EU PVSEC 2021 *online*

38th European Photovoltaic Solar Energy Conference and Exhibition

06 - 10 September 2021

THE INNOVATION PLATFORM FOR THE GLOBAL PV SOLAR SECTOR

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CONFERENCE PROGRAMME

www.photovoltaic-conference.com

CONFERENCE PROGRAMME

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

(i) = invited

Monday, 06 September 2021

MONDAY MORNING

CONFERENCE OPENING

PLENARY SESSION AP.1 / Scientific Opening

8:30 – 09:30 Devices in Evolution: Pushing the Efficiency Limits and Broadening the Technology Portfolio

Chairpersons:

Robert P. Kenny
European Commission JRC, Ispra, Italy

Wim C. Sinke
TNO Energy Transition, Petten, The Netherlands

AP.1.1 **Perfecting Silicon**
M. Boccard, V. Paratte, L. Antognini, J. Cattin, J. Dréon, D. Fébba, W. Lin, J. Thomet, D. Türkay & C. Ballif
EPFL, Neuchâtel, Switzerland

AP.1.2 **Beyond Single Junction Efficiencies**
R. Peibst
ISFH, Emmerthal, Germany

AP.1.3 **Electrification without Limitation**
S. DeLuca
EMC, Rochester, USA

Monday, 6 September 2021

09:45 – 10:15 Becquerel Prize Ceremony

Chair of Ceremony:
Christophe Ballif
Chairman of the Becquerel Prize Committee,
EPFL, Neuchâtel, Switzerland

Becquerel Prize Winner 2021
Ulrike Jahn
VDE Renewables, Germany

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

Laudatio
Thomas Nordmann
TNC Consulting, Switzerland

10:30 – 11:15 Opening Addresses

Chaired by:
João M Serra
EU PVSEC Conference General Chair.
Faculdade de Ciências da Universidade de Lisbon, Portugal

Kadri Simson
European Commissioner for Energy

João M Serra
EU PVSEC Conference General Chair.
Faculdade de Ciências da Universidade de Lisbon, Portugal

João Saldanha de Azevedo Galamba
Deputy Minister & Secretary of State for Energy, Portugal

Andreas Bett
Director, Fraunhofer ISE / representative from ESMC

11:30 – 12:30 Moderated Panel Discussion

The making of a climate-neutral continent: How to recover and boost a sustainable European PV production?

Moderation:

Radovan Kopecek
Director ISC Konstanz / Board member EUREC

Panellists:

Henrike Hahn
MEP, Greens/EFA Group in the European Parliament,
Committee Member Industry, Research and Energy,
Spokesperson for Industrial Policy of the German Green Party
in the European Parliament

Diederik Samsom
Head of Cabinet of Frans Timmermans, Executive Vice President for the European Green Deal, European Commission

Joaquim Nunes de Almeida
European Commission, Director for Mobility & energy intensive industries, DG GROW, European Commission

João Saldanha de Azevedo Galamba
Deputy Minister & Secretary of State for Energy, Portugal

Walburga Hemetsberger
CEO SolarPower Europe

Andreas Bett
Director Fraunhofer ISE

Monday, 6 September 2021

ORAL PRESENTATIONS 1AO.1

13:30 – 15:00 Advanced and Novel Approaches for Transparent Layers and Metal Contacting

Chairpersons:

Antonio Martí Vega
UPM, Madrid, Spain

Olindo Isabella
Delft University of Technology, The Netherlands

1AO.1.1 Transparent Electrodes Based on Refractory-Metal Oxides, as Cathodes and Anodes for Flexible Photovoltaics, Developed for High Throughput, Industrial Processing
T. Dimopoulos, S. Götz, R.A. Wibowo, N. Bansal, M. Bauch, D. Mehanni & B. Kubicek
AIT, Vienna, Austria
M. Valtiner
TU Wien, Vienna, Austria
G. Ligorio & E. List-Kratochvil
Humboldt University of Berlin, Germany
S. Narbey & T. Meyer
Solaronix, Aubonne, Switzerland
C. Linke, E. Franzke, H. Köstenbauer & J. Winkler
PLANSEE, Reutte, Austria

1AO.1.2 Transparent Electrodes for Flexible Nanowire Solar Cells
T. Mathieu-Pennober, F.H. Julien & M. Tchernycheva
C2N, Palaiseau, France
M. Foldyna
CNRS, Palaiseau, France
S.-T. Zhang & N. Schneider
IPVF, Palaiseau, France

1AO.1.3 Student Awards Finalist Presentation: Transparent N- and Nb- Doped NiO-Based Heterostructures for Transparent and Tandem Solar Cells and Energy Harvesting
C. Aivalioti, A. Papadakis, E. Manidakis, M. Androulidaki, M. Kayambaki, K. Tsagaraki, A. Kostopoulos, K. Stoumpos & E. Aperathitis
University of Crete, Heraklion, Greece
N.T. Pelekanos
FORTH, Heraklion, Greece
M. Modreanu
Tyndall National Institute, Cork, Ireland
G. Craciun & C. Romanitan
IMT, Bucharest, Romania

1AO.1.4 Amorphous Silicon-Free Heterojunction Crystalline Silicon Solar Cells Employing MoOx as Hole-Selective and Passivating Contact
S. Patwardhan, S. Maurya, A. Kumar & B. Kavaipatti
IIT Bombay, Mumbai, India

1AO.1.5 **Optimization of Carbon-Nanotube-Reinforced Composite Gridlines towards Commercialization**
A. Chavez & S.M. Han
Osazda Energy, Albuquerque, USA
B. Rummel & N. Dowdy
University of New Mexico, Albuquerque, USA
N. Bosco
NREL, Golden, USA
B. Rounsaville & A. Rohatgi
Georgia Institute of Technology, Atlanta, USA

1AO.1.6 **Metal Grid Finger Design Optimization for Cell to Module Ratio Using the Configurable Current Cell Technology**
B. Damiani
Solar Inventions, Atlanta, USA
A. Ebong
UNC Charlotte, USA

ORAL PRESENTATIONS 3AO.4

13:30 – 15:00 **Tandem Upscaling towards Industrialisation**

Chairpersons:

Damien Lachenal
Meyer Burger, Hauterive, Switzerland

Fabian Fertig
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

3AO.4.1 **Scale Up of Perovskite/Silicon Tandem Devices: Advances in Metallization, Silicon Surface Preparation, and Meniscus Coating for Rapid Fabrication of Large Area Devices**
B.A. Kamino, T. Offermans, B. Paviet-Salomon, A. Walter, C. Allebé, G. Christmann, L. Lauber, P. Wyss, A. Paracchino & S. Nicolay
CSEM, Neuchâtel, Switzerland
C. Ballif
EPFL, Neuchâtel, Switzerland

3AO.4.2 **Hybrid PVD/VTD Vapour Deposition Processing for Perovskite Tandem Solar Cell Upscaling**
Q. Guesnay, F. Sahli, N. Salsi, B. Niesen, C. Ballif & Q. Jeangros
EPFL, Neuchâtel, Switzerland
L. Duchêne
Empa, Dübendorf, Switzerland

Monday, 6 September 2021

3AO.4.3 **Tackling the Challenges for Industrialization of Perovskite Silicon Tandem Solar Cells**
J.C. Goldschmidt, P.S.C. Schulze, O.S. Kabakli, A.J. Bett, M. Bivour, R. Efinger, F. Feldmann, F.M. Gerspacher, B.S. Goraya, M. Heydarian, C. Luderer, C. Messmer, H. Nagel, S. Nold, M. Penn, C. Reichel, M.C. Schubert, C.A. Romero Sierra, L. Tutsch, M. Hermle & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany
B. Fett & B. Herbig
Fraunhofer ISC, Würzburg, Germany
H. King & V. Sittinger
Fraunhofer IST, Braunschweig, Germany
S. Lange & V. Naumann
Fraunhofer CSP, Halle (Saale), Germany

3AO.4.4 **Interface Passivation of Monolithic Perovskite/Silicon Tandem Solar Cells on Textured Wafers**
P. Fiala, X.-Y. Chin, F. Sahli, D. Jacobs, Q. Guesnay, C.M. Wolff, Q. Jeangros & C. Ballif
EPFL, Neuchâtel, Switzerland

3AO.4.5 **Robustness of Three-Terminal Perovskite/Silicon Tandem Solar Cells with Interdigitated Back-Contacts Against Spectral Variations**
P. Wagner, P. Tockhorn, S. Albrecht & L. Korte
HZB, Berlin, Germany

3AO.4.6 **Quantifying the Performance Gain of 6 Inch Bifacial 4T pk-Si Tandem Modules**
P. Manshanden, G. Coletti, V. Rosca, M.J. Jansen, K.M. de Groot & G.J. de Graaff
TNO Energy Transition, Petten, The Netherlands
L. Simurka, M. Najafi, V. Zardetto, I. Dogan, H. Fledderus & S.C. Veenstra
TNO Energy Transition, Eindhoven, The Netherlands
M. Creatore
Eindhoven University of Technology, The Netherlands

PANEL DISCUSSION 4/5AO.7

13:30 – 15:00 ***Managing Performance and Sustainability at the TW Scale***

Part 1: Computational PV
Almost 10% of presentations at this EUPVSEC deal with advanced computing. Algorithms, big data, machine learning, artificial intelligence, image recognition and satellite data processing appear in the titles of contributions which range from solar cell modeling, manufacturing, preventive maintenance, site selection to forecasting, nowcasting, user behavior and modeling of entire electricity systems. This panel discussion aims to get the view of top experts on how the tremendous progress of computing power in the last decade has influenced the way we assess photovoltaic technology at large. And most likely the next ten years will see even more.

Can substantial cost gains be achieved? Will we have intelligent inverters which will decide on their own about self-consumption, grid-feeding or storage? Will be there new players taking on the role of utilities by optimizing the services PV systems can deliver? What about optimizing PV in cities and on cars when a 3D model of the landscape is easily available in real time?

Part 2: Resource Efficiency of PV in Production, Use and Disposal
The latest IPCC report has been published recently and there is an urgent need for action to mitigate our emissions and save our limited resources.

PV systems do contribute significantly to the solution for nature conservation. Modern eco-friendly technologies and long lasting, repairable products are required in combination with sound circular economy approaches to process the huge anthropogenic stock of valuable resources at the end of life of the PV systems.

This panel discussion aims to get the view of top experts on how PV can form an even better sustainable solution to our increasing energy hunger. The discussion will cover international policy development needs, environmentally friendly, resource efficient production approaches including novel reuse and repair concepts, and the introduction of a sound circular economy.

Main questions are:
How can PV products and production processes be further optimized?
What is required to increase service life, and introduce repairable and easy recyclable PV products?
Which international policies are needed to support the introduction of such products and better circularity?

These are just some of the questions the panel will discuss and give the audience a glimpse into the future of "PV everywhere"

Monday, 6 September 2021

Moderator: Heinz Ossenbrink
Former European Commission JRC, Ispra, Italy

Co-moderator: Harry Lehmann
Federal Environment Agency of Germany, Dessau-Roßlau, Germany

Part 1: **Increasing Computational Approaches to PV Deployment**

Panelists: Gerhard Mütter
Enery, Vienna, Austria

Ana Gracia Amillo
European Commission JRC, Ispra, Italy

Claudia Buerhop-Lutz
HI ERN, Erlangen, Germany

Nelson Sommerfeldt,
KTH Royal Institute of Technology, Stockholm, Sweden

Part 2: **Resource Efficiency of PV in Production, Use and Disposal**

Panelists: Nieves Espinosa
European Commission JRC, Seville, Spain

Karsten Wambach
Wambach-Consulting, Petersdorf, Germany

Susan Huang
Solar Energy Technologies Office, Washington, USA

Toralf Nitsch
Rinovasol, Weiden, Germany

Jose Bilbao Bernales
UNSW Australia, Sydney, Australia

Karl-Anders Weiß
Fraunhofer ISE, Freiburg, Germany

ORAL PRESENTATIONS 1AO.2

15:15 – 16:45 Innovative Approaches for Solar Cells and Photovoltaic Materials

Chairpersons:

Marin Rusu
HZB, Berlin, Germany

Jozef (Jef) Poortmans
imec, Leuven, Belgium

1AO.2.1 Progress in Three-Terminal Heterojunction Bipolar Transistor Solar Cells
E. Antolín, M.H. Zehender, S.A. Svatek, I. Garcia, P. García-Linares & A. Martí
UPM, Madrid, Spain
M.A. Steiner, E.L. Warren & A.C. Tamboli
NREL, Golden, USA

1AO.2.2 Omni-Directional PERC Solar Cells with Hierarchical Patterns and Micro-Lens by Silicone Encapsulation
M.J. Yun, Y.H. Sim, D.Y. Lee & S.I. Cha
KERI, Changwon, Republic of Korea

1AO.2.3 Predicting Solar Cell Material Limits from Fourier-Transform Photocurrent Spectroscopy Measurements
J. Holovsky & A. Peter Amalathas
CTU in Prague, Czech Republic
K. Ridzonová
ASCR, Prague, Czech Republic

1AO.2.4 Structural and Optical Study of Europium Doped ZnO FIlms Grown on Different Substrates
V.F. Gremenok, E.P. Zaretskaya & A.V. Stanchik
NASB, Minsk, Belarus
V.V. Khoroshko
BSUIR, Minsk, Belarus
A.N. Pyatlitski, V.A. Saladukha & T.V. Piatlitskaya
JSC “INTEGRAL”, Minsk, Belarus
N. Akcay
Baskent University, Ankara, Turkey

1AO.2.5 Invited

1AO.2.6 BaZrS3 Chalcogenide Perovskite Thin Films by H2S Sulfurization
J.A. Marquez-Prieto, M. Rusu, H. Hempel, I.Y. Ahmet, M. Kölbach, I. Simsek, L. Choubrac, G. Gurieva, R. Gunder, S. Schorr & T. Unold
HZB, Berlin, Germany

Monday, 6 September 2021

ORAL PRESENTATIONS 3AO.5

15:15 – 16:45 Tandem Solar Cells Process and Performance

Chairpersons:

Arnaud Walter
CSEM, Neuchâtel, Switzerland

Steve Albrecht
HZB, Berlin, Germany

3AO.5.1 Two-Terminal III-V//Si Triple-Junction Solar Cells with One-Sun Conversion Efficiencies of 35.9 %
P. Schygulla, R. Müller, O. Höhn, H. Hauser, B. Bläsi, F. Predan, J. Benick, M. Hermle, F. Dimroth, S.W. Glunz & D. Lackner
Fraunhofer ISE, Freiburg, Germany

3AO.5.2 How to Make PERC Suitable for Perovskite-Silicon Tandem Solar Cells: A Simulation Study
C. Messmer, J. Schön, S. Lohmüller, J.C. Goldschmidt, M. Bivour, S.W. Glunz & M. Hermle
Fraunhofer ISE, Freiburg, Germany

3AO.5.3 Process and Layer Optimization for the Fabrication of Highly Efficient Perovskite/ACIGS Thin-Film Tandem Solar Cells
S. Essig, T. Wahl, S. Paetel, D. Hariskos, T. Magorian-Friedlmeier, M. Loy, J. Hanisch, E. Ahlswede & M. Powalla
ZSW, Stuttgart, Germany

3AO.5.4 Maximizing the Optical Performance of Nanotextured Perovskite/Silicon Tandem Solar Cell Using Numerical Optimizations
K. Jäger, J. Sutter & C. Becker
HZB, Berlin, Germany
M. Hammerschmidt & P.-I. Schneider
JCMwave, Berlin, Germany

3AO.5.5 Periodic Nanostructures for High-Efficient Perovskite/Silicon Tandem Solar Cells
J. Sutter, P. Tockhorn, P. Wagner, K. Jäger, A. Al-Ashouri, B. Stannowski, S. Albrecht & C. Becker
HZB, Berlin, Germany

3AO.5.6 Over 22% Flexible All-Perovskite 4-Terminal Tandem Solar Cells
Y. Zwirner, H. Lai, A.N. Tiwari & F. Fu
Empa, Dübendorf, Switzerland
Y. Hou
National University of Singapore, Singapore

ORAL PRESENTATIONS 2AO.8

15:15 – 16:45 Manufacturing and Production of Silicon Cells

Chairpersons:

David M. Pera
University of Lisbon, Portugal

Pierre Verlinden
Amrock, McLaren Vale, Australia

2AO.8.1 Introductory Oral: From Upscaling PERC to the Next Technology Cycle: Transparent Passivating Contacts May Merge n- and p-Type Cell Technology
P.P. Altermatt, G. Xu, X. Zhang, D. Chen, Y. Chen & Z. Feng
Trinasolar, Changzhou, China

2AO.8.2 Establishment of a 1.3 GWp Solar Power Plant and 500 MWp Integrated Manufacturing Facility in Turkey: Showcase for the Revival of Solar Manufacturing in Europe
P. Fath
RCT-Solutions, Konstanz, Germany
F. Es
Kalyon PV, Ankara, Turkey

2AO.8.3 Explaining the Efficiencies of Mass-Produced p-Type Cz-Si Solar Cells by Interpretable Machine Learning
S. Wasmer, K. Hübener & B. Klöter
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

2AO.8.4 Inline High-Intensity Light Soaking Treatment to Improve the Efficiency of Silicon Heterojunction Solar Cells
S. Roder, A. Moldovan, S. Pingel, J. Schneider & J.-F. Nekarda
Fraunhofer ISE, Freiburg, Germany

2AO.8.5 Precise and Low-Cost I-V Curve Measurement of Industrial Busbar-Less Silicon Solar Cells by Using Flexible Spring Suspension (FSS) Probe Bars
K. Kamatani, H. Kitamura, H. Kojima, Y. Nakamichi, Y. Fujita, K. Shibamoto & S. Kojima
KOPEL (Kyoshin Electric), Kyoto, Japan

VISUAL PRESENTATIONS 4AV.1

15:15 – 16:45 PV Module Design, Components and Ageing

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

Monday, 6 September 2021

ORAL PRESENTATIONS 1AO.3

17:00 – 18:30 Innovative Approaches for Module Concepts

Chairpersons:

Igor Konovalov
University of Applied Sciences Jena, Germany

Francesco Roca
ENEA, Portici, Italy

1AO.3.1 The Potential of Glass-Fibre-Reinforcement: (Thermo-)Mechanical Testing of Light-Weight PV Modules
J. Govaerts, K. Moliya, T. Borgers, R. Van Dyck, A.S.H. van der Heide, L. Tous & J. Poortmans
imec, Genk, Belgium
B. Luo
KU Leuven, Belgium
A. Morlier
ISFH, Emmerthal, Germany
F. Lisco
EPFL, Neuchâtel, Switzerland
L. Cerasti & M. Galiazzo
Applied Materials, Olmi di San Biagio, Italy

1AO.3.2 Prototyping and Testing of a Reconfigurable Series-Parallel PV Module
A. Calcabrini, M. Muttillo, M. Zeman, P. Manganiello & O. Isabella
TU Delft, The Netherlands

1AO.3.3 High-Resolution Electroluminescence Study of Alternative Patterning P1 Strategies for CIGS Modules
C.O. Ramírez Quiroz , J. Müller & K. Orgassa
NICE Solar Energy, Schwäbisch Hall, Germany
V. Cardin & L.-I. Dion-Bertrand
Photon, Montréal, Canada
M. Salvador
KAUST, Thuwal, Saudi Arabia
N. Gasparini
Imperial College London, United Kingdom

1AO.3.4 Application of Transparent Grid Backsheet and Grid Glass to the Power Generation of Bifacial Photovoltaic Module
J. Chen, P Ni & X. Cai
Talesun Solar, Suzhou, China

1AO.3.5 Solder Paste for Interconnecting Structured Ribbons on the Back Side of the c-Si Cells
N.S. Pujari, P.M. Krithika & S. Sarkar
Macdermid Alpha Electronics Solutions, Bangalore, India
C. Bilgrien
Macdermid Alpha Electronics Solutions, Plainfield, USA

1AO.3.6 **Enhancing the Performance of Luminescent Solar Concentrator Photovoltaic Devices Using Multiple Organic Dyes and Bifacial Silicon Solar Cells**
N. Desai & M. Aghaei
Eindhoven University of Technology, The Netherlands
A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands

ORAL PRESENTATIONS 3AO.6

17:00 – 18:30 Organic and Dye-Sensitised Photovoltaics

Chairpersons:

Veronica Bermudez Benito
QEERI, Doha, Qatar

Wolfgang Tress
Zurich University of Applied Sciences, Winterthur, Switzerland

3AO.6.1 **Introductory Oral: From-Lab-to-Fab of 3rd Generation PV - Issues, Challenges, and Installations**
D. Bagnis
CSEM, Belo Horizonte, Brazil

3AO.6.2 **Economic Assessment and Market Perspectives of emerging Thin Film, Organic and Perovskite-Based PV Technologies**
B. Azzopardi
MCAST, Paola, Malta

3AO.6.3 **Invited**

3AO.6.4 **Effect of Additives and Annealing on the Performance of Nonfullerene-Based Binary and Ternary Organic Photovoltaics**
E. Moustafa, A.A.A. Torimtubun, J. Pallarès Marzal & L.F. Marsal Garví
URV, Tarragona, Spain

3AO.6.5 **Calibration of a Dye-Sensitized Photovoltaic Large Area Module**
G. Bardizza, D. Pavanello, H. Müllejans & E.D. Dunlop
European Commission JRC, Ispra, Italy

Monday, 6 September 2021

ORAL PRESENTATIONS 2AO.9

17:00 – 18:30 Production Processes of Silicon Solar Cells

Chairpersons:

Derk L. Bätzner
Meyer Burger Research, Hauterive, Switzerland

Peter Fath
RCT-Solutions, Konstanz, Germany

2AO.9.1 **Effects of Plasma Etching on Dopant Compensation between p- and n-Type Poly-Si Fingers in Passivated Interdigitated Back Contact Solar Cells**
M.B. Hartenstein & S. Agarwal
Colorado School of Mines, Golden, USA
S. Harvey, W. Nemeth, V. LaSalvia, M. Page, D.L. Young & P. Stradins
NREL, Golden, USA

2AO.9.2 **Low Stress & Ductile Plating Metallization for Reliable Bifacial TOPCon Solar Cells and Modules**
S. Kluska, B. Grübel, G. Cimiotti, C. Schmiga & A.J. Beinert
Fraunhofer ISE, Freiburg, Germany
I. Kubitza, P. Müller & T. Voss
Atotech, Berlin, Germany

2AO.9.3 **Equipment and Process Development for Rapid Manufacturing Ni/Cu Plated Contacts in Si Solar Cells**
Y. Chang, S. Wang, R. Deng, J. Ji & C.M. Chong
UNSW Australia, Sydney, Australia
S. Li
Kunming University of Science and Technology, China

2AO.9.4 **Application of Artificial Intelligence Techniques for Optimization of Metallization Process**
E. Boscolo Marchi, A. Dalla Lana, S. Visintin, M. Galiazzo & A. Voltan
Applied Materials, Olmi di San Biagio, Italy

2AO.9.5 **High Throughput Solar Cell Processing by Oxidation of Wafer Stacks**
M. Meßmer, S. Lohmüller, J. Weber & A. Wolf
Fraunhofer ISE, Freiburg, Germany

2AO.9.6 **Reliability Evaluation of PV Modules Fabricated from Treated Solar Cells by Laser Enhanced Contact Optimization (LECO) Process**
B. Jäckel, H. Hanifi, U. Zeller, M. Pander & P. Schenk
Fraunhofer CSP, Halle (Saale), Germany
E. Krassowski, H. Zhao & E. Hofmüller
CE Cell Engineering, Kabelsketal, Germany

VISUAL PRESENTATIONS 4AV.2

17:00 – 18:30 PV Module Characterisation, Testing and Outdoor Performance

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

Tuesday, 07 September 2021

ORAL PRESENTATIONS 4BO.1

08:30 – 10:00 PV Module Design and Materials

Chairpersons:

Ralph Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

Christian Thiel
European Commission JRC, Ispra, Italy

4BO.1.1 Overview of the Latest Results Achieved in the H2020 Funded Project HighLite Aiming for High-Performance, Low-Cost and Sustainable c-Si PV Modules Tailored for Different Applications
L. Tous & J. Govaerts
imec, Leuven, Belgium
S. Harrison & C. Carrière
CEA, Le Bourget-du-Lac, France
F. Buchholz & A. Halm
ISC Konstanz, Germany
A. Faes & G. Nogay
CSEM, Neuchâtel, Switzerland
A. Ingenito & F.-J. Haug
EPFL, Neuchâtel, Switzerland
F. Feldmann, D. Raine & M. Mittag
Fraunhofer ISE, Freiburg, Germany
F. Haase & A. Morlier
ISFH, Emmerthal, Germany
M. Bokalič, K. Brecl & M. Topic
University of Ljubljana, Slovenia
J.C.P. Kester
TNO Energy Transition, Petten, The Netherlands
S. Wendlandt
PI Berlin, Germany
M. Galiazzo & A. Voltan
Applied Materials, Olmi di San Biagio di Callalta, Italy
G. Galbiati & L. Theunissen
Henkel Electronic Materials, Westerlo, Belgium
F. Torregrosa
Ion Beam Services, Peynier, France
M. Grimm
3D-Micromac, Chemnitz, Germany
J. Denafas & T. Radavičius
Soli Tek, Vilnius, Lithuania
P. Lukinskas
Valoe Cells, Vilnius, Lithuania
J. Kaakkunen & T. Savisalo
Valoe, Mikkeli, Finland
T. Regrettier
Voltec Solar, Dinsheim-sur-Bruche, France

4BO.1.2 **Needs, Challenges and Approaches for New Service Life Estimation Models for PV Modules – Results from IEA PVPS Task 13 Subtask 1.4**
K.-A. Weiß & I. Kaaya
Fraunhofer ISE, Freiburg, Germany
G. Oreski
PCCL, Leoben, Austria
L. Bruckman & R.H. French
CWRU, Cleveland, USA
T. Tanahashi
AIST, Tsukuba, Japan

4BO.1.3 **C-Si PV for Curved Surfaces: 3D Simulations and Measurement of Performance**
M. Spath, N. Guillevin, L.A.G. Okel, A.R. Burgers & B.K. Newman
TNO Energy Transition, Petten, The Netherlands

4BO.1.4 **Understanding Interfacial Degradation in Glass/Glass Photovoltaic Module Packaging**
M. Owen-Bellini, D.B. Sulas-Kern, L. Spinella, P. Ndione, S.W. Johnston & L.T. Schelhas
NREL, Golden, USA
S. Ulicna & A. Sinha
SLAC, Menlo Park, USA

4BO.1.5 **Holistic Design Optimization of the PV Module Frame: CTM, FEM, COO and LCA Analysis**
A. Tummalieh, A.J. Beinert, C. Reichel & M. Mittag
Fraunhofer ISE, Freiburg, Germany

4BO.1.6 **FoilMet®-Interconnect Shingling (FIS): Aluminum Foil Based Interconnection for Modules with Shingled Solar Cells**
J. Paschen, O. John, P. Baliozian & J.-F. Nekarda
Fraunhofer ISE, Freiburg, Germany

ORAL PRESENTATIONS 5BO.6

08:30 – 10:00 **Solar Radiation Modelling and Instrumentation**

Chairpersons:

Marion Schroedter-Homscheidt
German Aerospace Center, Oldenburg, Germany

Manajit Sengupta
NREL, Golden, USA

5BO.6.1 **Adapting PVGIS to Trends in Climate, Technology and User Needs**
A.M. Gracia Amillo, A. Martinez Fernandez, N. Taylor & E.D. Dunlop
European Commission JRC, Ispra, Italy
P. Mavrogiorgios
Fincons, Ispra, Italy
G. Arcaro
Piksel, Milan, Italy
I. Pinedo Pascua
Non affiliated, Ispra, Italy

Tuesday, 7 September 2021

5BO.6.2 **Improving the Prediction of DNI via Physics-Based Simulation of All-Sky Circumsolar Radiation**
Y. Xie, J. Yang & M. Sengupta
NREL, Golden, USA
Y. Liu
BNL, Upton, USA

5BO.6.3 **Characterizing the Convergence and Robustness of the Kernel Density Mapping Method for Site-Adaptation of Global Horizontal Irradiation in Western Europe**
L. Yezeguelian, C. Vernay & T. Carriere
SOLAÏS, Sophia Antipolis, France
P. Blanc
MINES ParisTech, Sophia Antipolis, France

5BO.6.4 **Optimizing Methodology for Estimating Global Horizontal Irradiance (GHI) Using Solar Photovoltaics' Output AC Power Measurements**
M.A. Khan & N. Sommerfeldt
KTH Royal Institute of Technology, Stockholm, Sweden
D.-E. Archer
CheckWatt, Danderyd, Sweden

5BO.6.5 **Uncertainty of Tilted Irradiance Measurements Using Photodiodes and Reference Cells**
A. Driesse
PV Performance Labs, Freiburg, Germany
S. Wilbert
Institute of Solar Research, Tabernas, Spain
A. Forstinger
CSP Services, Cologne, Germany

5BO.6.6 **Uncertainty Calculation Method for Photodiode Pyranometers**
A. Forstinger & B. Kraas
CSP Services, Cologne, Germany
S. Wilbert
Institute of Solar Research, Tabernas, Spain
A. Driesse
PV Performance Labs, Freiburg, Germany

ORAL PRESENTATIONS 2BO.11

08:30 – 10:00 Poly-Silicon Passivated Contacts

Chairpersons:

Martin Hermle
Fraunhofer ISE, Freiburg, Germany

Barbara Terheiden
University of Konstanz, Germany

2BO.11.1 Local PECVD SiOxNy/n-Poly-Si Deposition through a Shadow Mask for POLO IBC Solar Cells
V. Mertens, S. Schäfer, M. Stöhr, A. Mercker, A. Köhler, L. Mettner, R. Brendel & T. Dullweber
ISFH, Emmerthal, Germany
N. Ambrosius
LPKF SolarQuipment, Garbsen, Germany
T. Pernau & H. Haverkamp
centrotherm international, Blaubeuren, Germany

2BO.11.2 Fabrication of Poly-Si on Locally Etched SiOx Passivating Contacts on c-Si of Various Surface Morphologies
C. Lima Salles de Souza & S. Agarwal
Colorado School of Mines, Golden, USA
W. Nemeth, H. Guthrey & P. Stradins
NREL, Golden, USA

2BO.11.3 Local Passivating Contacts from Laser Doped P+ Polysilicon
F. Buchholz, J. Hoß, H. Chu, V.D. Mihailetchi, A. Chaudhary, J. Arumughan, J. Lossen, R. Kopecek & E. Wefringhaus
ISC Konstanz, Germany

2BO.11.4 Novel Poly-Si:Ga/SiOx Passivating Contacts through Non-Equilibrium Doping
K. Chen & S. Agarwal
Colorado School of Mines, Golden, USA
E. Napolitani
University of Padova, Italy
S. Theingi, H. Guthrey, W. Nemeth, M. Page, P. Stradins & D.L. Young
NREL, Golden, USA

2BO.11.5 Controlling Doping Density in DC-Sputtered In-Situ Phosphorous-Doped Polysilicon Layers for Passivating Contacts
L. Nasebandt, B. Min, R. Peibst & R. Brendel
ISFH, Emmerthal, Germany
S. Hübner, T. Dippell & P. Wohlfart
Singulus Technologies, Kahl am Main, Germany

2BO.11.6 Hydrogenation of Sputtered ZnO:Al Layers for Double Side Poly-Si/SiOx Integration
C. Seron, T. Desrues, F. Jay, A. Lanterne & S. Dubois
CEA, Le Bourget-du-Lac, France
Q. Rafhay & A. Kaminski-Cachopo
IMEP-LAHC, Grenoble, France

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ORAL PRESENTATIONS 1BO.16

08:30 – 10:00 Fundamental Studies in the Forefront of PV

Chairpersons:

Takeshi Tayagaki
AIST, Tsukuba, Japan

Phoebe Pearce
University of Cambridge, United Kingdom

1BO.16.1 Assessment of Photon Recycling in Perovskite Solar Cells by Full Opto-Electronic Simulation
S. Zeder & U. Aeberhard
Fluxim, Winterthur, Switzerland
B. Ruhstaller
ZHAW, Winterthur, Switzerland

1BO.16.2 Student Awards Finalist Presentation: Optic Filters as Multi-Purpose Devices for Photovoltaic Applications: Models for Full Performance Assessment and Optimized Design
J.C. Ortiz Lizcano, P.A. Procel Moya, R. Santbergen, G. Frantzi, P. Seoane da Silva, A. Calcabrini, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

1BO.16.3 Towards Megapixel Resolution Compressed Sensing Current Mapping of Photovoltaic Devices Using Digital Light Processing
G. Koutsourakis, A. Thompson & J.C. Blakesley
NPL, Teddington, United Kingdom

1BO.16.4 Experimental Test of Heat Recovery in Silicon Solar Cells with Thermoelectric Materials
K. Kamide, T. Mochizuki & H. Takato
AIST, Koriyama, Japan
J. Sakuma & H. Akiyama
The University of Tokyo, Kashiwa, Japan

1BO.16.5 On the Non-Ideal Diode Factor in Solar Cells and the Existence of Multiple Quasi-Fermi Levels
I. Ramiro
CEMOP/UNINOVA, Caparica, Portugal
P.G. Linares & A. Martí
UPM, Madrid, Spain

1BO.16.6 Fast and Spatially Resolved Characterization of Secondary Phases in Kesterite Thin Films by Near-Infrared Imaging
L. Choubrac, F. Akhundova, J.A. Marquez-Prieto, P. Becker & T. Unold
HZB, Berlin, Germany

VISUAL PRESENTATIONS 3BV.1

08:30 – 10:00 Perovskite Solar Cells and Modules

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

ORAL PRESENTATIONS 4BO.2

10:30 – 12:00 PV Module Outdoor Performance and Energy Rating

Chairpersons:

Yoshihiro Hishikawa
AIST, Tsukuba, Japan

Stefan Winter
PTB, Braunschweig, Germany

4BO.2.1 Evaluation of Energy Yield and Energy Rating for Perovskite / Silicon Tandem Modules in Different Climates Using a Hybrid Approach
M.R. Vogt, A. Nour El Din, G. Pilis, R. Santbergen, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands
V.D. Mihailetchi & C. Picon
ISC Konstanz, Germany

4BO.2.2 Comparison of Different Approaches to Determine the Nominal PV Module Operating Temperature (NMOT)
W. Herrmann
TÜV Rheinland Energy, Cologne, Germany
K. Lee
Array Technologies, Albquqerque, USA
C. Monokroussos
TÜV Rheinland, Shanghai, China

4BO.2.3 Outdoor Performance of Anti-Soiling Coatings in Various Climates of Saudi Arabia
M.Z. Khan, K. Lange, V. Naumann, C. Hagendorf, R. Gottschalg & K. Ilse
Fraunhofer CSP, Halle (Saale), Germany
A. Ghaffar
Anhalt University of Applied Sciences, Köthen, Germany
M.A. Bahattab, I.M.S. Abaalkheel, M.H.M. Alqahtani, A.A.A. Aldhuwaile, S. Alqahtani & H. Qasem
KACST, Riyadh, Saudi Arabia
M. Mirza
Fraunhofer ISC, Würzburg, Germany

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4BO.2.4 Energy Contribution of Rear-Side Irradiance for Bifacial Photovoltaic Modules
G.L. Martins & S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
L. Burnham
Sandia National Laboratories, Albuquerque, USA
S.-Y. Oh & W.K. Kim
Yeungnam University, Gyeongsan, Republic of Korea
T.R. Betts
Loughborough University, United Kingdom
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
B.W. Figgis
QEERI, Doha, Qatar
C.D. Rodríguez-Gallegos
SERIS, Singapore
A.K. Vidal de Oliveira, M. Braga & R. Rüther
UFSC, Florianópolis, Brazil

4BO.2.5 Outdoor Performance Evaluation of Shingle Modules
S. Malik, D. Daßler, M. Pander, B. Jäckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4BO.2.6 Quantitative Evaluation of the Shading Resilience of PV Modules
N. Klasen, D. Weißer, T. Roessler & A. Kraft
Fraunhofer ISE, Freiburg, Germany

ORAL PRESENTATIONS 5BO.7

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

Chairpersons:

Ana Maria Gracia Amillo
European Commission JRC, Ispra, Italy

Wilfried G.J.H.M. van Sark
Utrecht University, The Netherlands

5BO.7.1 Comparison and Optimization of Forecasting Methods for Photovoltaic Power and Energy Generation with and without Exogenous Inputs
A. Starosta & N. Munzke
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany

5BO.7.2 Spatio-Temporal Machine Learning Methods for Multi-Site PV Power Forecasting
R.E. Carrillo Rangel, B. Schubnel, J. Simeunovic, R. Langou & P.-J. Alet
CSEM, Neuchâtel, Switzerland

5BO.7.3 **Assessment of Cloud Mask Forecasts from the WRF-Solar Ensemble Prediction System**
J. Yang, M. Sengupta & Y. Xie
NREL, Golden, USA
J.-H. Kim & P.A. Jimenez
National Center for Atmospheric Research, Boulder, USA

5BO.7.4 **A hybrid solar irradiance nowcasting approach: combining all sky imager systems and persistence irradiance models for increased accuracy**
B. Nouri, N. Blum & S. Wilbert
German Aerospace Center, Almería, Spain
L.F. Zarzalejo
CIEMAT, Madrid, Spain

5BO.7.5 **Cloud Segmentation and Classification for Improvement the Short-Term PV Forecasting Using Sky Imager Camera**
D.L. Ha, D. Melliti, M. Philippe & S. Ghalila-Sevestre
CEA, Grenoble, France
J. Lehaire, T. Capelle & G. Tremoy
Steadysun, Le Bourget-du-Lac, France

5BO.7.6 **Using Quadrocopters to Measure Spatially Distributed Irradiance Data and Analyse Cloud Motion Vectors (CMVs)**
M. Zehner, M. Jäkel, M. Heigl, M. Brodbeck & A. Boschert
Rosenheim Technical 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

ORAL PRESENTATIONS 2BO.12

10:30 – 12:00 **Advanced Process Technologies for High-Efficiency Silicon Solar Cells**

Chairpersons:

Giso Hahn
University of Konstanz, Germany

Stefan W. Glunz
Fraunhofer ISE, Freiburg, Germany

2BO.12.1 **Student Awards Finalist Presentation: Influence of Hydrogen on the Mechanism of Firing Stability of Polysilicon Passivating Contacts**
D. Kang, H.C. Sio, J. Stuckelberger, C. Sun, T.N. Truong, S.P. Phang & D. Macdonald
ANU, Canberra, Australia
D. Yan
University of Melbourne, Australia
R. Liu
Western Sydney University, Australia

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2BO.12.2 **On the Necessity to Avoid Strong Charges of Hydrogen-Donating Dielectric Layers on the p+-(i)-n+ Rear Side of Interdigitating Back-Contact Solar Cells**
M. Rienäcker, Y. Larionova, S. Wolter, R. Brendel & R. Peibst
ISFH, Emmerthal, Germany
J. Krügener
Leibniz University of Hannover, Germany

2BO.12.3 **Driven-in RVD Emitters and Adopted TOPCon Layers for Simultaneous Crystallization during RVD**
M. Drießen, A. Richter, J.-I. Polzin, F. Feldmann, B. Steinhauser, M. Ohnemus, C. Weiss, J. Benick & S. Janz
Fraunhofer ISE, Freiburg, Germany

2BO.12.4 **Approaching 23% with p-Type Back Junction Solar Cells Featuring Screen-Printed Al Front Grid and Passivating Rear Contacts**
B. Min, N. Wehmeier, H. Schulte-Huxel, R. Witteck, T. Brendemühl, T. Daschinger, F. Haase, Y. Larionova, L. Nasebandt, R. Peibst & R. Brendel
ISFH, Emmerthal, Germany
K. Tsuji & M. Dhamrin
Toyo Aluminium, Shiga, Japan

2BO.12.5 **Q CELLS Silicon Solar Cells of > 24% Efficiency Fabricated with Mass-Production Processes**
F. Fertig, B. Klöter, I. Höger, K. Petter, E. Jarzembowski, M. Junghänel, C. Klenke, A. Weihrauch, M. Schley, K. Kim, A. Schwabedissen, M. Kauert, K. Duncker, J. Cieslak, R. Hönig, J. Scharf, F. Kersten, S. Wasmer, C. Ke, C. Baer, C. Gerbig, L. Burtone, L. Niebergall, M. Schütze, S. Schulz, S. Peters, A. Mette, M. Schaper, M. Fischer & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

2BO.12.6 **Large Area Co-Plated Bifacial n-PERT Cells with Polysilicon Passivating Contacts on Both Sides**
S. Singh, P. Choulat, J. Govaerts, A.S.H. van der Heide, V. Depauw, F. Duerinckx, L. Tous & J. Poortmans
imec, Leuven, Belgium
R.C.G. Naber, M. Lenes & M.R. Renes
Tempress, Vaassen, The Netherlands

ORAL PRESENTATIONS 6BO.17

10:30 – 12:00 Electrical Grid Integration / Solar Power Generation Coupling with Energy Storage

Chairpersons:

Giovanna Adinolfi
ENEA, Portici, Italy

Francesco Dolci
European Commission JRC, Petten, The Netherlands

6BO.17.1 Finding the Maximum Penetration Level of Rooftop Photovoltaic Systems and Analyzing Their Impact on the Low Voltage Grid in Amsterdam
M. Verkou, Z. Ahmad, M. Zeman, H. Ziar & O. Isabella
Delft University of Technology, The Netherlands

6BO.17.2 A Free Online Tool for the Simulation of Collective Self-Consumption in Brussels
B. Sarr, J. Leloux & J. Robledo Bueno
LuciSun, Sart-Dames-Avelines, Belgium
Z. Zhao & P. Hendrick
Free University of Brussels, Belgium

6BO.17.3 Assessment of Prospective Sites for PV- Seawater Pumped Hydro Storage Hybrid Systems Using the AHP-GIS Approach: A Case Study in Marrakesh-Safi Region, Morocco
F.-Z. Ouchani, O. Jbaihi & A. Ghennioui
Green Energy Park, Benguerir, Morocco
A. Alami Merrouni
LPTPME Laboratory, Oujda, Morocco
M. Maaroufi
Mohammed V University, Rabat, Morocco

6BO.17.4 Frequency Support with Ultra-Capacitor ESS for Micro Grid with High Share of PV Production
E. Toutain & N. Stankovic
EDF R&D, Moret-sur-Loing, France

6BO.17.5 Methodology for Sizing Electric Storage Using Solar Variability
V.A. Martinez Lopez, H. Ziar, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

6BO.17.6 Sizing of PV Self-Consumption Systems in Residential Applications
C.A. Madureira da Silva & T.M. Martins da Costa
Voltalia, Oliveira de Frades, Portugal

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VISUAL PRESENTATIONS 3BV.2

10:30 – 12:00 CIGSe, CdTe and Kesterites / OPV / III-V and Related Compounds / Tandems

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

ORAL PRESENTATIONS 4BO.3

13:30 – 15:00 Induced Degradation in PV Modules

Chairpersons:

Hartmut Nussbaumer
Zurich University of Applied Sciences, Winterthur, Switzerland

Henning Nagel
Fraunhofer ISE, Freiburg, Germany

4BO.3.1 Introductory Oral: Review of Induced Degradation Phenomena Affecting PV Modules
G. Hahn
University of Konstanz, Germany

4BO.3.2 LID and LETID Evolution of PV Modules during Outdoor Operation and Indoor Tests
E. Fokuhl, D. Philipp, G. Mülhöfer & P. Gebhardt
Fraunhofer ISE, Freiburg, Germany

4BO.3.3 Latest PID and LeTID Results: Current Module Types Affected by Both Negative and Positive System Voltage
T. Weber, S. Koch, B. Lippke, N. Murali, P. Grunow & S. Xuereb
PI Berlin, Germany

4BO.3.4 Contribution of the Front and Rear Sides to the Potential Induced Degradation in Bifacial Silicon Heterojunction Solar Modules
O. Arriaga Arruti, L. Gnocchi, F. Lisco, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland

4BO.3.5 A Grey Box Model for Shunting-Type Potential Induced Degradation in Silicon Photovoltaic Cells under Environmental Stress
A. Schils, R. Breugelmans & E. Voroshazi
imec, Genk, Belgium
J. Carolus
Hasselt University, Genk, Belgium
J. Ascencio-Vásquez
3E, Brussels, Belgium
A. Wabbes, E. Bertrand & S. Scheerlinck
ENGIE Laborelec, Linkebeek, Belgium
M. Daenen
Hasselt University, Diepenbeek, Belgium

ORAL PRESENTATIONS 3BO.8

13:30 – 15:00 Absorber Synthesis for Thin-Film Cells and Modules

Chairpersons:

Stefan Paetel
ZSW, Stuttgart, Germany

Mirjam Theelen
TNO/Solliance, Eindhoven, The Netherlands

3BO.8.1 Introductory Oral: Improved CIGSSe Absorber Homogeneity with Cd-Free Sputtered ZnOS Buffer Layer at World Record Efficiency on 30x30cm2 Laminated Module
P. Eraerds, M. Fürfanger, H. Elanzeery, A. Weber, J. Röder, S. Grünsteidl, C. Schubbert, M. Algasinger, M. Hála, T.P. Niesen, A. Zelenina, M. Stölzel, P. Borowski, R. Lechner, T. Dalibor & J. Palm
Avancis, Munich, Germany

3BO.8.2 Adding Ga is Important to Get Good Sulfide Chalcopyrite Solar Cells
S. Siebentritt, M. Sood, D. Adeleye, A. Dwivedi, A. Lomuscio & S. Shukla
University of Luxembourg, Belvaux, Luxembourg

3BO.8.3 Alternative Alkali Fluoride Post-Deposition Treatment under Sulfur for High Efficiency Cu(In,Ga)Se2-Based Solar Cells
P. Tsoulka, S. Harel, L. Arzel & N. Barreau
University of Nantes, France

3BO.8.4 Recent Progresses in Kesterite Solar Cells: Towards the Reduction of the Voc Deficit
E. Saucedo, J. Puigdollers González & A. Pérez-Rodríguez
UPC, Barcelona, Spain

3BO.8.5 Study of SnO2/CdSexTe1-x/CdTe Solar Cells Fabricated by Selenium Treatment of the Absorber Layer
E. Artegiani, V. Kumar, P. Punathil, S. Zanetti & A. Romeo
University of Verona, Italy
M. Bertoncello, M. Meneghini & G. Meneghesso
University of Padua, Italy

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PANEL DISCUSSION 2BO.13

13:30 – 15:00 *Towards Ultimate Single-Junction Silicon Cells – Industry Perspective*

Photovoltaic technology is at a historical juncture: not only PV is poised to take over the largest share of new generation capacity, starting right now, but it will also become the largest source of global electricity generation by mid-century. PV technology is also reaching amazing levels in efficiency, reaching > 80% of the theoretical efficiency limit for single-junction Silicon solar cells, and in cost, down to less than US$0.25/W for Mono-Si PV modules. Despite approaching the efficiency ceiling, Single-Junction Silicon solar cells keep improving and module cost is expected to reach US$0.10/W in the next decade. It is now time to prepare ourselves to the production and deployment of multi-TW of PV system. Will PERC continue to be the "workhorse" of the industry? What innovation can we expect in module design? Are 182mm or 210mm the ultimate wafer sizes? Will TOPCon, HJT or IBC compete for more market share? Do we need another technology? Which technology will be the ultimate single-junction device for a multi-TW market? Are these technologies developed with durability (30 … 50 years), sustainability and recycling in mind?

Moderator: Pierre Verlinden
Amrock, McLaren Vale, Australia

Co-moderator: Delfina Muñoz
CEA, Le Bourget-du-Lac, France

Panelists: Pietro Altermatt
Trinasolar, Changzhou, China

Yichun (YC) Wang
LONGi, Shaanxi, China

Christophe Ballif
EPFL, Neuchâtel, Switzerland

Chung-Wen Lan
NTU, Taipei, Taiwan

Peter Fath
RCT-Solutions, Konstanz, Germany

VISUAL PRESENTATIONS 1BV.3

13:30 – 15:00 Fundamental Studies in the Forefront of PV / Novel Materials and Concepts for Cells and Modules

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

ORAL PRESENTATIONS 4BO.4

15:15 – 16:45 PV Module Testing and Characterisation

Chairpersons:

Tony Sample
European Commission JRC, Ispra, Italy

Werner Herrmann
TÜV Rheinland Energy, Cologne, germany

4BO.4.1 Power Prediction of Si Photovoltaic Modules by Electroluminescent Images: Assessing the Physics Learned by a CNN
L. Lüer, J. Hepp, M. Hoffmann, B. Doll & C.J. Brabec
FAU, Erlangen, Germany
K. Forberich, C. Buerhop-Lutz, T. Winkler, S. Rodrigues, J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany

4BO.4.2 Dependency of Iam Losses in Colored BIPV Products on the Refractive Index of Colorants
M. Babin, A.A. Santamaria Lancia, S. Thorsteinsson, P.B. Poulsen, A. Thorseth, C. Dam-Hansen & M. Linde Jakobsen
Technical University of Denmark, Roskilde, Denmark

4BO.4.3 Dark IV-Curves as a Method for in Situ Module Characterisation
J. Fröbel, B. Jäckel & M. Pander
Fraunhofer CSP, Halle (Saale), Germany

4BO.4.4 Interlaboratory Comparison of Voltage Sweep Methods Used for the Electrical Characterization of Encapsulated High-Efficiency c-Si Solar Cells
C. Monokroussos & J.Q. Gao
TÜV Rheinland, Shanghai, China
M. Yoshita & K. Yamagoe
AIST, Tsukuba, Japan
H. Müllejans & D. Pavanello
European Commission JRC, Ispra, Italy
K. Ramspeck
h.a.l.m. elektronik, Frankfurt, Germany
D. Hinken & K. Bothe
ISFH, Emmerthal, Germany

Y. Fujita
Kyoshin Electric, Kyoto, Japan
G. Arnoux, F. Pinto & R. Ambigapathy
Pasan, Neuchâtel, Switzerland
Q. Shi
SIMIT CAS, Shanghai, China
H. Wilterdink
Sinton Instruments, Boulder, USA
Y. Chen & Y. Ping
Trina Solar Energy, Changzhou, China

4BO.4.5 Effects of Inhomogeneous Snow Load on the Mechanics of a PV Module
P. Romer, A.J. Beinert & M. Mittag
Fraunhofer ISE, Freiburg, Germany

4BO.4.6 Optical Strain and Temperature Sensing within Photovoltaic Laminates
P. Nivelle, L. Maes & M. Daenen
UHasselt, Belgium
J. Poortmans
imec, Leuven, Belgium

ORAL PRESENTATIONS 3BO.9

15:15 – 16:45 Characterisation of Chalcogenide Solar Cell Absorbers and Modules

Chairpersons:

Alex Redinger
University of Luxembourg, Luxembourg

Ayodhya Nath Tiwari
EMPA, Dübendorf, Switzerland

3BO.9.1 Introductory Oral: CIGS Devices with Increased Bandgap Energy: Results of the EFFCIS Project
W. Witte, D. Hariskos, S. Paetel & M. Powalla
ZSW, Stuttgart, Germany
M. Maiberg, S. Zahedi-Azad, P. Pistor, H. Kempa & R. Scheer
Martin Luther University, Halle, Germany
D. Hauschild, V. van Maris, L. Weinhardt, C. Heske, X. Jin, R. Schneider, D. Gerthsen, J. Seeger, F. Wilhelmi & M. Hetterich
Karlsruhe Institute of Technology, Germany
M. Blankenship
University of Nevada, Las Vegas, USA
J. Keutgen & O. Cojocaru-Mirédin
RWTH Aachen University, Germany
E. Ghorbani & K. Albe
TU Darmstadt, Germany
A. Nikolaeva, J.A. Marquez-Prieto, M. Krause, S. Schäfer, D. Abou-Ras, T. Unold & R. Mainz
HZB, Berlin, Germany
M. Schweiger & B. Dimmler
NICE Solar Energy, Schwäbisch Hall, Germany

3BO.9.2 **Heat-Light Soaking Treatments for High-Performance CIGS Solar Cells on Flexible Polyimide Foils**
R. Carron, S. Nishiwaki, S.-C. Yang, M. Ochoa, X. Sun & A.N. Tiwari
Empa, Dübendorf, Switzerland

3BO.9.3 **Unveiling the Effect of RbF-PDT in High Efficiency CIGSe Devices: Development of a Methodology for Predicting Solar Cell Performance**
R. Fonoll-Rubio, E. Grau-Luque, I. Becerril-Romero, A. Pérez-Rodríguez, M. Guc & V. Izquierdo-Roca
IREC, Barcelona, Spain
S. Paetel
ZSW, Stuttgart, Germany
M. Fissé, L. López-Conesa, S. Estradé & F. Peiró
University of Barcelona, Spain

3BO.9.4 **Invited**

3BO.9.5 **Post-Mortem Analysis of CIGS Solar Modules Damaged due to Potential Induced Degradation**
P. Yilmaz, R. Aninat & M. Theelen
TNO/Solliance, Eindhoven, The Netherlands
T. Weber
PI Berlin, Germany
J. Schmitz
University of Twente, Enschede, The Netherlands

ORAL PRESENTATIONS 2BO.14

15:15 – 16:45 **Wafer-Based Silicon Heterojunction Solar Cells**

Chairpersons:

Matthieu Despeisse
CSEM, Neuchâtel, Switzerland

Arthur W. Weeber
TNO Energy Transition, Petten, The Netherlands

2BO.14.1 **Student Awards Finalist Presentation: Temperature-Dependent Performance of Silicon Heterojunction Solar Cells with Molybdenum Oxide as a Hole-Selective Contact**
A.H.T. Le, N. Borojevic & Z. Hameiri
UNSW Australia, Sydney, Australia
J. Dréon & M. Boccard
EPFL, Neuchâtel, Switzerland

2BO.14.2 **P-Type Si Based Heterojunction Solar Cells: Will They Make Sense?**
D. Andronikov, A. Abramov, K. Emtsev & I. Nyapshaev
R&D Center TFTE, St-Petersburg, Russian Federation
B. Hallam, A.H. Soeriyadi, B. Vicari Stefani & M. Wright
UNSW Australia, Sydney, Australia

2BO.14.3 **A Route towards High Efficiency Silicon Heterojunction Solar Cells**
W. Duan, A. Lambertz, D. Qiu, K. Bittkau, K. Qiu & K. Ding
Forschungszentrum Jülich, Germany

2BO.14.4 **Ultra-Thin Electron Collectors Based on nc-Si:H for High-Efficiency Silicon Heterojunction Solar Cells**
Y. Zhao, P.A. Procel Moya, L. Mazzarella, C. Han, F.D. Tichelaar, G. Yang, A.W. Weeber, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

2BO.14.5 **Impact of Handling Defects towards SHJ Cell Parameters**
A. Fischer, I. Voicu, S. Pingel, A. Moldovan & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

2BO.14.6 **Evaluation of Different Approaches for HJT Cells Metallization Based on Low Temperature Ag Pastes**
M. Galiazzo & N. Frasson
Applied Materials Italia, Olmi di San Biagio, Italy

VISUAL PRESENTATIONS 5BV.4

15:15 – 16:45 **Solar Radiation and Forecasting**

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

ORAL PRESENTATIONS 4BO.5

17:00 – 18:30 **Interconnects and Soldering**

Chairpersons:

Miguel-Ángel Muñoz-García
UPM, Madrid, Spain

Ronald Sinton
Sinton Instruments, Boulder, USA

4BO.5.1 **Enabling Climate Specific Modelling of Thermomechanical Fatigue in PV Module Interconnects by Help of Machine Learning Techniques**
G. Otnes, D. Lindholm, H. Fjær, L. Kvalbein, P. Seljom & S.E. Foss
Institute for Energy Technology, Kjeller, Norway

4BO.5.2 **Reliability Assessment for Industrial Soldered and Glued BJ-BC Solar Cell Interconnections**
T. Timofte, M.I. Devoto, D. Tune & A. Halm
ISC Konstanz, Germany
R. Wade, F. Köhler & T. Fischer
Teamtechnik Maschinen und Anlagen, Freiberg, Germany

4BO.5.3 **Corrosion Behavior of the Metallization Including Ternary Glass Frits in the High-Temperature and High-Humidity Test**
T. Semba & A. Masuda
Niigata University, Japan

4BO.5.4 **Thermomechanical Fatigue of Solder Joint and Interconnect Ribbon: Impact of Low Lamination Temperature**
D. Lindholm, G. Otnes, S.E. Foss & H. Fjær
Institute for Energy Technology, Kjeller, Norway
H.-Y. Li & G. Cattaneo
CSEM, Neuchâtel, Switzerland

4BO.5.5 **Power Loss Analysis and Interconnection of SHJ Structure: from Cell to Module**
J. Yu, Y. Zhao, L.S. Peris, A. Lambertz, W. Duan, V. Volker, C. Zahren & K. Ding
Forschungszentrum Jülich, Germany

4BO.5.6 **Improved Measurement of the Contact Resistivity of ECA-Based Joints**
M.I. Devoto, T. Timofte, A. Halm & D. Tune
ISC Konstanz, Germany

ORAL PRESENTATIONS 3BO.10

17:00 – 18:30 **III-V Solar Cells and Related Compounds**

Chairpersons:

Gianluca Timò
RSE, Piacenza, Italy

Giovanni Flamand
imec, Leuven, Belgium

3BO.10.1 **Introductory Oral: Improvements in Ultra-Light and Flexible Epitaxial Lift-off GaInP/GaAs/GaInAs Solar Cells for Space Applications**
J. Schön, E. Fehrenbach & D. Lackner
Fraunhofer ISE, Freiburg, Germany
G.M.M.W. Bissels, P. Mulder, R.H. van Leest, N. Gruginskie & E. Vlieg
tf2 devices, Nijmegen, The Netherlands

3BO.10.2 **III-V Multijunction Solar Cells on Ultrathin Ge/Si Virtual Substrates Grown at Low Temperature by RF-PECVD**
I. Garcia, V. Orejuela & I. Rey-Stolle
UPM, Madrid, Spain
M. Ghosh & P. Roca i Cabarrocas
CNRS, Palaiseau, France

3BO.10.3 **200 mm Germanium Wafers for Epitaxial Growth of III/V Space Grade Solar Cells**
T. Kubera, J. Strate, V. Khorenko, S. Sommer & W. Köstler
Azur Space, Heilbronn, Germany
J. Vanpaemel & K. Dessein
Umicore, Olen, Belgium

3BO.10.4 **High-Low Refractive Index Stacks as Antireflection Coatings for Triple-Junction Solar Cells**
G. Hou & I. Rey-Stolle
UPM, Madrid, Spain

3BO.10.5 **Approaching Theoretical Band Gap of ZnSnN2 Films via Bias Magnetron Co-Sputtering at Room Temperature**
A. Virfeu, F.M. Alnjiman, A. Borroto, J. Ghanbaja & J.F. Pierson
University of Lorraine, Nancy, France
C. Longeaud, S. Le Gall & L. Kopprio
CNRS/GeePs, Gif-sur-Yvette, France
J.-P. Vilcot
University of Lille 1, France

ORAL PRESENTATIONS 2BO.15

17:00 – 18:30 **TCO and Metallisation for Silicon Heterojunction Cells**

Chairpersons:

Pere Roca i Cabarrocas
LPICM-CNRS, Palaiseau, France

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

2BO.15.1 **Strategies for Minimizing ITO Consumption in SHJ Modules: Combined Consideration of Electro-Optical Performance and Costs**
L. Tutsch, L. Jakob, C. Luderer, T. Hatt, B.S. Goraya, U. Heitmann, J. Bartsch, B. Bläsi, S. Pingel, A. Moldovan, S. Nold, M. Hermle & M. Bivour
Fraunhofer ISE, Freiburg, Germany

2BO.15.2 **On the Interplay between Room-Temperature Sputtered IWO and Underlying Thin Film Silicon Stacks in Silicon Heterojunction Solar Cells**
C. Han, Y. Zhao, L. Mazzarella, R. Santbergen, A. Montes, P.A. Procel Moya, G. Yang, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

2BO.15.3 **Low Temperature Post-Process Repassivation for Heterojunction Cut-Cells**
S. Harrison, B. Portaluppi, P. Bertrand, V. Giglia & W. Favre
CEA, Le Bourget-du-Lac, France
A. Sekkat & D. Munoz-Rojas
Grenoble INP, France

2BO.15.4 **High-Speed Metallization on SHJ Solar Cells by Parallel Dispensing - Towards 650 mm/s Process Speeds at Line Widths below 40 µm**
K. Gensowski, M. Much, E. Bujnoch, S. Tepner & F. Clement
Fraunhofer ISE, Freiburg, Germany
K. Muramatsu
Namics, Niigita City, Japan
M. Pospischil
HighLine Technology, Freiburg, Germany

2BO.15.5 **Ink-Jet Printing of Silicon Heterojunction: From Cell Power to Module Reliability**
A. Faes, J. Champliaud, N. Badel, J. Levrat, J. Escarré Palou, G. Cattaneo, B. Paviet-Salomon, L.-L. Senaud, P. Wyss, C. Allebé, G. Christmann, A. Descoeudres, J. Geissbühler, H.-Y. Li, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland
H. Watanabe
HIROSE ELECTRIC, Yokohama, Japan

2BO.15.6 **Evaluation of Chemical Reaction at the Interface between Low-Temperature Curing Electrode Paste and High Mobility Transparent Conductive Oxide Film for Silicon Heterojunction Solar Cells**
T. Nishihara & A. Ogura
Meiji University, Kawasaki, Japan
K. Muramatsu
Namics, Niigata, Japan
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
S. Yasuno
JASRI, Hyogo, Japan

VISUAL PRESENTATIONS 6BV.5

17:00 – 18:30 **Power Electronics and Electrical Grid Integration / Storage / Energy System Integration**

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

Wednesday, 08 September 2021

ORAL PRESENTATIONS 4CO.1

08:30 – 10:00 **Polymers and Encapsulation of PV Modules**

Chairpersons:

Lucie Garreau-Iles
DuPont, Meyrin, Switzerland

Christian Camus
LayTec, Berlin, Germany

4CO.1.1 **Introductory Oral: The Role of Polymers in Photovoltaics: Recognition or Underestimation?**
G. Oreski
PCCL, Leoben, Austria

4CO.1.2 **Value Proposition of UV-Absorbers in PV Module Encapsulation**
P. Hacke, K. Hurst, D.C. Miller, J. Qian, L.T. Schelhas & M. Woodhouse
NREL, Golden, USA
S.L. Moffitt & A. Sinha
SLAC, Menlo Park, USA

4CO.1.3 **Understanding Aging Mechanisms of Different Encapsulant Materials for Glass/Glass Photovoltaic Modules**
S. Ulicna & A. Sinha
SLAC, Menlo Park, USA
D.C. Miller, L.T. Schelhas & M. Owen-Bellini
NREL, Golden, USA

4CO.1.4 **Degradation Evaluation of Thermoplastic Polyolefin Encapsulant Used in c-Si PV Modules and Laminates**
B. Adothu & S. Mallick
IIT Bombay, Mumbai, India
P. Bhatt
Waaree Energies, Surat, India
F.R. Costa
Borealis, Linz, Austria

4CO.1.5 **Effects of Climate and Microclimate on EVA Degradation from Field Aged PV Modules**
C. Barretta, G. Oreski & A. Macher
PCCL, Leoben, Austria
J. Ascencio-Vásquez
3E, Brussels, Belgium
M. Topic
University of Ljubljana, Slovenia
M. Köntges
ISFH, Emmerthal, Germany
K. Resch-Fauster
University of Leoben, Austria

ORAL PRESENTATIONS 3CO.5

08:30 – 10:00 **Advances in Perovskite Materials and Process Engineering for High Efficiency Cells**

Chairpersons:

Luigi Vesce
University of Rome "Tor Vergata", Italy

Ching-Fuh Lin
NTU, Taipei, Taiwan

3CO.5.1 **Introductory Oral: PEDOT:PSS Free Tin-Lead Perovskite Solar Cells with Efficiency more than 23%**
G. Kapil, Q. Shen & S. Hayase
University of Electro-Communications, Tokyo, Japan
T. Bessho & H. Segawa
University of Tokyo, Japan

3CO.5.2 **Over 10% Flexible Tin Based Perovskite Solar Cells**
H. Lai, A.N. Tiwari & F. Fu
Empa, Dübendorf, Switzerland

3CO.5.3 **All-Evaporated, All-Inorganic CsPbI3 Perovskite-Based Devices for Dual Application as Solar Cell and Broadband Photodetector**
M.I. Pintor Monroy, I. Goldberg, K. Elkhouly, E. Georgitzikis, G. Croes, N. Annavarapu, W. Qiu, Y. Kuang, R. Gehlhaar & J. Genoe
imec, Leuven, Belgium

3CO.5.4 **Bromide Surface Treatment for Bulk Passivation for Efficient Perovskite Solar Cells with High Open-Circuit Voltage**
Y. Li, M.A. Green, A.W.Y. Ho-Baillie & S. Huang
UNSW Australia, Sydney, Australia

3CO.5.5 **Combined Application of Interlayer and Additive Engineering in Highly Efficient Perovskite Solar Cells and Modules**
X. Zhang, W. Song, S. Lammar, T. Merckx, A. Aguirre, Y. Kuang, A. Hadipour, T. Aernouts & J. Poortmans
imec, Genk, Belgium
S.C. Veenstra
TNO Energy Transition, Eindhoven, The Netherlands
Y. Zhan
Fudan University, Shanghai, China

Wednesday, 8 September 2021

ORAL PRESENTATIONS 5CO.9

08:30 – 10:00 **Advanced Monitoring and Fault Detection in PV Systems**

Chairpersons:

Gerhard Mütter
Enery, Vienna, Austria

Björn Müller
Enmova, Freiburg, Germany

5CO.9.1 **Analysis of Automatic Fault Detection Methods for Commercially Operated PV Power Plants**
E. Sarquis Filho & P.J. Costa Branco
Lisbon University, Portugal
N. Holland, B. Müller & K. Kiefer
Fraunhofer ISE, Freiburg, Germany

5CO.9.2 **Fault Detection in Operation and Maintenance of PV Systems**
A. Louwen & D. Moser
Eurac Research, Bolzano, Italy
F. Venturini, C. Torrero & D. Miorandi
U-Hopper, Trento, Italy

5CO.9.3 **Failure Diagnosis and Trend-Based Performance Losses Routines for the Detection and Classification of Incidents in Large-Scale Photovoltaic (PV) Systems**
A. Livera & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
M. Theristis & J.S. Stein
Sandia National Laboratories, Albuquerque, USA

5CO.9.4 **Performance Imputation Techniques for Assessing Costs of Technical Failures in PV Systems**
S. Lindig, A. Louwen & D. Moser
Eurac Research, Bolzano, Italy
M. Herz
TÜV Rheinland Energy, Cologne, Germany
J. Ascencio-Vásquez
3E, Brussels, Belgium
M. Topic
University of Ljubljana, Slovenia

5CO.9.5 **Evaluating and Finding Optimal Data Filters for PLR Estimation with Bayesian Optimization**
E.B. Sveen, J.H. Selj & G. Otnes
Institute for Energy Technology, Kjeller, Norway

5CO.9.6 **Long-Term Degradation Assessment of Five Different Photovoltaic Technologies in Austria**
K. Cërriku & R. Höller
FH OOE, Wels, Austria

ORAL PRESENTATIONS 6CO.13

08:30 – 10:00 Solar Hydrogen

Chairpersons:

Franz P. Baumgartner
Zurich University of Applied Sciences, Winterthur, Switzerland

Jesus S. da Costa Fernandes
University of Applied Sciences Offenburg, Germany

6CO.13.1 Perovskite-Silicon Tandem Based Photoelectrochemical Systems for Efficient Solar Hydrogen Generation
A. Sharma, S. Karuturi, D. Zhang, F. Beck & K.R. Catchpole
ANU, Canberra, Australia

6CO.13.2 Development of Various Photovoltaic Driven Water Electrolysis Technologies for Green Solar Hydrogen Generation within the PECSYS Project
S. Calnan, R. Bagacki, F. Bao, I. Dorbandt, E. Kemppainen, C. Schary & R. Schlatmann
HZB, Berlin, Germany
M. Leonardi, S.A. Lombardo, R.G. Milazzo, S.M.S. Privitera & C. Connelli
CNR, Catania, Italy
D. Consoli, C. Gerardi & P. Zani
ENEL Green Power, Rome, Italy
M. Carmo, S. Haas, M. Lee, M. Müller & W. Zwaygardt
Forschungszentrum Jülich, Germany
J. Oscarsson & L. Stolt
Solibro Research, Uppsala, Sweden
M. Edoff, T. Edvinsson & I.B. Pehlivan
Uppsala University, Sweden

6CO.13.3 Variation in PV System Configuration's Generation Profiles is not Sufficient to Stabilise Deteriorating Kwh Price without Tens of GW Electrolyser Deployment in the Netherlands
B.B. Van Aken & I. Cesar
TNO Energy Transition, Petten, The Netherlands
P. Verstraten & B. Kaas
TNO Strategic Business Analysis, The Hague, The Netherlands

6CO.13.4 Photovoltatronics: Intelligent PV-Based Devices for Energy and Information Applications
H. Ziar, P. Manganiello, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

6CO.13.5 The Benefits of Co-Adoption of Solar with Flexible Electrolysis and Desalination Technologies
M. Ginsberg, A.A. Atia, D. Esposito & V. Fthenakis
Columbia University, New York, USA

6CO.13.6 Harmonization of the Life-Cycle Global Warming Impact of PV-Powered Hydrogen Production by Electrolysis
O. Kanz, K. Bittkau & K. Ding
Forschungszentrum Jülich, Germany
A.H.M.E. Reinders
Eindhoven University of Technology, The Netherlands

Wednesday, 8 September 2021

VISUAL PRESENTATIONS 2CV.1

08:30 – 10:00 Characterisation and Manufacturing of Crystalline Silicon Solar Cells

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

PLENARY SESSION CP.1

10:30 – 12:30 Industry and Applications: PV Going Everywhere

Chairpersons:

Rui Pestana
R&D NESTER, Lisbon, Portugal

Christophe Ballif
EPFL, Neuchâtel, Switzerland

CP.1.1 Bringing Perovskite Tandems to the Market
H. Snaith
University of Oxford, United Kingdom

CP.1.2 Quality, Durability and Integration of PV in Different Environments & Applications to Enable Innovative Changes
U. Jahn
VDE Renewables, Alzenau, Germany

CP.1.3 Inverters: A Pivotal Role in PV Generated Electricity
P. Hacke
NREL, Golden, USA

CP.1.4 From Building Integrated Photovoltaics to Landscape Integrated Photovoltaics: The Case of Agrivoltaics
A. Scognamiglio
ENEA, Portici, Italy

CP.1.5 European Strategic Research & Innovation Agenda (SRIA) for Photovoltaics – Fit for 55% and Climate Neutrality
M. Topic
University of Ljubljana, Slovenia
R. Drozdowski-Strehl
IPVF, Palaiseau, France
W.C. Sinke
TNO Energy Transition, Petten, The Netherlands

ORAL PRESENTATIONS 4CO.2

13:30 – 15:00 PV Module Backsheets

Chairpersons:

Gernot Oreski
PCCL, Loeben, Austria

Guy Beaucarne
Dow Silicones, Seneffe, Belgium

4CO.2.1 Advanced Analysis of Backsheet Failures from 26 Power Plants
J. Markert, S. Kotterer, D.E. Mansour, P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany

4CO.2.2 Structural Identification of Multi-Layer Polyethylene Terephtalate-Based Backsheets of Silicon Solar Modules with Near-Infrared Spectroscopy
O. Stroyuk, A. Vetter, C. Buerhop-Lutz, J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany
J. Hepp & C.J. Brabec
FAU, Erlangen, Germany

4CO.2.3 BACKFLIP: Identification of Materials and Changes Upon Aging of Emerging Fluoropolymer-Free and Industry-Benchmark PV Backsheets
L.T. Schelhas, M. Thuis, J.M. Newkirk, R.L. Arnold, K. Terwilliger & D.C. Miller
NREL, Golden, USA
S. Ulicna
SLAC, Menlo Park, USA
A. Sinha
Arizona State University, Mesa, USA
A. Maes & B.H. King
Sandia National Laboratories, Albuquerque, USA
K. Van Durme
DSM, Geleen, The Netherlands

4CO.2.4 Transparent Backsheets for Bifacial PV Modules
X. Gu, L. Perry, S. Smith, S.L. Moffitt, S.-J. Shen, S. Watson, L.-P. Sung, P.-C. Pan & D. Jacobs
NIST, Gaithersburg, USA

4CO.2.5 Repair of Cracked Backsheets: Long-Term Stability
Y. Voronko & G.C. Eder
OFI, Vienna, Austria
C. Breitwieser
Rembrandtin Coatings, Vienna, Austria
W. Mühleisen & L. Neumaier
SAL Silicon Austria Labs, Villach, Austria
S. Feldbacher & G. Oreski
PCCL, Leoben, Austria
N. Lenck
VDE Renewables, Alzenau, Germany

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4CO.2.6 Studying Time-Series of Wet Leakage Resistances for Modules with Various Backsheet Types
C. Buerhop-Lutz, O. Stroyuk, J. Zöcklein, J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany

ORAL PRESENTATIONS 3CO.6

13:30 – 15:00 Advanced Characterisation Applied to Perovskite Solar Cells

Chairpersons:

Shuzi Hayase
University of Electro-Communications, Chofu, Japan

Ilker Dogan
TNO Solliance, Eindhoven, The Netherlands

3CO.6.1 Student Awards Finalist Presentation: Contactless and Spatially-Resolved Determination of Current-Voltage Curves in Perovskite Solar Cells
A.D. Bui, D. Macdonald & H.T. Nguyen
ANU, Canberra, Australia

3CO.6.2 Electroluminescence Intensity Stabilization in Perovskite Solar Cells
M. Bokalič, M. Jošt, K. Brecl & M. Topic
University of Ljubljana, Slovenia

3CO.6.3 Investigating the Phase Evolution of Multi-Cation Perovskite Absorbers during Evaporation
K. Heinze, P. Stötzner, S. Förster, P. Wessel, R. Scheer & P. Pistor
Martin Luther University, Halle (Saale), Germany

3CO.6.4 On the Equilibrium Electrostatic Potential and Light-Induced Charge Redistribution under Illumination in Halide Perovskite Structures
D. Regaldo & J.-B. Puel
UMR IPV, Palaiseau, France
A. Bojar
Paris-Saclay University, Gif-sur-Yvette, France
S. Dunfield & J.J. Berry
NREL, Golden, USA
M. Frégnaux
UVSQ, Versailles, France
P. Schulz
CNRS, Palaiseau, France
J.-P. Kleider
CNRS, Gif-sur-Yvette, France

3CO.6.5 Perovskite Solar Cells with and without Phase Segregation
F. Ebadi & W. Tress
Zurich University of Applied Sciences, Winterthur, Switzerland
B. Yang
EPFL, Lausanne, Switzerland

3CO.6.6 **The Challenge of Designing Accelerated Indoor Tests to Predict the Outdoor Lifetime of Perovskite Solar Cells**
H. Köbler, M. Khenkin, R. Roy, N. Phung, Q. Emery, M. Remec, R. Schlatmann, C. Ulbrich & A. Abate
HZB, Berlin, Germany

ORAL PRESENTATIONS 2CO.10

13:30 – 15:00 **Characterisation of Crystalline Silicon Devices**

Chairpersons:

Karsten Bothe
ISFH, Emmerthal, Germany

Francesca Ferrazza
ENI, San Donato Milanese, Italy

2CO.10.1 **Analysis and Correction of Systematic Deviations in Measurements of the Spectral Irradiance of Solar Simulators**
C. Schinke, D. Hinken, M. Wolf & K. Bothe
ISFH, Emmerthal, Germany
I. Kröger, S. Nevas & S. Winter
PTB, Braunschweig, Germany

2CO.10.2 **Stable Reverse Bias or Integrated Bypass Diode in HIP-MWT+ Solar Cells Based on Different Industrial Rear Passivation**
T. Schweigstill, A. Spribille, J.D. Huyeng, F. Clement & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2CO.10.3 **Calibrated Characterization of Solar Cell by Luminescence Imaging**
D. Ory & N. Paul
EDF R&D, Palaiseau, France
L. Lombez
IPVF, Palaiseau, France

2CO.10.4 **A Round Robin - HighLiting on the Passivating Contact Technology**
T. Fellmeth, F. Feldmann, B. Steinhauser, H. Nagel, S. Mack & M. Hermle
Fraunhofer ISE, Freiburg, Germany
F. Torregrosa
Ion Beam Services, Peynier, France
A. Ingenito, F.-J. Haug & A. Morisset
EPFL, Lausanne, Switzerland
F. Buchholz & A. Chaudhary
ISC Konstanz, Germany
T. Desrues
CEA, Le Bourget-du-Lac, France
F. Haase, B. Min & R. Peibst
ISFH, Emmerthal, Germany
L. Tous
imec, Leuven, Belgium

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2CO.10.5 **Influence of the Bulk Resistivity on the Solar Cell Performance and Module Reliability**
A. Augusto, A. Srinivasa & S.G. Bowden
Arizona State University, Tempe, USA

2CO.10.6 **Origin of Na+ Responsible for PID-S Failures: Impact of Cell Surface Contamination**
J. Clenney, R. Meier & M.I. Bertoni
Arizona State University, Tempe, USA
E. Martinez Loran & D. Fenning
UCSD, La Jolla, USA

PANEL DISCUSSION 6/7CO.14

13:30 – 15:00 ***PV: The Key Element Towards 100% Renewables. How to Make it Happen?***

As the cheapest energy source in history, PV is redefining the way we think about energy. Will everything else have to adapt to it? This panel discussion will look into the technical and non-technical changes ahead, including grid integration, markets, policy and finance.

Moderator: Kai-Philipp Kairies
ACCURE Battery Intelligence, Aachen, Germany

Co-moderator: Marion Perrin
Oscaro-Power, Paris, France

Panelists: Jutta Paulus
Member of the European Parliament, Brussels, Belgium

Antonio Albino Marques
REN, Porto, Portugal

Ulfert Höhne
OurPower, Vienna, Austria

Carolin Funk
Blue Bear, Berkeley, USA

John McKiernan
ESB, Dublin, Ireland

Invited

VISUAL PRESENTATIONS 5CV.2

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

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

ORAL PRESENTATIONS 4CO.3

15:15 – 16:45 Performance of BOS Components

Chairpersons:

Jens Dirk Moschner
KU Leuven, Heverlee, Belgium

Urs Muntwyler
BUAS, Bern, Switzerland

4CO.3.1 Performance Analysis of Shaded PV Module Power Electronic Systems
F.P. Baumgartner, C. Allenspach & F. Carigiet
ZHAW, Winterthur, Switzerland

4CO.3.2 Development of Mission Profiles for Humidity Models in the Reliability Testing of PV Inverters
R. Thiagarajan & P. Hacke
NREL, Golden, USA
J. Flicker
Sandia National Laboratories, Albuquerque, USA

4CO.3.3 Student Awards Finalist Presentation: Design Description of an Open Source FPGA Based MPPT
U. Sainz Estébanez & N. Azkona
UPV/EHU, Bilbao, Spain

4CO.3.4 Module-Inverters (Microinverters): Influence of Module Size on Conversion Efficiencies and Energy Yields
S. Krauter & J. Bendfeld
University of Paderborn, Germany

4CO.3.5 Analysis and Development of a Fault-Tolerant Power Converter for Solar PV Applications
A. Filba-Martinez, C. Cabré-Piqueras, L. Trilla, P. Paradell Sola & J.L. Domínguez-García
IREC, Barcelona, Spain

4CO.3.6 Context-Sensitive PV Plant Components Benchmarking Based on Monitoring Data
J. Ascencio-Vásquez
Envision Digital, Redwood City, USA
W. Vanheusden, K. de Brabandere & M. Richter
3E, Brussels, Belgium
S. Lindig & D. Moser
Eurac Research, Bolzano, Italy

ORAL PRESENTATIONS 3CO.7

15:15 – 16:45 Large Area Perovskite Solar Cells and Modules

Chairpersons:

Giorgio Bardizza
European Commission JRC, Ispra, Italy

Maria Isabel Pintor Monroy
imec/KU Leuven, Belgium

3CO.7.1 Introductory Oral: Step-by-Step Approach towards Stable, Semi-Transparent, Bifacial, Flexible Perovskite Solar Modules
I. Dogan, V. Zardetto, L. Simurka, H. Fledderus, W. Verhees, D. Zhang, M. Najafi, P. Manshanden, Y. Galagan, S.C. Veenstra & R.A.J.M. Andriessen
TNO/Solliance, Eindhoven, The Netherlands
A. Bracesco & M. Creatore
Eindhoven University of Technology, The Netherlands
A. Aguirre & T. Aernouts
imec, Genk, Belgium

3CO.7.2 Perovskite Solar Cells Fabricated by Industrial-Scalable PVD + Blade Coating Process and Green Solvents
S. Siegrist, A.N. Tiwari & F. Fu
Empa, Dübendorf, Switzerland

3CO.7.3 Tuning Precursors Ink Stoichiometry for High Efficiency Scalable Perovskite Photovoltaics
M. Fievez, E. Fayard, C. Roux, M. Manceau, S. Cros & S. Berson
CEA, Le Bourget-du-Lac, France
W.L. Leong
NTU, Singapore

3CO.7.4 Efficient Upscaling of Perovskite Photovoltaics: Advantages of Fully-Evaporated Layer Fabrication and All-Laser-Scribed Interconnections
D.B. Ritzer & A. Basibüyük
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany
T. Abzieher, T.J. Feeney, F. Laufer, S. Ternes, B.S. Richards & U.W. Paetzold
Karlsruhe Institute of Technology, Germany
S. Bergfeld
Bergfeld Lasertech, Aachen, Germany

3CO.7.5 Scalable Fabrication of Efficient Multi Cation Perovskite Solar Modules at Ambient Condition
L. Vesce, M. Stefanelli, L.A. Castriotta & A. Di Carlo
University of Rome II, Italy
J. Herterich, M. Kohlstädt & U. Würfel
Fraunhofer ISE, Freiburg, Germany

ORAL PRESENTATIONS 6CO.11

15:15 – 16:45 Solar PV in the Energy System

Chairpersons:

Ingrid Weiss
WIP Renewable Energies, Munich, Germany

Bruno Gaiddon
HESPUL, Lyon, France

6CO.11.1 Future PV Supply in the Netherlands: Spatially Resolved Profiles for Building, Land and Water-Bound Installations Considering Three Energy Transition Scenarios
N. Nortier, W.G.J.H.M. van Sark & B.B. Kausika
Utrecht University, The Netherlands
M. Paardekooper, A. Blankert, C. Lucas & A. van der Neut
Geodan Amsterdam, The Netherlands
S.L. Luxembourg & A.A. Mewe
TNO Energy Transition, Petten, The Netherlands

6CO.11.2 Optimized Machine Learning Method for PV Power Prediction
H. Heck, U. Muntwyler & E. Schüpbach
BUAS, Burgdorf, Switzerland

6CO.11.3 Energy Model for a Rural Region in Germany - Results and Balancing of Electricity Production and Consumption
J. Bunner & H. te Heesen
Trier University of Applied Sciences, Neubrücke (Nahe), Germany

6CO.11.4 Hybrid PV-Systems for Electrification and Sector Coupling of Road Transport Sector in Norway
J. Fagerström, L. Kvalbein, J. Danebergs, T.U. Nærland, A. Lind & K. Espegren
Institute for Energy Technology, Kjeller, Norway

6CO.11.5 Sector Coupled Energy Model for the European Electricity, Heat and Transport Sectors - Methodology
A. Blinn & H. te Heesen
Trier University of Applied Sciences, Hoppstädten-Weiersbach, Germany

6CO.11.6 Energy Management System for Electric Bus Charging Hub with Local Storage and PV Energy Integration
S. Ranta, H. Huerta, D. Roggo, O. Huhtala, A. Heinonen & V. Lavonen
TUAS, Turku, Finland
J. Pouget
HES-SO VALAIS//WALLIS, Sion, Switzerland

Wednesday, 8 September 2021

VISUAL PRESENTATIONS 5CV.3

15:15 – 16:45 PV Systems: Planning, Plant Optimisation Tools, Advanced Installation Criteria, Construction Issues / Concentrators and PV for Space Applications

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

ORAL PRESENTATIONS 4CO.4

17:00 – 18:30 Recycling, Repair and Reuse of PV Modules

Chairpersons:

Karl-Anders Weiß
Fraunhofer ISE, Freiburg, Germany

Claire Agraffeil
CEA, Le Bourget-du-Lac, France

4CO.4.1 Sustainable Photovoltaics - Increasing Recyclability and Reparability of PV Modules
G. Oreski, S. Feldbacher & F. Wanghofer
PCCL, Leoben, Austria
T. Dobra
University of Leoben, Austria
G.C. Eder
OFI, Vienna, Austria
L. Neumaier & C. Hirschl
SAL Silicon Austria Labs, Villach, Austria
M. Feichtner
KIOTO, St. Veit/Glan, Austria
H. Figl
IBO, Vienna, Austria
M. Aarnio-Winterhof
Borealis Polyolefine, Linz, Austria

4CO.4.2 Re-Use of Decommissioned PV Modules: Opportunities and Technical Guidelines
A.S.H. van der Heide, L. Tous, J. Poortmans & E. Voroshazi
imec, Genk, Belgium
K. Wambach
bifa Environmental Institute, Augsburg, Germany
J. Clyncke
PV Cycle, Brussels, Belgium

4CO.4.3 For a More Sustainable Future – Mylar® UVHPET™ Backsheets Containing Polymeric Post-Consumer Recycled Content
E. Parnham, S. Davies, D. Stratiychuk-Dear & S. Kaeselau
DuPont Teijin Films, Redcar, United Kingdom

4CO.4.4 **Circular Economy of Photovoltaic Modules with Low Environmental Impact by the Use of Dense Fluids as Delamination Process**
A. Briand, C. Audoin & O. Doucet
CEA, Grenoble, France
G. Lumia, J.C. Ruiz, A. Leybros & A. Grandjean
CEA, Bagnols sur Cèze, France

4CO.4.5 **Energy Payback Time of Photovoltaic Electricity Generated by Passivated Emitter Rear and Rear Cell (PERC) Solar Modules: A Novel Methodology Proposal**
Q. Makolli, M. Salibi, F. Schönberger, E. Bousi, D. Nuga & L. Friedrich
Fraunhofer ISE, Freiburg, Germany
S. Almajali & K. Amelung
University of Freiburg, Germany

4CO.4.6 **Terawatt Scale PV by 2050 and Competition for Minerals: The Case of Silver and Copper**
P. Macé, E. Bosch & M. Aleman
Becquerel Institute, Brussels, Belgium

ORAL PRESENTATIONS 3CO.8

17:00 – 18:30 **Standardisation and Outdoor Performance of Perovskite Solar Cells and Modules**

Chairpersons:

Sjoerd Veenstra
TNO Energy Transition, Eindhoven, The Netherlands

Solenn Berson
CEA, Le Bourget-du-Lac, France

3CO.8.1 **Introductory Oral: Emerging PV Standards, the Case of Perovskite Solar Cells and Modules**
C.J. Fell
CSIRO Energy Technology, Mayfield West, Australia

3CO.8.2 **Emerging Technologies in Photovoltaics: Critical Issues and Perspectives for Electrical Performance Measurements**
G. Bardizza, H. Müllejans, D. Pavanello & E.D. Dunlop
European Commission JRC, Ispra, Italy

3CO.8.3 **Lifetime Evaluation of Encapsulated Carbon Based Perovskite Cells Exposed to Damp-Heat Conditions**
N. Kyranaki, M. Matheron & S. Cros
CEA, Le Bourget-du-Lac, France
C. Farha, L. Perrin, L. Flandin & E. Planès
LEPMI, Grenoble, France
L. Wagner & K. Saddedine
Fraunhofer ISE, Freiburg, Germany
D. Martineau
Solaronix, Aubonne, Switzerland

Wednesday, 8 September 2021

3CO.8.4 **Long-Term Outdoor Stability of Perovskite Solar Cells and How It Fits with Indoor Accelerated Aging**
M. Khenkin, Q. Emery, M. Remec, H. Köbler, J. Li, B. Stannowski, A. Abate, E. Unger, R. Schlatmann & C. Ulbrich
HZB, Berlin, Germany

3CO.8.5 **Nanoscale Interfacial Engineering Enables Highly Stable and Efficient Perovskite Photovoltaics**
A. Krishna, H. Zhang, Z. Zhou, M. Dankl, O. Ouellette, F.T. Eickemeyer, S.M. Zakeeruddin, U. Rothlisberger, M. Grätzel & A. Hagfeldt
EPFL, Lausanne, Switzerland
T. Gallet & A. Redinger
University of Luxembourg, Luxembourg
F. Fu
EMPA, Dübendorf, Switzerland
M. Mensi
EPFL, Sion, Switzerland
G.N. Manjunatha Reddy
CNRS, Lille, France

ORAL PRESENTATIONS 5CO.12

17:00 – 18:30 **PV Systems: Planning, Plant Optimisation Tools, Advanced Installation Criteria, Construction Issues**

Chairpersons:

Franck Al-Shakarchi
CEA, Le Bourget-du-Lac, France

Heinz Ossenbrink
Former European Commission JRC, Ispra, Italy

5CO.12.1 **Student Awards Finalist Presentation: Predicting PV Self-Consumption in Villas with Machine Learning**
F. Galli & N. Sommerfeldt
KTH Royal Institute of Technology, Stockholm, Sweden

5CO.12.2 **The Role of Collective Self-Consumption in the Promotion of BIPV in Multi Apartment Building Façades**
R. Amaro e Silva, G. Luz & M. Centeno Brito
University of Lisbon, Portugal
C. Gerçek & A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands

5CO.12.3 **High Resolution 3D Solar Photovoltaic (PV) Potential Map for TU Delft Campus and Real Estate**
Y. Zhou, M. Verkou, M. Zeman, H. Ziar & O. Isabella
Delft University of Technology, The Netherlands

5CO.12.4 **Comparative Energy Yield Study of Vertically Installed Bifacial PV Modules Measured by a Miniturized Test Rig**
H. Nussbaumer, M. Klenk, M. Morf, G. Fil & F. Carigiet
ZHAW, Winterthur, Switzerland

5CO.12.5 **Floating Solar Photovoltaic Projects: Engineering Lessons Learnt from Concept Design to Construction**
B. Danglade, B. Briere, M. Ikhennicheu, M. Lynch & F. Gorintin
INNOSEA, Nantes, France

5CO.12.6 **How Digitalization Can be a Driver for Supporting More and More the Solar Deployment?**
E. Saretta, P. Bonomo & F. Frontini
SUPSI, Mendrisio, Switzerland
V.K. Nguyen & W. Maeder
CADCAMation, Onex, Switzerland

VISUAL PRESENTATIONS 6CV.4

17:00 – 18:30 **PV on/in Buildings / PV in Infrastructure, on Water and on Vehicles; PV and Agriculture**

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

Thursday, 9 September 2021

ORAL PRESENTATIONS 5DO.1

08:30 – 10:00 **Application of Machine Learning & Modelling in PV Systems**

Chairpersons:

João M. Almeida Serra
University of Lisbon - FCiencias.ID, Portugal

Dirk Stellbogen
ZSW, Stuttgart, Germany

5DO.1.1 **Advanced Analytics on I-V Curves and Electroluminescence Images of Photovoltaic Modules Using Machine Learning Algorithms**
V. Kumar & P. Maheshwari
PV Diagnostics, Mumbai, India

5DO.1.2 **Automatic Fault Detection and Classification in PV Systems by the Application of Machine Learning Algorithms**
G.D. Rupakula, D. Daßler, S. Malik & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

5DO.1.3 **Research on Digital Twin System of Photovoltaic Array**
K. Ding, X. Chen, J. Zhang & S. Weng
Hohai University, Changzhou, China
L. Feng
University of Applied Sciences Bielefeld, Minden, Germany

5DO.1.4 **Auto-Parametrising the Digital Twin of Photovoltaic Power Systems**
A. Tuomiranta, I.T. Horvath, A. Schils & E. Voroshazi
imec, Genk, Belgium
K. de Brabandere
3E, Brussels, Belgium

5DO.1.5 **Application of Machine Learning to Assess the Thermal Behaviour of PV Modules in Different Climate Zones**
J. Ascencio-Vásquez
Envision Digital, Redwood City, USA
I. Kaaya
Fraunhofer ISE, Freiburg, Germany
M. Topic
University of Ljubljana, Slovenia

5DO.1.6 **Estimating Day Ahead Photovoltaic Production Distribution Functions for the Risk Assessment of Control Energy Provision**
M. Steinbrecher, B. Kubicek & M. Rennhofer
AIT, Vienna, Austria

ORAL PRESENTATIONS 6DO.6

08:30 – 10:00 BIPV Implementation: Design, Assessment and Performance

Chairpersons:

Miguel Centeno Brito
University of Lisbon, Portugal

Francesco Frontini
SUPSI, Canobbio, Switzerland

6DO.6.1 A Multi-Layer Modelling Framework for Techno-Socio-Economical Penetration of Photovoltaics
M. Verkou, Z. Ahmad, M. Zeman, H. Ziar & O. Isabella
Delft University of Technology, The Netherlands

6DO.6.2 Assessing the Solar Energy Potential at Urban Scale Using a 3D City Model and an Innovative GIS Based Methodology: A Case Study
G. Fattoruso, S. de Vito & G. Di Francia
ENEA, Portici, Italy
G. Sorrentino, M. Nocerino & M. Fabbricino
University of Naples, Italy

6DO.6.3 High Quality Solutions of Building-Integrated Photovoltaics (BIPV) – Results of a World Wide Competition in 2020
G. Becker, F. Flade, R. Krippner, B. Schiebelsberger & W. Weber
Bavarian Association for the Promotion of Solar Energy, Munich, Germany

6DO.6.4 Comparison of IEC 61853-1 Matrix Evaluations Based on Indoor and Outdoor Measurement Data from PVPS Task 15 BIPV Round-Robin
R.M.E. Valckenborg
TNO, Eindhoven, The Netherlands
K.A. Berger & U. Gusztáv
AIT, Vienna, Austria
G.C. Eder
OFI, Vienna, Austria
L. Gaisberger
UAS Upper Austria, Wels, Austria
M. Tabakovic
UAS Technikum 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 Martinez
Tecnalia, Derio, Spain
J.T. Kim
Kongju National University, Cheonan, Republic of Korea
A.G. Imenes
University of Agder, Grimstad, Norway

6DO.6.5 Prefabricated Renewable Energy Façades for Cost-Effective Buildings (PREFAB)
C. de Keizer, S. Villa, M. Dörenkämper, D. Out & B. van de Vorst
TNO Energy Transition, Eindhoven, The Netherlands

6DO.6.6 Long-Term Performance of Building Integrated Photovoltaic Systems and Shade Induced Degradation
A. Fairbrother, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland
E. Özkalay & G. Friesen
SUPSI, Mendrisio, Switzerland

ORAL PRESENTATIONS 4DO.11

08:30 – 10:00 Sustainability Aspects of PV

Chairpersons:

Paula Perez-Lopez
Mines ParisTech, Sophia-Antipolis, France

Karsten Wambach
Wambach-Consulting, Petersdorf, Germany

4DO.11.1 Eco-Design and Energy Labeling for Photovoltaic Modules, Inverters and Systems – Enabling a Sustainable Value Chain in the EU?
A. Wade
International Thin-Film Solar Industry Association (PVthin), Brussels, Belgium
D.H. Neuhaus, L. Probst & H. Wirth
Fraunhofer ISE, Freiburg, Germany
T.C. Sauer
EXXERGY, Gräfelfing, Germany
D. Moser
Eurac Research, Bolzano, Italy
C. Rohr
NorSun, Oslo, Norway
R. Rossi
SolarPower Europe, Brussels, Belgium

4DO.11.2 A Comparative Life Cycle Assessment of PV Modules – Influence of Database and Background System
S. Herceg, M. Fischer, P.H. Brailovsky & T. Dannenberg
Fraunhofer ISE, Freiburg, Germany
A.-K. Briem & M. Held
Fraunhofer IBP, Stuttgart, Germany

4DO.11.3 Life Cycle Assessment of Thin-Film, Flexible, Silicon-Based Solar Cells in the Netherlands
G. Limodio, S. Makhlouf & A.H.M. Smets
Delft University of Technology, The Netherlands
D. Bartesaghi & E.A.G. Hamers
HyET Solar, Arnhem, The Netherlands

4DO.11.4 **Sustainable Material Flows in the PV Sector: What Work Remains to be Done to Achieve SDG12?**
E. Gervais, S. Herceg, S. Nold & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4DO.11.5 **Assessing Plausible Environmental Implications of a Ground-Mounted Perovskite/Si Tandem PV System**
C. Salas-Redondo, J.-B. Puel & A. Julien
IPVF, Palaiseau, France
C.F. Blanco
Leiden University, The Netherlands
S. Cucurachi & W.J.G.M. Peijnenburg
University Leiden, The Netherlands
L. Oberbeck
Total Gas, Paris La Défense, France

4DO.11.6 **Process Simulation and Digitization for Comprehensive Life-Cycle Sustainability and Technoeconomic Assessment of Silicon, Perovskite and their Tandem Photovoltaic Systems**
N. Bartie
Helmholtz-Zentrum Dresden-Rossendorf, Germany
L. Cobos-Becerra & R. Schlatmann
HZB, Berlin, Germany
M. Fröhling
Technical University of Munich, Straubing, Germany
M. A. Reuter
SMS Group, Düsseldorf, Germany

VISUAL PRESENTATIONS 7DV.1

08:00 – 10:00 **Economics, Markets and Education**

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

Thursday, 9 September 2021

ORAL PRESENTATIONS 5DO.2

10:30 – 12:00 **PV Systems Operation and Field Inspection**

Chairpersons:

Claudia Buerhop-Lutz
HI ERN, Erlangen, Germany

Anne Migan-Dubois
GeePs, Gif-sur-Yvette, France

5DO.2.1 **Quantifying Performance Loss Rates of Photovoltaic Modules Using Ground-Based vs Satellite-Based Insolation and Temperature Data**
E. Özkalay & G. Friesen
SUPSI, Mendrisio, Switzerland
A. Virtuani, A. Fairbrother & C. Ballif
EPFL, Neuchâtel, Switzerland
A. Skoczek
Solargis, Bratislava, Slovakia

5DO.2.2 **Quality Assurance of the Photovoltaic Power Plants Installation Stage - a Complementary Strategy Based of Photoluminescence and Steady-State Thermography**
L. Koester, A. Astigarraga, S. Lindig & D. Moser
Eurac Research, Bolzano, Italy
M. Antinori
Viridis Energia, Milan, Italy
G. Manzolini
Polytechnic University of Milan, Italy

5DO.2.3 **Crawler Robot Photoluminescence System for High Throughput Failure Analysis and Quality Control of Installed PV Modules**
F. Talkenberg & M. Menz
greateyes, Berlin, Germany
B. Doll, M. Hoffmann, L. Lüer & C.J. Brabec
FAU, Erlangen, Germany
R. Schüler & M. Baier
IBC Solar, Bad Staffelstein, Germany

5DO.2.4 **Comparison of Imaging Techniques for PV Module Inspection in the Field**
I. Høiaas, M. Vukovic, M. Jakovljevic & I. Burud
NMBU, Ås, Norway

5DO.2.5 **From Infrared Thermography to String-Level Performance – Correlating Thermal Signatures with Production Data**
B.L. Aarseth
University of Oslo, Kjeller, Norway
M.B. Øgaard & E.S. Marstein
Institute for Energy Technology, Kjeller, Norway

5DO.2.6 **Repair and Preventive Maintenance of PV Modules with Degrading Backsheets Using Flowable Silicone Sealant**
G. Beaucarne & E. Jadot
Dow Silicones, Seneffe, Belgium
G.C. Eder & Y. Voronko
OFI, Vienna, Austria
W. Mühleisen
SAL Silicon Austria Labs, Villach, Austria

ORAL PRESENTATIONS 6DO.7

10:30 – 12:00 **BIPV Development and Customisation: Approaches and Experimental Results**

Chairpersons:

Alessandra Scognamiglio
ENEA, Portici, Italy

Pierluigi Bonomo
SUPSI, Canobbio, Switzerland

6DO.7.1 **Experimental Assessment and Data Analysis of Colored Photovoltaic in the Field of BIPV Technology Application**
R. Roverso, L. Maturi, M. Pelle, A. Astigarraga & E. Lucchi
Eurac Research, Bolzano, Italy
P. Ingenhoven
Free University of Bolzano, Italy

6DO.7.2 **Photovoltaic Modules with Natural Materials for a Seamless Building Integration**
A. Morlier, S. Blankemeyer, R. Witteck, H. Schulte-Huxel, T. Daschinger, S. Bräunig, M. Köntges & R. Brendel
ISFH, Emmerthal, Germany

6DO.7.3 **Outdoor Test Results and Model Verification of Aesthetics PV Facades**
L.H. Slooff-Hoek, A.R. Burgers, K.M. de Groot & N.J.J. Dekker
TNO Energy Transition, Petten, The Netherlands
T. Minderhoud & G. Gijzen
UNStudio, Amsterdam, The Netherlands
T. Sepers
TS Visuals, Oudkarspel, The Netherlands
Y. de Groot
BAM, Bunnik, The Netherlands
W. van Strien & J.A.M. van Roosmalen
Solar Visuals, Oudkarspel, The Netherlands

6DO.7.4 **Development of a Neutral Color Photovoltaic Window Based on Luminescent Solar Concentrators**
P. Bernardoni, D. Vincenzi, G. Mangherini, A. Andreoli & M. Gjestila
University of Ferrara, Italy
L. Gila & L. Caccianotti
Eni, Novara, Italy
C. Pesenti
Eni, San Donato Milanese, Italy

Thursday, 9 September 2021

6DO.7.5 **Student Awards Finalist Presentation: Customizable Color- and Shape-Design of Inkjet-Printed Perovskite Solar Cells for Building-Integrated Photovoltaics**
H. Eggers, F. Schackmar, S. Gharibzadeh, T. Abzieher, D.B. Ritzer, B.S. Richards & U.W. Paetzold
Karlsruhe Institute of Technology, Germany
C. Erban
Sunovation, Elsenfeld, Germany

6DO.7.6 **Color Coated Glazing for Next Generation BIPV: Performance vs Aesthetics**
B. Riedel, P. Messaoudi, Y.B. Assoa, P. Thony & I.A. Tsanakas
CEA, Le Bourget-du-Lac, France
L.-E. Perret-Aebi
EPFL, Neuchâtel, Switzerland

ORAL PRESENTATIONS 7DO.12

10:30 – 12:00 **PV Business Opportunities Today and Tomorrow**

Chairpersons:

Christian Breyer
Lappeenranta University of Technology, Finland

Thomas Nordmann
TNC Consulting, Feldmeilen, Switzerland

7DO.12.1 **A Snapshot of Global PV Markets - The Latest Survey Results on PV Markets and Policies from the IEA PVPS Programme in 2020**
G. Masson
IEA-PVPS – Task 1, Brussels, Belgium
A. Jäger-Waldau
European Commission JRC, Ispra, Italy
I. Kaizuka
RTS Corporation, Chuo-ku, Japan
J. Lindahl
Becquerel Sweden, Knivsta, Sweden
J. Donoso Alonso
UNEF, Madrid, Spain

7DO.12.2 **Potential BIPV Market in Key European Countries by 2030**
P. Macé, E. Bosch & A. van Rechem
Becquerel Institute, Brussels, Belgium

7DO.12.3 **Super PV Project Innovations - LCOE Assessment and Competitiveness**
T. Haarberg
BNW-Energy, Trondheim, Norway
P. Macé & E. Bosch
Becquerel Institute, Brussels, Belgium
J. Ulbikas
Applied Research Institute for Prospective Technologies, Vilnius, Lithuania
J. Denafas
Soli "Tek R&D", Vilnius, Lithuania
A.G. Ulyashin
SINTEF, Oslo, Norway

7DO.12.4 **Evolution of Cost Assessment of Tandem Perovskite-Silicon Modules and LCOE Comparison to Silicon Technologies in Europe**
C. Moreno Castillo, J.-B. Puel & A. Julien
IPVF, Palaiseau, France
M. Woodhouse
NREL, Golden, USA
L. Oberbeck
Total Gas, Renewables and Power, Paris La Défense, France

7DO.12.5 **Projected Costs for Competing Photovoltaic Technologies Achieving over 30% Module Efficiency at Terawatt Scale in 2050**
T.M. Bruton
TMB Consulting, Woking, United Kingdom

7DO.12.6 **LCOH Calculation of Hydrogen Electrolysis from Off-Grid PV Plant Using Two Different Methods**
J. Lehmann, A. Wabbes, E. Gonzalez Miguelañez & S. Scheerlinck
ENGIE Laborelec, Linkebeek, Belgium

VISUAL PRESENTATIONS 4DV.2

10:30 – 12:00 BOS Components / Sustainability and Recycling of PV Modules

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

Thursday, 9 September 2021

ORAL PRESENTATIONS 5DO.3

13:30 – 15:00 Performance of Field and BIPV Systems

Chairpersons:

Bjørn L. Aarseth
University of Oslo, Kjeller, Norway

Peter Lechner
ZSW, Stuttgart, Germany

5DO.3.1 **Advanced Method to Determine the Gain of Bifacial PV Systems**
D. Stellbogen, P. Lechner, J. Schnepf, O. Schanz & D. Geyer
ZSW, Stuttgart, Germany

5DO.3.2 **Study of the Evolution of the Performance of Domestic Installations in France**
M.E.H. Jed, P.-O. Logerais, O. Riou & F. Delaleux
UPEC, Lieusaint, France
M. El Bah
Nouakchott-Al-Aasriya University, Mauritania

5DO.3.3 **Terrain-Following Single-Axis Tracking PV Systems: Advantages and Performance Analysis**
A. Shishavan & V.R. Abbaraju
Nextracker, Fremont, USA
F. Borrelli
University of California, Berkeley, USA

5DO.3.4 **Analysis of the Irradiance Non-Uniformity on the Performance of Vertical and Tilted Bifacial PV Module Arrays**
M. Calcagnotto Mascarello, R.P. Kenny, T. Lyubenova, A.M. Gracia Amillo & J. Lopez-Garcia
European Commission JRC, Ispra, Italy

5DO.3.5 **Technical Performance Evaluation of BIPV and BAPV Systems**
P. Ollas, J. Persson & P. Kovács
RISE Research Institutes of Sweden, Borås, Sweden

5DO.3.6 **Method for Collecting and Identifying Issues in Operation. BIPV Systems Improvement Solution**
S. Boddaert
CSTB, Sophia Antipolis, France
D. Trebosc
BDPV, Castanet Tolosan, France
V. Delisle & C. Kapsis
CanmetENERGIES, Varennes, Canada
N. Martín Chivelet
CIEMAT, Madrid, Spain
M. Machado
Tecnalia, San Sebastián, Spain
H.R. Wilson & J. Eisenlohr
Fraunhofer ISE, Freiburg, Germany
A.G. Imenes
University of Agder, Grimstad, Norway

G.C. Eder
OFI, Vienna, Austria
P. Macé
Becquerel Institute, Brussels, Belgium
J.T. Kim
Kongju National University, Cheonan, Republic of Korea
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
M. Ritzen
Zuyd University of Applied Science, Heerlen, The Netherlands
P. Kovács
RISE, Boras, Sweden
H. Ishii
LIXIL, Tokyo, Japan
F. Frontini & P. Bonomo
SUPSI, Canobbio, Switzerland
K. Kappel
Solar City Denmark, Copenhagen, Denmark
K.H.B. Frederiksen
Kenergy, Horsens, Denmark

ORAL PRESENTATIONS 6DO.8

13:30 – 15:00 Vehicle Integrated PV: Potential Energy Yield Simulations

Chairpersons:

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

Jonathan Govaerts
imec, Genk, Belgium

6DO.8.1 Development of High-Efficiency Solar Cell Modules for PV-Powered Vehicles
M. Yamaguchi, K. Nakamura, R. Ozaki, N. Kojima & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
K. Araki, Y. Ota & K. Nishioka
University of Miyazaki, Japan
T. Takamoto
SHARP, Nara, Japan
C. Thiel, A.M. Gracia Amillo, A. Tsakalidis, A. Tansini, G. Fontaras, E.D. Dunlop, N. Taylor & A. Jäger-Waldau
European Commission JRC, Ispra, Italy
T. Masuda, T. Nakado & K. Yamada
Toyota, Susono, Japan
K. Okumura
Toyota, Shizuoka, Japan
Y. Zushi & T. Tanimoto
Nissan Motor, Yokosuka, Japan

6DO.8.2 Yield Potential of Vehicle Integrated Photovoltaics on Commercial Trucks and Vans
C. Kutter, L.E. Alanis, D.H. Neuhaus & M. Heinrich
Fraunhofer ISE, Freiburg, Germany

Thursday, 9 September 2021

6DO.8.3 Energy Flow Modelling of the Benefits of Integrated PV in Heavy Duty Transport
B.K. Newman, A.J. Carr, T.R. Burgers & A. Binani
TNO Energy Transition, Petten, The Netherlands
R. Derks
IM Efficiency, Helmond, The Netherlands

6DO.8.4 Demonstration of Feeding VIPV-Converted Energy into the High-Voltage On-Board Network of Practical Light Commercial Vehicles for Range Extension
R. Peibst, F. Haase, H. Schulte-Huxel, S. Blankemeyer, M. Köntges, C. Hollemann & R. Brendel
ISFH, Emmerthal, Germany
R. Steib, A. Semmelmann & S. Lutz
Continental Engineering Services, Nuremberg, Germany
M. Brunner & A. Schiessl
Vitesco Technologies, Regensburg, Germany
S. Wöhe & R. Wecker
a2solar, Erfurt, Germany
G. Wetzel & J. Krügener
Leibniz University of Hannover, Germany
H.-J. Nonnenmacher & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany
A. Salavei, K. Ding, A. Lambertz & B.E. Pieters
Forschungszentrum Jülich, Germany
S. Janke, B. Stannowski & L. Korte
HZB, Berlin, Germany

6DO.8.5 VIPV Modelling Method for Dynamic Scenarios
N. Patel, K. Bittkau, B.E. Pieters, E. Sovetkin & K. Ding
Forschungszentrum Jülich, Germany
A.H.M.E. Reinders
Eindhoven University of Technology, The Netherlands

6DO.8.6 Energy Yield Simulation of 3D Curved VIPV Modules
S. Neven-du Mont, C. Kutter, D.H. Neuhaus & M. Heinrich
Fraunhofer ISE, Freiburg, Germany

PANEL DISCUSSION 1/3DO.13

13:30 – 15:00 ***Tandems: The Real Game Changer?***

With silicon solar cells approaching their theoretical efficiency limit, focus is shifting to tandem technologies to continue innovation and cost reduction. While the potential is clear, many issues remain open for discussion: Which choice of materials provides the best balance between high efficiency, low production cost, high stability, and resource abundance to allow for TW-scale deployment? What is the best device concept, 2-, 3- or 4-terminal? How can we translate fundamental science and record lab efficiencies into relevant manufacturing? How can we create a healthy industrial ecosystem including research, equipment manufacturing and actual cell and module production? We would like to discuss these and other questions with you, the audience, and an exciting panel which brings together a diverse set of perspectives and experience.

Moderator: Jan Christoph Goldschmidt
Fraunhofer ISE, Freiburg, Germany

Co-moderator: Phoebe Pearce
University of Cambridge, United Kingdom

Panelists: Henry Snaith
University of Oxford, United Kingdom

Wolfgang Guter
Azur Space, Heilbronn, Germany

Frank Feldmann
Solarlab Aiko, Freiburg, Germany

Guido Agostinelli
IFC, Washington, USA

Nancy Haegel
NREL, Golden, USA

Bart Vermang
imec, Genk, Belgium

D. Polverini
European Commission DG GROWTH, Brussels, Belgium

Thursday, 9 September 2021

VISUAL PRESENTATIONS 2DV.3

13:30 – 15:00 **Technologies for High Temperature Passivating Contacts and Homo Junction Silicon Solar Cells / Low Temperature Routes for Silicon Cells**

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

ORAL PRESENTATIONS 5DO.4

15:15 – 16:45 **The Effect of Soiling and Snow Cover on PV System Performance**

Chairpersons:

Gerhard Mathiak
TÜV Rheinland Energy, Cologne, Germany

David Moser
Eurac Research, Bolzano, Italy

5DO.4.1 **Field Deployment of the Optical Soiling Sensor DUSST: 1 Year of Outdoor Operation**
A. Fernández Solas, L. Micheli, F. Almonacid-Cruz & E.F. Fernández
University of Jaén, Spain
M. Muller
NREL, Golden, USA

5DO.4.2 **Experimental Setup for the Validation of Soiling Measurements**
F. Wolfertstetter, J. Carballo & S. Wilbert
German Aerospace Center, Almeria, Spain
L.F. Zarzalejo, M.C. Alonso-García & J. Polo
CIEMAT, Madrid, Spain
D. Martinez
CIEMAT, Tabernas, Spain

5DO.4.3 **Student Awards Finalist Presentation: Data-Driven Assessment of Soiling Loss in Photovoltaic Plants**
K. Yurtseven & E. Karatepe
Dokuz Eylul University, Izmir, Turkey
E. Deniz
Entegro Enerji Sistemleri, Izmir, Turkey

5DO.4.4 **Modelling Anti-Soiling Coating Performance and Price for PV Systems**
L. Micheli, F. Almonacid-Cruz & E.F. Fernández
University of Jaén, Spain
G.P. Smestad
Sol Ideas Technology Development, San Jose, USA
K. Ilse
Fraunhofer CSP, Halle (Salle), Germany

5DO.4.5 **Estimation of Snow Loss for Photovoltaic Plants in Norway**
M.B. Øgaard, H.N. Riise & J.H. Selj
Institute for Energy Technology, Kjeller, Norway

5DO.4.6 **Modelling and Impact of Solar Eclipses on PV Energy Production**
J. Ascencio-Vásquez
Envision Digital, Redwood City, USA
R. Amaro e Silva
University of Lisbon, Portugal
E. Urrejola
ATAMOSTEC, Antofagasta, Chile
K. Brecl & M. Topic
University of Ljubljana, Slovenia

ORAL PRESENTATIONS 6DO.9

15:15 – 16:45 **Vehicle Integrated PV and Floating PV Applications**

Chairpersons:

Eszter Voroshazi
CEA, Le Bourget-du-Lac, France

Kaining Ding
Forschungszentrum Jülich, Germany

6DO.9.1 **Student Awards Finalist Presentation: Strategies for the Analysis of Shading Effects in Vehicle Integrated Photovoltaics**
J. Macías Rodríguez, R. Herrero, I. Antón Hernández & R. Núñez
UPM, Madrid, Spain

6DO.9.2 **VIPV: Thermocompression Process Development and Simulation to Integrate Photovoltaic Cells in a Double-Curved Composite Structure**
T. Duigou, F. Chabuel & J. Gaume
CEA, Grenoble, France
G. Dennler, P. Francescato & L. Tenchine
Industrial Technical Center for Plastics and Composites, Bellignat, France
G. Habchi, M. Lagache & P. Saffre
University Savoie Mont Blanc, Annecy, France

6DO.9.3 **Versatile Lightweight Photovoltaic Module Line at CSEM Using High Efficiency Crystalline Silicon Cells, with Customized Module Stacks to Meet Application Oriented Reliability and Aesthetic Targets**
S. Prabhudesai, P. Duvoisin, C. Charriere, X. Bulliard, A. Faes, G. Cattaneo, J. Escarré Palou, H.-Y. Li, G. Nogay, A. Saury, P. Merme, C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

6DO.9.4 **The Effect of Wind and Drought on an Open FPV System**
T. Kjeldstad, D. Lindholm & J.H. Selj
Institute for Energy Technology, Kjeller, Norway

6DO.9.5 **Opening Up New Land Resources for Vertical Bifacial Solar Modules Using a "Nature-Conserving Agrivoltaics" Concept**
N. Pannicke-Prochnow & R. Stretz
Helmholtz-Centre for Environmental Research, Leipzig, Germany
J. Schneider
Leipzig University of Applied Sciences, Germany
C. Gerhards
Fraunhofer IMW, Leipzig, Germany
B. Volz
Next2Sun, Berlin, Germany

6DO.9.6 **Operational Constraints of Hybrid Hydropower-Connected Floating PV Projects**
S. Merlet & M. Korpås
NTNU, Trondheim, Norway
B. Thorud
Multiconsult Norge, Oslo, Norway

VISUAL PRESENTATIONS 2DV.4

15:15 – 16:45 **Crystalline Silicon Technology / Thin-Film and Foil-Based Silicon Cells**

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

ORAL PRESENTATIONS 7DO.5

17:00 – 18:30 **Integration of PV in the Local and Regional Context**

Chairpersons:

Maria Getsiou
European Commission DG RTD, Brussels, Belgium

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

7DO.5.1 **Spatial Implications of Solar PV in the Netherlands: Assessment of Several Land Use Variants and Policy Choices**
R. Quax & W. van Hooff
TKI Urban Energy, Utrecht, The Netherlands
M. Londo & W.G.J.H.M. van Sark
Utrecht University, The Netherlands
T. Kuijers & J. Witte
Generation Energy, The Hague, The Netherlands
W.C. Sinke
TNO Energy Transition, Petten, The Netherlands

7DO.5.2 **Do North-Facing BIPV Facades in Europe Make Sense? - Policy Drivers for PV in Buildings (and Infrastructures)**
A. Virtuani, A. Fairbrother, F. Lisco, L.-E. Perret-Aebi, N. Wyrsch & C. Ballif
EPFL, Neuchâtel, Switzerland

7DO.5.3 **SimZukunft - Four Energy Scenarios for a Typically Swiss City**
U. Muntwyler, N. Pflugradt & E. Schüpbach
BUAS, Burgdorf, Switzerland

7DO.5.4 **SocialRES Energy Innovation Framework: a Comparative Analysis of Existing Business Models for RES Cooperative, Aggregators and Crowdfunders**
I. Lizarralde, M. Hamwi, A. Abi Akle & B. Samir
ESTIA Institute of Technology, Côte Basque, France
S. Caneva, S. Wilhelm & D. van der Zande
WIP Renewable Energies, Munich, Germany
V. Kromrey, D. Vedel & L. Lentzen
Bodensee-Stiftung, Radolfzell, Germany
A. Schneller, K. Kohl & J. Doerpinghaus
Adelphi, Berlin, Germany
J. Hoffmann
Adelphi, Bluemen, Germany
E. Schmid & C. Crippa
Fondazione Icons, Lodi, Italy
E. Denny, J. Carroll & H. Wu
Trinity College Dublin, Ireland
M. Regidor & S. Mulero
CARTIF Foundation, Valladolid, Spain
I. Lacoste
I-ENER, Saint-Jean-Pied-de-Port, France
R. Ruiz, S. Campos & E. Otero
ENERGETICA, Zaragosa, Spain
N. Brito Jorge
GoParity, Lisbon, Portugal
F. Onofre
Power Parity, Lisbon, Portugal
K. Harder
Abundance, London, United Kingdom
T. Šimek
REGEA, Zagreb, Croatia
D. Leonte & M. Policarp
Tractebel, Bucharest, Romania

7DO.5.5 **Optimal Allocation Method for a Fair Distribution of the Benefits in an Energy Community**
V. Casalicchio, M.G. Prina & D. Moser
Eurac Research, Bolzano, Italy
G. Manzolini
Polytechnic University of Milan, Italy

7DO.5.6 **How Will Network Impacts of Distributed PV, Electric Vehicles, and Heat Pumps Depend on Local Context and Where Is Flexibility Most Needed? A Geographically Disaggregated Study across Great Britain**
S. Few, P. Djapic, G. Strbac, J. Nelson & C. Candelise
Imperial College London, United Kingdom

Thursday, 9 September 2021

ORAL PRESENTATIONS 2DO.10

17:00 – 18:30 **Defects in Silicon and their Characterisation**

Chairpersons:

Dennis Bredemeier
ISFH, Emmerthal, Germany

Stephan Riepe
Fraunhofer ISE, Freiburg, Germany

2DO.10.1 **Electronic Properties and Structure of Boron-Hydrogen Complexes in Crystalline Silicon**
J.A. De Guzman, V. Markevich, M. Halsall & A. Peaker
University of Manchester, United Kingdom
J. Coutinho
University of Aveiro, Portugal
N.V. Abrosimov
IKZ Institute for Crystal Growth, Berlin, Germany

2DO.10.2 **Realising the Potential of Fluorine Passivation for Defects and Interfaces in Silicon**
H.C. Sio, D. Kang, C. Samundsett & D. Macdonald
ANU, Canberra, Australia

2DO.10.3 **Influence of Intentional Alkali Metals and Alkaline Earth Metal Contamination on PID of Silicon Solar Cells**
J. Hepp, C. Huse, B. Doll & C.J. Brabec
I-MEET, Erlangen, Germany
V. Naumann
Fraunhofer CSP, Halle (Saale), Germany
A. Linsenmeyer
SUNSET, Adelsdorf, Germany
J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany

2DO.10.4 **Application of Δn Normalised Time, Γ: Linear Injection-Level Dependence on LeTID and the Recovery in Crystalline Silicon**
M. Kim, A. Ciesla, M. Abbott & B. Hallam
UNSW Australia, Sydney, Australia
C. Sun
ANU, Canberra, Australia
D. Chen
Sundrive Solar, Kirrawee, Australia

2DO.10.5 **Student Awards Finalist Presentation: Electron Paramagentic Resonance Investigation of Mechanism of Light- and Elevated-Temperature-Induced Degradation in Ga-Doped Cz Si**
A.R. Meyer, P.C. Taylor & S. Agarwal
Colorado School of Mines, Golden, USA
V. LaSalvia, W. Nemeth, M. Page, D.L. Young & P. Stradins
NREL, Golden, USA

2DO.10.6 Optimization of Laser Excitation and Eddy-Current Sensor Based Carrier Lifetime Measurement for Si Ingots
D. Krisztian, F. Korsós, I. Saegh, G. Paráda & P. Tüttö
Semilab, Budapest, Hungary
X. Dong
Semilab Trade Shanghai, China
H. Deng, S. Wang & X. Chen
LONGi Clean Energy, Shaanxi, China

VISUAL PRESENTATIONS

17:00 – 18:30 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 together with the winners and interested audience.

Friday, 11 September 2020

ORAL PRESENTATIONS 7EO.1

08:30 – 10:00 Policies, Scenarios and Instruments for Large Scale PV Deployment

Chairpersons:

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

Nigel Taylor
European Commission JRC, Ispra, Italy

7EO.1.1 Building Criteria for the Energy Labelling of Photovoltaic Modules and Residential Systems
D. Polverini
European Commission DG GROWTH, Brussels, Belgium
A.M. Gracia Amillo, N. Taylor, T. Sample, E. Salis & E.D. Dunlop
European Commission JRC, Ispra, Italy

7EO.1.2 The Key Contribution of Solar PV to Remain in a Decarbonization Path Compatible with the Paris Agreement
M. Victoria
Aarhus University, Denmark

7EO.1.3 Smart Strategies for the Transition in Coal Intensive Regions
R. Mergner, R. Janssen & D. Rutz
WIP Renewable Energies, Munich, Germany
C. Malamatenios & G. Veziryianni
CRES, Athens, Greece
D. Knoche, A. Rademacher & R. Schlepphorst
Research Institute for Post-Mining Landscapes (FIB), Finsterwalde, Germany
L. Fonseca, R. Michie & W. Den Hoed
University of Strathclyde, United Kingdom
A. Nikolaev
BSERC, Sofia, Bulgaria
C. Doczekal
Güssing Energy Technologies, Austria
G. Arrowsmith & N. de la Vega
EUREC, Brussels, Belgium
G. Popescu
ISPE, Bukarest, Romania
J. Lukic
Energo Projekt ENTEL, Belgrade, Serbia
I. Volchyn & D. Bondzyk
Coal Energy Technology Institute, Kyiv, Ukraine
M. Pietrzykowski & M. Chodak
University of Agriculture in Krakow, Poland
T. Rees & K. Palmer
Welsh Assembly Government, Cardiff, United Kingdom
J. Frouz
Charles University, Pargue, Czech Republic
M. Hendrychova
Czech University of Life Sciences, Prague, Czech Republic

S. Irimie
Jiu Valley Social Institute, Petrosani, Romania

7EO.1.4 **PEARL PV Country Reports: An Extensive Overview of the Status of PV System Installations, Policies and PV Research**

I. Farkas & D. Atsu
Szent Istvan University, Godollo, Hungary
A. Raghoebarsing
University of Twente, Enschede, The Netherlands
S. Boddaert
CSTB, Sophia Antipolis, France
N.M. Pearsall
Northumbria University, Newcastle upon Tyne, United Kingdom
D. Moser
Eurac Research, Bolzano, Italy
A.H.M.E. Reinders
Eindhoven University of Technology, The Netherlands

7EO.1.5 **SOLAR-ERA.NET - European Cooperation in PV RTDI and Beyond - Highlights, Lessons Learned and Future Perspectives**

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 & M. Schulte
Forschungszentrum Jülich, Germany
I. Carlos
FECYT, Coruna, Spain
E. Fernández & B. Gómez
MINECO, Madrid, Spain
M. Sopena
CDTI, Madrid, Spain
P.-J. Rigole
Swedish Energy Agency, Eskilstuna, Sweden
O. Bernsen
Netherlands Enterprise Agency, Den Haag, The Netherlands
L. Polain
Public Service of Wallonia, Jambes, Belgium
G. Carchon
VLAIO, Gent, Belgium
E. Afentaki
GSRT, Athens, Greece
P. Leptos
RPF, Lefkosia, Cyprus
P. Rale
ADEME, Metz, France
P. Bain
ANR, Paris, France
K. Karaösz
TUBITAK Marmara Research Center, Gebze, Turkey
A. Covello
MIUR, Rome, Italy
E. Lutter
Climate and Energy Fund, Vienna, Austria
A. Hipfinger
Austrian Research Promotion Agency (FFG), Vienna, Austria
G. Friedmann
Ministry of Energy, Jerusalem, Israel

Friday, 10 September 2021

7EO.1.6 **Impact of Public and Private Funding on the Development of the Photovoltaic Sector and the Achievement of 2030 Energy Transition Targets**

D. Moser, F. De Nigri, S. Pezzutto & S. Gantioler
Eurac Research, Bolzano, Italy

ORAL PRESENTATIONS 5EO.2

08:30 – 10:00 **Concentrators and PV for Space Applications**

Chairpersons:

Ignacio Antón Hernández
UPM, Madrid, Spain

Carsten Baur
European Space Agency, Noordwijk, The Netherlands

5EO.2.1 **Suitable Silicon Solar Cell Technologies for Use in Space Applications**

V.D. Mihailetchi, C. Peter & R. Kopecek
ISC Konstanz, Germany
M. Okandan
mPower Technology, Albuquerque, USA

5EO.2.2 **Student Awards Finalist Presentation: Ultra-Thin Photovoltaics for Space Power Systems with Enhanced Radiation Tolerance**

L. Sayre, E. Camarillo Abad, P. Pearce & L.C. Hirst
University of Cambridge, United Kingdom
A.D. Johnson
IQE, Cardiff, United Kingdom
P.-M. Chausse, P.-M. Coulon & P. Shields
University of Bath, United Kingdom

5EO.2.3 **Electrons Irradiation of III-V//Si Solar Cells for Space Applications**

M. Medjoubi, L. Vauche, C. Jany, F. Chabuel & R. Cariou
CEA, Grenoble, France
B. Boizot
CEA, Gif sur Yvette, France

5EO.2.4 **Light Weight Interconnection Weave for Space PV**
T. Borgers
imec, Genk, Belgium
J. Szlufcik, J. Govaerts, G. Doumen, L. Vastmans, E. Voroshazi & J. Poortmans
imec, Leuven, Belgium
M. Van den Storme & G. Van den Storme
VdS Weaving, Oudenaarde, Belgium
C. Brandt
ESA, Noordwijk, The Netherlands
D. Girolamo & S. Das
ESA, Paris, France
J. Verdonck
Thales Alenia Space in Belgium, Brussels, Belgium
P. Nivelle
Hasselt University, Diepenbeek, Belgium
S. De Vrieze
Centexbel, Grâce-Hollogne, Belgium

5EO.2.5 **First Mechanical Study on Lightweight Microconcentrators Systems for Space Applications**
V. Vareilles, A. Bermudez-Garcia, J. Francois, O. Raccurt, Y. Veschetti, P. Voarino & F. Chabuel
CEA, Grenoble, France

5EO.2.6 **What Is the Correct Efficiency for Terrestrial Concentrator PV Devices?**
H. Müllejans & E.D. Dunlop
European Commission JRC, Ispra, Italy
S. Winter
PTB, Braunschweig, Germany
M.A. Green
UNSW Australia, Sydney, Australia

ORAL PRESENTATIONS 2EO.3

08:30 – 10:00 **Feedstock and Wafer Processing / Thin-Film and Foil-Based Silicon Cells**

Chairpersons:

Marko Topic
University of Ljubljana, Slovenia

Noritaka Usami
Nagoya University, Japan

2EO.3.1 **Boron Removal from Molten Si via Reactive Gas Refining**
A. Hoseinpur & J. Safarian
NTNU, Trondheim, Norway
M. Müller
Forschungszentrum Jülich, Germany
K. Tang
SINTEF, Trondheim, Norway

2EO.3.2 **Efficiency Potential Analysis of p- and n-Type Epitaxially Grown Si Wafers**
C. Rittmann, M. Drießen, J. Dalke, C. Weiss, F. Schindler, R. Sorgenfrei, M.C. Schubert & S. Janz
Fraunhofer ISE, Freiburg, Germany

2EO.3.3 **Laser Cutting of Solar Cells by Using the Stress Cut Approach**
S. Krause, S. Hensel, M. Meusel, S. Eiternick & M. Turek
Fraunhofer CSP, Halle (Saale), Germany

2EO.3.4 **14% Efficiency Ultrathin Silicon Solar Cells with Improved Infrared Light Management Enabled by Hole-Selective Transition Metal Oxide Full-Area Rear Passivating Contacts**
H. Nasser, M. Zolfaghari Borra, E.H. Çiftpinar, B. Eldeeb & R. Turan
METU, Ankara, Turkey

2EO.3.5 **Optimization of the Conductivity and Crystalline Fraction of p-Type c-SiOx:H Films for Silicon Heterojunction Solar Cells**
A.D.J. OLIVARES-VARGAS, M. Poplawski & P. Roca i Cabarrocas
CNRS, Palaiseau, France
G. Kaur
IPVF, Palaiseau, France
A. Desthieux
EDF R&D, Palaiseau, France

2EO.3.6 **Lotus Leaf Structured Foils for Light Management and Self-Cleaning in Liquid Phase Crystallized Silicon Thin-Film Solar Cells**
D. Yoo, S. Garud, D. Amkreutz & C. Becker
HZB, Berlin, Germany

PLENARY SESSION EP.1

10:30 – 12:10 **Sustainability and Social Acceptance Preparing for the TW Era**

Chairpersons:

Andreas Wade
First Solar, Frankfurt, Germany

Marta Victoria
Aarhus University, Denmark

EP.1.1 **Sustainability of PV Manufacturing**
L. Wagner, L. Friedrich, A. Hinsch & J.C. Goldschmidt
Fraunhofer ISE, Freiburg, Germany
R. Pietzcker
PIK, Potsdam, Germany

EP.1.2 **A Framework for Implementing Requirements on the Carbon Footprint of Photovoltaic Modules under the Ecodesign Policy**
D. Polverini & C. Klos
European Commission DG GROWTH, Brussels, Belgium
N. Espinosa & A. Arcipowska
European Commission JRC, Seville, Spain

EP.1.3 **True Cost of Solar Hydrogen**
E. Vartiainen
Fortum Growth, Finland
C. Breyer
LUT University, Lappeenranta, Finland
D. Moser
Eurac Research, Bolzano, Italy
E. Román Medina
Tecnalia, Derio, Spain
C. Busto
Eni, Novara, Italy
G. Masson
Becquerel Institute, Brussels, Belgium
A. Jäger-Waldau
European Commission JRC, Ispra, Italy

EP.1.4 **Social Networks and Digital Gamification for Solar Literacy and Photovoltaic Communities - the SOLIS Solar Platform of Lisbon**
S.R. Freitas & M.J. Rodrigues
Lisboa E-Nova, Lisbon, Portugal

EP.1.5 **How Photovoltaics started to Change Architecture over the Last Two Decades**
B. Kaempfen
Kämpfen Zinke + Partner, Zurich, Switzerland

Friday, 10 September 2021

12:20 – 13:45 CONFERENCE CLOSING

Introduction to the Closing Session

João M Serra
EU PVSEC Conference General Chair,
Faculdade de Ciências da Universidade de Lisbon, Portugal

Highlights of the Conference

Robert Kenny
EU PVSEC Technical Programme Chairman,
European Commission JRC

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 31,
Bram Hoex

Representative IEEE PVSC,
William Shafarman

Representative WCPEC-8
Alessandra Scognamiglio

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

João M Serra
EU PVSEC Conference General Chair

Visual Presentations

Monday, 06 September 2021

VISUAL PRESENTATIONS 4AV.1

15:15 – 16:45 PV Module Design, Components and Ageing

Chairpersons:

Gernot Oreski
PCCL, Leoben, Austria

Guy Beaucarne
Dow Silicones, Seneffe, Belgium

4AV.1.1 Degradation of Photovoltaic Backsheets: Study of the Effect of Sample Preparation
J. Xia & H. Hu
DuPont R&D Center, Shanghai, China
W.J. Gambogi, K.R. Choudhury & M. Rodriguez
DuPont, Wilmington, USA

4AV.1.3 Performance and Durability of Tedlar® PVF Based Frontsheets
W.J. Gambogi, M. Demko, M. Teasley, B.-L. Yu, S. MacMaster, S. Kurian & K. Roy-Choudhury
DuPont, Wilmington, USA
L. Garreau-Iles
DuPont, Meyrin, Switzerland
H. Hu & O. Fu
DuPont, Shanghai, China
R. Khatri
DuPont, Gurgaon, India

4AV.1.4 Solar Heat Blocking Encapsulants to Increase Power Output and Lifetime of Crystalline Silicon PV
R. van Zandvoort, D. Mann & P. Buskens
BMC, Geleen, The Netherlands
H. Steijvers, M. Theelen & N. Meulendijks
TNO/Solliance, Eindhoven, The Netherlands

4AV.1.5 Impact of the Lamination Process on the Adhesion Properties of PV Modules and Their Damp Heat Stability
A.K. Öz, C. Herzog & C. Wellens
Fraunhofer ISE, Freiburg, Germany

4AV.1.6 Performance Analysis and CTM Simulations of 72-Half Cut PERC Cells Based Glass-Glass Modules with Various Encapsulant Materials
M. Çaliskan & F. Es
Kalyon PV, Ankara, Turkey

4AV.1.7 PV40+ Project: New Encapsulants and Testing Strategies to Achieve 40 Years of Lifetime
C. Barretta & G. Oreski
PCCL, Leoben, Austria
M. Yang & R. Schäffler
NICE Solar Energy, Schwäbisch Hall, Germany
A. Brandstätter
Lenzing Plastics, Austria
P. Lechner & D. Geyer
ZSW, Stuttgart, Germany
J. Wittfoth
CS Wismar, Germany
A. Gök & A.B. Paç
Gebze Technical University, Turkey

4AV.1.8 Methodology for Evaluating Solar Module Encapsulant Materials
H.-H. Hsieh, S.-H. Chen, M.-T. Lai & C.-P. Huang
ITRI, Hsinchu, Taiwan
C.-W. Kuo, T.-M. Kuan & C.-Y. Yu
TSEC, Hsinchu, Taiwan

4AV.1.9 Qualitative and Semi-Quantitative Analysis of Additives in Encapsulation Materials of PV Modules
S. Neubauer, A. Mordvinkin & S. Meyer
Fraunhofer CSP, Halle (Saale), Germany

4AV.1.10 Novel Test Methodology for Characterization of Fatigue Delamination Resistance of Glass/Glass Modules on Specimen Level
G. Riedl, R. Pugstaller & G.M. Wallner
Johannes Kepler University Linz, Austria
F.R. Costa
Borealis, Linz, Austria

4AV.1.11 Stability of Inks for Masking Ribbons in BIPV Modules
A. Borja Block, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland

4AV.1.12 Three-Dimensional Multi-Ribbon Back-Contact Interconnection: Latest Results on Reliability Testing
R. Van Dyck & A.W. Van Vuure
KU Leuven, Belgium
T. Borgers, J. Govaerts, A.S.H. van der Heide, L. Tous & J. Poortmans
imec, Genk, Belgium

4AV.1.13 Improved Eddy-Current Probe for Non-Destructive Characterization of Electrical Contacts in PV Modules
L. Neumaier, M. Lenzhofer, C. Hirschl & J. Kosel
SAL Silicon Austria Labs, Villach, Austria

4AV.1.15 Shingle Interconnection on HJT Solar Cells: Reliability Study and Upscaling for High Power PV Modules
C. Carrière, V. Barth, S. Harrison, A. Bettinelli & A. Derrier
CEA, Le Bourget-du-Lac, France
L. Cerasti & M. Galiazzo
Applied Materials, Olmi San Biagio, Italy
S. Wendlandt
PI Berlin, Germany

4AV.1.16 **Electrically Conductive Adhesive Interconnects: How Low Can You Go?**
D. Tune, I. Ullmann, M. Ignacia Devoto, T. Timofte & A. Halm
ISC Konstanz, Germany

4AV.1.17 **Study on Ions for Crystalline Silicon Solar Module under High External Potential**
H. Yang & H. Wang
Xi'an Jiaotong University, China

4AV.1.18 **Production Process FMEA: Effective Procedure to Detect Major Process Related Reliability Risks and Better Specify Reliable Productions Windows**
B. Jäckel & M. Pander
Fraunhofer CSP, Halle (Saale), Germany
D. Philipp & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4AV.1.19 **Advanced Degradation Modelling of Photovoltaic Modules and Materials**
K.A. Berger
AIT, Vienna, Austria
K. Knöbl
UAS Technikum Viena, Vienna, Austria
F. Schröder
Applied Statistics, Vienna, Austria
G. Oreski & C. Barretta
PCCL, Leoben, Austria
L. Neumaier
SAL Silicon Austria Labs, Villach, Austria
M. Feichtner
KIOTO, St. Veit/Glan, Austria
Y. Voronko & G.C. Eder
OFI, Vienna, Austria

4AV.1.20 **Accelerated Acid Corrosion Testing of Solar Cells: Test to Failure**
A. Fairbrother, B. Bergerot, L. Gnocchi, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland

4AV.1.21 **Modelling of Degradation Rates and Lifetime Estimations of Backsheets and Encapsulants: Hydrolysis and Photo-Degradation**
L. Castillon & G. Oreski
PCCL, Leoben, Austria
I. Kaaya
Fraunhofer ISE, Freiburg, Germany
J. Ascencio-Vásquez
3E, Brussels, Belgium

4AV.1.23 **Compatibility of Crosslinking Encapsulants with Smart Wire Connection Technology: Ways to Prevent Bubbles Formation**
D. Andronikov, I. Dmitriev, S. Yakovlev, E. Terukova & D. Orekhov
R&D Center TFTE, St-Petersburg, Russian Federation
N. Glebova & A. Nechitailov
Ioffe Physical-Technical Institute of Russian Academy of Sciences, St-Petersburg, Russian Federation
I. Shakhray
Avelar Solar Technology, Novocheboksarsk, Russian Federation

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4AV.1.24 **Motivation, Benefits, and Challenges for New Photovoltaic Material & Module Developments – Results from IEA PVPS Task 13 Subtask 1.1**
G. Oreski
PCCL, Leoben, Austria
J.S. Stein
Sandia National Laboratories, Albuquerque, USA
G.C. Eder
OFI, Vienna, Austria
K.A. Berger
AIT, Vienna, Austria
L. Bruckman
Case Western Reserve University, Cleveland, USA
J. Vedde
European Energy, Søborg, Denmark
K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4AV.1.25 **Hot Cells in High-Power PV Modules with Solar Cells from Larger Silicon Wafer Formats**
R. Witteck, M. Siebert, I. Kunze & M. Köntges
ISFH, Emmerthal, Germany

4AV.1.26 **Approaches for a Lightweight Module with Laminated Materials**
M. Heinrich, A.J. Beinert, P. Romer, L.C. Rendler, F. Basler & D.H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.27 **Shingled Solar Module for BIPV Application**
J. Zhu, N. Roosloot, G. Otnes & S.E. Foss
Institute for Energy Technology, Kjeller, Norway

4AV.1.28 **Simulation Tool for the Performance Optimization of Colored PV Modules**
C. Pfau, A.R. Bangash, C. Hagendorf & M. Turek
Fraunhofer CSP, Halle (Saale), Germany

4AV.1.29 **Lightweight Glass-Free Solar Modules Based on Polycarbonate and Fiberglass Protective Sheets**
K. Emtsev, S. Yakovlev, I. Dmitriev, E. Schebet, D. Andronikov & D. Orekhov
R&D Center TFTE, St-Petersburg, Russian Federation
I. Shakhray
Avelar Solar Technology, Novocheboksarsk, Russian Federation

4AV.1.30 **PV Module Design and Optimization for High Radiation and Harsh Desert Conditions**
J.-F. Lelièvre, H. Colin, R. Couderc, R. Soulas & D. Muñoz
CEA, Le Bourget-du-Lac, France
A. Halm & R. Kopecek
ISC Konstanz, Germany
A. Henriquez, P. Ferrada & E. Fuentealba
University of Antofagasta, Chile
F. Valencia & E. Urrejola
ATAMOSTEC, Antofagasta, Chile

4AV.1.31 **412 W Solar Module Using Silicon Heterojunction Cells and Shingle Interconnection**
M. Foti, C. Gerardi, A. Guglielmino, G. Litrico, M. Sciuto, A. Spampinato, A. Ragonesi, F. Rametta, A. Canino, A. Carbonaro, F. Coco & A.G.F. Di Stefano
ENEL Green Power, Catania, Italy
M. Galiazzo, L. Cerasti, E. Sovernigo & P. Fugolo
Applied Materials, Olmi di San Biagio, Italy
F. Bizzarri
ENEL Green Power, Rome, Italy

4AV.1.33 **Origami-Foldable Tessellated Crystalline-Si Solar Cell Module with Metal Textile Connections**
Y.H. Sim, M.J. Yun, D.Y. Lee & S.I. Cha
KERI, Changwon, Republic of Korea

4AV.1.35 **Cross-linking Kinetics of Photovoltaic Module Encapsulants – Investigation of Selected EVA and POE Grades**
B. Adothu, G.M. Wallner, R. Pugstaller & M. Tiefenthaler
Johannes Kepler University, Linz, Austria
F.R. Costa
Borealis, Linz, Austria
S. Mallick
IIT Bombay, Mumbai, India

4AV.1.36 **PV Module Transportation in Trucks with Two Different Floor Designs**
D. Vasudevan & A. Kottantharayil
IIT Bombay, Mumbai, India

VISUAL PRESENTATIONS 4AV.2

17:00 – 18:30 **PV Module Characterisation, Testing and Outdoor Performance**

Chairpersons:

Tony Sample
European Commission JRC, Ispra, Italy

Ralph Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

4AV.2.1 **Outdoor Photoluminescence and Electroluminescence Imaging of Silicon Modules in a String**
M. Vukovic, I.E. Høiaas, M. Jakovljevic, A.S. Flø, E. Olsen & I. Burud
NMBU, Ås, Norway

4AV.2.2 **Investigations on the Temperature Dependency of the Shunt Resistance in CIGS Thin-Film Solar Modules Using Dark IV-Curve Measurements**
L. Gerstenberg, P.K. Panda, S. Voswinckel & V. Wesselak
Nordhausen University of Applied Sciences, Germany

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4AV.2.3 **Complete Recovery of Crystalline Silicon Photovoltaic Modules by the Early Detection of Potential Induced Degradation**
M. Florides, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

4AV.2.4 **LeTID: Electrical Characteristics Analysis of Bifacial Silicon Modules under Accelerated Stress Tests**
G. Plessis, J. Dupuis, O.L. Rhazi & E. Sandré
EDF R&D, Moret-sur-Loing, France
K. Radouane
EDF Renewables, Paris La Defense, France

4AV.2.5 **Potential Induced Degradation (PID) Free Module Design via Interruption of the Electric Field**
K. Sporleder, B. Jäckel & R. Gottschalg
Fraunhofer IMWS, Halle (Saale), Germany
S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany

4AV.2.6 **Accurate Short-Circuit Current Measurements on Photovoltaic Modules – Challenges for On-Site Outdoor Determinations**
D. Daume, S. Schneider, T. Neumeyer, T. Beck, S. Steinbach & B. Hüttl
Coburg University of Applied Sciences, Germany
A. Schulze
Rosenheim University of Applied Sciences, Germany

4AV.2.7 **Calculation of the Short-Circuit Current of Colored BIPV Modules under Field Conditions by Application of Spectrally and Angle Resolved Measurement Data**
L. Clasing, U. Blieske & S. Schaaf
Cologne University of Applied Sciences, Germany
N. Riedel-Lyngskær & A.A. Santamaria Lancia
Technical University of Denmark, Roskilde, Denmark
N. Reiners
Fraunhofer ISE, Freiburg, Germany

4AV.2.8 **Impact of Encapsulant Color on the Performance of PV Modules under Desert Conditions**
B. Aldalali & R.I. Bourisli
Kuwait University, Safat, Kuwait
B. Alabdulrazzaq & A. Al-Qattan
KISR, Safat, Kuwait
A. Tuomiranta & J. Poortmans
imec, Leuven, Belgium

4AV.2.9 **The Impact of Real Albedo Values on Energy Estimation for Bifacial Modules**
H. Sánchez & S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
C. Meza
Costa Rica Institute of Technology, Cartago, Costa Rica
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

4AV.2.10 **Efficiency Loss in Coloured Photovoltaics: Estimating the Contribution from Reflection Loss and Absorption Loss**
A. Røyset & T. Kolås
SINTEF, Trondheim, Norway
M. Rudzikas
Center for Physical Sciences and Technology, Vilnius, Lithuania
A.G. Ulyashin
SINTEF, Oslo, Norway

4AV.2.11 **Characterization of Low Breakdown Voltage c-Si Solar Cells and Implications on the Annual DC Yield of Partially Shaded c-Si Modules**
A. Calcabrini, V. Kambhampati, P. Manganiello, M. Zeman & O. Isabella
TU Delft, The Netherlands

4AV.2.12 **Rapid Determination of Lateral Non-Uni-Formities of Solar Simulators for PV Modules**
M. Meusel & M. Turek
Fraunhofer CSP, Halle (Saale), Germany

4AV.2.13 **Angle of Incidence Study at Photovoltaic Modules with Polymer Front Sheet**
S. Wendlandt
PI Berlin, Germany
J. Govaerts & A.S.H. van der Heide
imec, Genk, Belgium
J. Kaakkunen & T. Savisalo
Valoe, Mikkeli, Finland
A. Morlier
ISFH, Emmerthal, Germany
D. Raine & D. Röder
Fraunhofer ISE, Freiburg, Germany

4AV.2.14 **In Situ Monitoring of Electrical Parameters of PV Modules under Mechanical Stress**
T. Duigou, R. Cariou, F. Chabuel, R. Couderc, J. Gaume,
A. Rafanomezantsoa & J.P. Rakotoniaina
CEA, Grenoble, France
G. Dennler & L. Tenchine
Industrial Technical Center for Plastics and Composites, Bellignat, France
G. Habchi, M. Lagache & P. Saffre
University Savoie Mont Blanc, Annecy, France

4AV.2.15 **Beyond Standard Equivalent Cell Temperature (ECT) Evaluation**
G.H. Yordanov & J.D. Moschner
KU Leuven, Belgium
M.G. Chowdhury & A.S.H. van der Heide
imec, Leuven, Belgium

4AV.2.16 **Design and Development of Solar Cell Integrated Moisture and Temperature Sensors for Photovoltaic Modules**
J.N.B. Patel, E. Fokuhl, K.S. Prakash, A.J. Beinert, P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany
V. Wesselak
Nordhausen University of Applied Sciences, Germany

4AV.2.17 **Temperature Irradiance Matrix for Energy Rating**
O. Bazkir & S. Meric
TUBITAK-UME, Kocaeli, Turkey

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4AV.2.18 **Classification of Uncertain I-V Curves in PV Modules Based on Current and Voltage Evaluation**
L. Feng & F.U. Hamelmann
University of Applied Sciences Bielefeld, Minden, Germany
N. Amin
UNITEN, Kajang, Malaysia
J. Zhang & K. Ding
Hohai University, Changzhou, China

4AV.2.19 **Influence of Light, Temperature and Current on Stabilized Output Power and Energy Yield of CdTe PV Modules**
M. Pander, B. Jäckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4AV.2.20 **Note on Parasitic Resistances Determination from Slope of I-V Curve**
T. Finsterle, L. Cerná, P. Hrzina & V. Benda
CTU, Prague, Czech Republic

4AV.2.21 **FTIR Spectroscopy: A Powerful Tool for Photostable PV Encapsulant Screening**
N. Pinochet & R. Couderc
CEA, Le Bourget-du-Lac, France
S. Therias
CNRS, Clermont-Ferrand, France

4AV.2.22 **Do We Correctly Determine the Power of Thin-Film Modules? Investigation of Stabilization Procedures for Power Determination of Thin-Film Modules**
T. Weber, M. Rennhofer, L. Schmidt, M. Grieb, A. El-Issa, J. Wagner,
D. Westermann, P. Grunow & S. Xuereb
PI Berlin, Germany

4AV.2.23 **Double-Sided Characterisation of Full-Size Bifacial PV Modules Based on Low-Cost LED Bias Light**
T. Lyubenova, R.P. Kenny, D. Shaw, D. Pavanello & J. Lopez-Garcia
European Commission JRC, Ispra, Italy

4AV.2.24 **Photovoltaic Module Performance Measurement Round Robin with Xenon and LED Based Sun Simulators**
S. Dittmann & G.L. Martins
Anhalt University of Applied Sciences, Köthen, Germany
J. Arp
PV Lab Germany, Potsdam, Germany
B. Jäckel
Fraunhofer CSP, Halle (Saale), Germany
T. Sample
European Commission JRC, Ispra, Italy
T.R. Betts
Loughborough University, United Kingdom
T. Wengert & M. Cosic
Underwriters Laboratories, Krefeld, Germany
C. Buerhop-Lutz
Forschungszentrum Jülich, Germany
K.A. Berger
AIT, Vienna, Austria
P. Lechner
ZSW, Stuttgart, Germany

4AV.2.25 **Development of Mobile Photovoltaic Laboratory Testing Service**
S.-X. Li, C.-J. Lin, W.-Y. Lin, C.F. Hsieh, T.-C. Wu & S.-T. Hsu
ITRI, Hsinchu, Taiwan

4AV.2.26 **Analysis of Performance and Deformation for Photovoltaic Module under Different Wind Speeds and Multi-Type Mechanical Loadings**
S.-T. Hsu, W.-Y. Lin & S.-Y. Ting
ITRI, Hsinchu, Taiwan

4AV.2.27 **FEM Simulation of Deformations in Strings of Shingled Solar Cells under Mechanical and Thermal Loading**
M. Lang, G. Oreski, P. Fuchs & E. Helfer
PCCL, Leoben, Austria
A. Halm
ISC Konstanz, Germany
M. Klenk
ZHAW, Winterthur, Switzerland

4AV.2.29 **Multi-Criteria Analysis Method to Evaluate Different Encapsulation Materials for PV Modules and Proposing a Suitable Candidate**
H.E. Hayati Soloot
Solar Edition, Qazvin, Iran
S. Moghadam
Solar Edition, Oslo, Norway

4AV.2.30 **Effects of Work-Shift and Production Line Differences on the Output Performance of an Industrial c-Si PV Module Manufacturing**
N.D. Yildirim, M. Yasin Bozkır, A. Kaplan, C. Avsaroglu & F. Es
Kalyon PV, Ankara, Turkey
O. Toka
Hacettepe University, Ankara, Turkey

4AV.2.31 **Thermal Cycle Analysis on Shingled Glass – Glass Samples with SHJ Cells**
S. Wendlandt
PI Berlin, Germany
C. Carrière, V. Barth, S. Harrison & A. Bettinelli
CEA, Le Bourget-du-Lac, France

4AV.2.32 **Enabling Measurement of PV Module Curvature: Towards Characterization of Thermomechanical Residual Stresses**
I. Rahmoun, T. Le Carre, B. Chambion, E. Mofakhami & A. Derrier
CEA, Le Bourget-du-Lac, France
J.-L. Bouvard & P.-O. Bouchard
CEMEF, Sophia-Antipolis, France

4AV.2.33 **Analysis of the Thermomechanical Behaviour of Concrete Facade Elements with Integrated Photovoltaic Modules**
P. Schenk, S. Schindler, M. Pander, U. Zeller, B. Jäckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4AV.2.34 **Structural Strength Analysis of Double-Glass Photovoltaic Modules Mounted on One-Axis Trackers at Different Boundary Conditions**
M.B. Günaydın, B. Sarıca & M. Günöven
Kalyon PV, Ankara, Turkey
O. Selimoglu, M.E. Karahallı & G.H. Çıkmaz
Ankara University, Turkey

4AV.2.35 **Spatially Resolved Leakage Current Density in Photovoltaic Modules**
H. Nagel, M. Glatthaar, D. Philipp, D.H. Neuhaus & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

4AV.2.36 **Electrical Bias Stabilisation of Power of the Photovoltaic Technologies**
A. Mittal, N. Zechner, M. Rennhofer & G. Újvári
AIT, Vienna, Austria
T. Weber
PI Berlin, Germany

4AV.2.37 **New Developments in Accelerated Weathering Tests for Back-Contact Modules**
G.J.W. Meijers, R.H.C. Janssen, L. Pastukhov, F. van Duijnhoven & N.E. Voicu
DSM, Geleen, The Netherlands

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VISUAL PRESENTATIONS 3BV.1

08:30 – 10:00 Perovskite Solar Cells and Modules

Chairpersons:

Sjoerd Veenstra
TNO Energy Transition, Petten, The Netherlands

Wolfgang Tress
Zurich University of Applied Sciences, Switzerland

3BV.1.1 Molecular Doping for Hole Transporting Materials in Hybrid Perovskite Solar Cells
V. Trifiletti & N. Manfredi
University of Milan, Italy
T. Degousée & O. Fenwick
Queen Mary University of London, United Kingdom
S. Colella
University of Salento, Lecce, Italy
A. Rizzo
CNR, Lecce, Italy

3BV.1.2 Exploring the Use of Methylammonium Iodide to Improve the Uniformity of the MAPbI3 Layer in HTM-Free Perovskite Solar Cells Equipped with Back Contacts Based on Agglomerates of Graphite and Black Carbon in an Ethylene-Vinyl Acetate in Toluene Solution
C. Montes & L. Ocaña
ITER, Granadilla de Abona, Spain
S. González-Pérez & B. González-Diaz
ULL, La Laguna, Spain

3BV.1.3 Evaporation Pressure Control on High Crystallization Perovskite Layer via Sandwich Evaporation Technique
H.-H. Shen, C.-H. Chang, W.-C. Lo & C.-F. Lin
National Taiwan University, Taipei, Taiwan

3BV.1.4 Testing Encapsulated Perovskite Solar Cells in a Climatic Chamber by Following the IEC 61215 and IEC 61646 Standards
L. Ocaña & C. Montes
ITER, Granadilla de Abona, Spain
S. González-Pérez & B. González-Diaz
University of La Laguna, Spain

3BV.1.5 Study of ALD-Grown SnO2 as an Electron Selective Layer for NIP Perovskite-Based Solar Cells
F. Gayot, E. Bruhat, M. Manceau & S. Cros
CEA, Le Bourget-du-Lac, France
E. de Vito
CEA, Grenoble, France

3BV.1.6 Characterization of Cesium Lead Bromide Iodide Mixed Perovskite (CsPbBr3-xIx) Prepared by Sequential Evaporation
G. Gordillo, J.C. Peña, O.G. Torres & M.C. Abella
National University of Colombia, Bogotá, Colombia

3BV.1.7 The Opportunity of Cadmium Stannate as Transparent Conducting Oxide for Perovskite-Based Concentrated Photovoltaic System
M. Khalid, A. Roy, S. Bhandari, S. Sundaram & T.K. Khalid
University of Exeter, Penryn, United Kingdom

3BV.1.8 Dimethylammonium-Substituted FASnI3 Perovskite Solar Cells
M.A. Kamarudin, S.R. Sahamir, K. Nishimura, S. Qing & S. Hayase
The University of Electro-Communications, Chofu, Japan
D. Hirotani & S. Iikubo
Institute of Technology, Kitakyushu, Japan
T. Minemoto
Ritsumeikan University, Shiga, Japan
K. Yoshino
University of Miyazaki, Japan

3BV.1.9 Assessing the Use of Polyvinylidene Fluoride as a Binder Material for Producing Carbon Based Inks Suitable for HTM-Free Perovskite Solar Cells
C. Montes & L. Ocaña
ITER, Granadilla de Abona, Spain
S. González-Pérez & B. González-Diaz
ULL, La Laguna, Spain

3BV.1.11 Synthesis and Defect Characterization of 2D Hybrid-Perovskites
G. Fischer
University of Applied Sciences Zittau/Görlitz, Germany
J. Beyer, H. Stöcker, J. Heitmann & M. Müller
Freiberg University of Technology, Germany

3BV.1.12 Development of an Organic Mixed Tin-Lead Bromide Rich Perovskite for Tandem Application
M. Kozolinsky, T. Hildebrandt & J. Rousset
EDF R&D, Palaiseau, France
F. Donsanti
IPVF, Palaiseau, France
F. Rousseau
ParisTech, France

3BV.1.14 3D/2D Perovskite Solar Cells with Improved Performance and Stability Based on a Novel Ammonium Salt
U. Gunes, E. Bag Celik, C. Ceren Akgul, M. Koç, M. Ameri, B. Eren Uzuner, M. Ghasemi, M. Cem Sahiner, I. Yildiz, H. Kaya, S. Yerci & G. Gunbas
METU, Ankara, Turkey

3BV.1.16 Effect of Annealing Temperature, Doping Concentration and Disposition Process on the ZnO Electron Transport Material for the Stable and Low-Cost Perovskite Solar Cell
A. Al-Ahmed, F. Khan, M. Ayeed, M. Al-Rasheidi & F.A. Al-Sulaiman
KFUPM, Dhahran, Saudi Arabia

3BV.1.17 **High Efficiency Perovskite Solar Cells Suitable for Harsh Climate and for Tandem Configuration**
S. Laalioui, K. Belrhiti Alaoui & B. Ikken
IRESEN, Rabat, Morocco
K. El Assali & A. Outzourhit
Cadi Ayyad University, Marrakesh, Morocco
Z. Naimi
Green Energy Park, Benguerir, Morocco

3BV.1.19 **A Study of Quenching Approaches to Optimize Ultrasonic Spray Coated Perovskite Layers Scalable for PV**
J. Silvano & J. Sala
Hasselt University, Diepenbeek, Belgium
T. Merckx, Y. Kuang, T. Aernouts, B. Vermang & W. Deferme
imec, Leuven, Belgium

3BV.1.20 **Minimizing the Interconnection Width of Laser Patterned Perovskite Solar Cells**
M. Fenske, C. Schultz, A. Bartelt & B. Stegemann
Berlin University of Applied Sciences, Germany
J. Dagar, R. Schlatmann & E. Unger
HZB, Berlin, Germany

3BV.1.21 **Outdoor Monitoring and Assessment of Perovskite Mini Modules**
V. Paraskeva, M. Norton, M. Hadjipanayi & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
A. Hadipour & A. Aguirre
imec, Leuven, Belgium
R. Ebner
AIT, Vienna, Austria

3BV.1.22 **Large-Area Perovskite Solar Cells with ALD-Grown SnO2 as Electron Transport Layer**
S.-T. Zhang, O. Fournier, V.-S. Nguyen, D. Coutancier, T. Vincent, A. Duchatelet, J. Rousset & N. Schneider
IPVF, Palaiseau, France

3BV.1.23 **Irradiations of Perovskites Solar Cells for Space Applications**
C. Costa, M. Manceau, C. Roux, F. Chabuel & R. Cariou
CEA, Grenoble, France
C. Inguimbert, S. Duzellier & T. Nuns
University of Toulouse, France

3BV.1.24 **An Ionic Origin of Large Ideality Factors in Perovskite Solar Cells**
D. Lan & D. Di
UNSW Australia, Sydney, Australia

3BV.1.25 **Optical and Electrical Characterization of Perovskite Mini-Modules**
R. Ebner, G. Újvári & A. Mittal
AIT, Vienna, Austria
M. Hadjipanayi, V. Paraskeva & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
A. Hadipour
imec, Leuven, Belgium

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3BV.1.26 **A Unified Capacitance Loss Mapping for Solar Cells Defects**
J. Sala, T. Kohl, M. Daenen & B. Vermang
Hasselt University, Diepenbeek, Belgium
G. Brammertz & T. Aernouts
imec, Heverlee, Belgium
M. Ahmadpour & M. Sandholm Madsen
University of Southern Denmark, Sønderborg, Denmark

3BV.1.27 **Performance Loss Analysis in Single-Junction Perovskite and Silicon/Perovskite Tandem Solar Cells Using Imaging Techniques**
A.A. Voznyi, J.P. Rakotoniaina, W. Favre, O. Dupré & M. Matheron
CEA, Le Bourget-du-Lac, France

3BV.1.28 **Optical Optimization of Perovskite Solar Cells**
M. Koç & S. Yerci
GUNAM, Ankara, Turkey

3BV.1.29 **Elaboration of a Very High Efficiency Ferrophotovoltaic Solar Cell Using Inorganic Ferroelectric Perovskite Nanoparticles in a Biopolymer Matrix (Ferro-OPV)**
R. Ndioukane, F. Balde & D. Kobor
Ziguinchor University, Senegal

3BV.1.30 **High Efficiency of Solar Cell during Long Exposition on Light Using PZN-4.5PT Inorganic Ferroelectric Perovskites Nanoparticles**
F. Balde, R. Ndioukane, A.K. Diallo, N.C.Y. Fall, M. Touré & D. Kobor
Ziguinchor University, Senegal

3BV.1.31 **VIPERLAB – An Infrastructure Platform to Accelerate the Development of Perovskite PV Technology in Europe**
N. Maticiuc, E. Unger & R. Schlatmann
HZB, Berlin, Germany

3BV.1.32 **EPKA or European Perovskite Alliance**
L. Huber
GreenSquare, Brussels, Belgium

3BV.1.33 **Framework for R+D Laser Processing Tools for Perovskite PV and OPV Research**
S. Bergfeld
Aachen University of Applied Sciences, Germany

VISUAL PRESENTATIONS 3BV.2

10:30 – 12:00 CIGSe, CdTe and Kesterites / OPV / III-V and Related Compounds / Tandems

Chairpersons:

Riccardo Po
eni spa, Novara, Italy

Ayodhya Nath Tiwari
EMPA, Dübendorf, Switzerland

Jan Christoph Goldschmidt
Fraunhofer ISE, Freiburg, Germany

Gerald Siefer
Fraunhofer ISE, Freiburg, Germany

3BV.2.1 Two Local Built-in Potentials of CZTSe Ge Bi-Layers Devices by Modulus Spectroscopy
S. Lee
Indiana State University, Terre Haute, USA
K.J. Price
Morehead State University, USA
E. Saucedo
IREC, Barcelona, Spain

3BV.2.2 DLTS Investigations on CIGS Solar Cells from an Inline Co-Evaporation System with RbF Post-Deposition Treatment
T. Helder, A. Kanevce, A. Bauer, M. Zinßer, T. Magorian-Friedlmeier & M. Powalla
ZSW, Stuttgart, Germany

3BV.2.3 Ge Incorporated Cu2(Cd,Zn)Sn(S,Se)4 Thin Films for Solar Cells: Combined DFT and Experimental Study
S. Zhuk, A. Stsiapanau & A. Smirnov
BSUIR, Minsk, Belarus
Y. Shao & X. Wang
Fuzhou University, China
A.A. Kistanov
University of Oulu, Finland

3BV.2.4 Design of Experiment Investigation of Processing Factors Involved in Two-Step Fabrication of CI(G)S Absorber Layers
S. Hamtaei, G. Brammertz, G. Birant, M. Rashid, J. Poortmans & B. Vermang
imec, Diepenbeek, Belgium
D.G. Buldu, T. Kohl, J. de Wild & M. Meuris
Hasselt University, Diepenbeek, Belgium

3BV.2.5 Analysis of Environmentally Friendly and Low Cost Non Vacuum Process for Cu2ZnSn(S,Se)4 Solar Cells
P. Punathil, S. Zanetti, E. Artegiani, V. Kumar & A. Romeo
University of Verona, Italy

3BV.2.6 Alteration of PV Cell Parameters via n-Doped Graphene Quantum Dots Incorporation on Solution-Processed CIGS Thin Film-Based Photovoltaic Cells
F. Khan
KFUPM, Dhahran, Saudi Arabia
J.H. Kim
DGIST, Daegu, Republic of Korea

3BV.2.8 Impact of Silver Alloying on the Device Performance and Stability in Low Temperature Grown (Ag,Cu)(In,Ga)Se2 Solar Cells
S.-C. Yang, J. Sastre, M. Krause, X. Sun, R. Hertwig, M. Ochoa, A.N. Tiwari & R. Carron
Empa, Dübendorf, Switzerland

3BV.2.9 Bi-Layered Structure of CuInSe2+CuInS2: A New Route towards Forming Sulfur Grading into CuInSe2 Thin-Film Solar Absorbers
F. Khavari, N. Saini, J. Keller, J.K. Larsen, K. Sopiha, N. Martin, T. Törndahl, C. Platzer-Björkman & M. Edoff
Uppsala University, Sweden

3BV.2.10 Multi-Dimensional Simulation of Chalcogenide Thin-Film Solar Cells – Towards Digital Twins and Conceptual Studies
M. Maiberg, F. Neduck, M. Morawski, C.-Y. Song, H. Kempa & R. Scheer
Martin Luther University, Halle (Saale), Germany
D. Abou-Ras
HZB, Berlin, Germany
P. Jackson & W. Witte
ZSW, Stuttgart, Germany

3BV.2.12 Potassium-Containing Back Electrode Engineering for High Performance CIGS Solar Cells
M. Simor, M. van der Vleuten, H. 't Mannetje, C.J. Cortes Chitiva, A. Todinova, V.S. Gevaerts & P.J. Bolt
TNO/Solliance, Eindhoven, The Netherlands

3BV.2.13 CdS Thickness Reduction in CIGS Solar Cells by Application of ALD-ZnxMg(1-X)O Layer
D. Bagrowski, S. Spiering & T. Schnabel
ZSW, Stuttgart, Germany

3BV.2.14 Solution-Processed Growth of High-Quality CISSe Solar Cells on ITO Back Contact
Y. Gao, Y. Li & M. Schmid
University of Duisburg-Essen, Germany

3BV.2.15 Combined In-Vacuo Spectral and Time-Resolved Photoluminescence Measurements for Comprehensive (Ag,Cu)(In,Ga)Se2 Absorber Layer Characterization
C. Camus, E. Malguth, E. Speiser, C. Kaspari, S. Paetel & V. Blank
LayTec, Berlin, Germany
P. Jackson & S. Essig
ZSW, Stuttgart, Germany
G.-P. De Salvo
VON ARDENNE, Dresden, Germany
R. Requena
RIBER, Bezons, France

3BV.2.16 **A Study of Ag Paste Contacts on Various TCO Layers for Cu(In,Ga)Se2 Thin Film Modules**
B. Sesli, J. Carolus, J. D´Haen, D. Reenaers, M. Meuris, M. Daenen & B. Vermang
UHasselt, Diepenbeek, Belgium
S. Sente
Henkel, Westerlo, Belgium
V.S. Gevaerts
TNO, Eindhoven, The Netherlands

3BV.2.26 **PV Cell for Varied Angle Performance Under Indoor Lighting Simulator**
Y.-S. Long, M.-A. Tsai & T.-C. Wu
ITRI, Hsinchu, Taiwan

3BV.2.27 **Multifunctionality of Nanodiamonds for OPV**
D. Miliaieva, J. Cermák & S. Stehlik
ASCR, Prague, Czech Republic
J. Kulicek & B. Rezek
Czech Technical University in Prague, Czech Republic

3BV.2.38 **Growth and Structural Characterization of GaSb/GaAs Quantum Dots: Prospective Applications in Photovoltaic Cells**
C. Ahia & E.L. Meyer
University of Fort Hare, Alice, South Africa
N. Tile, E.J. Olivier & R. Botha
Nelson Mandela University, Port Elizabeth, South Africa

3BV.2.39 **Wide-Bandgap III-V Photovoltaic Cell Development for Use in Ambient Light Harvesting**
J. Browne, I. Mathews & B. Corbett
Tyndall National Institute, Cork, Ireland
A. Chikhalkar, Y. Zou, S. Goodnick & R.R. King
Arizona State University, Tempe, USA
Z. Liu
MIT, Cambridge, USA

3BV.2.40 **Atomic Structure and Optical Properties of 1.0 eV GaAsBi Absorber**
T. Paulauskas, V. Pacebutas, J. Devenson & 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.2.51 **On Current Collection from Supporting Layers in Perovskite/c-Si Tandem Solar Cells**
M. Singh
Delft University and Technology, The Netherlands
P.A. Procel Moya, I. Syifai, R. van Heerden, M. Zeman, R. Santbergen & O. Isabella
Delft University of Technology, The Netherlands
A.W. Weeber
TNO Energy Transition, Petten, The Netherlands

3BV.2.52 **Perovskite/ACIGS 2-Terminal Tandem Solar Cells – Optimisation of Transport and Conductive Contact Layers**
T. Wahl, S. Essig, S. Paetel, M. Loy, J. Hanisch, E. Ahlswede & M. Powalla
ZSW, Stuttgart, Germany

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3BV.2.53 **Monolithic Perovskite/Silicon-Heterojunction Tandem Solar Cells with Nanocrystalline Si/SiOx Tunnel Junction**
L.V. Mercaldo, E. Bobeico, A. De Maria, M. Della Noce, M. Ferrara, V. La Ferrara, L. Lancellotti, G. Rametta, G.V. Sannino, I. Usatii & P. Delli Veneri
ENEA, Portici, Italy

3BV.2.54 **Mechanically-Stacked and Electrically-Connected Two-Terminal Tandem Module**
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan

3BV.2.56 **Towards Perovskite-CIGS Large Area Tandem Architectures**
V. Zardetto, M. Simor, I. Dogan, L. Simurka, H. Fledderus, D. Zhang, D. Roosen-Melsen, P.J. Bolt, G. Coletti, V.S. Gevaerts, S.C. Veenstra, H. Linden & R.A.J.M. Andriessen
TNO, Eindhoven, The Netherlands
A. Bracesco, K. Datta, M. Creatore & R.A.J. Janssen
Eindhoven University of Technology, The Netherlands
T. Aernouts
imec, Genk, Belgium

3BV.2.57 **Bichromatic Light Source for Subcell Performance Analysis in Perovskite/Silicon Tandem Solar Cells**
M. Jošt, G. Matic, B. Glažar, M. Jankovec & M. Topic
University of Ljubljana, Slovenia
E. Köhnen, B. Li & S. Albrecht
HZB, Berlin, Germany

3BV.2.58 **The Performance of Four-Terminal Perovskite-Silicon Tandem Solar Cells under Different Irradiance Levels**
A.B. Nikolskaia, M.F. Vildanova, S.S. Kozlov, O.V. Alexeeva, O.K. Karyagina & O.I. Shevaleevskiy
RAS, Moscow, Russian Federation

3BV.2.59 **Advanced LED Solar Simulator: Flexible and Fast Characterisation Tool for Research and Industrialisation of Perovskite/Silicon Tandem Solar Cells**
B. Mitchell, B. Mette, M. Scherff, S. Esefelder, P. Fuss-Kailuweit & T. Brammer
Wavelabs Solar Metrology Systems, Leipzig, Germany
L. Korte, E. Köhnen & S. Mariotti
HZB, Berlin, Germany

3BV.2.60 **The Impact of High Spectral Match: Using an LED Solar Simulator for Tandems**
B. Mihaylov, B.C. Duck, C.J. Fell, T.W. Jones, K.F. Anderson & G.J. Wilson
CSIRO Energy Technology, Mayfield West, Australia

3BV.2.61 **TCO Optimization of c-Si Heterojunction Solar Cells for Tandem Architecture by Optical Simulation**
M. Canino, V. Boldrini, R. Rizzoli, E. Centurioni, S. Lombardo & C. Summonte
CNR, Bologna, Italy
A. Terrasi
University of Catania, Italy

3BV.2.62 **Wide Bandgap Pure Sulfide CIGS Layers for Si/CIGS Tandem Cells from Metal Coevaporation Engineering and Sulfur Annealing**
A. Crossay, D. Cammilleri, J. Lontchi & A. Rebai
IPVF, Palaiseau, France
N. Barreau
University of Nantes, France
D. Lincot
CNRS, Palaiseau, France

3BV.2.64 **Interface Engineering of Silicon/Perovskite Two-Terminal Tandem Solar Cells**
A. Hadipour, Y. Kuang, H. Sivaramakrishnan Radhakrishnan, T. Aernouts & J. Poortmans
imec, Genk, Belgium
J. Sala
University Hasselt, Diepenbeek, Belgium

3BV.2.65 **Optimizing Top-TCO for Perovskite-Silicon Tandem Solar Cells**
H. King, V. Sittinger & T. Harig
Fraunhofer IST, Braunschweig, Germany
O.S. Kabakli, P.S.C. Schulze & J.C. Goldschmidt
Fraunhofer ISE, Freiburg, Germany

3BV.2.66 **Energy Yield and Performance Ratio of III-V on Silicon Dual Junction Solar Cells in Different Climate Zones**
O. Höhn, M. Hanser, M. Steiner, E. Lorenz, B. Bläsi, S.W. Glunz & F. Dimroth
Fraunhofer ISE, Freiburg, Germany

3BV.2.67 **Influence of Wafer Pyramid Morphology on the Performance of Monolithic Perovskite-Silicon Tandem Solar Cells**
A. Harter, A. Cruz Bournazou, K. Xu, F. Biegalke, A.B. Morales-Vilches, L. Korte, S. Albrecht & B. Stannowski
HZB, Berlin, Germany
A. Eljarrat
HU Berlin, Germany

3BV.2.68 **Tunnel Junction Formation on Silicon P++ Emitters by Gas Immersion Laser Doping**
G. Gaspar, A. Guerra, F.C. Serra, A.S. Viana, I. Costa, D.M. Pera, J. Almeida Silva, J.M. Serra & K. Lobato
University of Lisbon, Portugal
J. Arumughan
ISC Konstanz, Germany
L. Vines
University of Oslo, Norway

3BV.2.69 **Dual Quantum Tunneling in a Monolithic n-i-p Perovskite/c-Si Tandem Device: Bottom Cell with Modified SQIS Structure**
Z. Ma, K. Wu, Z. Lan, Y. Wang, F. Xu & L. Zhao
Shanghai University, China

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VISUAL PRESENTATIONS 1BV.3

13:30 – 15:00 **Fundamental Studies in the Forefront of PV / Novel Materials and Concepts for Cells and Modules**

Chairpersons:

Antonio Martí Vega
UPM, Madrid, Spain

Phoebe Pearce
University of Cambridge, United Kingdom

1BV.3.1 **Direct Unfavorable Impact of Hot Carriers on the Operation of a Single Junction Solar Cell**
J. Gradauskas, S. Ašmontas, A. Sužiedelis, A. Šilenas & A. Cerškus
CPST, Vilnius, Lithuania
O. Masalskyi
Vilnius Gediminas Technical University, Lithuania

1BV.3.2 **Tandem Luminescent Solar Concentrators: Optimizing the Number of Stacked Plates**
I.O. Sokolovskyi, M.R. Kulish, A.V. Sachenko & V.P. Kostylyov
NAS ISP, Kyiv, Ukraine
A.I. Shkrebtii / Chkrebtii
Ontario Tech University, Oshawa, Canada

1BV.3.3 **Defect Trapping in Thin Films Probed by High Frequency Modulated Photoluminescence**
B. Bérenguier, J. Hajhemati, V. Dufoulon, C. Darin Bapaume, P. Schulz & J.-F. Guillemoles
CNRS, Palaiseau, France

1BV.3.4 **Parametric Analysis of Random Subwavelength Structures with Anti-Reflective Properties on Photovoltaic Glasses**
C.L. Pinto Fuste, I. Cornago, E. Zugasti & J. Bengoechea
CENER, Sarriguren, Spain

1BV.3.5 **Accurate Determination of Contact Resistivity Using Fully Metallized Test Structures**
K. Tsoi, D. Türkay & S. Yerci
METU, Ankara, Turkey

1BV.3.6 **Detecting Electric Bottlenecks in Solar Cell Performance**
M. Zinßer, M. Loy, T. Helder, A. Bauer, T. Magorian-Friedlmeier & M. Powalla
ZSW, Stuttgart, Germany

1BV.3.7 **Ionization Energy and Diffusion Profile of Hydrogen in Silicon from First-Principles Calculations**
K. Ruzimov
Urgench State University, Uzbekistan
M. Ganchenkova
National Research Nuclear University MEPhI, Moscow, Russian Federation
S.Zh. Karazhanov
Institute for Energy Technology, Kjeller, Norway

1BV.3.8 **Computer Screen Assisted Solar Cell Spectral Response Measurement**
G. Di Francia & A. Romano
ENEA, Portici, Italy

1BV.3.9 **Increase Optical Performance of Silicon Based Heterojunction Solar Cells with TiO2 Nanorod Structures**
B. Sekertekin
Kalyon PV, Ankara, Turkey
A. Yildiz
Yildirmi Beyazit University, Ankara, Turkey

1BV.3.10 **Silicon Solar Cell Parameter Extraction by Neural Networks Trained on Simulated EL Imaging Data**
M. Battaglia, E. Comi, E. Knapp & T. Stadelmann
ZHAW, Winterthur, Switzerland
R. Hiestand & B. Ruhstaller
Fluxim, Winterthur, Switzerland

1BV.3.11 **Highly Transparent Nanostructured Lanthanum Molybdenum Barium Oxide: An Efficient Electron Acceptor for Excitonic Solar Cells**
N. Suresh Powar
DGIST, Daegu, Republic of Korea
M. Shanmugam
Hindustan Institute of Technology and Science, Tamil Nadu, India

1BV.3.21 **Surface Modification of Cover Glass for Solar Panels by Creating a Nanostructure on the Surface by Maskless Plasma Texturing with Fluorocarbon**
A. Okhorzina & N. Bernhard
Anhalt University of Applied Sciences, Köthen, Germany

1BV.3.22 **Modification of PEDOT:PSS Layer Properties by SWCNT and Ag Nanoparticles**
S.V. Mamykin, I.B. Mamontova, T.S. Lunko, O.S. Kondratenko & V.R. Romanyuk
NAS ISP, Kyiv, Ukraine

1BV.3.23 **Copper Oxides as Base Material for Solar Cells**
K. Gawlinska-Necek, Z. Starowicz & P. Panek
Polish Academy of Sciences, Krakow, Poland
R.P. Socha, M. Wlazło, G. Kolodziej & G. Putynkowski
CBRTP, Warsaw, Poland

1BV.3.24 **Hydrogenation Mechanisms in Photovoltaics: Unconventional In2Se3 Nanomaterial as an Example**
A.I. Shkrebtii / Chkrebtii, R. Minnings & G. Perinparajah
Ontario Tech University, Oshawa, Canada

1BV.3.25 **Observation of Hot Carriers under Natural Concentrated Sunlight**
I. Konovalov & N. Bhattacharjee
Ernst Abbe University of Applied Science, Jena, Germany

1BV.3.27 **Luminescent Solar Concentrator Photovoltaics Devices: Improving the Power Conversion Efficiency by Geometric Design Modifications**
X. Zhu & M. Aghaei
Eindhoven University of Technology, The Netherlands
A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands

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1BV.3.28 **Low Temperature Co-Selenised Antimony Selenide (Sb2Se3) Based Solar Cells by Vacuum Evaporation**
V. Kumar, E. Artegiani, P. Punathil & A. Romeo
University of Verona, Italy

1BV.3.29 **New Earth-Abundant Thin Film Solar Cells Based on Chalcogenides**
V. Trifiletti, A. Le Donne & S. Binetti
University of Milan, Italy

1BV.3.30 **Study of Photo-Thermionic Cells Based on Nanocristalline Diamond Films with Solar Concentration**
R. Garcia-Gutierrez, D. Ochoa-Romero & P. Tirado-Cantú
Universidad de Sonora, Hermosillo, Mexico

1BV.3.31 **Photovoltaic Response Dependence on the Resistive Switching State of Silicon Nanocrystal Multilayers**
J. López-Vidrier, J.L. Frieiro, S. González-Torres, J. Bertomeu, S. Hernández & B. Garrido
University of Barcelona, Spain
D. Yazıcıoglu, S. Gutsch & M. Zacharias
University of Freiburg, Germany

1BV.3.32 **The Synthesis and Research of Defect Structure of New Materials for Thin Films Solar Cells – Cu2-δMNSNS4 Solid Solutions**
M.V. Gapanovich, V.V. Rakitin, D.M. Sedlovets & G.V. Shilov
RAS, Chernogolovka, Russian Federation
I.N. Odin
Moscow State University, Russian Federation

1BV.3.33 **Copper Doped ZnO as Transparent Metal Oxide for Thin Film Solar Cell Application**
M.K. Hossain & M. Al-Rasheidi
KFUPM, Dhahran, Saudi Arabia

1BV.3.35 **Evaluation of the SoG Material for Solar Cell Applications**
S.C. Pop
SCP SYS, San Francisco, USA

1BV.3.36 **Growth and Characterization of Spin Coated Bismuth Sulfide Thin Films**
O. Karsandik, T. Özdal & H. Kavak
Çukurova University, Adana, Turkey

VISUAL PRESENTATIONS 5BV.4

15:15 – 16:45 Solar Radiation and Forecasting

Chairpersons:

Wilfried G.J.H.M. van Sark
Utrecht University, The Netherlands

Ana Maria Gracia Amillo
European Commission JRC, Ispra, Italy

5BV.4.1 Introducing the Third Edition of the Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications
J. Remund
Meteotest, Bern, Switzerland
A. Habte & M. Sengupta
NREL, Golden, USA
C.A. Gueymard
Solar Consulting, Colebrook, USA
S. Wilbert
German Aerospace Center, Almeria, Spain

5BV.4.2 Combination of Physics Based Simulation and Machine Learning for PV Power Forecasting of Large Power Plants
N. Holland, W. Herzberg, J. Bor & E. Lorenz
Fraunhofer ISE, Freiburg, Germany

5BV.4.3 Post Processing of Solar Irradiance Forecasts from WRF Model Using Satellite-Derived Data in French Guiana
M. Salloum, J. Macaire, S. Zermani, J. Bechet, A. Primerose & L. Linguet
University of French Guiana, Cayenne, French Guiana

5BV.4.4 Recurrent Neural Network for Short-Time Power Forecast for a 540 kWp Grid-Connected PV Plant Installed at the University of São Paulo, Brazil
W.W. Ferreira Fonseca & R. Zilles
USP, São Paulo, Brazil
F. Ramos Martins
UNIFESP, São Paulo, Brazil

5BV.4.5 Post Processing of Day-Ahead Solar Irradiance Forecast Using Satellite Derived Data in French Guiana
J. Macaire, M. Salloum, J. Bechet, S. Zermani & L. Linguet
University of French Guiana, Cayenne, French Guiana

5BV.4.6 72-Hour Prediction of Global Horizontal Irradiance Using the MLP
O. El Alani & A. Ghennioui
Green Energy Park, Benguerir, Morocco
H. Ghennioui
USMBA, Fez, Morocco
Y.-M. Saint-Drenan & P. Blanc
MINES ParisTech, France

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5BV.4.7 Novel Intraday Photovoltaic Production Forecasting Algorithm Using Deep Learning Ensemble Models
S. Theocharides, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
M. Theristis
Sandia National Laboratories, Albuquerque, USA

5BV.4.8 Solar Irradiance Forecasting Using Numerical Weather Prediction Model and INSAT-3D Based Satellite Model
A. Masoom & A. Bansal
IIT Roorkee, India

5BV.4.11 Comparison and Validation of Irradiance Data: Satellite Meteorological Dataset MERRA-2 vs. Meteonorm and German Weather Service (DWD)
A. Khatibi & S. Krauter
University of Paderborn, Germany

5BV.4.12 The Long-Term of the Albedo Stability under Different Weather Conditions
S. Suarez, G.A. Navas, I. Fernandez, J.M. Rivas, F. Alvarez, H. Muñoz, J. de la Peña & S. Rodríguez-Conde
Enertis Solar, Madrid, Spain

5BV.4.13 Open-Source Geospatial Data Service with an Application in Irradiance Modelling for VIPV
E. Sovetkin, N. Patel, A. Gerber & B.E. Pieters
Forschungszentrum Jülich, Germany

5BV.4.14 PV 2-State: A Simple but Accurate Short-Term PV Power Forecasting Tool
M. Paulescu, N. Stefu, A. Sabadus, C. Dughir & S. Bojin
West University of Timisoara, Romania

5BV.4.15 Cloud Height Estimation Using All Sky Imagers
J. Esteves, R. Pestana, Y. Cao & N. Pinho da Silva
R&D Nester, Sacavém, Portugal

5BV.4.16 GHI Historical Period Used for Energy Production Assessments
C. Hidalgo
DNV GL, Barcelona, Spain

5BV.4.17 Day-Ahead PV Generation Forecasting Based on Deep Learning Approach
D. Kothona, A. Zamanidou & G.C. Christoforidis
University of Western Macedonia, Kozani, Greece
I. Panapakidis
Western Macedonia University of Applied Sciences, Kozani, Greece

VISUAL PRESENTATIONS 6BV.5

17:00 – 18:30 **Power Electronics and Electrical Grid Integration / Storage / Energy System Integration**

Chairpersons:

Giovanna Adinolfi
ENEA, Portici, Italy

Kai-Philipp Kairies
ACCURE Battery Intelligence, Aachen, Germany

Ingrid Weiss
WIP Renewable Energies, Munich, Germany

6BV.5.1 **Accurate Testing Methods of Grid-Connected PV Inverters by Means of Real-Time Based Hardware-in-the-Loop (HIL) Simulation Topologie for Validation, Testing, and Grid Integration of Solar Plants**
G. Lauss, Z. Miletic, A. Banjac & C. Messner
AIT, Vienna, Austria

6BV.5.2 **Lora-Based Gateway Development for Solar PV Applications**
P. Paradell Sola, D. Sanchez & J.L. Domínguez
IREC, Barcelona, Spain

6BV.5.3 **Impact of Measurement Data Time Resolution on Predicted Lifetime of PV Inverters in Residential Solar Panel Systems**
O. Alavi, W. Van De Sande & M. Daenen
UHasselt, Diepenbeek, Belgium
L. Van Cappellen
imec, Heverlee, Belgium

6BV.5.4 **Reliability Analysis Framework for a Grid-Tied PV-Battery System: Influence of PV and Battery Degradation on Reliability of Power Electronic Systems**
O. Alavi, W. Van De Sande, L. Van Cappellen, W. De Ceuninck & M. Daenen
UHasselt, Diepenbeek, Belgium

6BV.5.15 **Tariff Design and Economic Dispatch in a DC Microgrid**
P. Ferreira Torres & R. Zilles
USP, São Paulo, Brazil
J. Tavares Pinho
UFPA, Belém, Brazil

6BV.5.16 **Effect of Energy Storage on Self-Consumption and Self-Sufficiency: A Field Study for a Nordic Climate**
P. Ollas, J. Persson & P. Kovács
RISE Research Institutes of Sweden, Borås, Sweden

6BV.5.17 **Micro-Grid Energy Management Control with a Vanadium Redox Flow and a Lithium-Ion Hybrid Battery System Control**
A.C. Neves Foles, L.A. Fialho, M.P.I. Collares-Pereira &
P.A. dos Santos Ribeiro Horta
University of Évora, Portugal

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6BV.5.27 **An Optimal Agent-Based Behaviors Model for Peer-to-Peer Energy Trading Linked to Blockchain**
M. Sajjad, A. Boumaiza & A. Sanfilippo
QEERI, Doha, Qatar

6BV.5.28 **Building a Demonstrator Facility for EV Smart Charging Including PV-Systems and a Bidirectional Charging Station (V2X)**
D. Zurflüh, U. Muntwyler & E. Schüpbach
BUAS, Burgdorf, Switzerland

6BV.5.29 **Validation of a Technical Solution for a Stand-Alone PV Heat Pump System without Batteries**
C. Lorenzo, R.H. Almeida & L. Narvarte Fernández
UPM, Madrid, Spain

6BV.5.30 **Regional Hydrogen Concept in the Commercial Sector for the Use of PV Yield**
H. Prinz & H. te Heesen
Trier University of Applied Sciences, Hoppstädten-Weiersbach, Germany

6BV.5.31 **Smart Energy Management for SMEs Using Digital Twins**
J.S. da Costa Fernandes, R. Rahul, P. Sawant, E. Schmitt, M. Schmidt,
N. Hartmann & R. Gasper
University of Applied Sciences Offenburg, Germany

6BV.5.32 **Energy Communities-Challenge and an Opportunities for Energy Decentralization and Efficiency. A Comparison of PV Based Case-Studies with Different Control Strategies**
D. Vito
Polytechnic University of Milan, Italy

6BV.5.33 **Degradation of Supply Reliability in Stand-Alone Systems due to Modeling Strategies**
L. Timaná, M. Gemignani, G. Rostegui & C.F.M. Almeida
University of São Paulo, Brazil

6BV.5.34 **The H2020 R&D Project SERENDI-PV: Innovating towards Improved Reliability, Higher Performance and Dispatchable Grid Integration for Photovoltaic Systems**
J. del Pozo, E. Román Medina & R. Alonso
Tecnalia, Derio, Spain
I.A. Tsanakas
CEA, Le Bourget-du-Lac, France
C. Schill
Fraunhofer ISE, Freiburg, Germany
M. Aleman
Becquerel Institute, Brussels, Belgium
I. Lombardero
QPV, Madrid, Spain
I. Weiss
WIP Renewable Energies, Munich, Germany
J. Leloux
LuciSun, Sart-Dames-Avelines, Belgium
M. Suri
Solargis, Bratislava, Slovakia
I. Lokhat
Cythelia, Montagnole, France
J. Berthelot
Akuo Energy, Paris, France
C. Monet
CNR, Lyon, France

M. Crespo
Grupo Cobra, Madrid, Spain
C. Breyer
Lappeenranta University of Technology, Finland
B. Idlbi
Ulm University of Applied Sciences, Germany
E. De Keyser
Next Kraftwerke, Brussels, Belgium
J. Reed
Mylight Systems, Jonage, France
M. Puente
Cegasa Energia, Miñano, Spain
M. Resch
Energie Güssing, Austria
I. Landibar
Ingeteam, Sarriguren, Spain

6BV.5.35 Techno-Economic Analysis of Marine Ecosystem to Achieve Zero Carbon Emission
J.Z. Tee & L.H.I. Lim
University of Glasgow, United Kingdom

6BV.5.36 An Off-Grid Photovoltaic System for Electrification of an Agricultural Project in Madagascar
H. Susic, L. Ide, J. Kurzyca, U. Blieske & R. Gecke
Cologne University of Applied Science, Germany

6BV.5.37 Energy Data Forecasting with Application to Blockchain-Based Local Energy Markets
A. Boumaiza, A.E. Arayyah & A. Sanfilippo
QEERI, Doha, Qatar

6BV.5.38 Load Data Acquisition in Rural East Africa for the Layout of Microgrids and Demand-Side-Management Measures
G. Hagile Philipo, J. Nakato Kakande & S. Krauter
University of Paderborn, Germany

6BV.5.39 Solar PV Powered United Nations Humanitarian Camps with Integrated Demand Flexibility and Tiered Resilience
M. Ray
IIT Kharagpur, India
S. Ray
Swami Vivekananda Seva Samity for Girls, Kolkata, India
I.D. Miller
University of Toronto, Canada

Wednesday, 08 September 2021

VISUAL PRESENTATIONS 2CV.1

08:30 – 10:00 Characterisation and Manufacturing of Crystalline Silicon Solar Cells

Chairpersons:

Francesca Ferrazza
ENI, San Donato Milanese, Italy

Peter Fath
RCT-Solutions, Konstanz, Germany

2CV.1.1 Comparing Optical Performance of a Wide Range of Perovskite/Silicon Tandem Architectures under Real-World Conditions
M. Singh, R. Santbergen, I. Syifai, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands
A.W. Weeber
TNO Energy Transition, Petten, The Netherlands

2CV.1.2 Learning an Empirical Digital Twin from Measurement Images for a Comprehensive Quality Inspection of Solar Cells
P. Kunze, S. Rein & M. Demant
Fraunhofer ISE, Freiburg, Germany
M. Hemsendorf
GP Solar, Konstanz, Germany
K. Ramspeck
h.a.l.m. elektronik, Frankfurt am Main, Germany

2CV.1.3 3D Finite Element Modelling of Micro Transfer Length Measurements on Contact Layers for Perovskite/Silicon Tandem Cells
S. Lange, V. Naumann & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany
G. Batista Caldeira
HFU, Furtwangen, Germany

2CV.1.4 Student Awards Finalist Presentation: “Do Not Blame the Butter for What the Bread Did” or How the Optical Properties of IBC Solar Cells Affect the Results of Spatially Resolved Characterization Methods
M. Kikelj, B. Lipovsek, M. Bokalič & M. Topic
University of Ljubljana, Slovenia
F. Buchholz
ISC Konstanz, Germany

2CV.1.5 Quantitative Contactless Determination of the Series Resistance of Silicon Solar Cells
H. Höffler, W. Wirtz, J. Greulich & S. Rein
Fraunhofer ISE, Freiburg, Germany

2CV.1.6 **Spectroscopic Inline Characterisation of Partially Processed Epi Wafers After Porosification**
S. Al-Hajjawi, H. Vahlman, J. Haunschild & S. Rein
Fraunhofer ISE, Freiburg, Germany
H. Schremmer
Meyer Burger, Zülpich, Germany

2CV.1.7 **Numerical Simulation and Experimental Characterization of c-Si Cells Mechanical Limits in Double Curvature Shape**
T. Duigou, S. Caplet, F. Chabuel, B. Chambion & J. Gaume
CEA, Grenoble, France
G. Dennler & L. Tenchine
Industrial Technical Center for Plastics and Composites, Bellignat, France
G. Habchi, M. Lagache & P. Saffre
University Savoie Mont Blanc, Annecy, France

2CV.1.8 **Determination of Effect of Laser Cutting Method on the Performance of Bifacial PERC Cells**
M. Çetmeli, B. Sekertekin, M. Çaliskan, U. Paralı, E. Aydogmus & F. Es
Kalyon PV, Ankara, Turkey

2CV.1.9 **Edge Recombination Influence on SHJ Voc**
L. Serenelli, L. Martini, F. Menchini, M. Izzi & M. Tucci
ENEA, Rome, Italy

2CV.1.10 **Denoising of Image Data for DWS Wafer Characterization Using Generative Adversarial Networks**
L. Kurumundayil, S. Rein & M. Demant
Fraunhofer ISE, Freiburg, Germany
H. Schremmer
Meyer Burger, Hohenstein-Ernstthal, Germany

2CV.1.11 **Stability Studies and Characterisation of Silicon Solar Cells via In-Situ Temperature and Light Dependent Suns-Voc Measurements**
M. Vaqueiro-Contreras, A. Teymouri, A. Mahboubi Soufiani, C. Chan,
A. Ciesla & B. Hallam
UNSW Australia, Sydney, Australia
H. Wilterdink
Sinton Consulting, Boulder, USA

2CV.1.12 **Impact of Cut Edge Recombination in High Efficiency Solar Cells – Measurement and Mitigation Strategies**
N. Chen, D. Tune, F. Buchholz, A. Halm & V.D. Mihailetchi
ISC Konstanz, Germany

2CV.1.14 **Performance Enhancement of PERC Solar Cell with SiOxNy Back Surface Passivation by Low Thermal Annealing Process**
A.E. Keçeci, G. Bektaş, E.H. Çiftpinar, S. Koçak Bütüner, H. Asav,
G. Kökbudak, B. Arıkan & R. Turan
GUNAM, Ankara, Turkey

2CV.1.15 **Impact of Light Induced Degradation on the Performance of Atmospheric Cu Contacted PERC Solar Cells**
S. Huneycutt & A. Ebong
UNC Charlotte, USA
K. Ankireddy, R. Dharmadasa & T. Druffel
Bert Thin Films, Louisville, USA

Wednesday, 8 September 2021

2CV.1.16 **Effect of Rear Finger Number on the Performance of Bifacial PERC Si Solar Cells**
M. Kaya, G. Korkmaz, F. Çambay Kuban, B. Sekertekin, M. Çetmeli & F. Es
Kalyon PV, Ankara, Turkey

2CV.1.17 **Progress in the Defect Detection in p-n Junction Isolation by Electroluminescence**
E. Cereceda, V. Fano, A. Otaegi, N. Azkona, F. Recart, J.R. Gutiérrez &
J.C. Jimeno
UPV/EHU, Bilbao, Spain

2CV.1.18 **Rethinking Photoluminescence for Understanding Solar Cell Degradation**
C. Terrados, J. Colina, M.A. González Rebollo, J. Jiménez, O. Martínez &
J. Serrano
UVa, Valladolid, Spain

2CV.1.19 **Development and Implementation of a Refined Model for Comprehensive Characterization and Optimization of Highly Efficient Silicon Solar Cells**
A.V. Sachenko, V.P. Kostylyov, V.M. Vlasiuk & I.O. Sokolovskyi
NAS ISP, Kyiv, Ukraine
M. Evstigneev
Memorial University of Newfoundland, St. John's, Canada
A.I. Shkrebtii / Chkrebtii
Ontario Tech University, Oshawa, Canada
D. Johnston, P. Michael & T. Missimer
Florida Gulf Coast University, Fort Myers, USA

2CV.1.20 **Light Trapping in Silicon Nanowire: Correlated Absorption Depth Profile, EM-Field Distribution and Exciton Generation Rate Distribution**
M.K. Hossain
KFUPM, Dhahran, Saudi Arabia
A. Wajeeh Mukhaimer
RMIT University, Melbourne, Australia

2CV.1.21 **The Effect of Firing Temperature and Doping Profile of Ion Implanted Boron on Contact Resistivity of Screen Printed Metal Contact**
E. Özmen, G. Bektaş, H.H. Canar, S. Koçak Bütüner, H. Asav, A.E. Keçeci &
R. Turan
GUNAM, Ankara, Turkey

2CV.1.22 **Selective Emitter Formation via Laser Doping with Picosecond Pulsed Laser for High Efficiency PERC Solar Cells**
H. Asav, A.E. Keçeci, G. Bektaş, S. Koçak Bütüner, G. Kökbudak,
H. Hüseyin Canar, B. Arıkan & R. Turan
METU, Ankara, Turkey

2CV.1.23 **Investigation of the Potential Induced Degradation for PERC and HJT Solar Cells**
M.-A. Tsai, Y.-S. Long & T.-C. Wu
ITRI, Hsinchu, Taiwan

2CV.1.24 **Deep-Subwavelength Sidewall Features – A Way to Increase Power Conversion Efficiency**
A. Prajapati
Ben Gurion University of the Negev, Beersheba, Israel
J. Llobet
IMB-CNM CSIC, Bellaterra, Spain
P. C. Sousa, H. Fonseca, C. Calaza & J. Gaspar
INL, Braga, Portugal
G. Shalev
Ben Gurion University of the Negev, Beer-Sheva, Israel

2CV.1.25 **Potential End-Use for Silicon Solar Cells Applications with Coated Europium-Based Luminescent Down-Shifters: Enhancement of Performance and Stability**
A. Elamri, K. BENABDERAZAK, O. Essaidi, M. Ouafi, O. Lakbita & O. Moudam
Mohammed VI Polytechnic University, Benguerir, Morocco
Z. Naimi & D. Barrit
Green Energy Park, Benguerir, Morocco

2CV.1.34 **Influence of Diamond Wire Sawing Process Variation on Commercial Mono PERC Solar Cell Production Parameters**
M.C. Raval, W. Jooss & P. Fath
RCT-Solutions, Konstanz, Germany
B. Gümüşs, E. Toker, M. Ender, E. Muti & F. Es
Kalyon PV, Ankara, Turkey

2CV.1.35 **Comparison of Electrical Performances of Solar Cells Made of Different n-Type Wafer Feedstocks**
G. Bektaş
GÜNAM, Ankara, Turkey
O. Aydin & F. Es
Kalyon PV, Ankara, Turkey
R. Turan
METU, Ankara, Turkey

2CV.1.36 **High-Throughput Dry Etching of Polysilicon Layers for TOPCon Solar Cell Production**
B. Kafle, S. Mack, C. Teßmann, A. Wolf, M. Hofmann & J. Rentsch
Fraunhofer ISE, Freiburg, Germany
L. Clochard & E. Duffy
Nines Photovoltaics, Dublin, Ireland

2CV.1.37 **Texturization of Monocrystalline Silicon by Metal-Assisted Chemical Etching: Analysis of Reaction Dynamics**
D.M. Pera, I. Costa, F. Serra, A. Guerra, K. Lobato, J.M. Serra & J. Almeida Silva
University of Lisbon, Portugal

2CV.1.39 **Optimization of Phosphorus Implant Dose and Activation Temperature for Emitter Formation of p-Type Silicon Solar Cells**
G. Bektaş, A.E. Keçeci, S. Koçak Bütüner & R. Turan
METU, Ankara, Turkey

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2CV.1.40 **Optimization of Laser Selective Emitter Process for Commercial Mono PERC Solar Cell Production**
E. Han
Kalyon PVŞ, Ankara, Turkey
F. Kaya, M. Ender, E. Muti & F. Es
Kalyon PV, Ankara, Turkey
D. Mink, M.C. Raval & P. Fath
RCT-Solutions, Konstanz, Germany

2CV.1.41 **Investigation of the Rear Side Passivation Layer on Bifacial PERC Solar Cells**
C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, L.-G. Wu, S.-C. Lin & C.-Y. Yu
TSEC, Hsinchu, Taiwan

2CV.1.42 **Effect of Surface Morphology on Passivation Quality of Al2O3/SiNx Stack Layer for PERC Solar Cell**
S. Koçak Bütüner, G. Bektaş, G. Kökbudak, M. Zolfaghari Borra, H. Asav, A.E. Keçeci, B. Arıkan & R. Turan
METU, Ankara, Turkey

2CV.1.43 **Development of Cost-Effective IBC Solar Cells Using APCVD Glass Layers**
V. Kuruganti, V.D. Mihailetchi & R. Kopecek
ISC Konstanz, Germany
S. Seren
SCHMID Group, Freudenstadt, Germany
O. Isabella
Delft University of Technology, The Netherlands

2CV.1.44 **Contactless Optimization of a Novel, Maskless Patterned Etching Process for Interdigitated Back Contact Cells**
M. Ghosh, J. Wang, F. Ouadjane, B. Carbonell, P. Bulkin, D. Daineka, K. Ouaras, P. Roca i Cabarrocas & E.V. Johnson
LPICM-CNRS, Palaiseau, France
S. Filonovich
TOTAL GRP, Courbevoie, France
J. Alvarez
CNRS, Gif-sur-Yvette, France

2CV.1.45 **Evaluation of Indium Oxide as Alternative TCO Material for Silicon Heterojunction Solar Cells**
D. Andronikov, I. Nyapshaev, K. Emtsev, G. Ivanov & A. Abramov
R&D Center TFTE, St-Petersburg, Russian Federation
V. Yakovlev
Hevel Solar, Novocheboksarsk, Russian Federation
M. Dimer, U. Graupner, M. Thumsch & E. Schneiderlöchner
VON ARDENNE, Dresden, Germany

2CV.1.46 **Highspeed Video Investigation on the Effect of Rheological Paste Properties on Fine-Line Printing of Silicon Solar Cell Front Side Contacts**
K. Abdel Aal, M. Ailinger & N. Willenbacher
Karlsruhe Institute of Technology, Germany

2CV.1.47 **Screen Printed Air Fired Copper**
T. Druffel, R. Dharmadasa, K. Ankireddy & K. Elmer
Bert Thin Films, Louisville, USA
A. Ebong & S. Huneycutt
UNC Charlotte, USA

2CV.1.48 **Investigation of Effect of Poly-Si Impurities on Cz-Ingot to Solar Module Production**
F. Çambay Kuban & F. Es
KalyonPV, Ankara, Turkey
E. Uçar, N. Yıldırım & F.S. Yıldırım
Kalyon PV, Ankara, Turkey

2CV.1.49 **Investigation of the Current Induced Degradation for Gallium Doped Silicon Solar Cells**
M.-A. Tsai, Y.-S. Long & T.-C. Wu
ITRI, Hsinchu, Taiwan
C.-W. Kuo, T.-M. Kuan & C.-Y. Yu
TSEC, Hsinchu, Taiwan

2CV.1.50 **Sol-Gel Method for Double Layer Coated Colored Silicon Solar Cells**
M. Rudzikas & A. Setkus
Center for Physical Sciences and Technology, Vilnius, Lithuania
N. Curmei & D. Sherban
Academy of Sciences of Moldova, Chisinau, Moldova
J. Doneliene & J. Ulbikas
Protech, Vilnius, Lithuania
A.G. Ulyashin
SINTEF, Oslo, Norway

2CV.1.53 **Mass Production of Tunnel Oxide Passivated Contacts Silicon Solar Cells**
K.-C. Lai, C.-P. Lin, S.-W. Chiu, W.-T. Chung, C.-J. Lan, C.-M. Wei, C.-K. Wu, Y.-C. Cheng, Y.-C. Lin, H.-W. Tsai, A.-H. Cheng, L.-T. Wang, W.-Y. Chen, C.-C. Li & H.S. Lin
Motech Industries, Tainan City, Taiwan

VISUAL PRESENTATIONS 5CV.2

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

Chairpersons:

Gerhard Mütter
Enery, Vienna, Austria

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

5CV.2.1 **Using On-Site Measurement Data and Laboratory Test Data of PV Modules for Evaluating the Performance Degradation**
M.-W. Chen & C.-H. Lin
TERTEC, Taoyuan, Taiwan
C.-I. Chen
National Central University, Taoyuan, Taiwan

5CV.2.3 **Temperature Coefficients of Photovoltaic Modules under Partial Shading Conditions**
O.K. Segbefia, B.R. Paudyal, A.G. Imenes & T.O. Saetre
University of Agder, Grimstad, Norway

Wednesday, 8 September 2021

5CV.2.6 **Performance Analysis of PV Modules Installed in the Alpine Region**
F. Carigiet & F.P. Baumgartner
ZHAW, Winterthur, Switzerland
D. Grunauer
EKZ, Zurich, Switzerland

5CV.2.7 **PV Plant Monitoring Needs Both – Data Analysis and On-Site Inspection**
W. Mühleisen, L. Neumaier, J. Kosel & C. Hirschl
SAL Silicon Austria Labs, Villach, Austria
R. Rattenberger
University of Applied Sciences Burgenland, Pinkafeld, Austria
P. Prasser
KIOTO, St.Veit, Austria

5CV.2.8 **Market Analysis and Economic Assessment of Photovoltaic Soiling Monitors**
J.G. Bessa, L. Micheli, E.F. Fernández & F. Almonacid-Cruz
University of Jaén, Spain

5CV.2.9 **Impact of Dust on PV Performance in Nigeria**
Y. N. Chanchangi, A. Ghosh, T.K. Khalid & S. Sundaram
University of Exeter, Penryn, United Kingdom

5CV.2.10 **Clouds Characterization and Simulation to Evaluate the Effect in the Stability of Photovoltaic Irrigation Systems**
F.J. Guillén Arenas & L. Narvarte Fernández
UPM, Madrid, Spain
J. Fernandez-Ramos
University of Malaga, Spain

5CV.2.11 **Deep Learning Based Image Feature Extraction for Predicting Climate Related Degradation of PV Modules**
L. Neumaier, J. Scherer, C. Schwarzlmüller & C. Hirschl
SAL Silicon Austria Labs, Villach, Austria
B. Kubicek
AIT, Vienna, Austria
F. Mödritscher
UAS Technikum Wien, Vienna, Austria

5CV.2.12 **Effects of Different Shading Scenarios on the Performance of PV Modules**
S. Meric, O. Bazkir & G. Yakın
TUBITAK-UME, Kocaeli, Turkey
B. Yılmaz & F. Koca
Kocaeli University, Turkey

5CV.2.13 **A Self-Referencing Method for Detecting Underperforming Strings in MWp-PV-Generators**
C. Buerhop-Lutz, T. Pickel, J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany

5CV.2.14 **Performance Evaluation of a High-Power PV Irrigation System for a Two-Year Operation Period**
J.I. Herraiz, R.H. Almeida & L. Narvarte Fernández
UPM, Madrid, Spain
M. Castillo-Cagigal
Qualifying PhotoVoltaics, Madrid, Spain

5CV.2.15 **A Machine Learning-Aided Underperformance Assessment of Solar Plants**
G. Guerra
DNV GL UK, Bristol, United Kingdom
P. Mercade Ruiz
Greenpowermonitor, Barcelona, Spain
L. Landberg
DNV GL, Hellerup, Denmark

5CV.2.16 **A Decision Support System for Cost-Effective Operation and Maintenance of PV Plants**
S. Gallmetzer, A. Louwen & D. Moser
Eurac Research, Bolzano, Italy
P. Ingenhoven
University of Adelaide, Australia

5CV.2.17 **Artificial Intelligence Based Solutions for PV Plant Condition Monitoring and Diagnosis Using Unmanned Aerial Vehicle Images and on-Site Measurements**
A. Betti
FlySight, Livorno, Italy
M. Tucci
University of Pisa, Italy
M. Moschella, A. Piazzi, L. Gigoni & C. Lanzetta
I-EM, Livorno, Italy

5CV.2.18 **Solar Photovoltaic Power Plant Inventory and Solar Modules Counting by Convolutional Neural Network from Aerial Imagery**
Y.-R. Lin, C.-Y. Huang, J.-S. Zhang & H.-L. Chen
ITRI, Tainan, Taiwan

5CV.2.19 **Installation and Data Analysis of the Photovoltaic Monitoring Station in Karapınar SPP, Turkey with Different Construction and Module Technologies**
H. Karakan, H.A. Ceyran, M. Günöven & A. Yazici
Kalyon PV, Ankara, Turkey

5CV.2.20 **Modeling a PV Fault Detection Approach with Regards to Machine Learning**
H. Sahota, J. Altkrüger, P. Akharath & V. Herbort
Ulm University of Applied Sciences, Germany
H. te Heesen
Trier University of Applied Sciences, Hoppstädten-Weiersbach, Germany

5CV.2.21 **Development of a Web Application for Yield Analysis of Photovoltaic Systems**
T. Krömer & M. Rumpler
Trier University of Applied Sciences, Birkenfeld, Germany
H. te Heesen
Trier University of Applied Sciences, Hoppstädten-Weiersbach, Germany

5CV.2.23 **Si-Heterojunction Modules: Outdoor Performance in Fixed and Tracking Conditions**
A. Titov, K. Emtsev, D. Andronikov, A. Abramov & D. Orekhov
R&D Center TFTE, St.-Petersburg, Russian Federation
I. Shakhray
Avelar Solar Technology, St.-Petersburg, Russian Federation

Wednesday, 8 September 2021

5CV.2.24 **Effects of the Biggest Snowfall of a Century in Madrid, on the Electricity Generation of Portrait Versus Landscape Layout Solar Panels**
M.A. Muñoz-García & G.P. Moreda
UPM, Madrid, Spain
M.C. Alonso-García
CIEMAT, Madrid, Spain

5CV.2.25 **Challenges of Predictive Maintenance**
P. Mercade Ruiz
GreenPowerMonitor, Barcelona, Spain
G. Guerra
DNV GL, Bristol, United Kingdom
L. Landberg
DNV GL, Hellerup, Denmark

5CV.2.26 **Soiling Impact on a Farmhouse, Rooftop PV System in Eastern Norway**
H.N. Riise & T.U. Nærland
IFE, Kjeller, Norway

5CV.2.27 **Operating Temperature, Structure Shading and Mismatch Loss Factors Measurements for 1P and 2P Trackers**
P. Merodio, F. Martinez-Moreno & E. Lorenzo
UPM, Madrid, Spain

5CV.2.28 **Ageing of Two 5kW PV Arrays at the IES-UPM After 8 Years of Operation**
F. Martinez-Moreno
UPM, Madrid, Spain
L.A. Fialho
University of Évora, Portugal
N. Tyutyundzhiev
Bulgarian Academy of Sciences, Sofia, Bulgaria

5CV.2.29 **Assessment of the Sensitivity of the Factors Affecting Performances of Large Scale PV Power Plant**
M.C. Diouf, M. Faye & A. Ndiaye
UADB, Bambey, Senegal
A. Thiam & V. Sambou
UCAD, Dakar, Senegal

5CV.2.30 **The Potential of the Rejected Brine as a Coolant for PV Temperature Reduction Purposes**
S. Kamfiroozi, B. Ghobadian & S. Gorjian
Tarbiat Modares University, Tehran, Iran
H. Ebadi & L. Savoldi
Polytechnic University of Turin, Italy
H. Vahabi
University of Tehran, Karaj, Iran
R. Talebnejad & A.R. Sepaskhah
Shiraz University, Iran

5CV.2.31 **Experimental and Theoretical Investigation of Fixed and Tracking PV Panel Performance in Tehran through Techno-Economic Aspects**
A. Tadjik & A. Gholami
Shahid Beheshti University, Tehran, Iran
S. Eslami & Y. Noorollahi
University of Tehran, Iran

5CV.2.32 Performance Evaluation of High Power Density PV Modules Using Correlation Analysis of Environmental Variables under High Irradiation Condition for Marine Photovoltaics
J. Hyun, W.B. Lee, J.-H. Choi, C.-S. Won & H.K. Ahn
Konkuk University, Seoul, Republic of Korea

5CV.2.33 Deep Learning Based Object Detection Algorithm for PV Module Defects
S. Xu & M. Ziyao
Nankai University, Tianjin, China

5CV.2.34 Electroluminescence Inspection: Revisiting the Hidden Side of a PV Module
R.J. Gómez, E. Jiménez, D. Sanz, C. Sandoval, J. Cuaresma, J.C. Vázquez, J. Rodríguez, A. Cendoya, S. Suarez, J. Martin, C. Arranz, G.A. Navas, J.M. Álvarez, F.R. Fernández, S. Rodríguez-Conde, I. Fernandez & V. Parra
Enertis Solar, Madrid, Spain

5CV.2.35 Development of an Automated Real-Time Diagnostic System for O&M of Large Scale Photovoltaic Arrays Operating under Outdoor Conditions
P.D.N. Ncube, E.L. Meyer & Z.S. Shibeshi
University of Fort Hare, Alice, South Africa

5CV.2.36 Impact of Mismatch on String Performance
P. Raux & L. Sauvage
Ener-Pacte, Lyon, France

5CV.2.37 Physical and Chemical Properties of Dust in the Pre-Aral Region of Uzbekistan and its Influence on Solar Modules
R. Bazarbayev & K. Yakubov
Urgench State University, Uzbekistan
B. Zhou & G.G. Zeng
Sichuan University, Chengdu, China
A. Allaniyazov
Karakalpak State University, Karakalpakstan, Uzbekistan
D. Mamedov & S.Zh. Karazhanov
Institute for Energy Technology, Kjeller, Norway
E.A.E. Ivanitskaya
National Research Nuclear University MEPhI, Moscow, Russian Federation
Q. Wei & H. Qian
Talesun Solar, Changshu, China
M. Ghali
Egypt-Japan University of Science and Tecchnology, Alexandria, Egypt

5CV.2.38 Influence of Shading on Photovoltaic Generation from Winter to Summer in Vanderbijlpark, South Africa
J. Bekker
Vaal University of Technology, Vanderbijlpark, South Africa

5CV.2.39 Experimental Study of the Operation of PV Strings at the MPP Closest to the Nominal MPP Voltage Instead of the Global MPP
K. Lappalainen & S. Valkealahti
Tampere University, Finland

Wednesday, 8 September 2021

5CV.2.40 Analysis of Temperature Inertia of PV Modules Using Different Temperature Estimation Models
A.K. Vidal de Oliveira, M. Braga & R. Rüther
UFSC, Florianópolis, Brazil
S.-Y. Oh
Yeungnam University, Gyeongsan, Republic of Korea
S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
C.D. Rodríguez-Gallegos & T. Reindl
SERIS, Singapore
T.R. Betts
Loughborough University, United Kingdom
L. Burnham
Sandia National Laboratories, Albuquerque, USA

5CV.2.41 Effect of the Number of Strings Per MPPT on the Inter-String Mismatch Loss in PV Systems
A. Karakish & G. Tourasse
KiloWattsol, Lyon, France

5CV.2.42 Field Characterization of Silicon Solar Module Backsheets by Near-Infrared Absorption (NIRA) Spectroscopy
O. Stroyuk, T. Pickel, T. Winkler, C. Buerhop-Lutz, J. Hauch & I.M. Peters
HI ERN, Erlangen, Germany

5CV.2.43 Overview of the Initial Energy Production at the 1300 MWp Kalyon Solar Power Plant in Karapınar, Turkey
M. Günöven & H. Karakan
Kalyon PV, Ankara, Turkey
A. Yazici & G. Duman
Kalyon Günes, Ankara, Turkey

5CV.2.45 Reduction in Solar Power Generation Due to Soiling Losses
S.H. Abbas Rizvi, V. Singh, M. Kumar & R. Bhasin
IIT Delhi, New Delhi, India
N. Gupta & J.S. Chawla
ReNew Power, New Delhi, India

5CV.2.46 New Findings on PV Fire Prevention - Fire Fighter Strategy for in-Roof PV Installations
U. Muntwyler & E. Schüpbach
BUAS, Burgdorf, Switzerland

5CV.2.47 State of the Art and Performance of the Photovoltaic PV System Fleet in Brussels: An Analysis of 8000 PV Installations
B. Sarr & J. Leloux
LuciSun, Sart-Dames-Avelines, Belgium
G. Neubourg
Becquerel Institute, Brussels, Belgium
G. Declève
Sunset Energy, Brussels, Belgium
R. Tieterickx, J. de Lathouwer & R. Lambert
Brugel, Brussels, Belgium

5CV.2.48 **Lifetime Degradation Studies of CdTe Solar Modules: Temperature, Irradiance, and Soiling Effects**
K. BENABDERAZAK, A. Elamri, O. Lakbita & O. Moudam
Mohammed VI Polytechnic University, Benguerir, Morocco
H. El Gallassi, K. Tijani, I. Ait Abdelmoula, Z. Naimi & D. Barrit
Green Energy Park, Benguerir, Morocco

5CV.2.49 **PV Fault Detection Threshold at the Module, String, and Inverter Levels**
M. Matam & H. Seigneur
Florida Solar Energy Center, Cocoa, USA

VISUAL PRESENTATIONS 5CV.3

15:15 – 16:45 **PV Systems: Planning, Plant Optimisation Tools, Advanced Installation Criteria, Construction Issues / Concentrators and PV for Space Applications**

Chairpersons:

Ignacio Antón Hernández
UPM, Madrid, Spain

David Moser
Eurac Research, Bolzano, Italy

5CV.3.1 **The Impact of Tracking Algorithms and Time Resolution on Energy Yield Modelling of Single Axis Tacker Systems**
A. Neubert
GL Maritime Software, Oldenburg, Germany
M. Hamer & P. Rainey
Garrad Hassan & Partners, Bristol, United Kingdom
M.A. Mikofski
Garrad Hassan America, Oakland, USA

5CV.3.2 **Inspection of Time Series Characteristics of Irradiance Governing the Sizing of PV Systems for High Autonomy in View of Reliability of Predicted Security of Supply**
H.G. Beyer
University of the Faroe Islands, Torshavn, Faroe Islands

5CV.3.4 **Analysis of Electrical Shading Effects in PV Systems**
B. Wittmer, A. Mermoud & M. Oliosi
PVsyst, Satigny, Switzerland

5CV.3.7 **Simulation and Analysis of Daily Shading Patterns on Luminescent Solar Concentrator Performances**
G. Mangherini, P. Bernardoni, A. Andreoli, M. Gjestila & D. Vincenzi
University of Ferrara, Italy
M. Tonezzer & P. Decarli
Powerglax, Vallelaghi, Italy

Wednesday, 8 September 2021

5CV.3.8 **Dynamic Simulation of the Shading Cast by a Wind Farm on an Adjacent Photovoltaic Plant**
J. Robledo Bueno, J. Leloux & B. Sarr
LuciSun, Sart-Dames-Avelines, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, USA
P. Darez
350Renewables, Las Condes, Chile

5CV.3.9 **Dynamic and Visual Simulation of the Bifacial Energy Gain for Photovoltaic Plants**
J. Robledo Bueno, J. Leloux & B. Sarr
LuciSun, Sart-Dames-Avelines, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, USA
A. Driesse
PV Performance Labs, Freiburg, Germany

5CV.3.10 **Fast and High-Resolution Calculation of Roof-Top and Façade PV Potentials Using Graphics Processor Accelerated Monte-Carlo Raytracing**
D. Bredemeier, E. Rott, C. Schinke & H. Wagner-Mohnsen
Leibniz University of Hannover, Germany
T. Gewohn, R. Niepelt & R. Brendel
ISFH, Emmerthal, Germany

5CV.3.11 **Experimental Evaluation of Performance Enhancement in a Bifacial PV System by a Highly Reflective Textile Ground Cover**
J. Moschner & G.H. Yordanov
KU Leuven, Belgium
L. Dupé
Beaulieu Technical Textiles, Comines-Warneton, Belgium

5CV.3.17 **Large Size Flexible and Laminated Space Photovoltaic Arrays**
T. Guerin, C. Jamin, P. Voarino, S. Noël, F. Chabuel & R. Cariou
CEA, Grenoble, France
D. Vergnet
Airbus Defence and Space, Toulouse, France
P. Zevenbergen
Airbus Defence and Space, Leiden, The Netherlands
V. Khorenko
Azur Space, Heilbronn, Germany

5CV.3.18 **Optically Enhanced c-Si Solar Cells for Ephemeral Space Applications**
D.M. Pera, I. Costa, F. Serra, A. Guerra, K. Lobato, J.M. Serra & J. Almeida Silva
University of Lisbon, Portugal

5CV.3.19 **Performance of Photovoltaic - Thermal (PVT) and Photovoltaic (PV) Systems under Various Weather Conditions**
R.R. Vardanyan, V.K. Dallakyan & N.K. Badalyan
NPUA, Yerevan, Armenia

VISUAL PRESENTATIONS 6CV.4

17:00 – 18:30 **PV on/in Buildings / PV in Infrastructure, on Water and on Vehicles; PV and Agriculture**

Chairpersons:

Eszter Voroshazi
CEA, Le Bourget-du-Lac, France

Pierluigi Bonomo
SUPSI, Canobbio, Switzerland

6CV.4.1 **The Inverse Lambertian Method: An Optical Tool for PV Solar Concentrators and Urban Heat Islands Characterization**
A. Parretta
University of Ferrara, Italy
M. Tucci
ENEA, Rome, Italy

6CV.4.2 **Solar Blinds as New Vertical Photovoltaic (PV) Surfaces – The Missing Link**
U. Muntwyler, E. Schüpbach & C. Renken
BUAS, Burgdorf, Switzerland
A. Faes
CSEM, Neuchâtel, Switzerland
T. Stöckli
Schenker Storen, Schönenwerd, Switzerland

6CV.4.3 **When Aesthetics Meets Sustainability through SUNCOL: The CO2-Neutral Wohnüberbauung Männedorf Project**
E. Luzi & E. Canosci
Sunage, Chiasso, Switzerland

6CV.4.5 **Effect of Incidence Angle and Coating Colour on CIGS-Modules Performance in One Full Year Outdoor Analysis**
R. Aninat, S. Villa, R.M.E. Valckenborg & M. Theelen
TNO, Eindhoven, The Netherlands
R.H.L. Borro
ReBor, Amsterdam, The Netherlands

6CV.4.6 **Analysis and Evaluation of Energy Economy Related BIPV Standardization Needs**
D. Valencia-Caballero & J.M. Vega de Seoane
Tecnalia, Donostia - San Sebastián, Spain
F. Parolini, P. Bonomo & F. Frontini
SUPSI, Canobbio, Switzerland
S. Boddaert
CSTB, Sophia Antipolis, France

6CV.4.7 **Supervised Machines Learning for BIPV Production**
D. Granados-López, D. Gonzalez-Peña, A. García-Rodríguez, S. García-Rodríguez & M. García-Fuente
UBU, Burgos, Spain

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6CV.4.8 **Maximizing Yield and Aesthetics of BIPV Façades: The Fully PV-Active ZigZag Structure**
S. Villa, R. Aninat & R.M.E. Valckenborg
TNO Energy Transition, Eindhoven, The Netherlands
X. Xu & W. van de Wall
Wallvision, Eindhoven, The Netherlands

6CV.4.9 **Simplified Prediction of the Impact of Building Integrated Photovoltaic Modules Ageing on Their Performance**
Y.B. Assoa & A. Rhone
CEA, Grenoble, France

6CV.4.10 **Standard-BIPV – A New BIPV System for Façades of Industrial Buildings Aiming at Easy Planning and Installation While Meeting High Aesthetic Standards**
J.-B. Eggers, I. Lützkendorf, N. Meyer, J. Höhne, S. Meier, C. Schmidt, W. Körner, M. Behnisch, J. Grosch, F. Ensslen, J. Eisenlohr & T.E. Kuhn
Fraunhofer ISE, Freiburg, Germany

6CV.4.11 **A Solar Hybrid PVT Driven Heat Pump System Real Performance Techno-Economic Analysis**
A. Sanz Martinez
Tecnalia, Derio, Spain
R. Fuente Dacal
UPV/EHU, Bilbao, Spain
A. Martin
Energy Panel, Lucena, Spain

6CV.4.12 **PV as a Cost-Competitive Solution for the Decarbonization of the EU Heat Sector**
A. Sanz Martinez
Tecnalia, Derio, Spain
R. Fuente Dacal
UPV/EHU, Bilbao, Spain
A. Martin
Energy Panel, Lucena, Spain

6CV.4.13 **Research and Development of Indoor Installation Type BIPV Screen**
H. Ishii
LIXIL, Tokyo, Japan

6CV.4.14 **BIPV with Novel Design Features - Design2PV-Modules and First Pilot Application**
J. Eisenlohr, F. Ensslen, J.-B. Eggers, L. Schäfer, D. Raine, M. Heinrich & T.E. Kuhn
Fraunhofer ISE, Freiburg, Germany
K. Görich & A. Tersluisen
ee concept, Darmstadt, Germany
J. Kimmerle, L. Schönrock & T. Stark
HTWG Konstanz, Germany
F. Jäger & O. Aßländer
acp systems, Zimmern, Germany
J. Höhne
GES, Korbußen, Germany

6CV.4.15 BESMART: Thermal Impact of Photovoltaic Modules Building Integration
Y.B. Assoa, D. Chavrier, I.A. Tsanakas, P. Thony, A. Mignonac, A. Blaise, J.V. Furtado Frazao de Medeiros & A. Rhone
CEA, Grenoble, France
L.-E. Perret-Aebi
EPFL, Neuchâtel, Switzerland

6CV.4.17 PV Half-Laminate Concept for Prefab Integration
V. Rosca, N. Guillevin & B.K. Newman
TNO Energy Transition, Petten, The Netherlands

6CV.4.19 Building Integrated Photovoltaics: Yield-Optimized Small Photovoltaic Module Solutions in Combination with Concrete Facades Elements
S. Schindler, P. Schenk & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany
S. Huth, A. Heller, F. Hülsmeier & J. Reise
Leipzig University of Applied Sciences, Germany
K. Wilhelm & M. Butler
TU Dresden, Germany
R. Grebe
Hering Bau, Burbach, Germany
D. Hirsch & C. Erban
Sunovation, Elsenfeld, Germany

6CV.4.20 Aesthetic Evaluation Criteria for Façade Integrated Photovoltaics in Urban Context
C. Xiang & B. Szybinska Matusiak
NTNU, Trondheim, Norway
C.T. Moscoso Paredes
SINTEF, Trondheim, Norway

6CV.4.21 A State of the Art of Design Criteria for Façade Integrated Photovoltaics
C. Xiang & B. Szybinska Matusiak
NTNU, Trondheim, Norway

6CV.4.22 Improving the Energy Performance of a South-Facing Building in Tehran with Solar Energy
S. Naderi
Shahid Beheshti University, Tehran, Iran
M. Najmoddin
Industrial Management Institute, Tehran, Iran
M. Emamipour
University of Applied Sciences and Technology Tehran, Iran

6CV.4.23 Architectural Integration of Photovoltaic in Green Facade Retrofitting
S. Naderi
Islamic Azad University, Tehran, Iran
M. Najmoddin
Industrial Management Institute, Tehran, Iran

6CV.4.28 Modelling the Passive Cooling Effect in the Context of Floating Photovoltaics
B. Amiot & R. Le Berre
EDF R&D, Moret sur Loing, France
S. Giroux-Julien
CETHIL, Villeurbanne, France
D. Boublil, G. Bayart & K. Radouane
EDF Renewables, Paris, France
K. Vermeyen
EDF Luminus, Brussels, Belgium

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6CV.4.30 Floating Photovoltaics: A SWOT Analysis
S. Moghadam
Solar Edition, Oslo, Norway
H.E. Hayati Soloot
Solar Edition, Qazvin, Iran

6CV.4.31 Key Performance Indices of Photovoltaic Carports
M. Loup, C. Allenspach, H. Hofmann, R. Vogt, F. Carigiet & F.P. Baumgartner
ZHAW, Winterthur, Switzerland

6CV.4.32 Geographical Distribution of Solar Urban Potential for Vehicle Integrated Photovoltaics
M.C. Centeno Brito, R. Amaro e Silva, D.M. Pera, F. Moura & J. Rocha
University of Lisbon, Portugal
T. Santos
University NOVA Lisbon, Portugal

6CV.4.35 Sustainable Optimization of PV Value Chain for Electromotive Applications
F. Popescu
Fraunhofer FOKUS, Berlin, Germany
S. Wendlandt
PI Berlin, Germany

6CV.4.36 A Python Based Design Library for a Photovoltaic Powered UAV
M.B. Günaydın & U. Paralı
Kalyon PV, Ankara, Turkey

6CV.4.37 Modeling and Simulation of Multipump Photovoltaic Irrigation Systems
J. Ramirez Ledesma, R.H. Almeida & L. Narvarte Fernández
UPM, Madrid, Spain

6CV.4.39 Simulating the Energy Yield of Bifacial Photovoltaic Modules Installed on Carports or Canopies
J. Robledo Bueno, J. Leloux & B. Sarr
LuciSun, Sart-Dames-Avelines, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, USA
A. Driesse
PV Performance Labs, Freiburg, Germany
P.-F. Drouin
Syneria, Paris, France

6CV.4.40 Performance Analysis of the World First Rigid-Type Commercial Scale Marine Photovoltaic System; Sihwa Lake Installation
W.C. Lawrence, C.-S. Won, D.-C. Kim, M. Gang & S.D. Kim
SCOTRA, Songpa-gu, Republic of Korea
H.-J. Kim, Y. Cho & H. Jo
K-Water Research Institute, Yuseong-gu, Republic of Korea
S. Shin
Rural Research Institute, Gyeonggi-do, Republic of Korea

6CV.4.41 **Lessons Learned from Simulating the Energy Yield of an Agrivoltaic Project with Vertical Bifacial Photovoltaic Modules in France**
J. Robledo Bueno, J. Leloux & B. Sarr
LuciSun, Sart-Dames-Avelines, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, USA
A. Driesse
PV Performance Labs, Freiburg, Germany
P.-F. Drouin
Syneria, Paris, France
S. Ortega
Amarenco, Lagrave, France
D. André
Amarenco Services, Lagrave, France

6CV.4.42 **Ground Irradiance Modelling: Of Key Importance for Designing Nature Inclusive Solar Parks and Agrivoltaics Systems**
B.B. Van Aken, A. Binani, T.R. Burgers & K. Cesar
TNO Energy Transition, Petten, The Netherlands
E. Barros
TNO Energy Transition, Utrecht, The Netherlands
F. van der Zee & A. Schotman
Wageningen Environmental Research, The Netherlands

Thursday, 9 September 2021

VISUAL PRESENTATIONS 7DV.1

08:30 – 10:00 **Economics, Markets and Education**

Chairpersons:

Thomas Nordmann
TNC Consulting, Feldmeilen, Switzerland

Maria Getsiou
European Commission DG RTD, Brussels, Belgium

7DV.1.1 **The Optimal Azimuth and Tilt Angle of BIPV Panels Considering the Prices at Electricity Spot Market**
I. Batic, D. Kotur & Z. Durisic
University of Belgrade, Serbia

7DV.1.2 **Evaluating the Impact of Climate Change on the Techno-Economic Performance of Building Integrated Photovoltaics Systems in Protected Contexts**
M. Pelle, M. Dallapiccola, L. Maturi & D. Moser
Eurac Research, Bolzano, Italy
A. Tatti & F. Causone
Polytechnic University of Milan, Italy

7DV.1.4 **Demand-Aware Electricity Price Prediction Based on LSTM and Wavelet Transform**
K. Iwabuchi, K. Kato, D. Watari, I. Taniguchi & T. Onoye
Osaka University, Suita, Japan
F. Catthoor & E. Shirazi
imec, Leuven, Belgium

7DV.1.5 **The Application of Blockchain in Community Energy Trading: A Study on Solar Energy Exchanges in Malta**
D. Formosa & B. Azzopardi
MCAST, Paola, Malta

7DV.1.6 **The Asset of Measurements for Project Finance and Project Value**
S. Weber, R. Meyer, R. Granados & B. Westphal
Suntrace, Hamburg, Germany

7DV.1.7 **Development of Conceptual Framework for Time of Generation Feed-in-Tariff for a Rooftop Photovoltaic System**
R.R. Urs & M. Marzband
Northumbria University, Newcastle upon Tyne, United Kingdom
A. Al-Sumaiti
Khalifa University, Abu Dhabi, United Arab Emirates
A. Abusorrah
King Abdulaziz University, Jeddah, Saudi Arabia

7DV.1.8 **How Innovative Citizen Financing Schemes Enable Large-Scale Energy Efficiency Measures in the Building Sector**
S. Wilhelm, S. Caneva & D. van der Zande
WIP Renewable Energies, Munich, Germany
J.-F. Marchand
ENERGINVEST, Würzburg, Germany
M. Casas
ENERGINVEST, Brussels, Belgium
F. Pause, M. Wimmer & J. Kamm
SUER, Würzburg, Germany
L. Couto
GOPARITY, Lisbon, Portugal
B. De Kezel
VEB, Brussels, Belgium
V. Segon & T. Simek
REGEA, Zagreb, Croatia
R. Adomaviciene, K. Vaskeliene, A. Gladkauskiene, D. Juškeviciene, D. Banyte & Z. Kaciuška
VIPA, Vilnius, Lithuania
C. Weber
European Crowdfunding Network, Brussels, Belgium

7DV.1.18 **Education and Awareness can Brand PV Technology Beautiful before Turning It Invisible**
S. Ray
Swami Vivekananda Seva Samity for Girls, Kolkata, India
M. Ray
IIT Kharagpur, India
T. Ram
HPTDC, Manali, India

7DV.1.19 **Development of Innovative Educational Material for Smart Grids - The Most Project**
M. Kovarova, S. Caneva & S. Arancón
WIP Renewable Energies, Munich, Germany
F. Pilo & S. Mocci
University of Cagliari, Italy
V. Efthymiou, A. Stavrou, G.E. Georghiou, 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, F. Ebe, B. Idlbi & S. Chen
Ulm University of Applied Sciences, Germany
A. Michiorri
MINES ParisTech, France
E. Loucaidou
Deloitte, Lemassol, Cyprus

7DV.1.20 **A Brand New Training Platform Aimed at Upscaling Solar Capacity Building**
B. Gaiddon & M. de l'Epine
HESPUL, Lyon, France
O. Verdeil, S. Anquetin & C. Corbet
CEA / INES, Le Bourget-du-Lac, France

7DV.1.22 **The Transition of Large-Scale Floating PV from Asia to Europe - Lessons Learnt, Market Study & Potential**
M.K. Le
Rystad Energy, Oslo, Norway

7DV.1.23 **A Prospective Analysis on the Integration of Variable Renewable (PV and Wind) Energies in the French Power System**
H.J.J. Yu
CEA, Gif sur Yvette, France

7DV.1.25 **Strategies and Technologies to Achieve a European Fossil-Energy-Free Agriculture - AgroFossilFree**
D. Rutz, F. Colmorgen & R. Janssen
WIP Renewable Energies, Munich, Germany
T. Balafoutis
Centre for Research & Technology Hellas, Thermi, Greece
K. Vaiopoulos
Centre for Research & Technology Hellas, Athens, Greece
C.A. Grøn Sørensen
Aarhus University, Denmark
D. Manolakos, A. Koutsouris & G. Papadakis
Agricultural University of Athens, Greece
M. Borzecka
Institute of Soil Science and Plant Cultivation, Pulawy, Poland
V. Bisevac
European Agricultural Machinery Association, Brussels, Belgium
D. Creupelandt
REScoop, Antwerp, Belgium
J. Román
European Conservation Agriculture Federation, Brussels, Belgium
F. Oudshoorn
Landbrug & Fodevarer, Kopenhagen, Denmark
D. Rossi
Confagricoltura, Rome, Italy
M. Próchniak
Lublin Agricultural Advisory Center, Konskowola, Poland
Z. Tsiropoulos
AGENSO, Athens, Greece
H. Brinks
DELPHY, Wageningen, The Netherlands
B. Caslin
TEAGASC, Carlow, Ireland
J. Sneij
Trama TecnoAmbiental, Barcelona, Spain
M. Zarranz
Initiativas Innovadoras, Navarra, Spain

7DV.1.26 **Open-Schooling on Solar Energy and Green Mobility - Action Targeting on Increasing the Students' Interest in Science and their Confidence in a Sustainable Future**
G. Mantescu, G. Gorghiu & M. Bizoi
Valahia University of Targoviste, Romania

VISUAL PRESENTATIONS 4DV.2

10:30 – 12:00 **BOS Components / Sustainability and Recycling of PV Modules**

Chairpersons:

Karsten Wambach
Wambach-Consulting, Petersdorf, Germany

Fabian Carigiet
ZHAW, Winterthur, Switzerland

4DV.2.1 **Aging Behavior of Polymeric Inverter Casings**
E. Helfer, P. Christöfl, G. Oreski, J. Petro & M. Gschwandl
PCCL, Leoben, Austria
D. Graf & P. Rechberger
Fronius, Thalheim bei Wels, Austria

4DV.2.3 **Influence of the Illumination, Temperature and Load on the Output Power of a Photovoltaic System Controlled by an MPPT Command Based on a P&O (Perturb and Observe) Algorithm**
H. Rhilane, I. El Idrissi, A. El Moudden & A. Aarib
University of Hassan II, Casablanca, Morocco

4DV.2.14 **Recycling and Reusing of Silver from End-of-Life Photovoltaics via Electroplating**
R. Deng, P. Ribeiro Dias, M. Monteiro Lunardi, S. Wang, J. Ji & C.M. Chong
UNSW Australia, Sydney, Australia

4DV.2.15 **End-of-Life Management of Solar Photovoltaic Panels in India - Identification of Needs, Stakeholders & Challenges**
K. Ganesan
MSc SELECT, Chennai, India
C. Valderrama
Polytechnic University of Catalonia, Barcelona, Spain

4DV.2.17 **Solubility of Solar Encapsulants – Improvement of Recycling Processes**
S. Feldbacher, I. Mühlbacher & G. Oreski
PCCL, Leoben, Austria
T. Dobra
Montanuniversität Leoben, Austria
M. Aarnio-Winterhof
Borealis Polyolefine, Linz, Austria

4DV.2.18 **Greenhouse Gas Emissions Avoidance by Photovoltaic Plants on the Road to Carbon Neutrality**
J. Tavora, M.J. Cortinhal & M. Meireles
ISCTE, Lisbon, Portugal

4DV.2.19 **Carbon Footprint Analysis of CIGS Thin-Film PV Modules with Focus on Building-Integrated Applications**
P. Borowski
Avancis, Munich, Germany
F. Grömmer & J. Seeger
Technical University of Dresden, Germany

4DV.2.21 **Techno-Socio-Economic Sustainable Recycling Approach Analysis for Handling End-of-Life PV Module Waste in India**
D. Jain, D.P. Halliday & M. Szablewski
Durham University, United Kingdom
N. Sengar
University of Kota, India

4DV.2.22 **Next Step - Single Crystalline Si Ingot by Use of 30% Recycled Silicon**
W. Palitzsch & I. Röver
LuxChemtech, Freiberg, Germany
Y.-J. Yook
S-TECH, Daegu, Republic of Korea
J.-S. Lee
KIER, Daejeon, Republic of Korea

4DV.2.23 **Waste - Based on Thin-Film and Silicon Photovoltaics - Very Welcome as Secondary Raw Materials**
W. Palitzsch, I. Röver, A. Killenberg & G. Schwichtenberg
LuxChemtech, Freiberg, Germany

4DV.2.24 **Feasibility of a Closed Loop Recycling System for Backsheets in Solar Modules – A Preliminary Study Taking into Consideration Product Design and Latest Recycling Processes**
Y. Morguet
COVEME, San Lazzaro di Savena, Italy
M. Vannini
COVEME, S. Lazzaro di Savena, Italy

VISUAL PRESENTATIONS 2DV.3

13:30 – 15:00 **Technologies for High Temperature Passivating Contacts and Homo Junction Silicon Solar Cells / Low Temperature Routes for Silicon Cells**

Chairpersons:

Pere Roca I Cabarrocas
LPICM-CNRS, Palaiseau, France

Thorsten Dullweber
ISFH, Emmerthal, Germany

2DV.3.1 **A Highly Passivating and Electron-Selective SiOx/SiCx Contact for Si Solar Cells Made with Fully Industrial Techniques**
R. Sharma, A. Alleva, H. Sivaramakrishnan Radhakrishnan, L. Tous & J. Poortmans
imec, Leuven, Belgium

2DV.3.2 **Firing-Stable PECVD SiOxNy/n-Poly-Si Passivating Contacts for High-Efficiency Silicon Solar Cells**
M. Stöhr, J. Aprojanz, R. Brendel & T. Dullweber
ISFH, Emmerthal, Germany

2DV.3.3 **Sputtered polySi(n) Passivating Contacts Compatible with Direct Metallization**
J.J. Diaz Leon, A. Ingenito, C. Allebé & S. Nicolay
CSEM, Neuchâtel, Switzerland
S. Libraro & C. Ballif
EPFL, Neuchâtel, Switzerland

2DV.3.4 **Large-Area Bifacial n-TOPCon Solar Cells with In Situ Phosphorus-Doped LPCVD-Based Poly-Si Passivating Contacts**
M. Firat, H. Sivaramakrishnan Radhakrishnan, F. Duerinckx, L. Tous, P. Choulat & J. Poortmans
imec, Leuven, Belgium
M. Recamán Payo
KU Leuven, Belgium

2DV.3.5 **Novel Metallisation Strategies of Front-Side Poly-Si(n) Passivating Contact Enabling 22.8% c-Si Solar Cells**
A. Morisset, F. Meyer, A. Khurana, S. Libraro, A. Ingenito, F.-J. Haug & C. Ballif
EPFL, Neuchâtel, Switzerland
S. Nicolay
CSEM, Neuchâtel, Switzerland

2DV.3.6 **Localisation of Front Side Passivating Contacts for Direct Metallisation of High-Efficiency c-Si Solar Cells**
F. Meyer, A. Ingenito, X. Niquille, F.-J. Haug & C. Ballif
EPFL, Neuchâtel, Switzerland
J.J. Diaz Leon, C. Allebé & S. Nicolay
CSEM, Neuchâtel, Switzerland

2DV.3.7 **Evaluation and Demonstration of Bifacial-IBC Solar Cells Featuring Poly-Si Alloy Passivating Contacts**
G. Yang, P.A. Procel Moya, C. Han, Z. Asalieh, Y. Zhao, L. Mazzarella, M. Zeman & O. Isabella
Delft University of Technology, The Netherlands

2DV.3.8 **P-Type TOPCon by Aluminium-Induced Crystallization of Amorphous Silicon**
R. Sharma, J. Szlufcik, H. Sivaramakrishnan Radhakrishnan & J. Poortmans
imec, Leuven, Belgium

2DV.3.9 **Interplay of IBC Cell's Front Surface Doping, Passivation Quality, and Stability under Ultraviolet Light Exposure**
H. Chu, V. Kuruganti, C. Peter & V.D. Mihailetchi
ISC Konstanz, Germany

2DV.3.10 **Novel Ag-Paste for Simultaneous Contacting of n+ and p+ Emitters through Contact-Supportive Well-Passivating APCVD Layers for PERT and IBC Solar Cells**
F. Geml, B. Gapp, M. Mehler, S. Sanz Alonso, H. Plagwitz & G. Hahn
University of Konstanz, Constance, Germany
C. Ebert
Gebr. Schmid, Freudenstadt, Germany
J. Booth, P. Sutton & S. Johnson
Johnson Matthey Technology Centre, Reading, United Kingdom
B. Cela Greven
Johnson Matthey, Maastricht, The Netherlands

Thursday, 9 September 2021

2DV.3.11 **Passivation of Ultrathin Polysilicon via a Simple One-Step Deposition Method for Large-Area Crystalline Silicon Solar Cells**
F.S. Minaye Hashemi, A. Gutjahr, J. Anker & A.A. Mewe
TNO Energy Transition, Petten, The Netherlands

2DV.3.12 **Novel Approach for Self-Aligned Local Polysilicon Layer**
Y. Cai, R. Chen, B.J. Hallam & F.E. Rougieux
UNSW Australia, Sydney, Australia

2DV.3.13 **Effects of Laser Scribing Adjacent to Electrically Conductive Adhesive Interconnects**
D. Rudolph, I. Ullmann, M. Ignacia Devoto, A. Halm & D. Tune
ISC Konstanz, Germany

2DV.3.14 **Evaluation of Bifacial Interdigitated-Back-Contact (IBC) Crystalline Silicon Solar Cells**
T. Tachibana, K. Tanahashi, K. Shirasawa & H. Takato
AIST, Koriyama, Japan

2DV.3.26 **Electrodeposition of Copper on Screen Printed Copper Seed-Grid for Metallization of Silicon Heterojunction Cells**
A. Lachowicz, N. Badel, G. Andreatta, N. Blondiaux, A. Faes, C. Allebé, J.J. Diaz Leon, A. Descoeudres, M. Despeisse, S. Nicolay & C. Ballif
CSEM, Neuchâtel, Switzerland

2DV.3.27 **Stable Copper Plated Metallization on SHJ Solar Cells & Investigation of Selective Al/AlOx Laser Patterning**
T. Hatt, J. Bartsch, S. Schellinger, J. Schneider, A.A. Brand, S. Kluska & M. Glatthaar
Fraunhofer ISE, Freiburg, Germany

2DV.3.28 **IWO Films for Silicon Heterojunction Solar Cells: Effects of the Sputtering Conditions on Optoelectronic Properties and Carrier Lifetime**
F. Menchini, L. Serenelli, L. Martini, E. Salza, G. Stracci, M. Izzi & M. Tucci
ENEA, Rome, Italy

2DV.3.29 **Integration of a New TCO Material for a-Si:H/c-Si Heterojunction Solar Cells and Effect on the TCO/Metal Contact Resistance**
W. Favre, L. Basset, S. Zogbo, F. Jay, F. Pernoud, A. Le Priol, O. Bonino & C. Roux
CEA, Grenoble, France
M. Sciuto, M. Foti & C. Gerardi
ENEL Green Power, Catania, Italy

2DV.3.30 **Experimental Modeling of PECVD Process Variations and Their Influence on HJT Solar Cell Light Soaking Behavior**
A.V. Semenov, A. Titov, S. Abolmasov, A. Abramov, I. Nyapshaev, K.V. Emtsev, D. Orekhov & D. Andronikov
R&D Center TFTE, St-Petersburg, Russian Federation

2DV.3.31 **Si Heterojunction Solar Cells with Dopant-Free Carrier-Selective Contacts**
E. Bobeico, M. Della Noce, L. Lancellotti, I. Usatii, L.V. Mercaldo & P. Delli Veneri
ENEA, Portici, Italy

2DV.3.32 **Edge Passivation of Heterojunction Solar Cells for Research Purposes**
M. Canino, V. Boldrini, R. Rizzoli, E. Centurioni, F. Bonafé, S. Lombardo & C. Summonte
CNR, Bologna, Italy
A. Di Mauro & M. Sciuto
ENEL, Catania, Italy

VISUAL PRESENTATIONS 2DV.4

15:15 – 16:45 **Crystalline Silicon Technology / Thin-Film and Foil-Based Silicon Cells**

Chairpersons:

Marko Topic
University of Ljubljana, Slovenia

Dennis Bredemeier
ISFH, Emmerthal, Germany

2DV.4.1 **Study 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

2DV.4.2 **Pouring the Remaining Melt as a Method to Reduce the Red Zone in the Top Region of mc-Silicon Ingots**
T. Bähr, M. Ghosh & M. Hamacher
Access, Aachen, Germany
C. Kranert & C. Reimann
Fraunhofer IISB, Erlangen, Germany

2DV.4.3 **Influence of an Active Crystal Cooling Device on the Shape of the Phase Boundary in Mono Ingots Grown by the Czochralski Technique**
F. Mosel, A.V. Denisov, K. Hess, B. Klipp & N. Sennova
PVA Crystal Growing Sytems, Wettenberg, Germany
C. Kranert
Fraunhofer THM, Freiberg, Germany
M. Trempa, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany

2DV.4.4 **Comparison of the Oxygen Concentration in Czochralski Silicon Crystal Obtained by a Simple Lumped-Parameter Model and Sophisticated 2D-3D Simulations**
J. Friedrich, M. Trempa & H. Koch
Fraunhofer IISB, Erlangen, Germany
F. Mosel & A. Mühe
PVA Crystal Growing Systems, Wettenberg, Germany

2DV.4.5 **Processing of a High-Quality Single Crystal Silicon: Optimized Parameters for the Czochralski Method**
E. Uçar, N. Yıldırım, F.S. Yıldırım, N.D. Yıldırım, M. Konyar & F. Es
KalyonPV, Ankara, Turkey

2DV.4.6 **Production and Characterization of n-Type Ingots and Wafers that are Produced at Industrial Standards**
O. Aydin, M. Konyar, H. Koç, E. Uçar, N. Yıldırım, F.S. Yıldırım & F. Es
Kalyon PV, Ankara, Turkey

2DV.4.7 **Ga-Doped Single Crystal Wafer Production**
M. Konyar, N. Yıldırım, F.S. Yıldırım, E. Uçar, O. Aydin & F. Es
Kalyon PV, Ankara, Turkey
W. Tao & M. Liang
Hunan Red Sun Photoelectricity Science and Techn., China
W. Jooss
RCT-Solutions, Konstanz, Germany

2DV.4.8 **The Effects of Cutting Fluid for Quality of Monocrystalline Silicon Wafers with Different Thickness**
N. Yıldırım, E. Uçar, F.S. Yıldırım, M. Konyar, E. Çamkara, B.K. Cihan & F. Es
KalyonPV, Ankara, Turkey

2DV.4.9 **Evaluation of Recycled and Non-Recycled Monocrystalline Silicon Solar Cells**
F.S. Yıldırım, N. Yıldırım, E. Uçar, M. Konyar, H. Koç, E. Çamkara & F. Es
Kalyon PV, Ankara, Turkey

2DV.4.10 **Making Of: Single Crystalline Si Ingot by Use of Up to 30% Recycled Silicon**
W. Palitzsch & I. Röver
LuxChemtech, Freiberg, Germany
Y.-J. Yook
S-TECH, Daegu, Republic of Korea
J.-S. Lee
KIER, Daejeon, Republic of Korea

2DV.4.11 **"Solar Wafer Inspection- What For?" or "The Real Impact of Wafer Defects on Cell Lines Yield"**
A. Schlezinger
Applied Materials, Santa Clara, USA

2DV.4.12 **Study of Infrared Images of Multicrystalline Silicon Wafers for 3D Visualization of a Multicrystalline Silicon Ingot**
S.M. Karabanov, O.A. Belyakov, A.E. Serebryakov & D.V. Suvorov
RSREU, Ryazan, Russian Federation

2DV.4.13 **Oxygen Diffusivity Enhancement due to Hydrogen- and Light-Soaking of Silicon: A First-Principles Modelling Study**
V.J.B. Torres, P. Santos & J. Coutinho
University of Aveiro, Portugal

2DV.4.24 **Study of a-Si:H Hydrogenated Amorphous Silicon for Photovoltaic Applications**
K. Ketroussi, R. Cherfi, H.Y. Seba, S. Tata, L. Chabane & A. Rahal
USTHB, Alger, Algeria

2DV.4.25 **Towards Ultra-Thin Silicon Solar Cells for High Specific Power Applications**
Y. Lan, X. Yan & A. Danner
National University of Singapore, Singapore
M. Delos Santos
SERIS, Singapore
D. Lai
NTU Singapore, Singapore

2DV.4.26 **Dynamic HW-CVD Process Development for Very High-Rate Thin-Film Silicon Deposition**
S. Leszczynski, C. Strobel, M. Albert & J.W. Bartha
Technical University of Dresden, Germany
B. Leszczynska
Leibniz Institute for Solid State and Materials Research Dresden, Germany
F. Stahr
FAP, Dresden, Germany

2DV.4.27 **Development of Modulated Surface Texturing for High-Efficiency Thin-Film, Flexible, Tandem Silicon-Based Solar Cells**
G. Limodio, G. Padmakumar, D. Rajagopal, A. Mehul Shah & A.H.M. Smets
Delft University of Technology, The Netherlands
D. Bartesaghi & E.A.G. Hamers
HyET Solar, Arnhem, The Netherlands

VISUAL PRESENTATIONS

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