential-Induced Degradation of the Shunting Type: on the Origin of Sodium in Shunt Paths**  
R. Breugelmans, J. Carolus & M. Daenen  
Hasselt University, Genk, Belgium  
A.S.H. van der Heide & E. Voroshazi  
imec, Genk, Belgium
- 4AV.1.32 Mechanical Strength Analysis of the Si-Heterojunction Modules with Different Cells and Module Designs**  
V. Levitskii, K.V. Emtsev, D. Andronikov, A. Abramov, E.I. Terukov & D. Orekhov  
R&D Center TFTE, St. Petersburg, Russian Federation  
I. Shakhray  
Avelar Solar Technology, Moscow, Russian Federation
- 4AV.1.33 PID Leakage Current Modelling by Application of Machine Learning Techniques**  
D. Stellbogen, P. Lechner, J. Schnepf, S. Hummel & F. Sehnke  
ZSW, Stuttgart, Germany
- 4AV.1.35 Characterization and Long Term Stability Analysis at Photovoltaic Modules with Shingled Cell Strings**  
S. Wendlandt, M. Ghebrelul & L. Podlowski  
PI Berlin, Germany
- 4AV.1.36 ATAMOSTEC Desert Label for PV Technologies**  
E. Urrejola  
ATAMOSTEC, Santiago, Chile  
P.-J. Ribeyron & D. Muñoz  
CEA, Le Bourget-du-Lac, France  
R. Kopecek  
ISC Konstanz, Germany
- 4AV.1.37 Numerical Analysis on Cell Crack Initiation due to Thermomechanical Stresses**  
L. Papargyri, P. Papanastasiou & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus
- 4AV.1.38 Sequential Module Testing: Results and Necessity Discussion**  
M. Pander, B. Jäckel, U. Zeller & M. Ebert  
Fraunhofer CSP, Halle (Saale), Germany
- 4AV.1.40 Detection of Solar Cell Cracks by Laser Line Induced Lateral Currents and Luminescence Imaging**  
G.A. dos Reis Benatto, A.A. Santamaria Lancia, T.K. Hass, P.B. Poulsen & S.V. Spataru  
Technical University of Denmark, Roskilde, Denmark



- 4AV.1.41 Reliability Study of Three Cell Architectures and the Degradation Induced by Moisture Ingress**  
S.C. Pop  
SCP SYS, San Francisco, USA  
M. Bora  
Lawrence Livermore National Laboratory, USA  
R. Schulze  
Sunrun, San Francisco, USA  
M. Rowell & D. Harwood  
D2 Solar, San Jose, USA
- 4AV.1.42 Failure Modes of Backsheets in Field and Laboratory Aged PV Modules**  
J. Tracy, W.J. Gambogi & K. Roy Choudhury  
DuPont, Wilmington, USA  
R. Khatri  
DuPont, Gurgaon, India  
J. Xia & H. Hu  
DuPont, Shanghai, China
- 4AV.1.43 Investigation on Leakage Current of PID-Affected and PID-Free Crystalline Silicon Solar Module**  
H. Wang & H. Yang  
Xi'an Jiaotong University, China
- 4AV.1.45 Accelerated LeTID Testing with Dark Current Voltage Characteristics Co-Measurement**  
B. Kubicek, K.A. Berger & G. Ujvári  
AIT, Vienna, Austria
- 4AV.1.46 Extending Module Lifetime through Development of FEA Analysis Guidelines for Micro-Crack Prediction of Silicon Cells**  
Y. Yu, Y. Ni & J.-N. Jaubert  
Canadian Solar, Suzhou, China  
T. Metals & H. Liu  
EDF R&D, Beijing, China  
E. Boyère & E. Lajoie-Mazenc  
EDF R&D, Paris, France
- 4AV.1.47 Backsheet Evaluation for Silicon Heterojunction Modules**  
A. Abramov, D. Andronikov, K. Emtsev, D. Orekhov, E. Terukova & S. Yakovlev  
R&D Center TFTE, St. Petersburg, Russian Federation  
I. Shakhrai  
Hevel Solar, Moscow, Russian Federation
- 4AV.1.48 Mechanical Degradation of Amorphous Silicon Solar Module**  
G. Osayemwenre & E.L. Meyer  
University of Fort Hare, Alice, South Africa
- 4AV.1.49 Durability of Polyolefin Encapsulation Based Modules: A Cross-Comparison of Commercially Available Solutions**  
B.X.J. Yu, R. Lv, J.-N. Jaubert & G. Xing  
Canadian Solar, Suzhou, China  
J. Dupuis & E. Lajoie-Mazenc  
EDF R&D, Moret Loing et Orvan, France  
C. Dugué & G. Goaer  
EDF ENR Photowatt, Bourgoin Jallieu, France
- 4AV.1.50 Ultra-Fast Imaging of Third Generation Photovoltaics**  
H. Hoppe & U. Schubert  
Friedrich Schiller University Jena, Germany

R. Meitzner  
Friedrich-Schiller-University Jena, Germany  
H. Kruschke  
InfraTec, Dresden, Germany

- 4AV.1.51 Understanding Migrations and Activation Energies Effects within Photovoltaic Modules Polymer Packaging to Predict 70 Years Service Life from Accelerated Weathering Tests on Coupons and Mini-Modules**  
F. Rummens  
RENOLIT, Oudenaarde, Belgium
- 4AV.1.52 Performance Degradation Research of PV Module Installed in Different Climate Area**  
M.-W. Chen, C.-H. Lin, C.-Y. Gao & B.-C. Kuo  
TERTEC, Taoyuan, Taiwan

## VISUAL PRESENTATIONS 4AV.2

15:15 – 16:45 Module Design Manufacture, Performance and Reliability (II)

### Chairpersons:

Christos Monokrousos  
TÜV Rheinland Energy, China

Gernot Oreski  
PCCL, Austria

- 4AV.2.1 Evaluation Method of PV Module Degraded by Shunt Resistance Decrease Using I-V Curve Measured in Exposure**  
T. Kohno, E. Bayu Miftahullatif, M. Fujimori, Y. Nagayama, T. Nakamura & K. Kondo  
Hitachi, Tokyo, Japan  
K. Banba & N. Fujii  
Hitachi Power Solutions, Ibaraki, Japan
- 4AV.2.2 Operation and Evaluation of a Bifacial PV Module Test Setup**  
W. Mühleisen, L. Neumaier & C. Hirschl  
SAL Silicon Austria Labs, Villach, Austria  
J. Löschnig  
KIOTO Solar, Wies, Austria  
A.R. Burgers & E.E. Bende  
TNO - Solar Energy, Petten, Netherlands  
S. Zamini  
AIT, Vienna, Austria
- 4AV.2.3 Improving Computational Efficiency of Mechanical Finite Element Method Simulations for PV Modules**  
N. Bosco, X. He & M. Springer  
NREL, Golden, USA
- 4AV.2.4 Post Mortem Analysis of Bifacial PV Modules Based on n-Type Crystalline-Si Cells Using Three Different Types of Encapsulants**



- P. Sommeling & J.M. Kroon  
TNO Energy Transition, Petten, Netherlands
- 4AV.2.5 Research on Photovoltaic Module Temperature Prediction Based on NWP Data**  
C. Yang & Z. Chen  
CMA, Wuhan, China
- 4AV.2.6 Reduction of ECA Amount for the Ribbon Interconnection of Heterojunction Solar Cells**  
C. Kaiser, V. Nikitina, T. Geipel & A. Kraft  
Fraunhofer ISE, Freiburg, Germany
- 4AV.2.7 Trend Tracking of Efficiency and CTM Ratio of PV Modules**  
A. Tummaliéh, A. Pfreundt & M. Mittag  
Fraunhofer ISE, Freiburg, Germany
- 4AV.2.8 Enhancing PV Module Thermomechanical Performance and Reliability by an Innovative Mounting Solution**  
A.J. Beinert  
Fraunhofer ISE, Freiburg, Germany  
A. Masolin  
Coolback Company, Amsterdam, Netherlands
- 4AV.2.9 Characteristics of Vertically Installed 3D-Type Photovoltaics**  
D. Nomura, H.-G. Kang & H. Nagaoyshi  
FUJICO, Kitakyushu, Japan  
M. Hayashi & T. Nomura  
CKD Corporation, Komaki, Japan  
M. Nakamura  
Ushio, Yokohama, Japan  
S. Hayase  
The University of Electro-Communications, Chofu, Japan
- 4AV.2.10 Reliability of the Industrial Shingling Module by ECA Characteristics**  
J.-W. Baik, C.-S. Park, S.-H. Gong, Y.-J. Kim, J.-Y. Lim, J.-W. Kang, Y. Min, K.K Hong, E.-J. Lee, S.-O. Choi & D.-S. Kim  
Shinsung Solar Energy, Jeungpyeong-gun, Republic of Korea
- 4AV.2.11 Relative Spectral Responsivity Measurements of Photovoltaic Modules with Band Pass Filter Technique**  
S. Meric & O. Bazkir  
TUBITAK-UME, Kocaeli, Turkey
- 4AV.2.12 Linearity Measurements of Photovoltaic Modules with Attenuating Irradiance Filter Technique**  
O. Bazkir & S. Meric  
TUBITAK-UME, Kocaeli, Turkey
- 4AV.2.13 The Bypass Diode – a Weakness in Today's PV Systems**  
D. Gfeller, R. Neukomm & U. Muntwyler  
BUAS, Burgdorf, Switzerland
- 4AV.2.14 Glass-Free Lightweight Solar Modules for Integrated Photovoltaics: the Use of Velcro as an Alternative Mounting System**  
F. Lisco, A.C. Oliveira Martins, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 4AV.2.15 Parametric Study of PV Module Variables for Increased Efficiency**  
R.I. Bourisli & B.S. Aldalali  
Kuwait University, Safat, Kuwait
- 4AV.2.16 Seasonal Performance Assessment of Various PV Technologies in a Desert Climate through Device Simulations and Outdoor Measurements**  
T. Katsaounis & A. Tzavaras  
KAUST, Thuwal, Saudi Arabia  
K. Kotsovos, I. Gereige, A. Basaheeh, M. Abdullah, A. Khayat, E. Al Habshi & A. Al-Saggaf  
Saudi Aramco, Thuwal, Saudi Arabia
- 4AV.2.18 Environmental Stability of the Semi-Flexible HJT Solar Panels**  
S. Yakovlev, E. Schebet, K. Emtsev, D. Andronikov, A. Abramov & D. Orekhov  
R&D Center TFTE, St. Petersburg, Russian Federation  
I. Shakhray  
Avelar Solar Technology, Moscow, Russian Federation
- 4AV.2.19 I-V Translation Procedure for Higher Accuracy and Compliance with PERC Cell Technology Requirements**  
C. Monokroussos  
TUV Rheinland, Shanghai, China  
H. Müllejans  
European Commission JRC, Ispra, Italy  
W. Herrmann  
TUV Rheinland Energy, Cologne, Germany
- 4AV.2.20 ECA Qualification Methodology for Photovoltaic Module Application**  
H. Gauthier, V. Barth, P. Berthelemy, N. Benberkane & A. Derrier  
CEA, Le Bourget-du-Lac, France
- 4AV.2.21 Reduction of Silver Based ECA for SHJ Module**  
P. Berthelemy, B. Commault, V. Barth, A. Bettinelli, R. Soulas & A. Derrier  
CEA, Le Bourget-du-Lac, France
- 4AV.2.24 411W Record 72 Half-Cells Glass Backsheet Module Using ECA Gluing Tabber Stringer**  
B. Commault, P. Berthelemy, A. Bettinelli, A. Danel, B. Chambion, R. Soulas, C. Roux, A. Derrier & Y. Veschetti  
CEA, Le Bourget-du-Lac, France  
X. Hernandez, A. Apraiz & J.-P. Aguerre  
Mondragon Assembly, Aretxabaleta, Spain
- 4AV.2.25 Apollo Large-Area Steady-State Solar Simulator as a Versatile Tool for PV Device Performance Measurements**  
H. Müllejans, E. Salis, D. Pavanello, G. Bardizza, J. Lopez-Garcia, W. Zaaiman, D. Shaw, T. Sample & E.D. Dunlop  
European Commission JRC, Ispra, Italy
- 4AV.2.26 Performance of Bifacial and Monofacial Heterojunction Modules in Moderate Climatic Conditions**  
A. Titov, K. Emtsev, D. Andronikov, A. Abramov & D. Orekhov  
R&D Center TFTE, St. Petersburg, Russian Federation  
I. Shakhray  
Avelar Solar Technology, Novocheboksarsk, Russian Federation
- 4AV.2.27 Preparing IBC Module Assembly for High Volume Production: from Lab to Fab**  
A. Halm, T.L. Timofte, E. Wefringhaus & R. Harney  
ISC Konstanz, Germany  
N. Chen  
Delft University of Technology, Netherlands  
J. Liu, J. Ma, Y. Guo & P. Dong



- SPIC Solar Power, Xi'an, China
- 4AV.2.28 Novel PV Module Interconnection Design and Mounting Orientation to Reduce Inhomogeneous Soiling Losses in Desert Regions**  
H. Hanifi, M.Z. Khan, B. Jäckel, C. Hagendorf & K. Ilse  
Fraunhofer CSP, Halle (Saale), Germany  
A.A. Abdallah  
QEERI, Doha, Qatar  
J. Schneider  
Fraunhofer IMW, Leipzig, Germany
- 4AV.2.29 High Efficiency Flexible and Lightweight PV Modules Using Crystalline Silicon Solar Cells**  
J. Ulbikas  
Applied Research Institute for Prospective Technologies, Vilnius, Lithuania  
M. Rudzikas  
Center for Physical Sciences and Technology, Vilnius, Lithuania  
P. Dubravskij  
UAB "Modern E-Technologies", Vilnius, Lithuania  
A.G. Ulyashin  
SINTEF, Oslo, Norway
- 4AV.2.31 Method for Evaluating the Severity of Solar Cell Cracks in Electroluminescence Images**  
S.V. Spataru, G.A. dos Reis Benatto, T.K. Hass, A.A. Santamaria Lancia, P.B. Poulsen & S. Thorsteinsson  
Technical University of Denmark, Roskilde, Denmark
- 4AV.2.32 Characterisation of Angular Dependent Optical Properties of Different Coloring Technologies Employed in BIPV Products**  
M. Babin, A.A. Santamaria Lancia, A. Thorseth & S. Thorsteinsson  
Technical University of Denmark, Roskilde, Denmark
- 4AV.2.34 Measurement and Simulation of Moisture Ingress in PV Modules in Various Climates**  
S. Mitterhofer, J. Slapšak, M. Jankovec & M. Topic  
University of Ljubljana, Slovenia  
A. Astigarraga & D. Moser  
Eurac Research, Bolzano, Italy  
G. Oviedo Hernández & P.V. Chiantore  
BayWa, Rome, Italy  
L. Wei  
SERIS, Sigapore, Singapore  
Y. S. Khoo  
SERIS, Singapore, Singapore  
J. Rabanal-Arabach, E. Fuentealba, M. Trigo-Gonzalez & P. Ferrada  
University of Antofagasta, Chile
- 4AV.2.35 Superhydrophillic Self Cleaning SiO<sub>2</sub>/TiO<sub>2</sub> Thin Film Coating for Solar Glass Cover Application**  
A. Abhinav & S. Mallick  
IIT Bombay, Mumbai, India
- 4AV.2.36 Comparison of Double Glass and Glass/Backsheet Bifacial Module Designs**  
W.J. Gambogi, M. Demko, B.-L. Yu, S. MacMaster, S. Kurian & K. Roy Choudhury  
DuPont, Wilmington, USA  
A. Borne  
DuPont, Geneva, Switzerland  
H. Hu, Y. Hu & Z. Pan

- DuPont, Shanghai, China
- 4AV.2.37 Analysis of the PV Modules Aging Mechanisms in the Moroccan Climate for the Development of a Desert PV Module**  
A. Bouaichi, Z. Naimi, A. Ghennioui, H. Zitouni, A. Benazzouz, B. Ikken, S. Sarikh & A. Benlarabi  
Green Energy Park, Benguerir, Morocco  
A. El Amrani & C. Messaoudi  
Moulay Ismail University, Meknes, Morocco
- 4AV.2.38 Characterizing Modules Light Management Potential with Existing (Structured Ribbons and Films, Multiwire) and Next Gen Materials by Means of Hemispheric IAM (HIAM) Robust Method**  
M. Falsini  
, Firenze, Italy
- 4AV.2.40 Module Design and Yield Evaluation of Indoor and Outdoor Measurements for Bifacial Modules**  
D. Daßler, S. Malik & S. Schindler  
Fraunhofer CSP, Halle (Saale), Germany  
D. Berrian & J. Libal  
ISC Konstanz, Germany  
A. Karsenti & N. Eisenberg  
SolAround, Jerusalem, Israel
- 4AV.2.41 Correlation between Imaging and Electrical Characterization Techniques of Solar Cell Cracks in Photovoltaic Modules**  
S.V. Spataru, G.A. dos Reis Benatto, A.A. Santamaria Lancia, P.B. Poulsen & S. Thorsteinsson  
Technical University of Denmark, Roskilde, Denmark  
H.R. Parikh  
Aalborg University, Denmark
- 4AV.2.42 Experimental Energy Characterization of PV Modules under Partial Shading Conditions with Two Different Bypass Diode Configurations**  
W. Braga Junior, M. de Jesus dos Santos Rodrigues, P. Ferreira Torres, J. Tavares Pinho, M.A. Barros Galhardo & W. Negrao-Macedo  
UFPA, Belém, Brazil  
G.F. Pinto Filho & A.R. Arrifano Manito  
USP, São Paulo, Brazil
- 4AV.2.43 Comparison of Power Performances for Shingled PV Module with Bifacial and p-PERC PV Modules for Floating and Marine Photovoltaics**  
H.-K. Ahn  
Konkuk University, Seoul, Republic of Korea
- 4AV.2.44 Active Thermography Based Performance Analysis & Defected Area Calculation of PV Modules**  
M. Amin, M. Islam, G. Hasan, S. Dewan, I. Ahmed & M.M. Rahman  
BRAC University, Dhaka, Bangladesh
- 4AV.2.46 Study on Output Characteristics of Shingled Photovoltaic Module According to Printability of Electrically Conductive Adhesive**  
S.H. Kim & J. Moon  
KETI, Gyeonggi-do, Republic of Korea
- 4AV.2.47 Bifaciality Factor and Ideality Factor of PERC Bifacial Solar Module under Different Irradiances**  
H. Yang & H. Wang  
Xi'an Jiaotong University, China



- 4AV.2.48 Bifacial Modules for Large Scale PV Plants: Lessons Learned and Current Limitations from a Factory Inspection Outlook**  
R.J. Gómez, E. Jiménez, D. Sanz, C. Sandoval, J. Cuaresma, J.C. Vázquez, S. Rodríguez-Conde, H. Silva & V. Parra  
Enertis Solar, Madrid, Spain
- 4AV.2.49 Optimization of PV Module Glass Thickness in a Desert Climate for Maximum Energy Yield**  
B. Aldalali & R. Bourisli  
Kuwait University, Safat, Kuwait  
B. Alabdulrazzaq & A. Al-Qattan  
KISR, Safat, Kuwait  
I.T. Horvath & J. Poortmans  
imec, Leuven, Belgium
- 4AV.2.50 Performance Analysis of Polycrystalline Module Based on Faults Causes**  
L. Feng & F.U. Hamelmann  
Bielefeld University of Applied Science, Minden, Germany  
J. Zhang & K. Ding  
Hohai University, Changzhou, China
- 4AV.2.51 Power Stabilization Methods on Thin-Film Photovoltaics: a Round-Robin Test**  
A. Mittal, M. Rennhofer & G. Újvári  
AIT, Vienna, Austria  
T. Weber  
PI Berlin, Germany  
E.J. Achterberg  
Solar Tester, Schinnen, Netherlands  
L. Plessing  
CrystalSol, Vienna, Austria  
E. Sovetkin  
Forschungszentrum Jülich, Germany
- 4AV.2.52 CDF Study of Hybrid Solar Panels with PCM**  
D. Gonzalez-Peña, A. García-Rodríguez, D. Granados-López, M.I. Dieste-Velasco & C. Alonso-Tristán  
UBU, Burgos, Spain
- 4AV.2.53 Determination of a PV Module Power Matrix with an LED Solar Simulator**  
S. Riechelmann & H. Sträter  
PTB, Braunschweig, Germany
- 4AV.2.55 Extending Quality and Adapting for the Future: The European Solar Test Installation Laboratory Extends Its ISO/IEC 17025:2017 Accreditation to Cover Bi-Facial Devices, Energy Rating Power Matrix and Device Linearity**  
L. Castellazzi, J. Lopez-Garcia, E. Salis, D. Pavanello, D. Shaw, H. Müllejjans, G. Bardizza, R.P. Kenny, M. Field, T. Sample, W. Zaaiman & E.D. Dunlop  
European Commission JRC, Ispra, Italy

**VISUAL PRESENTATIONS 4AV.3**

**17:00 – 18:30 Inverters, Micro-Inverters and BOS Components / Sustainability and Circular Economy**

**Chairpersons:**

Jose Luis Domínguez-García  
IREC, Spain

Karsten Wambach  
Wambach-Consulting, Germany

- 4AV.3.1 Design of an Integrated I-V Tracer and Maximum Power Point Tracker**  
B. Dai  
TNO, Eindhoven, Netherlands  
M. Appelhof & B. Ozturk  
3T, Eindhoven, Netherlands
- 4AV.3.2 Implementation of a MPPT Using Open Hardware FPGA**  
U. Sainz Estébanez & N. Azkona  
UPV/EHU, Bilbao, Spain
- 4AV.3.3 Particle Swarm Optimization with Reducing Boundaries (PSO-RB) for Maximum Power Point Tracking of Partially Shaded PV Arrays**  
A. Beltran & S. Das  
Kennesaw State University, Marietta, USA
- 4AV.3.4 Accurate Determination of Micro-Inverter Performance Using Electrically Biased PV Modules**  
J.D. Moschner, J. Tant & J. Driesen  
KU Leuven | EnergyVille, Genk, Belgium  
A. Wabbes & S. Scheerlinck  
ENGIE Laborelec, Linkebeek, Belgium
- 4AV.3.5 Accurate Testing Methods of Grid-Connected PV Inverters by Means of Real-Time Based Hardware-in-the-Loop (HIL) Simulation Topologies for Validation, Testing, and Grid Integration of Solar Plants**  
G. Lauss, Z. Miletic, A. Banjac & C. Messner  
AIT, Vienna, Austria
- 4AV.3.6 Elevated Temperatures Affecting Efficiency, Overall Performance and Energy Yield of PV Microinverters**  
S. Krauter & J. Bendfeld  
University of Paderborn, Germany
- 4AV.3.7 Optimal Design of Series-Parallel Differential Power Processing Converters for Photovoltaic Array Energy Systems**  
M. Etarhouni, B. Chong & L. Zhang  
The University of Leeds, United Kingdom
- 4AV.3.8 Module-Level Power Electronics under Indoor Performance Tests**  
F.P. Baumgartner, S. Richter, C. Meier, C. Allenspach & F. Carigiet  
ZHAW, Winterthur, Switzerland
- 4AV.3.10 Thermal Impact of Grid Injection Limits on Inverter Operation**  
J. Despeghel, S. Ravyts & J. Driesen  
KU Leuven, Heverlee, Belgium





- 4AV.3.11 Key Innovations on Power Electronics and Communications Leading to a LCOE Reduction of Solar PV**  
 J.L. Domínguez-García, L. Trilla, P. Paradell & V. Izquierdo  
 IREC, Barcelona, Spain  
 D. Horbacauskas & J. Ulbikas  
 PROTECH, Vilnius, Lithuania  
 K. Khemiri  
 EOLANE, Vailhauquès, France  
 M. Jankovec  
 University of Ljubljana, Slovenia  
 D. Golob  
 COSYLAB, Ljubljana, Slovenia  
 J. Aime  
 CEA, Le Bourget-du-Lac, France
- 4AV.3.12 Advanced Integration of Inverter and Tracker for Optimized Non-Astronomical Algorithm with Higher Yield**  
 X. Gu, Y. Zheng, C. Wang, C. Gao & S. Wan  
 Huawei Technologies, Madrid, Spain
- 4AV.3.13 The Impact of Tracker Structure on Bifacial PV Performance**  
 F. Gross, W. Landman & M. Balz  
 sbp sonne, Stuttgart, Germany
- 4AV.3.24 Bright Prospects for Solar PV End of Life Management in India**  
 J.N. Malaviya  
 MSEC, Pune, India
- 4AV.3.26 Reversible Adhesives for Frames and Junction Boxes**  
 F. Wanghofer, A. Wolfberger & G. Oreski  
 PCCL, Leoben, Austria  
 L. Neumaier  
 Silicon Austria Labs, Villach, Austria
- 4AV.3.28 Second Life of PV Modules – Experience and Results from the CIRCUSOL Project**  
 W. Palitzsch & I. Röver  
 LuxChemtech, Freiberg, Germany  
 T. Rommens  
 VITO, Mol, Belgium
- 4AV.3.30 Combustion Based Delamination of Si Based Glass/Glass Photovoltaic Modules**  
 X. Ma, H. Bu & A.G. Ulyashin  
 SINTEF, Oslo, Norway  
 M. Rudzikas  
 Center for Physical Sciences and Technology, Vilnius, Lithuania  
 J. Denafas  
 Solitek R&D, Vilnius, Lithuania  
 J. Ulbikas  
 UAB "Modern E-Technologies", Vilnius, Lithuania
- 4AV.3.31 End-of-Life Management of Photovoltaic Panels in Austria: Current Situation and Outlook**  
 T. Dobra, M. Wellacher & R. Pomberger  
 University of Leoben, Austria
- 4AV.3.33 Recovery of Raw Materials in End-of-Life Photovoltaic Modules Recycling**  
 J.-P. Mai & N. Resay

JPM Silicon, Braunschweig, Germany  
 R. Arafat & C. Herrmann  
 TU Braunschweig, Germany  
 M. Neubert  
 Rovak, Wilsdruff, Germany





Tuesday, 08 September 2020

## VISUAL PRESENTATIONS 3BV.1

08:30 – 10:00 Perovskites

## Chairpersons:

Sjoerd Veenstra  
TNO Energy Transition, Netherlands

Wolfgang Tress  
EPFL, Switzerland

**3BV.1.1 The Structural, Mechanical, Thermal, Electronic and Optical Properties of Halide Perovskites Cs<sub>2</sub>TiX<sub>6</sub> (X=Cl,Br,I): First-Principles Investigations**

Y. Nouri, B. Hartiti, A. Batan & S. Fadili  
University of Hassan II, Mohammedia, Morocco  
F. Reniers, C. Buess-Herman & T. Segato  
Free University of Brussels, Belgium  
M. Siadat & P. Thevenin  
University of Lorraine, Metz, France

**3BV.1.4 Preparation of Titanium Dioxide Electron Transport Material and Fabrication of Perovskite Solar Cells**

N. AlJufairi  
QEERI, Doha, Qatar

**3BV.1.6 Optical and Electrical Characterization of Perovskites**

R. Ebner, B. Kubicek, G. Ujvári, A. Mittal, N. Bansal & T. Dimopoulos  
AIT, Vienna, Austria  
M. Hadjipanayi, V. Paraskeva, M. Hadjikypris & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
A. Hadipour  
imec, Leuven, Belgium

**3BV.1.8 Epoch-Making 3D Photovoltaic with Complete Sealing**

T. Nomura & M. Hayashi  
CKD, Komaki, Japan  
D. Nomura, H.-G. Kang & H. Nagaoyoshi  
FUJICO, Kitakyushu, Japan  
M. Nakamura  
USHIO, Kanagawa, Japan  
S. Hayase  
University of Electro-Communications, Chofu, Japan

**3BV.1.9 Novel Photovoltaic Devices Using Ferroelectric Material**

R. Ndioukane & D. Kobor  
UASZ, Ziguinchor, Senegal  
L. Motte & J. Solard  
University of Paris 13, France

**3BV.1.11 Phase Evolution during Growth and Annealing of Co-Evaporated Perovskite Absorbers**

K. Heinze, H. Kempa, J. Vaghani, T. Burwig, J. Ge, R. Scheer & P. Pistor  
Martin-Luther-University, Halle (Saale), Germany

**3BV.1.14 Outdoor Monitoring System with MPP Tracking for Perovskite Solar Cells**

B. Glažar, G. Matic & M. Topic  
University of Ljubljana, Slovenia  
M. Jost  
HZB, Berlin, Germany

**3BV.1.15 Ultralight Perovskite Solar Cells for Low Intensity Low Temperature (LILT) Applications**

J. Grandier, R.S. Kowalczyk & J. Brophy  
JPL, Pasadena, USA  
M.D. Kelzenberg, S. Demchyshyn, S.P. Loke, N. Vaidya & H.A. Atwater  
Caltech, Pasadena, USA

**3BV.1.16 Ferroic Domain and Domain Walls in Halide Perovskites**

J.S. Yun, D.H. Kim & J. Seidel  
UNSW Australia, Sydney, Australia

**3BV.1.17 Co-Doping Strategy of C60 Toward High Efficiency Inorganic CsPbI<sub>2</sub>Br Perovskite Solar Cells and Modules**

C. Liu, Y. Yang, C. Zhang, S. Wu & Y. Mai  
Jinan University, Guangzhou, China  
L. Wei  
CAS, Shenzhen, China

**3BV.1.18 Doped Engineering Fabricated High-Crystallization Perovskite Solar Cell as MAPbI<sub>2.95</sub>Cl<sub>0.05</sub>**

C.-H. Kuan, H.-J. Syu & C.-F. Lin  
NTU National Taiwan University, Taipei, Taiwan

**3BV.1.19 Perovskite Solar Cells under Outdoor Conditions**

M. Khenkin, M. Stepanov, M. Riedel, N. Phung, A. Abate, R. Schlattmann & C. Ulbrich  
HZB, Berlin, Germany  
E. Katz  
BGU, Midreshet Ben-Gurion, Israel

**3BV.1.20 Investigations on the Formation Mechanism of Fully Vapour-Processed Perovskite Absorbers**

T. Moser, K. Artuk, Y. Jiang, T. Feurer, A.N. Tiwari & F. Fu  
EMPA, Dübendorf, Switzerland

**3BV.1.21 Photoferroelectric and Ferrophotovoltaic Characteristics of Silicon-Perovskites Nanoparticles Heterojunction**

N.C.Y. Fall, R. Ndioukane, M. Touré & D. Kobor  
UASZ, Ziguinchor, Senegal  
M. Pasquinelli  
Aix Marseille University, France  
T. Dobbins  
Rowan University, Glassboro, USA

**3BV.1.22 Improvements on the Stability of MAPbI<sub>3</sub> Thin Films Against UV Radiation by a Low Temperature Encapsulation Method That Uses Commercial Ethylene-Vinyl Acetate Sheets**

L. Ocaña, C. Montes, M. Friend & M. Cendagorta  
ITER, Granadilla de Abona, Spain  
S. González-Pérez & B. González-Díaz  
ULL, La Laguna, Spain



- 3BV.1.23 Technical Analysis of Mixed Binders Based on Epoxy Resin and Ethylene-Vinyl Acetate to Produce Conductive Inks for the Metallization of Perovskite Solar Cells via Screen Printing Technique**  
C. Montes, L. Ocaña, M. Friend & M. Cendagorta  
ITER, Granadilla de Abona, Spain  
S. González-Pérez & B. González-Díaz  
University of La Laguna, Spain
- 3BV.1.24 Optimizing for Yearly Energy Yield: Pathways for In-Coupling and Light Trapping**  
R. Häusermann, M. Kamperman, U. Aeberhard, D. Braga, B. Blülle & B. Ruhstaller  
Fluxim, Winterthur, Switzerland
- 3BV.1.25 Optical and Electrical Properties of Thin Film Based on Inorganic PNZ-4.5PT Perovskite Ferroelectric Deposited on ITO Glass Substrate for Photovoltaic Application**  
F. Balde, M. Touré, R. Ndioukane, A.K. Diallo, N.C.Y. Fall & D. Kobor  
Ziguinchor University, Senegal
- 3BV.1.26 The Key Role of Surface Defects Passivation on the Stability of Perovskite Absorber under Controlled Humidity Revealed by In Situ X-Ray Diffraction Study**  
M.A. Akhavan Kazemi, A. Krishna, J.-N. Chotard, S. Gottis & F. Sauvage  
University of Picardie, Amiens, France
- 3BV.1.27 Developing an Agglomerate of Graphite and Black Carbon in an Ethylene-Vinyl Acetate in Toluene Solution for Producing Electrodes for HTM-Free Perovskite Solar Cells**  
C. Montes, L. Ocaña, M. Friend & M. Cendagorta  
ITER, Granadilla de Abona, Spain  
S. González-Pérez & B. González-Díaz  
University of La Laguna, Spain
- 3BV.1.29 Synthesis of Perovskite Films for Photovoltaics: Influence of the Reagents' Ratio on the Material Properties**  
V.P. Kostilyov, A.V. Sachenko, I.O. Sokolovskyi, S.D. Kobylanska, P.V. Torchyniuk, O.I. V&apos;yunov & A.G. Belous  
NAS ISP, Kiev, Ukraine  
V. Vlasjuk  
ISP of NASU, Kiev, Ukraine  
A.I. Shkrebti / Chkrebti  
Ontario Tech University, Oshawa, Canada
- 3BV.1.30 Hole Transfer NiO Layers with Enhanced Properties for All-Inorganic Perovskite Solar Cells**  
E. Manidakis, E. Darivianaki & C.C. Stoumpos  
University of Crete, Heraklion, Greece  
M. Androulidaki, K. Tsagaraki, A. Kostopoulos, G. Michail, N.T. Pelekanos & E. Aperathitis  
FORTH, Heraklion, Greece  
M. Modreanu  
Tyndall National Institute, Cork, Ireland
- 3BV.1.32 Synthesis of Mixed-Halide Hybrid Perovskites for Defect Characterization**  
G. Fischer  
Zittau/Görlitz University of Applied Sciences, Germany  
M. Müller, J. Beyer & J. Heitmann  
Freiberg University of Technology, Germany

- 3BV.1.33 Advanced Chemical Characterization of Perovskite Systems: XPS and GD-OES Coupling**  
P. Dally, D. Messou & M. Robillard  
IPVF, Palaiseau, France  
A. Yaiche & J. Rousset  
EDF R&D, Palaiseau, France  
S. Béchu & M. Bouttemy  
UVSQ, Versailles, France
- 3BV.1.34 Tailoring Perovskite Ink for Upscale Deposition by Slot-Die: Understanding the Influence of Surfactant Addition**  
S. Bernard, S. Jutteau, A. Yaiche, A. Duchatelet & J. Rousset  
EDF R&D, Palaiseau, France  
S. Cacovich  
IPVF, Palaiseau, France  
F. Sauvage  
University of Picardie, Amiens, France
- 3BV.1.35 Numerical Simulation of Bias Dependent Ion Re-Distribution in Perovskite Solar Cells**  
D. Sivadas, S. Chandra Tirupati & P.R. Nair  
IIT Bombay, Mumbai, India
- 3BV.1.36 A Practicable Way Doping Perovskite Solar Cell to Fabricate MAPb<sub>1-x</sub>Cl<sub>3-x</sub>**  
C.-H. Kuan, H.-J. Syu, P.-T. Kuo & C.-F. Lin  
NTU, Taipei, Taiwan
- 3BV.1.38 Lamination: A Versatile Route for Stable Perovskite Photovoltaics**  
J. Roger, R. Schmager, J.A. Schwenzer, F. Schackmar, T. Abzieher, M. Malekshahi Byranvand, B. Abdollahi Nejand, P. Fassl, M. Worgull, B.S. Richards & U.W. Paetzold  
Karlsruhe Institute of Technology, Germany
- 3BV.1.40 Effective Charge Extraction by Contact Engineering in Inverted Perovskite Solar Cells**  
T. Ripolles, C. Redondo-Obispo & C. Coya  
URJC, Móstoles, Spain

#### VISUAL PRESENTATIONS 3BV.2

10:30 – 12:00 **CI(G)S, CdTe and Related Thin Films / Organic and Dye-Sensitised Devices / II-V and Related Compound Semiconductors / Tandems**

#### Chairpersons:

Gianluca Coletti  
TNO Energy Transition, Netherlands

Giorgio Bardizza  
European Commission JRC, Italy

Volker Sittinger  
Fraunhofer IST, Germany



- 3BV.2.2 Achievement of Graded Band Gap in CdTe Solar Cells through Selenization of the Absorber**  
E. Artegiani, V. Kumar & A. Romeo  
University of Verona, Italy
- 3BV.2.3 Study of Post Sulphurization/Selenization Processes for Solution Processed CZTS Thin Films**  
P. Punathil, S. Zanetti, E. Artegiani & A. Romeo  
University of Verona, Italy
- 3BV.2.5 Effects of CdCl<sub>2</sub> Treatment Time on the Performance of Semi-Transparent CdTe Solar Cells**  
F. He, L. Wu, J. Li & L.H. Feng  
Sichuan University, Chengdu, China
- 3BV.2.7 Throughout RF Magnetron Sputtering Route to Fabricate CZTS Thin-Film Solar Cell**  
A.K. Sen Gupta, E.M.K.I. Ahamed, M. Quamruzzaman & M.A. Matin  
Chittagong University of Engineering and Technology, Bangladesh  
N. Amin  
The National Energy University, Kajang, Malaysia
- 3BV.2.8 Raman Spectroscopy as a Possible in-Line Inspection Tool for CIGS Solar Cells in Comparison with Photoluminescence Measurements**  
K. Harms, L. Neumaier, W. Mühleisen & C. Hirschl  
SAL Silicon Austria Labs, Villach, Austria  
G.V. Rao, T. Zimmermann & P. Kratzert  
Solibro, Bitterfeld-Wolfen, Germany
- 3BV.2.9 P3 Structuring for Post-Monolithic Interconnections on CIGS Thin Film Solar Cells with Ultrashort Pulsed Laser Radiation at a Wavelength of 1030 nm**  
N. Hambach, S. Kasper, G. Schöpe, B.E. Pieters & S. Haas  
Forschungszentrum Jülich, Germany  
R. Schäffler  
NICE Solar Energy, Schwäbisch Hall, Germany
- 3BV.2.10 Kesterite Solar-Cells by Drop-Casting of Inorganic Sol-Gel Inks**  
G. Tseberlidis, V. Trifiletti, A. Le Donne, L. Frioni, M. Acciarri & S. Binetti  
University of Milan, Italy
- 3BV.2.11 CIGS Modules with Copper Plated Metallization**  
A. Lachowicz, G. Christmann, S. Nicolay & C. Ballif  
CSEM, Neuchâtel, Switzerland
- 3BV.2.12 Chalcogenide Solar Cells with Transparent Back Contacts for Bifacial and Tandem Applications**  
I. Becerril-Romero, S. Giraldo, K. Tiwari, M. Placidi, Y. Sánchez, A. Perez-Rodriguez, E. Saucedo & Z. Jehl Li Kao  
IREC, Sant Adrià de Besòs, Spain
- 3BV.2.13 Optimization of NaF Doping for Ultra-Thin CIGSe Solar Cells**  
Y. Li & M. Schmid  
University of Duisburg-Essen, Germany  
G. Yin  
Wuhan University of Technology, China

- 3BV.2.19 Integration of TiO<sub>2</sub> in Oxide/Metal/Oxide-Electrodes for Increased Colour Rendering of CIGS Solar Cells**  
K. Gehrke, N. Neugebohrn & N. Klaassen  
DLR, Oldenburg, Germany
- 3BV.2.21 Machine Learning for CIGS Process Development**  
R. Hünig, F. Sehnke, S. Paetel & A. Bauer  
ZSW, Stuttgart, Germany
- 3BV.2.22 Scalable Approach for Fast In-Line Thickness Assessment of Nanometric AlxO Water Barrier Layers for Encapsulation of Flexible PV Modules**  
E. Grau-Luque, M. Guc, I. Becerril-Romero & V. Izquierdo-Roca  
IREC, Barcelona, Spain  
A. Perez-Rodriguez  
University of Barcelona, Spain  
P.J. Bolt & F.J. van den Bruele  
TNO, Eindhoven, Netherlands  
U. Rühle  
Flisom, Dübendorf, Switzerland
- 3BV.2.25 Elaboration of Wide Bandgap CIGS on Silicon by Electrodeposition of Stacked Metal Precursors and Sulfur Annealing**  
A. Crossay, D. Cammilleri & D. Lincot  
IPVF, Palaiseau, France  
A. Rebai  
CNRS, Palaiseau, France  
N. Barreau  
University of Nantes, France
- 3BV.2.26 Studies on the Capacitance Spectroscopy of Cu<sub>2</sub>ZnSnS<sub>4</sub> Typed Solar Cells Anisotype Heterojunction by SCAPS-1D**  
O. Akinrinola, A.O. Awodugba, M.K. Awodele & O. Akinrinola  
LAUTECH, Ogbomoso, Nigeria  
M. Jain  
University of The Gambia, Banjul, Gambia  
A. Ibiyemi  
Federal University Oye-Ekiti, Nigeria
- 3BV.2.27 Performance Enhancement of Bifacial and Semitransparent Solar Cells with Ultrathin Cu(In,Ga)Se<sub>2</sub> Absorber Layers Prepared by Single-Stage Co-Evaporation**  
M.J. Shin, S.J. Park, A. Lee, A. Cho, K. Kim, S.K. Ahn, J.H. Park, J.S. Yoo, D. Shin, I. Jeong, J.H. Yun, J. Gwak & J.S. Cho  
KIER, Daejeon, Republic of Korea
- 3BV.2.28 Effect of Sulfurization Time on the Structural Properties of SnS Films**  
V.R. Minnam Reddy, S. Gedi, W.K. Kim & C. Park  
Yeungnam University, Gyeongsan, Republic of Korea  
K.T. Ramakrishna Reddy  
Sri Venkateswara University, Tirupati, India
- 3BV.2.29 Design of Dielectric SiO<sub>2</sub> Nanoparticle in Solution-Processed CISSe Solar Cells**  
Y. Gao & M. Schmid  
University of Duisburg-Essen, Germany
- 3BV.2.30 Improving Interface of Kesterite Solar Cell by Solution-Processed Alkali-PDT Treatment**  
M. He, C. Yan, J. Huang & X. Hao  
UNSW Australia, Sydney, Australia



- J.H. Kim  
Chonnam National University, Gwangju, Republic of Korea
- 3BV.2.31 Investigation of Band Gap and Band Tailing in (Cu<sub>1-x</sub>Ag<sub>x</sub>)<sub>2</sub>ZnSnSe<sub>4</sub> Thin Films Alloys**  
S. Perret, R. André & H. Mariette  
CNRS, Grenoble, France  
J. Bleuse, Y. Curé, F. Emieux, F. Roux & L. Grenet  
CEA, Grenoble, France
- 3BV.2.33 Impedance Spectroscopy Models of CZTSe Nanolayer Ge Bi-Layers Devices**  
S. Lee  
Indiana State University, Terre Haute, USA  
K.J. Price  
Morehead State University, USA  
E. Saucedo  
IREC, Barcelona, Spain
- 3BV.2.34 Effect of CdS<sub>1</sub>-XTex Intermix Layer Thickness on CdTe Solar Cell Performance**  
N. Kumar Das, J. Chakrabarty & M.A. Matin  
Chittagong University of Engineering and Technology, Bangladesh  
S.F.U. Farhad  
BCSIR Labs, Dhaka, Bangladesh  
N. Amin  
National University of Malaysia, Kajang, Malaysia
- 3BV.2.35 Effect of ZnO Intermediate Layer on the Properties of CZTSe Absorber Layer**  
V. Kumar & U.P. Singh  
KIIT University, Bhubaneswar, India
- 3BV.2.36 Alkali Post-Deposition Treatment of Cu(In,Ga)(S,Se)<sub>2</sub> Solar Cell Absorbers Grown under Atmospheric Pressure**  
P. Reyes-Figueroa, T. Kodalle, T. Bertram, A. Villanueva-Tovar, E. Waack, R. Haberecht, C.A. Kaufmann, R. Klenk & R. Schlatmann  
HZB, Berlin, Germany
- 3BV.2.37 Chemical Bath Deposition: Design and Development of Instrumentation for Growth Thin-Film Solar Cell Layers**  
D.F. Bohórquez Vargas, M.F. Hurtado-Morales & C.F. Reyes Bello  
Central University, Bogotá, Colombia
- 3BV.2.38 Development of High-Efficiency Cu(In,Ga)Se<sub>2</sub> Thin-Film Photovoltaics on Flexible Stainless Steel Substrates: Impacts of Ga Grading on Device Performances**  
D. Shin, K. Kim, I. Jeong, Y.J. Eo, S. Song, A. Cho, S.K. Ahn, J.S. Cho, J.H. Park, J.S. Yoo, S.J. Ahn, J.H. Yun & J. Gwak  
KIER, Daejeon, Republic of Korea
- 3BV.2.39 A Low-Temperature X-Ray Diffraction Study of the Cu<sub>2</sub>ZnSnSe<sub>4</sub> Thin Films on a Mo Foil Substrate**  
A.V. Stanchik, V. Chumak, V.F. Gremenok & T.V. Shoukavaya  
NASB, Minsk, Belarus  
S. Baraishuk  
BSATU, Minsk, Belarus
- 3BV.2.48 Dynamical Monte Carlo Simulations to Investigate the Morphology Influence on Organic Solar Cell Performances**  
H. Bencherif, L. Dehimi, A. Yousfi, L. Saidi, M.A. Abdi & F. Meddour

- University of Batna, Algeria  
F. Pezzimenti & F.G. Della Corte  
UNIRC, Reggio Calabria, Italy
- 3BV.2.49 Organic Solar Cells Based on an Anthradithiophene Conjugated Polymer**  
G. Bianchi, F. Melchiorre, C. Carbonera, G. Corso, R. Barbieri & R. Po  
Eni, Novara, Italy  
F. Ferrazza  
Eni, San Donato Milanese, Italy  
F. Tinti & N. Camaioni  
CNR, Bologna, Italy  
A. Nitti & D. Pasini  
University of Pavia, Italy
- 3BV.2.51 Improved Efficiency of Vacuum Free Bulk Hetero-Junction Solar Cells by Incorporating Gold (Au) Nanoparticles**  
N.T.N. Truong, C.-D. Kim, V.H. Thai & C. Park  
Yeungnam University, Gyeongsan, Republic of Korea
- 3BV.2.53 Preliminary Study of the Role of Fluorinated Phthalocyanines as Non-Fullerene Acceptors in Ternary Organic Solar Cells**  
A.A.A. Torimtubeun, J. Pallarès Marzal & L.F. Marsal Garví  
URV, Tarragona, Spain  
J. Follana-Berná & A. Sastre-Santos  
University Miguel Hernández, Elche, Spain
- 3BV.2.54 Characterization of PEDOT:PSS Functionalized by Dimethyl Sulfoxide and Triton X-100 and TiO<sub>2</sub> Nanoparticles**  
A. Yaseen, E.S. Marstein & S.Zh. Karazhanov  
Institute for Energy Technology, Kjeller, Norway  
A. Vázquez-López, D. Maestre, J. Ramírez-Castellanos & A. Cremades  
UCM, Madrid, Spain
- 3BV.2.55 High Efficiency Inverted Polymer Solar Cells Fabricated Based on ZnO-ETL Utilizing Spray Pyrolysis Technique**  
E. Moustafa, J.G. Sánchez López, L.F. Marsal Garví & J. Pallarès Marzal  
URV, Tarragona, Spain
- 3BV.2.56 Evaluation Emerging PV Performance under Energy Harvesting for Indoor Lighting Applications**  
Y.-S. Long, M.-A. Tsai, T.-C. Wu & S.-T. Hsu  
ITRI, Hsinchu, Taiwan
- 3BV.2.57 Student Awards Finalist Presentation: Selective NIR-Conversion in Dye-Sensitized Solar Cells: A New Generation of Fully Transparent and Colorless Photovoltaic**  
W. Naim  
LRCS, Amiens, France  
F. Grifoni, I. Dzeba & F. Sauvage  
LCRS, Amiens, France  
N. Barbero & C. Barolo  
University of Turin, Italy  
I. Nikolinakos & S. Haacke  
University of Strasbourg, France
- 3BV.2.59 Structural, Optical, Dielectrical and Electrical Properties of Aloe Vera Leaf Exudate: Novel Application in Solar Cell**  
S.K. Hnawi, A. Nayad, H. Ait Dads, A. Agdad, A. Oueriagli & M. Ait Ali  
Cadi Ayyad University, Marrakech, Morocco



- 3BV.2.70 Growth and Characterization of 1.0 eV GaAsBi for Photovoltaic Applications**  
T. Paulauskas, V. Pacebutas, J. Devenson, R. Butkutė, B. Cechavicius, S. Stanionyte, A. Naujokaitis, M. Skapas & A. Krotkus  
Center for Physical Sciences and Technology, Vilnius, Lithuania  
M. Caplovicová & V. Vretenár  
Slovak University of Technology, Bratislava, Slovakia  
X. Li & M. Kociak  
University of Paris Sud, Orsay, France
- 3BV.2.71 Reducing Voc Loss in Wafer Bonded Four-Junction Solar Cells with Improved p-GaAs/n-InP Interfaces**  
G. Li, H. Lu, X. Li, W. Zhang & M. Wu  
SISP, Shanghai, China
- 3BV.2.74 Scalable and Low Cost Back End of Line Technologies for Production of III-V Solar Cells**  
N. Hayatiroodbari, C. Hendler, A. Wheeldon & R. Trattinig  
JOANNEUM RESEARCH, Weiz, Austria
- 3BV.2.75 Limits for the Fabrication of Broadband Antireflection Coatings for Multijunction Solar Cells Using Thin Films**  
G.J. Hou & I. Rey-Stolle  
UPM, Madrid, Spain
- 3BV.2.76 A New Mathematical Approach for the Performance Simulation of Multijunction (MJ) Solar Cells**  
G. Timò  
RSE, Piacenza, Italy  
L.C. Andreani  
University of Pavia, Italy
- 3BV.2.77 Optimization of INSB Epitaxial Layer Growth Conditions Using MOVPE: Prospective Applications in Photovoltaic Cells**  
C.C. Ahia & E.L. Meyer  
University of Fort Hare, Alice, South Africa
- 3BV.2.88 How to Fabricate Low-Resistance Heterointerfaces for Tandem Cells by Direct Bonding at Low Temperatures**  
Y. Ohno  
Tohoku University, Sendai, Japan  
J. Liang & N. Shigekawa  
Osaka-City University, Japan  
H. Yoshida  
Osaka University, Japan  
R. Miyagawa  
Nagoya Institute of Technology, Japan  
Y. Shimizu & Y. Nagai  
Tohoku University, Ibaraki, Japan
- 3BV.2.89 Promising Materials for High Efficiency Dual Junction Solar Cell Directly Grown on Si**  
D.N. Micha  
Federal Center of Technological Education of Rio de Janeiro, Petrópolis, Brazil
- 3BV.2.91 Integration Challenges of a Perovskite Cell in a Monolithic Tandem: Focus on the HTM/TCO Interface**  
O. Dupré, N. Nguyen, C. Roux, D. Muñoz, M. Matheron, M. Manceau & S. Berson  
CEA, Le Bourget-du-Lac, France

- M. Foti, G. Condorelli & C. Gerardi  
ENEL Green Power, Catania, Italy
- 3BV.2.92 Promising Properties of Zinc Oxynitride as a Top Cell Absorber in Tandem Solar Cells**  
K. Karlsen, L. Vines, I.J.T. Jensen, E. Monakhov & K. Bergum  
University of Oslo, Norway
- 3BV.2.93 Cesium-Containing Triple Cation Perovskites as Tandem Partners for Silicon Solar Cells**  
S. Ašmontas, J. Gradauskas, A. Grigučevičienė, K. Leinartas, K. Petrauskas, A. Selskis, A. Sužiedlis & E. Širmulis  
Center for Physical Sciences and Technology, Vilnius, Lithuania
- 3BV.2.95 Combined PV Device, Module and System Modelling for Predicting the Annual Energy Yield of Perovskite / Silicon Tandem Based PV Systems**  
M. Singh, R. Santbergen, Z. Wang, A. Nour El Din, C.M. Ruiz Tobon, P.A. Procel Moya, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands
- 3BV.2.97 Tailor-Made Light Management Nano-Structures for Perovskite-Silicon Tandem Solar Cells**  
J. Sutter, D. Eisenhauer, A.B. Morales-Vilches, P. Wagner, P. Tockhorn, S. Albrecht, B. Stannowski & C. Becker  
HZB, Berlin, Germany
- 3BV.2.98 Research on Wafer Bonding Technique for GaInP/GaAs Dual Junction Solar Cells**  
H. Wang, W. Zhang, P. Gao, H. Zhang & Q. Sun  
Tianjin Institute of Power Sources, China
- 3BV.2.99 Versatile Passivating Contacts Development for High Efficiency Tandem Applications**  
A. Walter, G. Nogay, B.A. Kamino, A. Paracchino, S.-J. Moon, J.J. Diaz Leon, G. Christmann, M. Dussouillez, L. Ding, S. Rafizadeh, A. Ingenito, B. Paviet-Salomon, C. Allebé, M. Despeisse, C. Ballif & S. Nicolay  
CSEM, Neuchâtel, Switzerland
- 3BV.2.100 Nanostructured Photoelectrodes Based on Ytria Stabilized Zirconia: Applications to Perovskite/c-Si Tandem Solar Cells**  
M.F. Vildanova, A.B. Nikolskaia, S.S. Kozlov, O.K. Karyagina, O.V. Alexeeva & O.I. Shevaleevskiy  
RAS, Moscow, Russian Federation
- 3BV.2.101 Life Cycle Assessment of Perovskite on Crystalline Silicon Tandem Modules at Industrial Scale**  
C. Salas Redondo  
Institut Photovoltaïque d'Île-de-France, Palaiseau, France  
C.F. Blanco  
Leiden University, Netherlands  
K. Alvino  
IPVF, Palaiseau, France  
W.J.G.M. Peijnenburg  
National Institute of Public Health and the Environment, Bilthoven, Netherlands  
L. Oberbeck  
Total Gas, Paris La Défense, France
- 3BV.2.102 Sequential Silicon Surface Melting and Atmospheric Pressure Phosphorus Doping for Crystalline Tunnel Junction Formation in Silicon/Perovskite Tandem Solar Cells**





G. Gaspar, J. Canhoto Cardoso, I. Costa, A. Guerra, A. Viana, M.E.M. Jorge, D. Vilhena, D. Pera, J. Almeida Silva, A.M. Vallêra, J.M. Almeida Serra & K. Lobato  
University of Lisbon, Portugal  
L. Vines  
University of Oslo, Norway

**3BV.2.103 Optimization of IBC Silicon Bottom Solar Cell for Three Terminal Perovskite Tandem Devices**

V.D. Mihailetschi, H. Chu, R. Roescu & R. Kopecek  
ISC Konstanz, Germany

**3BV.2.104 Optimization of Transparent Conductive Oxides for Silicon-Perovskite Tandem Solar Cells**

V. Sittinger & H. King  
Fraunhofer IST, Braunschweig, Germany

**VISUAL PRESENTATIONS 5BV.3**

**13:30 – 15:00 Solar Resource and Forecasting**

**Chairpersons:**

Wilfried van Sark  
Utrecht University, Netherlands

Ana Maria Gracia Amillo  
European Commission JRC, Italy

**5BV.3.1 The Impact of Distance, Cardinal Direction and Time on Solar Irradiance Estimation: a Case Study**

L. Visser, S. Knibbeler, T. AlSkaif & W.G.J.H.M. van Sark  
Utrecht University, Netherlands

**5BV.3.2 Solar Power Forecast Using Satellite Pictures**

J. Esteves, N. Pinho da Silva & Y. Cao  
R&D Nester, Sacavém, Portugal  
R. Pestana  
REN, Sacavém, Portugal

**5BV.3.3 Silicon Sensors vs. Pyranometers – Review of Deviations and Conversion of Measured Values**

M.J. Rivera Aguilar & C. Reise  
Fraunhofer ISE, Freiburg, Germany

**5BV.3.4 Field Trial of Met Station Using PV Reference Cells**

M. Gostein & W. Stueve  
Atonometrics, Austin, USA  
R. Clark  
7X Energy, Austin, USA

**5BV.3.5 Modeling Tool Validation for the Yield Prediction of Bifacial East West Vertical PV System in Nordic Conditions**

S. Ranta, H. Huerta, O. Huhtala & A. Heinonen  
TUAS, Turku, Finland

J.S. Stein  
Sandia National Laboratories, Albuquerque, USA

**5BV.3.7 Irradiance Variability in Distributed Solar Photovoltaic Systems**

K. Murray, D.J. Morrow & R. Best  
Queen's University Belfast, United Kingdom

**5BV.3.8 Meteor Norm Version 8.0**

J. Remund, S.C. Müller & M. Schmutz  
Meteotest, Bern, Switzerland

**5BV.3.10 Analysis of Hourly Solar Irradiance Prediction Based on Meteorological Radiation Model Using Open Weather Data and Measured Solar Radiation**

J. Han & W.-K. Park  
ETRI, Yuseong-gu, Republic of Korea

**5BV.3.12 Development of PV-Forecasting Methods: Evaluation, Applications and Economic Potentials**

L. Gaisberger & R. Höller  
University of Applied Sciences Upper Austria, Wels, Austria

**5BV.3.14 Direct and Diffuse Components of the Solar Radiation Collected by PV Panels. Comparisons between Computations and Observations at Lille and Evora**

T. Elias  
HYGEOS, Lille, France  
R. Salgado & F. Lopes  
University of Évora, Portugal  
N. Ferlay  
University of Lille, Villeneuve d'Ascq, France

**5BV.3.16 Potential of the Amazon Region and the Impact of Forest Fires on Photovoltaic Generation**

C. Magalhães, A. Gallina, L. Lima, L. Silva & T. Lima  
UFAC, Rio Branco, Brazil  
V.O. da Silva, S.G. Relva & D. Peyerl  
University of São Paulo, Brazil

**5BV.3.17 Performance Evaluation of Cost-Effective Irradiance Sensors Versus Thermopile Pyranometer**

S. Karki, H. Ziar & O. Isabella  
Delft University of Technology, Netherlands  
M. Korevaar & T. Bergmans  
Kipp & Zonen, Delft, Netherlands

**5BV.3.18 Statistical Analysis of a Rooftop PV Plant for the Validation of a Forecast Algorithm**

J. Lehmann, B. Haut & S. Scheerlinck  
ENGIE Laborelec, Linkebeek, Belgium

**5BV.3.19 Towards Optimising the Albedo Measurement**

S. Suarez, I. Fernandez, J.M. Rivas, F. Alvarez, A. Andrés, H. Muñoz, J. de la Peña & S. Rodríguez-Conde  
Enertis Solar, Madrid, Spain

**5BV.3.20 Cloud Motion Vectors in All-Sky Images for Forecasting Solar Irradiance**

A. Boschert & M. Zehner  
Rosenheim University of Applied Sciences, Germany  
J. Schreder  
CMS Ing. Dr. Schreder, Kirchbichl, Austria





F. Flade  
Bavarian Association for the Promotion of Solar Energy, Munich, Germany

**5BV.3.21 Analysis of Irradiance Enhancement and Irradiance Volatility in High-Resolution Data Sets**

M. Zehner, N. Stut, F. Kaiser & A. Boschert  
Rosenheim University of Applied Sciences, Germany  
B. Mayer  
University of Munich, Germany  
F. Flade  
Bavarian Association for the Promotion of Solar Energy, Munich, Germany

**5BV.3.22 72-Hours Ahead Global Horizontal Irradiance Forecasting Using Artificial Neural Network, Ground Measurements and Solar Geometry Calculations**

O. El Alani & A. Ghennioui  
IRESEN, Benguerir, Morocco  
H. Ghennioui  
USMBA, Fez, Morocco  
S. Sarikh  
Cadi Ayyad University, Marrakech, Morocco

**5BV.3.23 Forecasting Global Horizontal and Direct Normal Irradiation in the Arabian Peninsula for PV Applications: Sensitivity to the Explicit Treatment of Aerosols**

L. Martín Pomares, C. Fountoukis & A.A. Abdallah  
HBKU, Doha, Qatar

**5BV.3.24 Real-Time Global Coverage of Satellite Based Irradiation Data – Benchmark and Applications**

M. Schmutz, S.C. Müller & J. Remund  
Meteotest, Bern, Switzerland

**5BV.3.26 Comparing and Combining Machine Learning and Numerical Weather Prediction Models for Solar Forecasting**

G. Scabbia, A. Sanfilippo, C. Fountoukis, D. Perez-Astudillo & D. Bachour  
QEERI, Doha, Qatar

**5BV.3.27 Evaluation of the PV Resource Dataset in Central and North America**

Y. Xie & M. Sengupta  
NREL, Golden, USA

**5BV.3.29 Field Trial of Angled Multisensor Irradiance Decomposition (AMID) for Direct and Diffuse Irradiance Measurement**

M. Gostein & B. Stueve  
Atonometrics, Austin, USA  
B. Bourne  
Earthbound Analytics, Davis, USA  
F. Farina & A. Hoffman  
SunPower, Richmond, USA

**5BV.3.30 Japan's Vast Renewable Energy Resources**

C. Cheng, M. Stocks, R. Stocks, A. Blakers, B. Lu, D. Silalahi, A. Nadolny & L. Hayes  
ANU, Canberra, Australia

**5BV.3.31 Driving the Unknown towards Fuel Economy with a Sky-Imager in a Hybrid PV-Diesel System**

L.-E. Boudreault & N. Schmutz  
Reuniwatt, Sainte-Clotilde, Réunion  
T. Mart

Reuniwatt, Wiesenthau, Germany

**VISUAL PRESENTATIONS 1BV.4**

**15:15 – 16:45 Novel Photovoltaic Conversion Systems, Characterization Approaches and Device Designs / New Materials and Concepts for Cells and Modules**

**Chairpersons:**

Iñigo Ramiro  
UPM, Spain

Francesco Roca  
ENEL, Italy

**1BV.4.1 Hydrogen States in BaSi<sub>2</sub> by Muon Spin Rotation**

Z. Xu, T. Sato & T. Suemasu  
University of Tsukuba, Japan  
J. Nakamura, A. Koda & K. Shimomura  
KEK, Tsukuba, Japan

**1BV.4.2 Hot Carrier Evidence in a Solar Cell**

J. Gradauskas, S. Ašmontas, A. Sužiedlis, A. Šilenas, A. Cerškus, V. Vaicikauskas & O. Žalys  
CPST, Vilnius, Lithuania  
O. Masalskyi  
VGTU, Vilnius, Lithuania

**1BV.4.3 Modeling and Simulation of CdZnO/ZnO Heterostructure Based Multiple Quantum Wells for Photovoltaics**

G. Siddharth, R. Singh & S. Mukherjee  
IIT Indore, India

**1BV.4.4 Novel Electro-Thermal Modeling Approach for DC and AC Solar Cell Characterization**

M. Diethelm, R. Hiestand, S. Weidmann, S. Jenatsch, S. Altazin & L. Penninck  
Fluxim, Winterthur, Switzerland  
C. Kirsch, E. Comi, E. Knapp & B. Ruhstaller  
ZHAW, Winterthur, Switzerland

**1BV.4.5 ASA Software for Opto-Electrical Simulation of Silicon, CIGS and Perovskite Solar Cells**

R. Santbergen, C.M. Ruiz Tobon, P.A. Procel Moya, M. Singh, N. Rezaei, A. Calcabrini, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands

**1BV.4.6 High Frequency Modulated and Time Resolved Photoluminescence: towards a Full Temporal Characterization on III-V Semi-Conductor Materials**

W. Zhao  
IPVF, Palaiseau, France  
C. Rakotoarimanana, A.-M. Goncalves & A. Etcheberry  
CNRS/UVSQ, Versailles, France



- L. Lombez, J.-F. Guillemoles & B. Bérenguier  
CNRS, Palaiseau, France
- 1BV.4.7 The Superlattice Effect on Current Increase in Graphene/Oxide/n-GaAs Schottky Solar Cells**  
A.C. Varonides  
University of Scranton, USA
- 1BV.4.8 Highly Stable Thin Film Organic Solar Cells Using Poly Crystallized Silver Doped LaPO<sub>4</sub>**  
M.S.G. Hamed & G.T. Mola  
University of KwaZulu-Natal, Scottsville, South Africa
- 1BV.4.9 Transparent Matrix Materials for Efficient Luminescent Solar Concentrators**  
M.R. Kulish, V.P. Kostilyov, A.V. Sachenko & I.O. Sokolovskyi  
NAS ISP, Kiev, Ukraine  
A.I. Shkrebtiy / Chkrebtiy  
Ontario Tech University, Oshawa, Canada
- 1BV.4.12 Analysis of the Interface of RF-Sputtered MoO<sub>x</sub> Based Hole Selective Contact for Silicon Heterojunction Solar Cells (SHJ)**  
M.I. Elsmami, J. Cho, M. Recaman, I. Gordon & J. Poortmans  
imec, Leuven, Belgium  
E. Tresso  
Polytechnic University of Turin, Italy  
N. Fatima, M. Adib & K. Sopian  
SERI, Bangi, Malaysia
- 1BV.4.13 Absorption of the Solar Radiation with Arrays of Subwavelength Compound Parabolic Concentrators**  
A. Prajapati, G. Marko & G. Shalev  
BGU, Beer-Sheva, Israel
- 1BV.4.14 Cd<sub>1-x</sub>Zn<sub>x</sub>S Quantum Dots for Photovoltaics Application: First-Principles Study the Effects of the Metal Vacancies on the Structural, Electron and Emission Properties**  
I.M. Kupchak & D.V. Korbutyak  
NAS ISP, Kyiv, Ukraine  
N.F. Serpak  
Vinnytsia National Pirogov Medical University, Ukraine  
A.I. Shkrebtiy / Chkrebtiy  
Ontario Tech University, Oshawa, Canada
- 1BV.4.15 Understanding the Origins of P1-Induced Power Losses in CIGS Modules through High-Resolution Hyperspectral Luminescence**  
C.O. Ramirez Quiroz, J. Müller & K. Orgassa  
NICE Solar Energy, Schwäbisch Hall, Germany  
L.-I. Dion-Bertrand  
Photon, Montreal, Canada  
C.J. Brabec  
FAU, Erlangen, Germany
- 1BV.4.24 Impact of Spin Exchange Interaction on Charge Transfer in Dual Polymer Photovoltaic Composites**  
V.I. Krinichnyi, E.I. Yudanova, N.N. Denisov & V.R. Bogatyrenko  
Institute of Problems of Chemical Physics, Chernogolovka, Russian Federation  
A.A. Konkin  
Kazan Federal University, Russian Federation

- 1BV.4.25 Effect of Hydrogen Plasma Treatment on Silicon Quantum Dot Multilayers Using Amorphous SiO<sub>x</sub>**  
R. Akaishi, K. Gotoh, N. Usami & Y. Kurokawa  
Nagoya University, Japan  
S. Kato  
Nagoya Institute of Technology, Japan
- 1BV.4.26 Analysis of Selenization Processes for Antimony Selenide Solar Cells by Vacuum Evaporation**  
V. Kumar, E. Artegiani & A. Romeo  
University of Verona, Italy
- 1BV.4.27 Epitaxially Grown In<sub>2</sub>S<sub>3</sub>:V Thin Films for Intermediate Band Solar Cell Application**  
T. Jawinski, M. Lorenz, M. Grundmann & H. von Wenckstern  
University of Leipzig, Germany  
R. Scheer  
Martin Luther University, Halle (Saale), Germany
- 1BV.4.28 Titanium Disilicide as the Only Material for Electrode in Crystalline Silicon Solar Cells**  
E. Zugasti, J. Bengoechea, A. Buceta & A.R. Lagunas  
CENER, Sarriguren-Navarra, Spain
- 1BV.4.29 Semi-Transparent Thin Film Solar Cells for Photovoltaic Windows**  
I. Oja Acik, N. Spalatu, J.S. Eensalu, A. Katerski, E. Karber & M. Krunks  
Tallinn University of Technology, Estonia
- 1BV.4.30 Plasmonic Effect of Silver Nanoparticles on Enhancing Solar Cells Light Absorption**  
M.Z. Belmehdi, M. Zerdali, F. Bachiri & S. Hamzaoui  
USTO, Oran, Algeria  
M.A. Benali  
Djillali Liabes University, Bel Abbes, Algeria
- 1BV.4.32 Bionic Leaf-Vein Architecture: High Performance Transparent Conducting Electrodes with Low Ag Consumption for Resource-Efficient Solar Cell Applications**  
G. Jia, A. Dellith, C. Schmidt, J. Dellith, G. Schmidl, G. Andrä & J. Plentz  
IPHT, Jena, Germany
- 1BV.4.33 Nanocrystalline 3D Homojunctions for Energy Conversion Devices**  
S. Menezes  
InterPhases Solar, Moorpark, USA
- 1BV.4.36 First Measurement of Lifetime of Photogenerated Current Carriers in New Material for Thin Films Solar Cells – Cu<sub>2</sub>-NiSnSe<sub>4</sub> Solid Solutions**  
O.Yu. Urkhanov, M.V. Gapanovich, E.V. Rabenok, B.I. Golovanov & G.F. Novikov  
RAS, Chernogolovka, Russian Federation
- 1BV.4.37 Influence of Bath Composition and Temperature on the Growth Rate, Optical and Morphological Properties of ZnS Thin Films Produced by Chemical Bath Deposition**  
D. Alanis, M.R.R. Menon & A.F. da Cunha  
University of Aveiro, Portugal
- 1BV.4.38 Halide Processing Strategies for Efficient Antimony Selenide Thin Film Solar Cell Technology**  
N. Spalatu, R. Krautmann, A. Katerski, E. Karber, J. Hiie, I. Oja Acik & M. Krunks



Tallinn University of Technology, Estonia

**1BV.4.40 Upscaling R2R-Production Technologies and Low Viscous Intermittent Coating for OLEDs, OPVs and Perovskite Solar Cells**

T. Kolbusch, N. Meyer, X.H. Rooms, D. Kourkoulos & K.-P. Crone  
Coatema Coating Machinery, Dormagen, Germany

**1BV.4.41 Fractal-Structured Solar Cell Array from Tree Shape for 25% Enhancement of Energy Production**

Y.H. Sim, M.J. Yun, S.I. Cha & D.Y. Lee  
KERI, Changwon, Republic of Korea

**1BV.4.42 Insights by Non-Contact Eddy Current Imaging for Advanced Cell Concepts**

M. Klein, M. Fischer, B. Chen & S. Adam  
Suragus, Dresden, Germany

**1BV.4.43 A Novel Approach to Passivate p+-Si/TiO2 Contact Efficiently by Atomic Layer Deposition**

N. Mozaffari, H. Shen & K.R. Catchpole  
ANU, Canberra, Australia

**1BV.4.44 Metal Oxide-Based Junctions for Transparent Solar Cells and Energy Harvesting**

E. Manidakis  
University of Crete, Heraklion, Greece  
G. Michail, A. Kostopoulos, M. Kayambaki, K. Tsagaraki, M. Androulidaki, E. Gagaoudakis, G. Kiriakidis, N.T. Pelekanos & E. Aperathitis  
FORTH, Heraklion, Greece  
M. Schmidt & M. Modreanu  
University College Cork, Ireland

**1BV.4.45 Type-II In(As)P/InGaP Quantum Dots for Intermediate Band Solar Cells**

B. Vargas Rocha & P.L. Souza  
PUC-Rio, Rio de Janeiro, Brazil  
R. Jakomin  
UFRJ, Duque de Caxias, Brazil

**1BV.4.46 Optical 3D Device Simulation of BaSi2 Thin Film Solar Cells**

Y. Yamashita & T. Suemasu  
University of Tsukuba, Japan  
R. Santbergen, C.M. Ruiz Tobon, M. Zeman & O. Isabella  
Delft University of Technology, Netherlands

**1BV.4.47 On the Road towards Vehicle Integration: Glass-Fibre Reinforced Encapsulation Enabling Light-Weight and Curved Modules**

J. Govaerts, T. Borgers, A.S.H. van der Heide, L. Vastmans, R. Moors, G. Doumen & L. Tous  
imec, Genk, Belgium  
A. Bettinelli & S. Harrison  
CEA, Le Bourget-du-Lac, France  
B. Willems & G. Galbiati  
Henkel Electronic Materials, Westerlo, Belgium  
M. Gializzo & A. Fecchio  
Applied Materials, Olmi di San Biagio di Callalta, Italy  
J. Poortmans  
imec, Leuven, Belgium

**1BV.4.48 Encapsulation of Photovoltaic Modules in Composite Material through HP-RTM Process**

J. Aizpurua, W. Cambarau, I. Arrizabalaga, G. Imbuluzqueta, J.M. Hernandez, N. Yurrita, O. Ollo, F.J. Cano & O. Zubillaga  
Tecnalia, San Sebastian, Spain

**1BV.4.49 New Developments of Transparent Plastic Materials in Frontsheets and Backsheets as Valid Alternatives to Glass**

M. Manara  
Coveme, San Lazzaro di Savena, Italy

**1BV.4.51 Solar Cells Based on the PEDOT:PSS/Si Heterojunction with Ag Nanoparticles**

S.V. Mamykin, O.S. Kondratenko, I.B. Mamontova, T.S. Lunko, N.V. Kotova & T.R. Barlas  
NASU, Kiev, Ukraine

**1BV.4.52 Theoretical Investigation of Some Narrow Bandgap Semi-Conductors Based on Theophene and Phenylene for Photovoltaic Application**

S. Boussaidi  
Ibn Zohr University, Agadir, Morocco  
H. Zgou  
Ibn Zohr University, Ouarzazate, Morocco

**1BV.4.53 Smart Building Technology for Nano-Architectures**

S.E. Sungur  
Polytechnic University of Milan, Italy

**1BV.4.54 Novel AlxIn1-xN (x~0-0.60) on Si (111) Heterojunctions Deposited by RF Sputtering for Solar Cells**

M. Sun, R. Blasco, S. Elamrani, F.B. Naranjo & S. Valdueza-Felip  
UAH, Alcalá de Henares, Spain  
J. Olea  
UCM, Madrid, Spain  
A.F. Braña de Cal  
UAM, Madrid, Spain

**VISUAL PRESENTATIONS 6BV.5**

**17:00 – 18:30 Industrial Applications / PV Driven Energy Management and System Integration**

**Chairpersons:**

Ingrid Weiss  
WIP Renewable Energies, Germany

Hubert Aulich  
SC Sustainable Concepts, Germany

**6BV.5.2 Solar Energy Production and CO2 Avoidance of a 5.0 kW Solar Power Generator Integrated in a Mango Processing Facility**

E.M. Querkiol & E.B. Taboada  
University of San Carlos, Cebu City, Philippines

**6BV.5.3 Mobile Hybrid RES Innovative Power for Irrigation and Fertigation**



- B.-A. Onose, I. Murgescu & S.-A. Sontea  
INCDIE ICPE-CA, Bucharest, Romania
- 6BV.5.4 Optimising Own PV Consumption with PV Energy Yield Predictions from Machine Learning Algorithms and Weather Data**  
H. Heck, F. Kuonen, S. Bacha, A. Schmidt, E. Schüpbach & U. Muntwyler  
BUAS, Burgdorf, Switzerland
- 6BV.5.5 Assessment of the Benefits of Adding PV Generation into Existing Wind Power Plants**  
A.R. Arrifano Manito, M. Pinho Almeida, M. Cassares, K.J.F. Novaes Cândido de Souza, G. Figueiredo, J. Romel, P. Ferreira Torres, J. Tavares Pinho & R. Zilles  
University of São Paulo, Brazil
- 6BV.5.6 Electric Grid Planning for a PV powered Net-Zero City**  
N. Pflugradt & U. Muntwyler  
BUAS, Burgdorf, Switzerland
- 6BV.5.7 Solar PV Driven Child Mortality Alleviation in the Global South**  
M. Ray & B. Chakraborty  
IIT Kharagpur, India
- 6BV.5.8 Design of Regional Management System for Photovoltaic Power Plants**  
J. Kim, H. Choi, G. Jo, C. Lim & C. Kim  
Green Energy Institute, Mokpo, Republic of Korea  
D. Kwon  
Green ENS, Naju, Republic of Korea
- 6BV.5.9 Triggering Demand-Side-Management: Correlation of Electricity Prices, Share of Renewables, CO<sub>2</sub>-contents, and Grid-Frequency in the German Electricity Grid**  
S. Krauter & L. Zhang  
University of Paderborn, Germany
- 6BV.5.10 Reduction of Required Storage Capacities for a 100% Renewable Electricity Supply in Germany, if New PV Systems are Installed with an Increased Elevation Angle and Orientated in East-West Direction**  
S. Krauter & D. Rustemovic  
University of Paderborn, Germany
- 6BV.5.11 Machine Learning Driven Optimization of a Hybrid Electrical and Thermal System**  
M. Dallapiccola, F. Trentin, C. Dipasquale, R. Fedrizzi & D. Moser  
Eurac Research, Bolzano, Italy
- 6BV.5.12 The Potential of PV Module Tilt and Technology for Tuning Daily Energy Yield across the Year**  
J. Govaerts & I.T. Horvath  
imec, Genk, Belgium  
P. Manganiello  
Delft University of Technology, Netherlands  
J. Poortmans  
imec, Leuven, Belgium
- 6BV.5.13 An Optimal Agents-Based Behaviors Model for Peer-to-Peer Energy Trading Linked to Blockchain**  
M. Sajjad, A. Boumaiza & A. Sanfilippo  
QEERI, Doha, Qatar

- 6BV.5.14 Optimization of a 4.6-kW Residential Hybrid Solar Photovoltaic (PV) System - A Case Study**  
M. Viljoen & J. Bekker  
Vaal University of Technology, Vanderbijlpark, South Africa
- 6BV.5.15 Convolutional Neural Networks Applied to Sky Images for Short-Term Solar Irradiance Forecasting**  
Q. Paletta & J. Lasenby  
University of Cambridge, United Kingdom
- 6BV.5.16 Integration of Photovoltaic with Wind Power in Kuwait: Evaluation and Results**  
H. Alduaij, M. Al-Khayat & M. Al-Rasheedi  
KISR, Kuwait, Kuwait
- 6BV.5.17 First Steps towards Energy-Positive Territorial Collectivities in the French Overseas Departments: Optimal Mix of Electric Mobility, Photovoltaics and Energy Storage in Reunion Island**  
A. Guérin de Montgareuil  
CEA, St-Paul-lez-Durance, France  
I. Ingar  
Department of Reunion, Saint-Denis, Réunion
- 6BV.5.18 Towards a Simple and Robust Probabilistic Solar Variability Analysis Based on Transition Probability between Variability Classes of Sky State**  
F. Zhuang, Y.-M. Saint-Drenan & P. Blanc  
MINES ParisTech, Sophia Antipolis, France  
J.-P. Mangione & P. Salvado  
SPIE, Serres-Castet, France
- 6BV.5.19 Application of a Smart Energy Management System for a 250 kWp Solar Plant in Benguerir, Morocco**  
I. Ait Abdelmoula, A. Benazzouz, A. Rochd, Z. Naimi, B. Ikken & A. Ghennioui  
Green Energy Park, Benguerir, Morocco  
R. Lebreton & A. Degland  
Solveo Energie, Fenouillet, France
- 6BV.5.20 Agents-Based Modeling for a Transactive Energy Trading Blockchain Framework**  
A. Boumaiza, M. Sajjad & A. Sanfilippo  
QEERI, Doha, Qatar
- 6BV.5.21 Design and Implementation of an AI-Based and IoT-Enabled Home Energy Management System under Smart Grid Paradigm**  
A. Rochd, A. Benazzouz, I. Ait Abdelmoula, Z. Naimi, B. Ikken & A. Ghennioui  
Green Energy Park, Benguerir, Morocco
- 6BV.5.22 Energy Model for a Rural Region in Germany - Methodology**  
M.-C. Leonhard & H. te Heesen  
Trier University of Applied Sciences, Neubrücke (Nahe), Germany
- 6BV.5.23 Power Electronics System Topologies Recommender for PV/Battery Project Applications**  
B. Bourachdi & M. Salhi  
Moulay Ismail University, Meknes, Morocco
- 6BV.5.24 Firm PV Power Forecasts – Step One to Least-Cost Ultra-High PV Penetration**



M.J.R. Perez, A. Atkins, P. Keelin & S. Dise  
Clean Power Research, Napa, USA  
R.R. Perez  
SUNY, Albany, USA  
M. Pierro  
University of Rome Tor Vergata, Italy

- 6BV.5.25 Leveraging Electric Load Data and Grid Features to Design High-PV Penetration in Rural and Urban Settings in Portugal**  
G. Luz & R. Amaro e Silva  
University of Lisbon, Portugal  
S.R. Freitas  
Energy and Environment Agency of Lisbon, Portugal
- 6BV.5.26 Demand Informed Business Models for a Shared PV System Among Multiple Households: Search for Effective, Profitable and Fair Micro-Grids Using Agent-Based Modeling**  
M. Lovati, P. Huang, C. Olsmats & X. Zhang  
Dalarna University, Falun, Sweden  
L. Maturi  
Eurac Research, Bolzano, Italy
- 6BV.5.27 A Technological Framework for Optimising the Design of Photovoltaic Plants for Prosumers**  
J. Murta Pina, F. Monteiro, T. Pereira, S. Moraes, L. Romba Jorge, R. Lopes, J. Martins, A. Damas Mora & S. Correia  
NOVA School of Science and Technology, Caparica, Portugal  
F. Oliveira & H. Vieira  
Digitalmente, Caparica, Portugal  
M. Santos  
Engibase, Caparica, Portugal
- 6BV.5.29 Domestic Load Management with Renewable Energy Integration**  
I. Hammou Ou Ali & M. Maaroufi  
Mohammed V University, Rabat, Morocco
- 6BV.5.30 Residential PV Self-Consumption: Real Savings in a Spanish Household**  
H.-J. Rodríguez San Segundo  
Edhuna Consulting, Madrid, Spain  
N. López  
University of Madrid, Spain
- 6BV.5.31 Experimental Analysis of a Photovoltaic DHW Heat Pump**  
F.J. Aguilar Valero & P.G.V. Quiles  
University Miguel Hernández, Elche, Spain
- 6BV.5.32 Charging Efficacy of an Off-Grid Solar EV Carport in Airport Long-Stay Carparks**  
E. Heath, R. Ghotge & A.J.M. van Wijk  
Technical University of Delft, Netherlands
- 6BV.5.33 Load Profile Simulation Device for Solar PV Power Systems**  
O.K. Overen & E.L. Meyer  
University of Fort Hare, Alice, South Africa
- 6BV.5.34 A Free Online Tool for the Simulation of Collective Self-Consumption in Belgium**  
J. Leloux & J. Robledo  
LuciSun, Sart-Dames-Avelines, Belgium  
Z. Zhao & P. Hendrick  
Free University of Brussels, Belgium

- 6BV.5.35 Optimization of Continuous Power Supply: Experimental Models of BIPV Systems with Hydrogen Storage**  
G. Mantescu, N. Olariu & D. Let  
Valahia University of Targoviste, Romania  
V.T. Petcu  
Millenia Advisory, Bucharest, Romania  
H.M. Schuster  
Arena Innovation, Stuttgart, Germany





Wednesday, 09 September 2020

## VISUAL PRESENTATIONS 2CV.1

08:30 – 10:00 **Characterisation & Simulation of Si Cells / Fabrication and Production of c-Si Silicon Solar Cells and Related Processes**

## Chairpersons:

Francesca Ferrazza  
Eni, Italy

Peter Wohlfart  
SINGULUS, Germany

- 2CV.1.1 Fitting Current-Voltage Curves of Solar Cells with Artificial Neural Networks**  
A. Herguth  
University of Konstanz, Germany
- 2CV.1.2 Long-Term Stability of HJT Solar Cells under Illumination and UV Exposure**  
T. Luka, K. Sporleder, D. Hevisov, S. Eiternick & M. Turek  
Fraunhofer CSP, Halle (Saale), Germany  
J. Bauer  
University of Leipzig, Germany
- 2CV.1.3 Temperature-Dependent Suns-Voc and Suns-iVoc for Advanced c-Si-Based Solar Cell Characterization**  
J.P. Seif, A.H.T. Le, M.F. Zhang & Z. Hameiri  
UNSW Australia, Sydney, Australia  
T.G. Allen  
KAUST, Thuwal, Saudi Arabia  
R. Basnet  
ANU, Canberra, Australia
- 2CV.1.4 Accurate Performance Measurement of c-Si Solar Cells Adopting Advanced Metallization Technologies**  
S.K. Ahn, K. Kim, J.H. Yun, A. Cho, Y.J. Eo, J.S. Cho, S.J. Ahn, J.H. Park, J.S. Yoo, D. Shin, I. Jung, S. Lee, S. Song, A. Lee & J. Gwak  
KIER, Daejeon, Republic of Korea
- 2CV.1.5 High Efficiency Crystalline Silicon Solar Cell Assessment for Tandem Architecture**  
S. Pouliquen  
Air Liquide, Palaiseau, France  
S. Jutteau  
EDF, Palaiseau, France  
E. Drahi  
TOTAL, Palaiseau, France
- 2CV.1.6 Spectral Multi-Scale Characterization to Assess the Impact of Metallization Bleeding**  
S. Großer, S. Eiternick, S. Richter & M. Turek  
Fraunhofer CSP, Halle (Saale), Germany

- 2CV.1.7 Rapid Assessment of Optical Properties of Solar Cell Surfaces Using LED Solar-Simulators**  
K. Sporleder, D. Hevisov & M. Turek  
Fraunhofer CSP, Halle (Saale), Germany
- 2CV.1.8 Simulation of Doping Profile Trade-Off in Thin Emitter Architectures**  
B. Arunachalam, Q. Rafhay & A. Kaminski-Cachopo  
IMEP-LAHC, Grenoble, France  
A. Veau, T. Desrues & S. Dubois  
CEA, Le Bourget-du-Lac, France
- 2CV.1.9 EL and LBIC Characterization of Cut Edge Recombination in IBC Solar Cells**  
M. Bokalic, M. Kikelj, K. Brecl, M. Jankovec & M. Topic  
University of Ljubljana, Slovenia  
F. Buchholz & V.D. Mihailetchi  
ISC Konstanz, Germany
- 2CV.1.10 New Device for Accurate Measurement of Busbarless Bifacial Solar Cells by Using N.I.C.E.™ Technology**  
D. Reinwand, P. Wiechers & D. Kray  
Offenburg University of Applied Sciences, Germany
- 2CV.1.11 Comparing Microwave Detected Photoconductance, Quasi Steady State Photoconductance and Photoluminescence Imaging for Iron Analysis in Silicon Wafers**  
M. Pengerla, V. Kuruganti, J. Haunschild & S. Rein  
Fraunhofer ISE, Freiburg, Germany  
N. Schüler & K. Dornich  
Freiburg Instruments, Germany
- 2CV.1.12 6 Decades Research on Photovoltaic Technologies and Characterization in Republic of Serbia**  
I. Batas Bjelic  
Institute of Technical Sciences of SASA, Belgrade, Serbia
- 2CV.1.13 Measuring and Mitigating Edge Recombination in Modules Employing Laser Cut Cells**  
D. Tune, F. Buchholz & A. Halm  
ISC Konstanz, Germany
- 2CV.1.14 Influence of Injection Level and Wafer Resistivity on Series Resistance of Silicon Heterojunction Solar Cells**  
L. Basset, W. Favre & O. Bonino  
CEA, Le Bourget-du-Lac, France  
J.-P. Vilcot  
CNRS-IEMN, Villeneuve d'Ascq, France
- 2CV.1.16 Computational Optical Analysis of 3D Modeled Crystalline Silicon Substrates Randomly Textured**  
D.M. Pera, J. Canhoto Cardoso, D. Vilhena, G. Gaspar, K. Lobato, I. Costa, J.M. Almeida Serra & J. Almeida Silva  
University of Lisbon, Portugal
- 2CV.1.17 Study of the Doping and Voltage Dependence of the Series Resistance of a-Si:H/c-Si Heterojunction (SHJ) Solar Cells under Illumination**  
M.Y. Ghannam & Y. Abdurraheem  
Kuwait University, Safat, Kuwait  
H.S.R. Sivaramakrishnan Radhakrishna & I. Gordon  
imec, Leuven, Belgium





- 2CV.1.19 Assessment of Influencing Factors on Lifetime-Based Defect Analysis**  
R. Post & W. Kwapil  
University of Freiburg, Germany  
T. Niewelt & M.C. Schubert  
Fraunhofer ISE, Freiburg, Germany
- 2CV.1.20 A Simplified Double Diode Model for Modeling I-V Characteristic of Si Solar Cells**  
J. Zhang, J. Wu, K. Ding & X. Chen  
Hohai University, Changzhou, China  
L. Feng & F.U. Hamelmann  
University of Applied Sciences Bielefeld, Minden, Germany
- 2CV.1.22 Spectroscopic Investigation of BO-Related Light-Induced Degradation Defect in Czochralski Silicon**  
A. Meyer, P.C. Taylor & S. Agarwal  
Colorado School of Mines, Golden, USA  
M. Page, D.L. Young & P. Stradins  
NREL, Golden, USA
- 2CV.1.23 Revealing the Nano-Scale Structure and Properties of Pinholes in SiO<sub>x</sub> Layers for POLO Contacts**  
H. Guthrey, W. Nemeth, M. Page, D.L. Young, M.M. Al-Jassim & P. Stradins  
NREL, Golden, USA  
A. Kale, C. Lima Salles de Souza & S. Agarwal  
Colorado School of Mines, Golden, USA
- 2CV.1.32 Investigation of Bifacial PERC Cells Based on Rear Side SiO<sub>x</sub>N<sub>y</sub> Passivation**  
C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, L.-G. Wu, S.-C. Lin & C.-Y. Yu  
TSEC, Hsinchu, Taiwan
- 2CV.1.33 Innovative Process Control on Premium Technology Photovoltaic Cell and Module Manufacturing Line**  
F. Rametta, C. Colletti, C. Gerardi & D. Iuvara  
ENEL, Catania, Italy  
F. Bizzarri  
ENEL, Rome, Italy  
V. Barth, D. Muñoz & W. Favre  
CEA, Le Bourget-du-Lac, France  
M. Izzi  
ENEA, Rome, Italy
- 2CV.1.34 Improvement of mc-Si Wafers Quality for the Manufacture of Silicon Heterojunction Solar Cells**  
R. Barrio Martin, N. González Peñalba, I. Torres, J. Cárabe & J.J. Gandía  
CIEMAT, Madrid, Spain
- 2CV.1.37 The Influence of Pyramid Shapes on the Texturing Quality of Alkaline Etching Processes**  
A. El Jaouhari, F. Schoerg & R.-C. Brachvogel  
RENA, Berg, Germany  
B. Bläsi  
Fraunhofer ISE, Freiburg, Germany  
H. Kühnlein  
RENA, Freiburg im Breisgau, Germany
- 2CV.1.38 Ultrasonic-Assisted Chemical Etching (USACE) of Monocrystalline Silicon Wafer with HF-HCl-Cl<sub>2</sub> Mixtures**  
A. Stapf, B. Neubert, K. Halbfaß & E. Kroke  
Freiburg University of Technology, Germany
- 2CV.1.39 Advanced Light-Trapping Structures for Back-Contact Solar Cells Produced by Metal-Assisted Chemical Etching**  
D.M. Pera, A. Frota, I. Costa, D. Vilhena, J. Canhoto Cardoso, G. Gaspar, K. Lobato, J.M. Almeida Serra & J. Almeida Silva  
University of Lisbon, Portugal
- 2CV.1.40 Macroscopic Numerical Simulation of the Ozone-Based Wet Chemical Emitter Etch Back for Alkaline Textured Si-Wafers**  
T. Dannenberg, L. Mohr & M. Zimmer  
Fraunhofer ISE, Freiburg, Germany
- 2CV.1.42 Emitter Formation on n-Type Crystalline Silicon Rear Side Using Aluminum Firing and Etching**  
M. Zolfaghari Borra, E. Semiz, O. Aydin, H. Nasser, I. Pavlov, F. Es & R. Turan  
METU, Ankara, Turkey
- 2CV.1.43 BBr<sub>3</sub> Diffusion: Process Optimization for High-Quality Emitters with Industrial Cycle Times**  
E. Lohmüller, M. Glatz, S. Lohmüller, U. Belledin, S. Mack, T. Fellmeth & A. Wolf  
Fraunhofer ISE, Freiburg, Germany  
R.C.G. Naber  
Tempress, Vaassen, Netherlands
- 2CV.1.44 High Throughput Low Energy Industrial Emitter Diffusion and Oxidation**  
M. Meßmer, S. Nold, J. Weber, S. Lohmüller, J. Horzel & A. Wolf  
Fraunhofer ISE, Freiburg, Germany  
A. Piechulla  
centrotherm international, Blaubeuren, Germany
- 2CV.1.45 POC13-Based Emitter Diffusion Process with Lower Recombination Current Density and Homogeneous Sheet Resistance for Nanotextured Monocrystalline Silicon with Atmospheric Pressure Dry Etching**  
N.W. Khan, A.I. Ridoy, B. Kafle, M. Klitzke, S. Schmidt, A. Wolf, M. Hofmann & J. Rentsch  
Fraunhofer ISE, Freiburg, Germany  
L. Clochard  
Nines Photovoltaics, Dublin, Ireland
- 2CV.1.46 The Effect of Different Laser Wavelength on Bifacial Plated Laser Doped Selective Emitter Solar Cells**  
Y.-C. Chang, S. Wang, R. Deng, J. Ji & C.M. Chong  
UNSW Australia, Sydney, Australia  
S. Li  
Kunming University of Science and Technology, China
- 2CV.1.47 Self-Aligned Selective Emitter for PERC Based on Inkjettable UV-Polymer**  
R. Éfinger, B. Kafle, K. Demel, T. Ellahi, M. Jahn, M. Meßmer, J. Horzel, M. Zimmer, S. Kluska, S. Lohmüller, E. Lohmüller & R. Keding  
Fraunhofer ISE, Freiburg, Germany  
W. Shepherd & M. Pickrell  
SunChemical, Midsomer Norton, United Kingdom  
J. Hermans  
Meyer Burger, Eindhoven, Netherlands
- 2CV.1.48 Above 700 mV Implied Open Circuit Voltages from Thin ALD Al<sub>2</sub>O<sub>3</sub> Films Capped by PECVD SiN<sub>x</sub> on p Type Cz-Si Wafers for PERC Solar Cells**



G. Kökbudak, H. Nasser, A.E. Keçeci & R. Turan  
GÜNAM, Ankara, Turkey  
M. Zolfaghari Borra  
METU, Ankara, Turkey

**2CV.1.49 Field Effect Passivation of Plasma Oxidized SiO<sub>x</sub> Layer Using SiH<sub>4</sub>/N<sub>2</sub> on Boron Doped Emitter Surface by PECVD**

M.Q. Khokhar, D. Oh, D.P. Pham, S. Lee, Y. Kim, E.-C. Cho & J. Yi  
University of Sungkyunkwan, Suwon, Republic of Korea

**2CV.1.50 Newly Developed High-Throughput PECVD Source and Platform for Industrial Production of PERC and TOPCon Silicon Solar Cells**

M. Dörr, F. May, T. Dippell & P. Wohlfart  
Singulus Technologies, Kahl am Main, Germany

**2CV.1.51 Laser Assisted Separation Processes for Bifacial pSPEER Shingle Solar Cells**

A. Münzer, P. Baliozian, K. Ahmed, A. Nair, E. Lohmüller, T. Fellmeth & R. Preu  
Fraunhofer ISE, Freiburg, Germany

**2CV.1.52 Interface Properties of Nickel Seed Layer Deposited by Electroless and Light-Induced Plating and Its Effect on Solar Cell Performance**

D. Priyadarshani, A. Kottantharayil & M. Neergat  
IIT Bombay, Mumbai, India

**2CV.1.53 Project "Rock-Star" – High-Speed Rotary Printing for Solar Cell Metallization: From Vision to Reality**

A. Lorenz, K. Zengerle, M. Linse, S. Tepner, F. Clement & R. Preu  
Fraunhofer ISE, Freiburg, Germany

J. Röth

ASYS Automationssysteme, Dornstadt, Germany  
N. Wirth, R. Greutmann, S. Gombert & H. Brocker  
Gallus Ferd. Rüesch, St. Gallen, Switzerland  
M. Lehner

Lehner Engineering, Engelburg, Switzerland

A. Senne & D. Reukauf  
ContiTech, Northeim, Germany

A. Mette

Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

F. Hage & M. Drews

ASYS, Dornstadt, Germany

J. Rohde

Zecher, Paderborn, Germany

E. Dörsam

Technical University of Darmstadt, Germany

**2CV.1.55 Lifetime Analysis of Bifacial-Ready Contacting of Busbarless and Multibusbar Solar Cells for Industrial Mass Production**

P. Waleska, K. Ramspeck & M. Meixner  
h.a.l.m. elektronik, Frankfurt am Main, Germany

**2CV.1.56 Evaluation of Inline High Intensity Illumination Treatments Against LeTID**

H. Vahlman, S. Roder, J.-F. Nekarda & S. Rein  
Fraunhofer ISE, Freiburg, Germany

K. Krauß

Rehm Thermal Systems, Blaubeuren, Germany

**2CV.1.57 Upgrade Technologies for Silicon Photovoltaics – Part I: Industrial Solution to Minimize the Negative Impact of Light Induced Degradation**

T. Pernau  
centrotherm international, Blaubeuren, Germany  
C. Derricks, G. Hahn & A. Herguth  
University of Konstanz, Germany  
L. Helmich, J. Schmidt & D. Walter  
ISFH, Emmerthal, Germany

**2CV.1.58 Investigation of the Accelerated Degradation and Regeneration Testing for p-Type PERC Cells**

M.-A. Tsai, Y.-C. Lee, C.-W. Kuo, T.-M. Kuan, H.-H. Hsieh, C.-Y. Yu & T.-C. Wu  
ITRI, Hsinchu, Taiwan

**2CV.1.59 The International Technology Roadmap for Photovoltaics and the Significance of Its Decade-Long Projections**

P. Baliozian, S. Tepner, K. Gensowski, F. Clement, S. Nold & R. Preu  
Fraunhofer ISE, Freiburg, Germany

M. Fischer

Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

J. Trube & S. Herritsch

VDMA, Frankfurt am Main, Germany

**2CV.1.60 Efficient Deployment of Deep Neural Networks for Quality Inspection of Solar Cells Using Smart Labeling**

P. Kunze, J. Greulich & M. Demant  
Fraunhofer ISE, Freiburg, Germany

K. Ramspeck

h.a.l.m. elektronik, Frankfurt am Main, Germany

M. Hemsendorf & A. Vetter

GP Inspect, Neuried, Germany

**2CV.1.61 Screen Utility Simulation - Explaining the Evolution and Future of Screen Printed Metallization of Si-Solar Cells**

S. Tepner, L. Ney, M. Singler, M. Linse, A. Lorenz, M. Pospischil, F. Clement & R. Preu

Fraunhofer ISE, Freiburg, Germany

**2CV.1.62 Effect of X-Y Translation Table Speeds to the Optical Absorption of Silicon Solar cells Textured by Pulsed Nd:YAG Laser**

N.H. Abdul Razak, K. Sopian, N. Amin & M. Akhtaruzzaman  
National University of Malaysia, Bangi, Malaysia

**VISUAL PRESENTATIONS 6CV.2**

13:30 – 15:00

**Integration of Photovoltaic in Buildings, Vehicle, Infrastructure and Landscape**

**Chairpersons:**

Alessandra Scognamiglio  
ENEA, Italy

Francesco Frontini  
SUPSI, Switzerland



- 6CV.2.1 OPV-Façades – Student Design Concepts of Multi-Functional Solar Façades**  
R. Krippner, G. Becker & F. Flade  
SeV Bavaria, Munich, Germany
- 6CV.2.2 PV Energy Yield Measurements of Electric Vehicles and Electric Vehicle Charging Station**  
U. Muntwyler, D. Zurflüh & E. Schüpbach  
BUAS, Burgdorf, Switzerland
- 6CV.2.3 Wind and Wave Effect on Floating Solar Panel**  
S.-T. Hsu  
ITRI, Hsinchu, Taiwan  
K.-C. Su  
National Cheng Kung University, Tainan, Taiwan
- 6CV.2.4 Architectural Design Optimization Study of Color BIPV Module Applying the BIM Design Environment**  
H. Jeon & K. Choi  
BIMS, Seoul, Republic of Korea  
S. Lee & K.-J. Kim  
KCL, Incheon, Republic of Korea
- 6CV.2.5 System Design and Economic Configuration of Building Integrated Photovoltaic**  
Z. Ni, J. Jiang, X. Cai, L. Hu, G. Shi, H. Cao, W. Lu & Z. Wu  
Talesun Solar, Suzhou, China
- 6CV.2.6 Yield Calculations of a PV System Integrated in Cruise Ships: A Case Study in the Waters of the Caribbean**  
P. Schwager, K. Gehrke & M. Vehse  
DLR, Oldenburg, Germany
- 6CV.2.7 Summary of PV Systems Implemented within SMARTER TOGETHER, an EU-Funded Smart City Project**  
B. Gaidon  
HESPUL, Lyon, France  
F. Gonçalves  
Energy Cities, Brussels, Belgium  
V. Cerna  
GOPA Com, Brussels, Belgium  
M. Valentin & E. Vignali  
SPL Lyon-Confluence, France  
V. Stoppel & B. Klassen  
City of Munich, Germany  
N. Morishita-Steffen  
MGS Munich, Germany  
S. Hartmann & L. Schneider  
City of Vienna, Austria
- 6CV.2.8 Architectural Criteria for PV Integration in Heritage Landscape**  
L. Sandoval Huth  
ISCTE, Lisbon, Portugal
- 6CV.2.9 Long-Term Reliability of PV-Modules in Alpine Environment**  
G.C. Eder & Y. Voronko  
OFI, Vienna, Austria  
W. Mühleisen  
SAL Silicon Austria Labs, Villach, Austria  
K. Knöbl  
UAS Technikum Wien, Vienna, Austria

- P. Kefer  
FH OOE, Wels, Austria  
C. Panhuber  
Energie AG OÖ Power Solutions, Linz, Austria
- 6CV.2.10 Cleanvelope – Students Concepts of Refurbishment with Solar Energy and Building Greening**  
R. Krippner  
Nuremberg Tech, Germany  
F. Flade  
Bavarian Association for the Promotion of Solar Energy, Munich, Germany
- 6CV.2.11 Weather Data Influence on a Photovoltaic Driven Heat Pump System for Net-Zero Energy Multi-Family Buildings**  
J. Schmidli, D. Carbonell, M. Haller & C. Biba  
University of Applied Sciences Rapperswil, Switzerland
- 6CV.2.12 Integration of Solar Energy Systems for Increased Societal Support**  
S. Lavrijssen  
Tilburg University, Netherlands  
W. Folkerts  
TNO, Eindhoven, Netherlands  
B. Van Mierlo & S. Stremke  
University of Wageningen, Netherlands  
L. Franco-Garcia & A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands  
R. Loonen  
Eindhoven University of Technology, Netherlands  
H. Cornelissen  
VU University Amsterdam, Netherlands  
W.G.J.H.M. van Sark  
Utrecht University, Netherlands  
E. Alarcon-Llado & A. Polman  
AMOLF, Amsterdam, Netherlands  
A.W. Weeber  
Delft University of Technology, Petten, Netherlands
- 6CV.2.13 Novel BIPV Products with Innovative Glass Coatings - New Degrees of Freedom in BIPV Design**  
R. Trattnig  
Joanneum Research, Weiz, Austria  
Y. Voronko & G.C. Eder  
OFI, Vienna, Austria  
G. Cattaneo  
CSEM, Neuchâtel, Switzerland  
A. Kornherr  
ERTEX Solar, Amstetten, Austria  
T. Buchsteiner  
FDT, Schladming, Austria  
F. Jamschek  
ehoch2 energy engineering, Mötz, Austria
- 6CV.2.14 Integration of Solar Modules in Double Glazing Elements**  
N. Neugebohrn, N. Osterthun, K. Gehrke & M. Vehse  
DLR, Oldenburg, Germany
- 6CV.2.15 Cooling of PV Modules in Floating PV Power Plants**  
E.S. Marstein, D. Mortensen, D. Lindholm, H. Fjær & J.H. Selj  
Institute for Energy Technology, Kjeller, Norway



- 6CV.2.16 Outdoor Testing Facility for an Experimental Validation of Yield Predictions for Building-Integrated Photovoltaic Modules**  
T. Gewohn, M. Koopmeiners, M.R. Vogt, B. Lim & R. Brendel  
ISFH, Emmerthal, Germany  
C. Schinke  
Leibniz University Hannover, Germany
- 6CV.2.17 Evaluations on Energy Performance of BIPV Systems**  
C.D. Zomer, I.P. Custódio & R. Rütther  
UFSC, Florianópolis, Brazil
- 6CV.2.19 Organic Photovoltaic Modules Installation: Italy and Algeria Case Studies**  
C. Busto, G. Corso, G. Gorni, R. Po, A. Terenzi, I. Trattenero & F. Ferrazza  
eni, Novara, Italy  
M. Asses, C. Derennes, D. Hau, G. Pic & V. Vannieuwenhuys  
ARMOR, Nantes, France  
S. Leva & A. Dolara  
Polytechnic University of Milan, Italy
- 6CV.2.20 How High Albedo Improves Vertical Bifacial PV Performance: Simulations and Measurements on a Solar Noise Barrier**  
S. Villa, M.M. de Jong, J.C.P. Kester, A.R. Burgers & W. Folkerts  
TNO Energy Transition, Eindhoven, Netherlands
- 6CV.2.21 Evaluation of the Solar Resource and Energy Generation in Vehicle Integrated Photovoltaics**  
J. Macías Rodríguez, R. Herrero, R. Núñez & I. Antón Hernández  
UPM, Madrid, Spain
- 6CV.2.22 Fire Performance Assessment of BIPV Facades Equipped with Active Rapid Shutdown**  
F. Parolini, P. Bonomo, F. Frontini, M. Caccivio & G. Bellenda  
SUPSI, Canobbio, Switzerland  
G. Manzini  
RSE, Milan, Italy  
G. Traina  
Giordano Institute, Gatteo, Italy  
P. Cancelliere  
Italian National Fire Services, Rome, Italy
- 6CV.2.23 Impact of Configurations on the Performance Prediction of Building Integrated Photovoltaic Modules**  
Y.B. Assoa  
CEA, Le Bourget-du-Lac, France
- 6CV.2.24 Monitoring Solar Highways: Performance and Lessons Learned from Operating a Bifacial Solar Noise Barrier**  
M.M. de Jong & S. Villa  
TNO Energy Transition, Eindhoven, Netherlands  
J.C.P. Kester  
TNO Energy Transition, Petten, Netherlands  
J. van der Heijden  
Ministry of Infrastructure and Water Management, &apos;s Hertogenbosch, Netherlands  
S. Verkuilen  
Heijmans Wegen, Rosmalen, Netherlands  
W. Folkerts  
&apos;s Hertogenbosch, Eindhoven, Netherlands

- 6CV.2.25 Potential of Wind and Solar Energy Available in an Aerial Basin: Taking Advantage of the Integration of Dams Hydrosystems**  
F.M. Valadao, V.O. da Silva, S.G. Relva, R. De Paula, A.L. Linhares, M. Galvao, A. Abubakar, A.L.V. Gimenes, M.E.M. Udaeta & L.C.R. Galvao  
University of São Paulo, Brazil
- 6CV.2.26 Bio-Inspired Design of a Dynamic Solar Photovoltaic Envelope with Evolving Functionalities**  
J. Ratovonkery, Y.B. Assoa & C. Ménézo  
CEA-LITEN, Le Bourget-du-Lac, France
- 6CV.2.28 Energy and Exergetic Analysis of a Photovoltaic-Thermal System Using a Dynamic Bidimensional Model for High Radiation and High Geographical Altitude Conditions**  
A.A. Taquichiri Ayaviri, M. Mendoza, M. Lague, E. Peñaranda & J. Velazco  
Technical University of Oruro, Bolivia  
M. Cortes, C. Portillo, M. Henriquez & A. Mallco  
University of Antofagasta, Chile
- 6CV.2.31 Towards Net-Zero Public Buildings through BIPV: a Case Study in Castilla-León (Spain)**  
D. Granados-López, M.I. Dieste-Velasco, A. García-Rodríguez, D. Gonzalez-Peña & C. Alonso-Tristán  
UBU, Burgos, Spain
- 6CV.2.33 The Impact of Building Shape and Density on Active Solar Energy Potential**  
S. Bensehla & Y. Lazri  
University Guelma, Algeria
- 6CV.2.34 Koepfen-Geiger Climate Classification Not a Determinant for the Siting of Offshore Floating Photovoltaics**  
A. Ayyad, S.Z. Mirbagheri Golroodbari & W.G.J.H.M. van Sark  
Utrecht University, Netherlands
- 6CV.2.35 Outdoor Performance and Future Potential of Infra Integrated PV**  
E.M.B. Heller  
Amsterdam University of Applied Science, Netherlands  
K.E. Sewalt  
TNO, Delft, Netherlands
- 6CV.2.36 Re-Uniting Photosynthesis and Photovoltaics: Design for Architectural Greenhouses**  
A. Scognamiglio, L.V. Mercaldo, M. Della Noce, M. Ferrara & P. Delli Veneri  
ENEA, Portici, Italy  
C.A. Toledo Arias  
UPCT, Cartagena, Spain  
F. Carteni, F. Giannino, M. Zotti & S. Mazzoleni  
University of Naples, Portici, Italy  
N. Salvatori  
University of Udine, Italy
- 6CV.2.37 Community Energy Production at Airports - Taking Relationship to the Next Level?**  
F. Kis  
Budapest Airport, Hungary  
I. Mudra  
, Budapest, Hungary
- 6CV.2.39 PV in Mobility: Various Solutions for On-Board PV and PV Charging Stations for EVs**



D. Dijken & A. van der Ham  
 Lightyear, Helmond, Netherlands  
 R.H.H.S. Derks  
 IM Efficiency, Heerlen, Netherlands  
 P. Cats  
 TRENS, Arnhem, Netherlands  
 A.J. Carr & B.K. Newman  
 TNO Energy Transition, Petten, Netherlands  
 C. Gerçek, A. Sierra Rodriguez & A.H.M.E. Reinders  
 University of Twente, Enschede, Netherlands

**6CV.2.41 Land Use Efficiency and Land Occupation of Utility-Scale Photovoltaic Power Plants in Continental Portugal**  
 J. Tavora, M.J. Cortinhal & M. Meireles  
 ISCTE, Lisbon, Portugal

**6CV.2.42 Shiwa Off-Shore Floating PV Pilot Test South Korea 2014 ~2019**  
 W. Lawrence (Ph.D.), C.-S. Won & M. Gang  
 SCOTRA, Seoul, Republic of Korea  
 H.-J. Kim, Y. Cho & H. Jo  
 K-Water Research Institute, Yuseong-gu, Republic of Korea  
 H.-K. Ahn & B.G. Bhang  
 Konkuk University, Seoul, Republic of Korea  
 S. Shin  
 Rural Research Institute, Gyeonggi-do, Republic of Korea

**6CV.2.45 Power Generation Performance Analysis of High-Efficiency CIGS BIPV Modules - Based on Actual and Measurement Data Analysis**  
 R. Lee  
 Hanbat National University, Daejeon, Republic of Korea  
 J. Yoon, H. Kim & H. Lee  
 Hanbat National University, Daejeon, Republic of Korea

**6CV.2.46 A Comparison of the Different Solar Cell Technologies for Integrated Photovoltaics**  
 M. Heinrich, T.E. Kuhn, F. Dimroth, U. Würfel, H. Neuhaus & S.W. Glunz  
 Fraunhofer ISE, Freiburg, Germany  
 M. Powalla  
 ZSW, Stuttgart, Germany

**6CV.2.47 A Standardized Classification of Agrivoltaic Systems**  
 B. Willockx, B. Uytterhaegen, B. Ronsijn & J. Cappelle  
 KU Leuven, Gent, Belgium

## VISUAL PRESENTATIONS 5CV.3

15:15 – 16:45 Operation, Performance and Maintenance of PV Systems

### Chairpersons:

João M. Almeida Serra  
 University of Lisbon, Portugal

Gerhard Mütter  
 ALTESO, Austria

**5CV.3.1 Outdoor Performance Modeling of a Vertically Arranged Bifacial PV Module in Ben Guerir, Morocco**  
 A. Benazzouz, Z. Naimi, B. Ikken, A. Ghennioui, A. Bouaichi & H. Zitouni  
 IRESEN, Rabat, Morocco  
 A.A. Lamrini & R. Ouladsine  
 International University of Rabat, Morocco

**5CV.3.2 25-kW Grid-Tie Solar Photovoltaic (PV) System for the Engineering S-Building at Vaal University of Technology in Vanderbijlpark, South Africa**  
 J. Bekker & M. Viljoen  
 Vaal University of Technology, Vanderbijlpark, South Africa

**5CV.3.3 Concept of Graphene Enhanced Solar Cell and Performance Prediction**  
 C.-W. Wu, R.-T. Chang & C.-G. Huang  
 CAS, Beijing, China

**5CV.3.4 Experimental Study of the Behaviour of the Global MPP of Partially Shaded PV Strings**  
 K. Lappalainen & S. Valkealahti  
 Tampere University, Finland

**5CV.3.5 Fitting Procedure for PV Panel Measured Current-Voltage Curves**  
 H. Kalliojärvi-Viljakainen, K. Lappalainen & S. Valkealahti  
 Tampere University, Finland

**5CV.3.6 Soiling, New Portable Measurement Tool and Characterization Method, to Get Easy and Quick Field Diagnostic**  
 E. Pilat  
 CEA / INES, Le Bourget-du-Lac, France  
 M. Amhal  
 CEA, Le Bourget-du-Lac, France

**5CV.3.7 Novel Model to Estimate Transmittance Soiling Losses Using DUSST, an Innovative Soiling Sensor**  
 A. Fernández Solas, L. Micheli, F. Almonacid-Cruz & E.F. Fernández  
 University of Jaén, Spain  
 J. Morse & M. Muller  
 NREL, Golden, USA

**5CV.3.9 PV-Module's Backsheet Compositions Affecting PV-System's Yield and Degradation**  
 C. Buerhop-Lutz, T. Pickel, T. Winkler, O. Stroyuk & J. Hauch  
 HI ERN, Erlangen, Germany  
 C. Camus  
 LayTec, Berlin, Germany  
 M. Neswal  
 ZAE Bayern, Erlangen, Germany  
 M. Heindl  
 SKZ-Testing, Würzburg, Germany

**5CV.3.11 Real Time Availability Calculation for a PV Plant Portfolio**  
 N. Lebert  
 HESPUL, Lyon, France  
 S. Fraisse  
 Epices Energie, Lyon, France





- 5CV.3.12 PV Infrastructure 1993+ and New Test Facilities for Education and Research**  
U. Muntwyler, D. Zurflüh & E. Schüpbach  
BUAS, Burgdorf, Switzerland
- 5CV.3.13 PV-AIDED: Photovoltaic Artificial Intelligence Defect Identification (PEARL TF-PV Project)**  
E. Sovetkin & B.E. Pieters  
Forschungszentrum Jülich, Germany  
T. Weber  
PI Berlin, Germany  
E.J. Achterberg  
Solar Tester, Schinnen, Netherlands  
A. Weeber  
Delft University of Technology, Netherlands  
B. Rau  
HZB, Berlin, Germany  
M. Rennhofer  
AIT, Vienna, Austria  
M. Theelen  
TNO, Eindhoven, Netherlands
- 5CV.3.14 The Adoption of IT Technologies, with a Focus on AI and Digital Twins, for PV Performance Optimization**  
G. Mütter, M. Volgo & C. Schön  
ALTESO, Vienna, Austria
- 5CV.3.15 PV String Fault Detection by Using the Clustering of Module Operating Points for Large-Scale PV Power Plant**  
K. Tanina & Y. Ueda  
Tokyo University of Science, Japan
- 5CV.3.16 Can Robotics in PV Plant Maintenance Develop Quickly Enough for the Set Roadmap?**  
F. Popescu  
Fraunhofer FOKUS, Berlin, Germany  
S. Wendlandt  
PI Berlin, Germany
- 5CV.3.18 Statistical Evaluation Approaches of PV Plants for O&M**  
V. Dimitrievska, W. Mühleisen, F. Pittino & C. Hirschl  
SAL Silicon Austria Labs, Villach, Austria  
N. Diewald  
Fronius, Wels, Austria  
M. Makula  
ENcome Energy Performance, Klagenfurt, Austria
- 5CV.3.19 Quantitative Assessment of the Power Loss of Silicon PV Modules by IR Thermography and Its Practical Application in the Field**  
J. Denz, C. Buerhop-Lutz, T. Pickel, J. Hauch & C.J. Brabec  
HI ERN, Erlangen, Germany  
C. Camus  
LayTec, Berlin, Germany
- 5CV.3.21 Integrated Concept for PV Plant Monitoring and Model Based Analytics**  
C. Gradwohl, B. Böckl & T. Kienberger  
University of Leoben, Austria  
M. Graefe & F. Langmayr  
Uptime Engineering, Graz, Austria  
W. Mühleisen  
SAL Silicon Austria Labs, Villach, Austria

- 5CV.3.22 Accuracy Analysis of Photovoltaic Simulation Softwares with Real Data**  
M.Y. Kinali  
Mevlana Development Agency, Konya, Turkey
- 5CV.3.23 Outdoor Fault Diagnosis of Field-Aged Solar Modules**  
O.K. Segbefia, A.G. Imenes & T.O. Saetre  
University of Agder, Grimstad, Norway
- 5CV.3.24 CIGS Photovoltaic Power Plants: Performance Analysis**  
S. Sarikh, M. Raoufi & A. Bennouna  
Cadi Ayyad University, Marrakech, Morocco  
O. El Alani, H. Zitouni & A. Bouaichi  
IRESEN, Rabat, Morocco
- 5CV.3.25 Outdoor IV Diagnosis of Photovoltaic Power Plants: Field Feedback**  
M. Amhal, A. Plissonnier, A. Revel, S. Lespinats & H. Colin  
CEA, Le Bourget-du-Lac, France
- 5CV.3.26 The Need for an Accuracy Check of Irradiation Sensors for Photovoltaic Power Plants**  
W. Mühleisen, L. Neumaier & C. Hirschl  
SAL Silicon Austria Labs, Villach, Austria  
M. Makula & B. Streit  
ENcome Energy Performance, Klagenfurt, Austria  
M. Graefe & C. Gradwohl  
Uptime Engineering, Graz, Austria
- 5CV.3.27 Performance Boost of Bifacial Silicon Heterojunction Modules: Verification Based on Field Data and Radiative Simulation**  
A. Tuomiranta, J. Levrat, A. Faes, M. Despeisse & P.-J. Alet  
CSEM, Neuchâtel, Switzerland  
J. Cattin, M. Boccard & C. Ballif  
EPFL, Neuchâtel, Switzerland  
H. Colin, V. Barth & D. Muñoz  
CEA, Le Bourget-du-Lac, France  
F. Rametta  
3SUN, Catania, Italy  
O. Dupré  
EPFL, Neuchâtel, France  
A. Richter  
Meyer Burger Technology, Gwatt (Thun), Switzerland  
C. Colletti  
ENEL Green Power, Catania, Italy  
M. Izzì  
ENEA, Rome, Italy  
H. Ghedira  
Khalifa University, Abu Dhabi, United Arab Emirates
- 5CV.3.28 Assessment of Photovoltaic Power Plants Using Fixed, Single Axis and Two Axis Tracking Systems**  
P.H. Veríssimo & R. Rüther  
UFSC, Florianópolis, Brazil
- 5CV.3.29 I-V Curve Measurement and Failure Analysis for Silicone Photovoltaic Power Plants**  
S. Sarikh, M. Raoufi & A. Bennouna  
Cadi Ayyad University, Marrakech, Morocco  
H. Zitouni, O. El Alani, A. Bouaichi, A. Benlarabi & B. Ikken  
IRESEN, Rabat, Morocco





- 5CV.3.30 Incidence Angle and Diffuse Radiation Adaptation of Soiling Measurements**  
F. Wolfertstetter & S. Wilbert  
German Aerospace Center, Tabernas, Spain  
A. Esquelli  
Berlin University of Technology, Germany  
N. Hanrieder  
German Aerospace Center, Almeria, Spain  
L.F. Zarzalejo  
CIEMAT, Madrid, Spain  
M. Korevaar, T. Bergmans & J. Mes  
Kipp & Zonen, Delft, Netherlands
- 5CV.3.31 The Dependence of LCOE on Solar Modules and Environmental Parameters**  
L. Xu, T.G. Allen & S. De Wolf  
KAUST, Thuwal, Saudi Arabia
- 5CV.3.32 Data Driven Risk Analysis and Decision Making in PV Investments – Quantification of Technical Risks**  
U. Jahn & M. Herz  
TUV Rheinland Energy, Cologne, Germany  
D. Moser & S. Lindig  
Eurac Research, Bolzano, Italy  
M. Richter  
3E, Brussels, Belgium  
K.A. Berger  
AIT, Vienna, Austria  
J. Vedde  
SiCon, Birkerød, Denmark  
M. Köntges  
ISFH, Emmerthal, Germany
- 5CV.3.33 Identifying Snow Events in PV System Data**  
M.B. Øgaard, A. Skomedal, H.N. Riise & J.H. Selj  
Institute for Energy Technology, Kjeller, Norway  
B.L. Aarseth  
University of Oslo, Kjeller, Norway
- 5CV.3.34 Machine Learning Based PV Online Fault Detection for Soiling and Shading**  
H.-F. Huang & C. Huang  
Thingnario, Taipei, Taiwan  
W.H. Hsu  
NTU, Taipei, Taiwan
- 5CV.3.35 A Machine Learning-Based Anomaly Detection System for Solar Inverters**  
P. Mercade Ruiz & G. Guerra  
Greenpowermonitor, Barcelona, Spain  
L. Landberg  
DNV GL, Hellerup, Denmark
- 5CV.3.36 PV-System Degradation Rates in the Nordics**  
E.B. Sveen, M.B. Øgaard, J.H. Selj & G. Otnes  
Institute for Energy Technology, Kjeller, Norway  
A.G. Imenes  
University of Agder, Kristiansand, Norway
- 5CV.3.37 Climate Related Dependence of Performance Losses of over 3,500 PV Systems**

- S. Lindig & D. Moser  
Eurac Research, Bolzano, Italy  
J. Leloux  
UPM, Madrid, Spain  
J. Ascencio-Vásquez & M. Topic  
University of Ljubljana, Slovenia
- 5CV.3.38 Cleaning the PV Panels, the First Laboratory Test Equipment for Assessing the Best Solutions**  
E. Pilat, A. Roisin, J. Deville, V. Viallet & J. Aime  
CEA, Le Bourget-du-Lac, France  
J. Magalhaes  
LYSI, La Ravoire, France
- 5CV.3.40 Soiling Rate Prediction from Meteorological Parameters Using an ANN Developed Model**  
H. El Gallassi & A. Ghennioui  
Green Energy Park, Benguerir, Morocco  
A. Alami Merrouni & M. Chourak  
University Mohammed I, Oujda, Morocco
- 5CV.3.41 Correlation of the Soiling Ratio and the Deposited Dust Density on Different Photovoltaic Technologies in Benguerir Morocco**  
H. Zitouni, A. Bouaichi, C. Hajjaj, A. Benazzouz, S. Sarikh, A. Ghennioui, Z. Naimi & B. Ikken  
IRESEN, Rabat, Morocco  
M. Regragui  
University Mohammed V-Agdal, Rabat, Morocco
- 5CV.3.44 Computer Vision Method for Extracting an Induced Electroluminescence Signal from Photovoltaic Modules in Daylight Conditions Using Drone-Captured Images**  
T.K. Hass, S.V. Spataru, G.A. dos Reis Benatto, A.A. Santamaria Lancia & P.B. Poulsen  
Technical University of Denmark, Roskilde, Denmark  
H.R. Parikh  
Aalborg University, Denmark
- 5CV.3.46 Analysis of Brazilian Power Plants Common Faults**  
A.K. Vidal de Oliveira, M. Braga, A. Medeiros Pires & R. Rütger  
UFSC, Florianópolis, Brazil  
M. Aghaei  
University of Freiburg, Germany
- 5CV.3.47 Development of Predictive Maintenance Algorithms for Photovoltaic Systems Using Synthetic Database**  
E.A. Sarquis Filho, F.C. Santos & P.J. Costa Branco  
Technical University of Lisbon, Portugal
- 5CV.3.48 Impact of Amazonian Climate and Forest Fires on Photovoltaic Generation**  
L. Lima, A. Gallina, C. Magalhães, L. Silva & T. Lima  
CEEAC, Rio Branco, Brazil  
V.O. da Silva & S.G. Relva  
University of São Paulo, Brazil
- 5CV.3.49 Failure Rates in Photovoltaic Systems: A Careful Selection of Quantitative Data Available in the Literature**  
E.A. Sarquis Filho, A. Zuniga & P.J. Costa Branco, J.F. Pereira Fernandes  
Technical University of Lisbon, Portugal



- 5CV.3.50 Thermal Infrared Imaging of mc-Si PV Modules under Changing Soiling Conditions**  
M. Vumbugwa, J.L. Crozier, E.E. van Dyk & F.J. Vorster  
NMU, Port Elizabeth, South Africa
- 5CV.3.52 Fault Detection in PV Systems by Lazy Nowcasting of Expected Energy Production through Half-Sibling Regression and Fast Time Series Analysis**  
G. Almondo  
MedMod, Stockholm, Sweden  
K. Nyman & D.-E. Archer  
Checkwatt, Danderyd, Sweden
- 5CV.3.53 Determination of a PV Module Malfunction from Their Maximum Power Point or from Their Operation Voltage, Two Different Strategies**  
J.C. Jimeno, E. Ortega, G. Aranguren, R. Gutierrez, E. Cereceda, A. Otaegi & V. Fano  
UPV/EHU, Bilbao, Spain  
O. Kunz  
UNSW Australia, Sydney, Australia
- 5CV.3.54 Analysis of the Performance of the I-V Curve Correction Methods in the Presence of Defects**  
B. Li, A. Migan-Dubois & D. Diallo  
CNRS/GeePs, Gif-sur-Yvette, France  
C. Delpha  
CNRS/CentraleSupélec, Gif-sur-Yvette, France

**VISUAL PRESENTATIONS 5CV.4**

**17:00 – 18:30 PV System Design and Modeling / Energy Storage / Concentrators and PV for Space Applications**

**Chairpersons:**

Kari Lappalainen  
Tampere, Finland

Ignacio Antón Hernández  
UPM, Madrid

Francesco Dolci  
European Commission JRC, The Netherlands

- 5CV.4.1 Student Awards Finalist Presentation: Techno-Economic Assessment of an Integrated PV System Using Innovative Sizing Tool for Educational Building (Case Study)**  
M. Hammad, A. Obayda, N. Khaled, I.M. Mahmoud & T.S. Abdel-Salam  
British University in Egypt, Elshrouk, Egypt
- 5CV.4.2 New Flexible Software for Study, Sizing and Energy Assess of Monofacial and Bifacial Technologies Which Takes into Account the Innovations of the PV Market of Large Scale Photovoltaic Plants Design**  
M. Carbone, D. Guida, E. Giuliano & S. Latella  
ENEL Green Power, Rome, Italy

- 5CV.4.3 Assessment of Rear Side Irradiation Mismatch for Tracked Versus Fixed-Tilt Bifacial Systems**  
T. Müller & B. Song  
ENGIE Laborelec, Santiago, Chile  
S. Scheerlinck  
ENGIE Laborelec, Linkebeek, Belgium
- 5CV.4.4 Economic Optimization of PV Systems with Storage**  
H. Apaydin, A. Viloz, B. Wittmer & A. Mermoud  
PVsyst, Satigny, Switzerland
- 5CV.4.6 Optimization of DC/AC Ratio in Different Climatic Zones: a Technical Analysis on a Sub-Hourly Level**  
I. Meyer & J. Tellez Mejia  
Mott MacDonald, Brighton, United Kingdom  
A. Salles  
Mott MacDonald, Paris, France  
V. Vorasitchai & N. Cherdangan  
Mott MacDonald, Bangkok, Thailand
- 5CV.4.8 Repercussions of Interannual Variability in Irradiance on Sizing PV for Autonomous Renewable Energy Systems**  
H.G. Beyer  
University of the Faroe Islands, Torshavn, Faroe Islands
- 5CV.4.9 The Construction of Test Fields for Photovoltaic Module Assessment**  
H. Choi, J. Kim, C. Lim, S. Lee & C. Kim  
Green Energy Institute, Mokpo, Republic of Korea  
S. Oh & J. Jung  
Yeungnam University, Daegu, Republic of Korea
- 5CV.4.10 Validation of the Solarfarmer Software with Operational Data**  
A. Neubert  
GL Maritime Software, Oldenburg, Germany  
M. Mikofski  
Garrad Hassan America, Oakland, USA  
M. Hamer & P. Rainey  
Garrad Hassan, Bristol, United Kingdom
- 5CV.4.11 Energy Yield Analysis of Bifacial Solar Arrays Considering Angular Reflection Losses**  
P. Tillmann, C. Becker & K. Jäger  
HZB, Berlin, Germany
- 5CV.4.14 Improved Solar Farm Performance via Design and Manipulation: Considering Momentum and Heat Transfer**  
S.E. Smith, A. Glick, N. Ali, J. Bossuyt, J. McNeal, G. Recktenwald & R.B. Cal  
Portland State University, USA  
M. Calaf  
University of Utah, Salt Lake City, USA
- 5CV.4.15 Design Considerations for Photovoltaic Systems Deployed in Snowy Climates**  
L. Burnham & D.S. Riley  
Sandia National Laboratories, Albuquerque, USA  
J.M. Pearce  
Michigan Technological University, Houghton, USA  
E. Whitney & C. Pike  
UAF, Fairbanks, USA



B. Walker  
Evolve|RE, Winooski, USA

- 5CV.4.16 GPU-Based Simulation of the Bifacial Energy Gain for PV Plants: First Results**  
J. Robledo & J. Leloux  
LuciSun, Sart-Dames-Avelines, Belgium  
C.A. Gueymard  
Solar Consulting, Colebrook, USA  
A. Driesse  
PV Performance Labs, Freiburg, Germany
- 5CV.4.17 Studies on Optimizing the Orientation of Fixed-Tilt Bifacial Modules and Its Impact on Energy Generation**  
P. Maheshwari, S. Patel, A. Mahajan & V. Chaudhari  
PV Diagnostics, Mumbai, India
- 5CV.4.18 Comparison of Different Data Sources for Machine Learning Algorithms in Photovoltaic Output Power Estimation**  
P. Graniero  
Free University of Berlin, Germany  
A. Louwen  
Eurac Research, Bolzano, Italy  
R. Schlatmann  
HZB, Berlin, Germany  
C. Ulbrich  
PVcomB, Berlin, Germany
- 5CV.4.27 Techno-Economic Analysis of Battery Energy Storage System in Grid-Connected Photovoltaic (PV) System**  
J.Z. Tee, Z.W. Tham, I. Lim & K. Zhou  
University of Glasgow, Singapore, Singapore  
O. Anaya-Lara  
University of Strathclyde, Glasgow, United Kingdom
- 5CV.4.28 Analysis and Optimization of the Battery Operation in Photovoltaic Systems**  
M. Andam, J. El Alami & Y. Louartassi  
Mohammed V University, Salé, Morocco
- 5CV.4.29 Performance Evaluation of Hydrogen Storage and Fuel Cell in EMS for PV Powered Factory**  
Y. Ogawa & Y. Ueda  
Tokyo University of Science, Japan  
M. Sugiyama  
University of Tokyo, Japan  
F. Aono  
Enoah, Aichi, Japan
- 5CV.4.30 Combined Heat and Power Systems for Decentralised Long Term Electricity Storage**  
P. Grunow  
PI Berlin, Germany
- 5CV.4.31 Addressing the Urgent Need for Battery and Energy Storage System Performance and Reliability Testing Standards**  
R. Mokidm  
RETC, Fremont, USA
- 5CV.4.32 Optimized Integration of VRFB Storage with Grid-Tied Solar PV Power System to Mitigate Voltage Instability Due to High PV Penetration**

N. Ra & A. Bhattacharjee  
BITS Pilani, Hyderabad, India

- 5CV.4.42 A Mobile PV Fluxmeter for the Optical Characterization of Parabolic Trough Concentrating Solar Power Plants**  
A. Parretta & A. Moretti  
University of Ferrara, Italy  
M. Izzi & M. Tucci  
ENEA, Rome, Italy
- 5CV.4.43 Simulation of Three-Dimensional Thermoelectric-Concentrator Photovoltaic Receivers at Ultra-High Concentrations**  
A. Valera, E.F. Fernández, P.M. Rodrigo, P.J. Pérez-Higueras & F. Almonacid-Cruz  
University of Jaén, Spain
- 5CV.4.44 Characterisation of Secondary Optics to Improve the Uniformity and Performance of Multi-Junction Solar Cells**  
J.M. Saura, M. Angeles Ceballos, J.P. Ferrer-Rodriguez, F. Almonacid-Cruz & E.F. Fernández  
University of Jaén, Spain  
D. Chemisana  
UDL, Lleida, Spain
- 5CV.4.45 Optimal Design of a Two Stage Micro Photovoltaic Concentrator**  
S. El Ayane, S. El Himer & A. Ahaitouf  
USMBA, Fez, Morocco
- 5CV.4.46 A New Hybrid System Integrating a Solar Parabolic Trough Collector with a Cylindrical Thermoelectric Generator**  
A. Habchi, B. Hartiti & N. Belouaggadia  
Hassan II University of Casablanca, Morocco  
H. Labrim  
CNESTEN, Rabat, Morocco  
E. Ntsoenzok  
CNRS, Orleans, France
- 5CV.4.47 Development of Large-Scale Solar Array with RF Antenna for Space Applications**  
K. Tanaka  
Japan Aerospace Agency, Sagamihara, Japan  
R. Mudassir & T. Yamagami  
Sokendai, Kanagawa, Japan  
T. Nakamura  
Tokyo University of Science, Kanagawa, Japan  
N. Sekiya  
Hosei University, Kanagawa, Japan  
K. Ijichi  
Jspacsystems, Kanagawa, Japan



Thursday, 10 September 2020

**VISUAL PRESENTATIONS 7DV.1**

**08:30 – 10:00**      **Costs, Economics, Finance and Markets / Assessment, Policies and Scenarios for Renewables; Societal and Global Challenges**

**Chairpersons:**

Nigel Taylor  
European Commission JRC, Italy

Silvia Caneva  
WIP Renewable Energies, Germany

**7DV.1.5 Super PV Progress Report – Developing Innovative High-Quality PV Systems to Regain European Leadership in the Global PV Market**

J. Urbikas & V. Urbikaite  
PROTECH, Vilnius, Lithuania  
J. Denafas  
Soli "Tek R&D", Vilnius, Lithuania  
R. Witteck & M. Köntges  
ISFH, Emmertal, Germany  
M. Topic  
University of Ljubljana, Slovenia  
F. Frontini, P. Bonomo & E. Saretta  
SUPSI, Canobbio, Switzerland  
P. Macé  
Becquerel Institute, Brussels, Belgium  
P.J. Bolt  
TNO, Eindhoven, Netherlands  
A.G. Ulyashin  
SINTEF, Oslo, Norway  
T. Haarberg  
BNW-Energy, Trondheim, Norway  
W. Palitzsch  
LuxChemtech, Freiberg, Germany  
B. Terheiden  
University of Konstanz, Germany  
I. Weiss & N. LaPointe  
WIP Renewable Energies, Munich, Germany  
J.L. Domínguez-García  
IREC, Barcelona, Spain

**7DV.1.7 Results from the Worldwide Performed Questionnaire: BIPV Market, Technology and Preferences**

C. Erban & H. Ley  
Sunovation, Elsenfeld, Germany

**7DV.1.8 Analysis of PV Price Development and PV Price Predictions in Switzerland**

U. Muntwyler & E. Schüpbach  
BUAS, Burgdorf, Switzerland

**7DV.1.10 Towards a Successful Dutch BIPV Sector**

A. De Vries  
Celstar, Brussels, Belgium  
A. Kahn  
4WWWIE, Ouderkerk aan de Amstel, Netherlands  
R. Comuth  
Adviesbureau Comuth, Maastricht, Netherlands  
W. van Hooff  
Holland Solar, Utrecht, Netherlands  
G. Verpaalen  
Kameleon Solar Specials, Roosendaal, Netherlands  
C. Maas  
Chatim, Heerlen, Netherlands  
S. de Ridder  
WellSun, Delft, Netherlands  
P. de Jong  
Solinso, Kessel, Netherlands  
W. van de Wall  
Wallvision, Heeze, Netherlands  
Z. Vroon  
ZUYD, Geleen, Netherlands  
A. Kuypers, J. Kester & R.M.E. Valckenborg  
TNO, Eindhoven, Netherlands  
W.G.J.H.M. van Sark  
Utrecht University, Netherlands  
R. Loonen  
Eindhoven University of Technology, Netherlands  
R. Derks  
Q-Roof, Heerlen, Netherlands  
E. Teunissen  
Berenschot, Utrecht, Netherlands

**7DV.1.11 South African Independent Power Producer Program Investments in Solar PV**

S. Zuma  
University of Fort Hare, Alice, South Africa

**7DV.1.12 Student Awards Finalist Presentation: Are Purchased Third Country Renewable Credits Worthwhile Than PV's in Malta?**

B. Bartolo  
MCAST, Paola, Malta  
B. Azzopardi, R. Mikalauskiene, V. Jately & S. Bhattacharya  
MCAST, Paola, Malta  
A. Guérin de Montgareuil  
CEA, St-Paul-lez-Durance, France

**7DV.1.14 LCOE Analysis of Talesun New-Generation Product**

P. Ni, Q. Wei, K. Huang, H. Tang, X. Cai, W. Lian & H. Qian  
Talesun Solar, Changshu, China  
J. Zhu  
Institute for Energy Technology, Kjeller, Norway

**7DV.1.15 Cost Benefit Analysis for Business Model in a Grid Connected PV System with Energy Storage**

J. Solis & C. Kato  
Karlstad University, Sweden  
J. Ericson & M. Nilsson  
Glava Energy Center, Sweden

**7DV.1.17 Super PV Project – Support Cost-Reduction of the PV System through Innovative Technologies on PV Module Level**

J. Denafas, P. Lukinskas, T. Radavičius & L. Petreniene



- Soli "Tek R&D", Vilnius, Lithuania  
J. Ulbikas  
PROTECH, Vilnius, Lithuania  
R. Witteck & M. Köntges  
ISFH, Emmerthal, Germany  
J. Crespo Gutierrez  
Lurederra, Los Arcos, Spain  
J. Cordon  
Tecnan, Los Arcos, Spain  
T. Carrère & R. Einhaus  
Apollon Solar, Saint Priest, France  
U. Rühle  
Flisom, Dübendorf, Switzerland  
P.J. Bolt, D. Roosen-Melsen & F.J. van den Bruele  
TNO, Eindhoven, Netherlands  
A.G. Ulyashin  
SINTEF, Oslo, Norway  
T. Haarberg  
BNW-Energy, Trondheim, Norway  
W. Palitzsch  
LuxChemtech, Freiberg, Germany  
N. LaPointe & I. Weiss  
WIP Renewable Energies, Munich, Germany
- 7DV.1.18 100% Renewable Electricity in Indonesia**  
D.F. Silalahi, A. Blakers, M. Stocks, B. Lu, C. Cheng, A. Nadolny & L. Hayes  
ANU, Canberra, Australia
- 7DV.1.27 Economic Analysis of Electricity Costs with More Solar Power Capacity in 2035 in France**  
H.J.J. Yu  
CEA, Gif sur Yvette, France
- 7DV.1.30 C-Si and Thin Film Photovoltaic Penetration Scenarios in Kano State - Nigeria**  
S.G. Relva, A. Abubakar, M.E.M. Udaeta, V.O. da Silva, A.L.V. Gimenes & C.F.M. Almeida  
University of São Paulo, Brazil
- 7DV.1.32 Statement of Certified PV Module Registration and Policy in Taiwan**  
M.-A. Tsai, M.-C. Chiu, Y.-Y. Lin, H.-M. Chang, W.-Y. Liang & T.-C. Wu  
ITRI, Hsinchu, Taiwan
- 7DV.1.33 The Renewable Energy Status of Offshore Islands in Taiwan**  
C.-H. Du & C.-W. Wu  
ITRI, Taipei, Taiwan  
L.-C. Huang & S.-T. Hung  
Taiwan Power Company, Taipei, Taiwan
- 7DV.1.34 An Updated SWOT Analysis of the Solar Energy and Best Practices to Enhance the Solar Energy Uptake in Solarise 2Seas Countries**  
T.E. Motoasca  
KU Leuven, Ghent, Belgium
- 7DV.1.35 Effects of Basic Access to Electricity on Future Power Demands by Rural Households in Developing Communities**  
N.N. Opiyo  
Ulster University, Londonderry, United Kingdom
- 7DV.1.36 Effects of Mobile-Platform-Based Microcredit Facilities on Uptake of PV Systems in Rural Developing Communities**

- N.N. Opiyo  
Ulster University, Londonderry, United Kingdom
- 7DV.1.37 A Resource-Efficient Europe – A Programme for Climate, Competitiveness and Employment**  
A.K. Lutzenberger  
Alrene, Siek, Germany
- 7DV.1.38 RESCUE - Resource-Efficient Pathways towards Greenhouse-Gas-Neutrality of the German Federal Environment Agency (UBA)**  
H. Lehmann  
Federal Environment Agency of Germany, Dessau-Roßlau, Germany
- 7DV.1.39 The Impact of Large-Scale PV Power Stations on Climate**  
C. Yang & Z. Chen  
CMA, Wuhan, China
- 7DV.1.41 Solar PV Powered and Consumer Motivation Secured Collective Energy Access Tier Scaling Prospect**  
M. Ray  
IIT Kharagpur, India  
I.D. Miller & L.H. Shu  
University of Toronto, Canada  
P. De  
Merck Sharp & Dohme, Mumbai, India
- 7DV.1.43 Text Annotation Made Easy (TAME) Handling Large Data Rooms Using Natural Language Processing Methods**  
M. Ngo & G. Tourasse  
kiloWattsol, Lyon, France
- 7DV.1.44 Australia, a Global Renewable Energy Pathfinder**  
A. Blakers, M. Stocks, B. Lu & C. Cheng  
ANU, Canberra, Australia
- 7DV.1.45 MOST Project – Advanced Master's Education based on Smart Grid Technology**  
S. Arancón, S. Caneva & M. Kovarova  
WIP Renewable Energies, Munich, Germany  
F. Pilo & S. Mocchi  
University of Cagliari, Italy  
V. Efthymiou, A. Stavrou, G.E. Georghiou, C. Panayi, M. Kynigos & C. Papadimitriou  
University of Cyprus, Nicosia, Cyprus  
G.C. Christoforidis, I. Panapakidis & A. Bouhouras  
Western Macedonia University of Applied Sciences, Kozani, Greece  
G. Heilscher, S. Hofbauer, F. Ebe, B. Idlbi & S. Chen  
Ulm University of Applied Sciences, Germany  
A. Michiorri  
MINES ParisTech, France  
E. Loucaidou & K. Ioannou  
Deloitte, Limassol, Cyprus





**VISUAL PRESENTATIONS 2DV.2****10:30 – 12:00 Silicon Wafer Technology / Thin Film and Foil-Based Si Cells****Chairpersons:**

Marko Topic  
University of Ljubljana, Slovenia

Stephan Riepe  
Fraunhofer ISE, Germany

**2DV.2.1 Crystalline Silicon Synthesis by Magnesiothermic Reduction of Natural Silica Sand**  
A. Darghouth, S. Aouida & B. Bessais  
CRTE n, Hammam-Lif, Tunisia

**2DV.2.4 “GFVis”: A Non-Destructive Method for Phase Front Analysis Based on Photos on Brick Sides**  
T. Trötschler, nee Strauch, S. Haddouk, A.S. Kovvali, A. Hess, P. Krenckel, S. Riepe, M. Demant & S. Rein  
Fraunhofer ISE, Freiburg, Germany  
H. Franz & C. Morche  
ALD Vacuum Technologies, Hanau, Germany

**2DV.2.6 Study of Diamond Wire Slicing Parameters by Three-Dimensional Visualization of a Multicrystalline Silicon Ingot**  
S.M. Karabanov, A.E. Serebryakov, D.V. Suvorov & A.S. Karabanov  
RSREU, Ryazan, Russian Federation  
O.A. Belyakov  
Helios-Resource, Saransk, Russian Federation

**2DV.2.7 Novel Study of Chemical Etching for Diamond-Cut Multi-Crystalline Silicon Wafers**  
V. Matkivskyi & G. Tranell  
NTNU, Trondheim, Norway  
A. Røyset, J.H. Kvello, M. Juel, I. Kaus, P. Tettie & B. Rynningen  
SINTEF, Trondheim, Norway

**2DV.2.9 Kerfless Wafering Approach with Si and Ge Templates for Si, Ge and III-V Epitaxy**  
C. Weiss, M. Drießen, W. Schreiber & S. Janz  
Fraunhofer ISE, Freiburg, Germany

**2DV.2.10 Methodology to Determine Bulk Crystal Quality in Terms of Carrier Lifetime without Wafering**  
M. Müller, A. Weber, A.I. Kropp, M. Ehrl, T. Urban, P. Häussermann, B. Neubert, A. Albrecht, S. Seidel, R. Otto & J. Heitmann  
Freiburg University of Technology, Germany  
K. Dadzis & R. Menzel  
IKZ Institute for Crystal Growth, Berlin, Germany  
M. Trempa & C. Reimann  
Fraunhofer IISB, Erlangen, Germany  
C. Kranert  
Fraunhofer THM, Freiberg, Germany

**2DV.2.11 Early Stage Quality Assessment in Silicon Ingots from MDP Brick Characterization**  
A.S. Kovvali, M. Demant, B. Rebba & S. Rein  
Fraunhofer ISE, Freiburg, Germany  
N. Schüler  
Freiberg Instruments, Germany

**2DV.2.13 Light and Elevated Temperature Induce Degradation of Ga-Doped Monocrystalline Silicon Wafer**  
H. Li, X. Wang, C. Zhou & W.J. Wenjing  
CAS, Beijing, China

**2DV.2.14 Effective Lifetime Variations Significant for Process Evaluation or Just an Artifact of Wafer Size and Quality? – An Attempt to Quantify Material Induced Variations**  
C. Fischer, A. Schmid, A. Zuschlag & G. Hahn  
University of Konstanz, Germany

**2DV.2.15 Firing-Triggered LID (FT-LID) of the Carrier Lifetime in Cz-Si Wafers**  
M. Winter, L. Helmich, D.C. Walter & J. Schmidt  
ISFH, Emmerthal, Germany

**2DV.2.18 Limitations of the Growth Rate of Silicon Mono Ingots Grown by the Czochralski Technique**  
F. Mosel, A.V. Denisov, B. Klipp & N. Sennova  
PVA TePla, Wetztenberg, Germany  
C. Kranert  
Fraunhofer THM, Freiberg, Germany  
M. Trempa, C. Reimann, J. Friedrich & T. Jung  
Fraunhofer IISB, Erlangen, Germany

**2DV.2.19 Experimental Research of the Influence of Electromagnetic Stirring of Silicon Melt on Multicrystalline Silicon Parameters**  
S.M. Karabanov, O.A. Belyakov, D.V. Suvorov, E.V. Slivkin & A.S. Karabanov  
RSREU, Ryazan, Russian Federation

**VISUAL PRESENTATIONS 2DV.3****13:30 – 15:00 Crystalline Silicon Solar Cell Technologies****Chairpersons:**

Arthur Weeber  
TNO Energy Transition, Netherlands

Thorsten Dullweber  
ISFH, Germany

**2DV.3.2 Evaluation of Heterojunction Solar Cell Losses due to Half-Cell Processes**  
M. Turek, O. Breitenstein, S. Eiternick & S. Großer  
Fraunhofer CSP, Halle (Saale), Germany  
K. Sporleder





Fraunhofer CSP, Halle, Germany

- 2DV.3.3 Impact of Hydrogen Plasma Treatment on a-Si:H/a-SiO<sub>x</sub>:H Passivation Film**  
K. Saito  
Fukushima University, Japan  
T. Takamura, Y. Ichikawa & M. Konagai  
Tokyo City University, Japan
- 2DV.3.4 Graphene-Based Transparent Electrode Incorporated into Silicon Heterojunction Solar Cell Technology**  
I. Torres, S. Fernández, J.J. Gandía, N. González Peñalba, R. Barrio Martín, M. de Cruz & J. Cárabe  
CIEMAT, Madrid, Spain
- 2DV.3.5 Laser-Induced Oxidation of Doped Poly-Si at Room Temperature for Si Solar Cells with Structured Passivated Contacts**  
S. Schäfer, A. Mercker, V. Mertens, T. Neubert, A. Köhler, L. Mettner, R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany
- 2DV.3.7 Alternative Cz Ingot Squaring and Half-Cell Cutting Methodology for Low-Temperature PV Cell and Module Technologies**  
J.F. Lelièvre, S. Harrison, M. Albaric, L. Carton, B. Portaluppi & V. Barth  
CEA, Le Bourget-du-Lac, France
- 2DV.3.8 Silver- and Indium-Free Silicon Heterojunction Solar Cell**  
A. Lachowicz, G. Christmann, S. Nicolay & C. Ballif  
CSEM, Neuchâtel, Switzerland
- 2DV.3.10 Lateral Transport in Passivating Contact Solar Cells: The Challenge of Current Crowding for High Resistive TCOs**  
M. Bivour, C. Messmer, L. Tutsch, C. Luderer, J. Schön & M. Hermle  
Fraunhofer ISE, Freiburg, Germany
- 2DV.3.11 Advanced PERC Solar Cells with TOPCon Passivated Layers**  
S.-Y. Chen, S.-C. Liu, S.-P. Hsu, C.-P. Huang, Y.-S. Chen, C.H. Tsai & C.-J. Huang  
ITRI, Tainan, Taiwan
- 2DV.3.12 Lean Integration of p- and n-Type High-Temperature Passivating Contacts Deposited by PECVD and Activated during Short or Long Annealing**  
J.J. Diaz Leon, C. Allebé, A. Ingenito, G. Nogay, A. Descoedres, M. Despeisse & S. Nicolay  
CSEM, Neuchâtel, Switzerland  
P. Wyss, F.-J. Haug & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 2DV.3.13 Influence of the TCO Oxygen Content on the TCO/a-Si Heterojunction and Its Thermal Stability**  
C. Luderer, L. Tutsch, D. Kurt, M. Bivour & M. Hermle  
Fraunhofer ISE, Freiburg, Germany
- 2DV.3.14 Technological Viability and Proof-of-Concept of Applying Low-Temperature PECVD Si<sub>x</sub>N<sub>y</sub> for Inkjet-Masked Selective Emitters**  
B. Kafle, K. Demel, R. Efinger, R. Keding & M. Hofmann  
Fraunhofer ISE, Freiburg, Germany  
W. Shepherd & M. Pickrell  
Sun Chemical, Bath, United Kingdom

- 2DV.3.15 Lithium Doped Nickel Oxide as Hole Transport Layer for Heterostructure Solar Cells**  
F. Menchini, L. Serenelli, L. Martini, E. Salza, M. Izzi & M. Tucci  
ENEA, Rome, Italy  
S. Rakhshani, A. Latini, G. de Cesare & D. Caputo  
Sapienza University of Rome, Italy
- 2DV.3.16 Insights on Cell Edge Defects Impact and Post-Process Repassivation for Heterojunction**  
B. Portaluppi, S. Harrison & V. Giglia  
CEA, Le Bourget-du-Lac, France  
A. Sekkat & D. Munoz-Rojas  
University of Grenoble Alpes, France
- 2DV.3.17 Low Temperature Ag-Paste Screening for Silicon Hetero Junction Solar Cells and Modules**  
S. Pingel, D. Erath, T. Wenzel, D. Eberlein, A. De Rose, S. Tepner, J. Schube, S. Nold, A. Moldovan, A. Lorenz & F. Clement  
Fraunhofer ISE, Freiburg, Germany
- 2DV.3.18 Investigating the Effect of Interstitial Fe Impurity Contamination on n-Type cz-Silicon Material for High Efficiency Solar Cell Processing**  
A.T. Hajjiah  
Kuwait University, Safat, Kuwait  
I. Gordon, J. Szlufcik, J. Poortmans & J. John  
imec, Leuven, Belgium
- 2DV.3.19 Front Side Optimization on Boron- and Gallium-Doped Cz-Si PERC Solar Cells Exceeding 22% Conversion Efficiency**  
E. Lohmüller, J. Greulich, P. Saint-Cast, S. Lohmüller, S. Schmidt, U. Belledin, T. Fellmeth, S. Mack, G. Emanuel, K. Krieg, M. Zimmer, M. Linse, J. Horzel, M. Meßmer, A. Wolf & R. Preu  
Fraunhofer ISE, Freiburg, Germany  
R. Kunert & F. Zobel  
Fraunhofer CSP, Halle (Saale), Germany
- 2DV.3.21 PECVD Shadow Mask Deposition of a-Si Fingers – a Short Cut to Structured Poly-Si for Local Passivating Contacts**  
M. Stöhr, B. Beier, R. Brendel & T. Dullweber  
ISFH, Emmerthal, Germany
- 2DV.3.22 Evidence of Charge Polarity Reversal in Silicon Oxide Film Deposited by Atomic Layer Deposition**  
T. Mochizuki, K. Usuki, K. Tanahashi & H. Takato  
AIST, Koriyama, Japan  
A. Ito & H. Nakanishi  
SCREEN, Kyoto, Japan  
I. Kawayama  
Kyoto and Osaka University, Japan  
M. Tonouchi  
Osaka University, Suita, Japan
- 2DV.3.23 A Study on the Influence of Aluminum Oxide Layer Properties on Contact Formation**  
B. Gapp, F. Geml, J. Engelhardt & G. Hahn  
University of Konstanz, Germany
- 2DV.3.24 Silicon Wafers with a Thickness below 130-Micrometers in Mass Production of Heterojunction Solar Cells**  
I. Nyapshaev, K. Emtsev & D. Andronikov  
R&D Center TFTE, St. Petersburg, Russian Federation



A. Ivanov, V. Tarasov, A. Dubrovskiy & P. Ishmuratov  
 Hevel Solar, Novocheboksarsk, Russian Federation  
 I. Shakhrai  
 Avelar Solar Technology, Moscow, Russian Federation

- 2DV.3.26 Laser Annealing of Selective and Passivating Contact Layers for Crystalline Silicon Solar Cells**  
 S. Kurth, W. Beyer, M. Pomaska, J. Kirchhoff, S. Kasper, A. Gerber & S. Haas  
 Forschungszentrum Jülich, Germany  
 J. Hoß & J. Lossen  
 ISC Konstanz, Germany
- 2DV.3.27 P-Type  $\mu\text{-Si:H}$  Based Hole Selective Fired Passivating Contacts (FPC) without Hydrogenation After Firing**  
 A. Desthieux & J. Posada  
 EDF R&D, Palaiseau, France  
 B. Bazer-Bachi & G. Goaer  
 Photowatt, Bourgoin-Jallieu, France  
 E. Drahi  
 TOTAL, Paris la Defense, France  
 P. Roca i Cabarrocas  
 CNRS, Palaiseau, France
- 2DV.3.28 An Investigation of an Atmospheric Screen-Printable Cu Paste and Rapid Thermal Sintering Contact for Cost-Effective Silicon Solar Cell**  
 A. Ebong, K. Ren & S. Huneycutt  
 UNC Charlotte, USA  
 R. Dharmadasa, K. Ankireddy & T. Druffel  
 Bert Thin Films, Louisville, USA
- 2DV.3.29 VOx Heterojunctions Applied to Thin c-Si Solar Cells**  
 G. López, E. Ros, G. Masmitjà, P.R. Ortega, C. Voz Sánchez,  
 J. Puigdollers González & I. Martín  
 UPC, Barcelona, Spain
- 2DV.3.30 Improved Performance of TiOx Based Dopant-Free Selective Contact with Metal Doped TiOx**  
 W. Liang, J. Tong, P. Narangari, S. Armand, K.J. Weber, A. Blakers & K.C. Fong  
 ANU, Canberra, Australia  
 K. McIntosh  
 PV Lighthouse, Coledale, Australia
- 2DV.3.31 Module Reliability of Solar Cells with Ultra-Thin Plated Metallization for Silver and Nickel Reduction**  
 S. Hoffmann, A. De Rose & A. Kraft  
 Fraunhofer ISE, Freiburg, Germany  
 M. Passig, N. Bay & D. Brunner  
 RENA, Freiburg, Germany
- 2DV.3.32 Rear-Emitter Si Heterojunction Solar Cells with Front n-Type SiOx Electron Collector and Back MoOx Hole Collector**  
 E. Bobeico, M. Della Noce, L. Lancellotti, I. Usatii, L.V. Mercaldo & P. Delli Veneri  
 ENEA, Portici, Italy
- 2DV.3.33 An Industrial Feasible n+ Poly-Si-IBC Screen Printed Solar Cell with 702 mV Voc on Large Area p-Type Substrates**  
 L.J. Koduvelikulathu, J. Lossen, A. Adrian, D. Rudolph, Z.-W. Peng,  
 A. Chaudhary & R. Harney

ISC Konstanz, Germany  
 M. Troeller, A. Piechulla, V.X. Nguyen, D. Seiffert, T. Pernau & H. Haverkamp  
 centrotherm international, Blaubeuren, Germany  
 F. Haase & R. Peibst  
 ISFH, Emmerthal, Germany

- 2DV.3.35 P- and n-Doped Layers Optimization for Silicon Heterojunction Solar Cells in the Rear Emitter Configuration**  
 A.V. Semenov, A. Abramov, D. Andronikov, K. Emtsev & E.I. Terukov  
 R&D Center TFTE, St. Petersburg, Russian Federation  
 I. Shakhrai  
 Hevel Solar, Moscow, Russian Federation
- 2DV.3.36 Screen-Printed Aluminium Contacts on n+-Doped Silicon**  
 S. Suzuki, M. Nakahara, N. Morishita, T. Kuroki & M. Dhamrin  
 Toyo Aluminium, Shiga, Japan  
 Z.-W. Peng, K. Tsuji & T. Buck  
 ISC Konstanz, Germany
- 2DV.3.38 Reduced Surface Reflection of Solar Silicon and Solar Glass by Maskless Plasma Texturing with CHF<sub>3</sub>/H<sub>2</sub>**  
 A. Okhorzina & N. Bernhard  
 Anhalt University of Applied Sciences, Köthen, Germany
- 2DV.3.39 Role of Wafer Thickness in Performance of Silicon Heterojunction Solar Cells**  
 O. Astakhov, T. Merdzhanova, D. Weigand, L. Wolf, A. Gad, K. Ding & U. Rau  
 Forschungszentrum Jülich, Germany
- 2DV.3.40 Fabrication of a Silicon Nanoparticle Layer on a Textured Silicon Substrate for Decreasing Reflectance**  
 S. Kato & T. Soga  
 Nagoya Institute of Technology, Japan
- 2DV.3.42 Colorization of Si Based Solar Cells and Panels Using Double Layer Coatings**  
 M. Rudzikas & A. Setkus  
 Center for Physical Sciences and Technology, Vilnius, Lithuania  
 M. Stange & A.G. Ulyashin  
 SINTEF, Oslo, Norway  
 J. Ulbikas  
 Applied Research Institute for Prospective Technologies, Vilnius, Lithuania
- 2DV.3.43 Study on Carrier Selective Passivation for p-Type Crystalline Solar Cell**  
 Z. Yang, Q. Wei & P. Ni  
 Talesun Solar, Suzhou, China  
 Y. Xu  
 NUAA, Nanjing, China
- 2DV.3.44 Inverted Pyramids Texturization of Monocrystalline Silicon for Highly Efficient Light Trapping: Monitoring H<sub>2</sub>O<sub>2</sub> Evaporation by Voltammetric Detection**  
 S. Kubendhiran, G. Sison, H.P. Hsu & C.-W. Lan  
 NTU, Taipei, Taiwan
- 2DV.3.45 Band-Offset Reduction for Effective Hole Carrier Collection in Bifacial Silicon Heterojunction Solar Cells**  
 D.P. Pham, S. Lee, E.-C. Cho, Y. Kim, Y.-H. Cho & J. Yi  
 University of Sungkyunkwan, Suwon, Republic of Korea



- 2DV.3.46 Local Laser Crystallization of a-Si on Tunneling SiO<sub>2</sub> for Passivated Contacts of Solar Cells**  
G. Jia, A. Gawlik, G. Andrá & J. Plentz  
IPHT, Jena, Germany
- 2DV.3.47 Interdigitated Back Contact Silicon Heterojunction Solar Cells: Towards Industrially Feasible Manufacturing Methods**  
S. Abolmasov, V.N. Verbitskiy, A. Titov, G. Shelopin, P. Valkov & E.I. Terukov  
R&D Center TFTE, St. Petersburg, Russian Federation
- 2DV.3.48 Single-Shot and Periodic Photoelectrochemical Texturing of Silicon for Improved Light Absorption**  
N. Avishan, A. Akbiyik, E. Yüce & A. Bek  
METU, Ankara, Turkey
- 2DV.3.49 New Procedure for Specific and High Absorbents Silicon Surface Nanotextures: Inverted Pyramids, Cubic Nano-Microholes, Spiroconical Nano-Microholes and Rhombohedral - Stared Nanosheets Bouquets**  
N.C.Y. Fall, M. Touré, R. Ndioukane, A.K. Diallo & D. Kobor  
Ziguinchor University, Senegal  
M. Pasquinelli  
Aix Marseille University, France
- 2DV.3.50 Analysis of Electrical Properties by Various Electrode Design of Shingled Solar Cells with p-Type PERC Structure**  
D. Oh, Y. Kim & J. Yi  
Sungkyunkwan University, Suwon, Republic of Korea
- 2DV.3.51 Heterojunction Silicon Solar Cells Incorporating Unpatterned MoO<sub>x</sub> and LiF/Al Layers on Wet-Chemically Processed Silicon Surfaces**  
K. Tsoi & M. Ghasemi  
GÜNAM, Ankara, Turkey  
D. Türkay, E. Donercark, R. Turan & S. Yerci  
METU, Ankara, Turkey
- 2DV.3.52 Engineering SiO<sub>2</sub>/TiO<sub>2</sub> Stacks for Improved Electron Selective Contacts**  
I. Costa, D. Vilhena, G. Gaspar, D. Pera, J. Canhoto Cardoso, K. Lobato, J. Almeida Silva & J.M. Almeida Serra  
University of Lisbon, Portugal
- 2DV.3.53 Back Contact Coating to Increase the Efficiency of Polycrystalline Silicon Solar Cells**  
R. AbdelRassoul & S. El-Hashash  
AASTMT, Alexandria, Egypt  
A.-E.-H.-B Kashyout  
SRTA-City, Alexandria, Egypt

**VISUAL PRESENTATIONS****15:15 – 16:45 POSTER AWARDS WINNERS SESSION****Chairperson:**Julio Cárabe  
CIEMAT, Spain

Aiming to increase the visibility of poster awards winners and as a recognition to the quality of their presentation, the winners will be presented on this dedicated Poster Awards Winners session. This session will be composed of 2 parts: The above mentioned presentation of the winners, and a chat discussion in a dedicated virtual room together with the winners and interested audience.

