

38th European Photovoltaic Solar Energy Conference and Exhibition (EU PVSEC 2021)

Online
6-10 September 2021

Volume 1 of 3

Editors:

**J.M. Almeida Serra
R. Kenny
P. Helm**

ISBN: 978-1-7138-5213-1

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2021) by WIP – Renewable Energies
All rights reserved.

Printed with permission by Curran Associates, Inc. (2022)

For permission requests, please contact WIP – Renewable Energies
at the address below.

WIP – Renewable Energies
Sylvensteinstr. 2
81369 Munchen
Germany

Phone: +49 89 72012735
Fax: +49 89 72012791

wip@wip-munich.de

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS
of EU PVSEC 2021 Proceedings Papers

EU PVSEC Committees	III
Subject Index	VI
Foreword	XXIX

Oral PRESENTATIONS 1AO.1 Advanced and Novel Approaches for Transparent Layers and Metal Contacting

1AO.1.4	Amorphous Silicon-Free Heterojunction Crystalline Silicon Solar Cells Employing MoO _x as Hole-Selective and Passivating Contact <i>S. Patwardhan, S. Maurya, A. Kumar, B. Kavaipatti</i>	1
1AO.1.5	Optimization of Carbon-Nanotube-Reinforced Composite Gridlines towards Commercialization <i>A. Chavez, B. Rummel, N. Dowdy, S.M. Han, N. Bosco, B. Rounsaville, A. Rohatgi</i>	7
1AO.1.6	Metal Grid Finger Design Optimization for Cell to Module Ratio Using the Configurable Current Cell Technology <i>B. Damiani, A. Ebong</i>	10

Oral PRESENTATIONS 1AO.2 Innovative Approaches for Solar Cells and Photovoltaic Materials

1AO.2.1	Progress in Three-Terminal Heterojunction Bipolar Transistor Solar Cells <i>E. Antolín, M.H. Zehender, S.A. Svatek, M.A. Steiner, M. Martínez, I. García, P. García-Linares, E.L. Warren, A.C. Tamboli, A. Martí</i>	14
1AO.2.4	Structural and Optical Study of Europium Doped ZnO Films Grown on Different Substrates <i>V.F. Gremenok, E.P. Zaretskaya, A.V. Stanchik, A.V. Mudryi, V.V. Khoroshko, A.N. Pyatlitski, V.A. Saladukha, T.V. Piatlitskaya</i>	19

Oral PRESENTATIONS 1AO.3 Innovative Approaches for Module Concepts

1AO.3.1	The Potential of Glass-Fibre-Reinforcement: (Thermo-)Mechanical Testing of Light-Weight PV Modules <i>J. Govaerts, K. Molliya, B. Luo, T. Borgers, R. Van Dyck, A.S.H. van der Heide, L. Tous, A. Morlier, F. Lisco, L. Cerasti, M. Galiazzo, J. Poortmans</i>	24
1AO.3.5	Solder Paste for Interconnecting Structured Ribbons on the Back Side of the c-Si Cells <i>N.S. Pujari, P.M. Krithika, S. Sarkar, C. Bilgrien</i>	28
1AO.3.6	Enhancing the Performance of Luminescent Solar Concentrator Photovoltaic Devices Using Multiple Organic Dyes and Bifacial Silicon Solar Cells <i>N. Desai, M. Aghaei, A.H.M.E. Reinders</i>	32

Oral PRESENTATIONS 1BO.16 Fundamental Studies in the Forefront of PV

1BO.16.4	Experimental Test of Heat Recovery in Silicon Solar Cells with Thermoelectric Materials <i>K. Kamide, T. Mochizuki, J. Sakuma, H. Akiyama, H. Takato</i>	37
1BO.16.5	On the Non-Ideal Diode Factor in Solar Cells and the Existence of Multiple Quasi-Fermi Levels <i>I. Ramiro, P.G. Linares, A. Martí</i>	41

Visual PRESENTATIONS 1BV.3 Fundamental Studies in the Forefront of PV / Novel Materials and Concepts for Cells and Modules

1BV.3.2	Tandem Luminescent Solar Concentrators: Optimizing the Number of Stacked Plates <i>I.O. Sokolovskyi, M.R. Kulish, A.V. Sachenko, V.P. Kostylyov, A.I. Shkrebtii / Chkrebiti</i>	45
1BV.3.3	Defect Trapping in Thin Films Probed by Frequency Domain Photoluminescence <i>B. Bérenguier, A. Asseko, J.-F. Guillemoles</i>	49

1BV.3.4	Optimization of Random Subwavelength Structures with Anti-Reflective Properties on Photovoltaic Glasses <i>C.L. Pinto Fuste, I. Cornago, E. Zugasti, J. Bengoechea</i>	54
1BV.3.5	Accurate Determination of Contact Resistivity With Fully Metallized Test Structures <i>K. Tsoi, D. Türkay, S. Yerci</i>	59
1BV.3.9	Increase Optical Performance of Silicon Based Heterojunction Solar Cells with TiO ₂ Nanorod Structures <i>B. Sekertekin, A. Yıldız</i>	64
1BV.3.21	Surface Modification of Cover Glass for Solar Panels by Creating a Nanostructure on the Surface by Maskless Plasma Texturing with Fluorocarbon <i>A. Okhorzina, N. Bernhard</i>	68
1BV.3.22	Modification of PEDOT:PSS Layer Properties by SWCNT and Ag Nanoparticles <i>S.V. Mamykin, I.B. Mamontova, T.S. Lunko, O.S. Kondratenko, V.R. Romanyuk</i>	72
1BV.3.23	Copper Oxides as Base Material for Solar Cells <i>K. Gawlinska-Necek, Z. Starowicz, R.P. Socha, M. Włazło, G. Kolodziej, G. Putynkowski, P. Panek</i>	76
1BV.3.24	Hydrogenation Mechanisms in Photovoltaics: The Unconventional In ₂ Se ₃ Nanomaterial as an Example <i>R. Minnings, A.I. Shkrebtii / Chkrebiti, G. Perinparajah</i>	80
1BV.3.27	Luminescent Solar Concentrator Photovoltaics Devices: Improving the Power Conversion Efficiency by Geometric Design Modifications <i>X. Zhu, M. Aghaei, A.H.M.E. Reinders</i>	86
1BV.3.28	Low Temperature Co-Selenised Antimony Selenide (Sb ₂ Se ₃) Based Solar Cells by Vacuum Evaporation <i>V. Kumar, E. Artegiani, P. Punathil, A. Romeo</i>	89
1BV.3.33	Copper Doped ZnO as Transparent Metal Oxide for Thin Film Solar Cell Application <i>M.K. Hossain, M. Al-Rasheidi</i>	92
1BV.3.35	Evaluation of the Inkjet Printable Dopant Material for Solar Cell Applications <i>S.C. Pop, K. Ridgeway, P. Yin</i>	96

Oral PRESENTATIONS 2AO.8 Manufacturing and Production of Silicon Cells

2AO.8.1	From Upscaling PERC to the Next Technology Cycle: Transparent Passivating Contacts May Merge n- and p-Type Cell Technology <i>P.P. Altermatt, G. Xu, X. Zhang, D. Chen, Y. Chen, Z. Feng</i>	100
2AO.8.3	Explaining the Efficiencies of Mass-Produced p-Type Cz-Si Solar Cells by Interpretable Machine Learning <i>S. Wasmer, K. Hübener, B. Klöter</i>	107
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 <i>K. Kamatani, H. Kitamura, H. Kojima, Y. Nakamichi, Y. Fujita, K. Shibamoto, S. Kojima</i>	111

Oral PRESENTATIONS 2AO.9 Production Processes of Silicon Solar Cells

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 <i>M.B. Hartenstein, S. Harvey, W. Nemeth, V. LaSalvia, M. Page, D.L. Young, S. Agarwal, P. Stradins</i>	115
2AO.9.3	Equipment Development for Simultaneously Bifacial Plating Metallization in Bifacial Solar Cells <i>Y.-C. Chang, S. Wang, R. Deng, S. Li, J. Ji</i>	119
2AO.9.4	Application of Artificial Intelligence Techniques for Optimization of Metallization Process <i>E. Boscolo Marchi, A. Dalla Lana, S. Visintin, M. Galiazzo, A. Voltan</i>	124
2AO.9.5	High Throughput Solar Cell Processing by Oxidation of Wafer Stacks <i>M. Meßner, S. Lohmüller, F. Braun, J. Weber, A. Wolf</i>	130

Oral PRESENTATIONS 2BO.11 Poly-Silicon Passivated Contacts

2BO.11.1	Local PECVD SiOxNy/n-Poly-Si Deposition through a Shadow Mask for POLO IBC Solar Cells <i>V. Mertens, S. Schäfer, M. Stöhr, A. Mercker, A. Köhler, L. Mettner, R. Brendel, N. Ambrosius, T. Pernau, H. Haverkamp, T. Dullweber</i>	135
2BO.11.3	Local Passivating Contacts from Laser Doped P+ Polysilicon <i>F. Buchholz, J. Linke, J. Hoß, H. Chu, V.D. Mihailetti, A. Chaudhary, J. Arumughan, J. Lossen, R. Kopecek, E. Wefringhaus</i>	140
2BO.11.4	Novel Poly-Si:Ga/SiOx Passivating Contacts through Non-Equilibrium Doping <i>K. Chen, E. Napolitani, M. De Tullio, C.-S. Jiang, S. Theingi, W. Nemeth, M. Page, P. Stradins, S. Agarwal, D.L. Young</i>	144
2BO.11.5	Controlling Doping Density in DC-Sputtered In-Situ Phosphorous-Doped Polysilicon Layers for Passivating Contacts <i>L. Nasebandt, B. Min, S. Hübler, T. Dippell, P. Wohlfart, R. Peibst, R. Brendel</i>	147
2BO.11.6	Hydrogenation of Sputtered ZnO:Al Layers for Double Side Poly-Si/SiOx Integration <i>C. Seron, T. Desrues, F. Jay, A. Lanterne, G. Borvon, F. Torregrosa, Q. Rafshay, A. Kaminski, S. Dubois</i>	150
Oral PRESENTATIONS 2BO.12 Advanced Process Technologies for High-Efficiency Silicon Solar Cells		
2BO.12.2	Rear Side Dielectrics on Interdigitating p+-(i)-n Back-Contact Solar Cells – Hydrogenation vs. Charge Effects <i>M. Rienäcker, Y. Larionova, J. Krügener, S. Wolter, R. Brendel, R. Peibst</i>	154
2BO.12.4	Approaching 23% with p-Type Back Junction Solar Cells Featuring Screen-Printed Al Front Grid and Passivating Rear Contacts <i>B. Min, N. Wehmeier, H. Schulte-Huxel, R. Witteck, T. Brendemühl, T. Daschinger, F. Haase, Y. Larionova, L. Nasebandt, K. Tsuji, M. Dhamrin, R. Peibst, R. Brendel</i>	158
Oral PRESENTATIONS 2BO.14 Wafer-Based Silicon Heterojunction Solar Cells		
2BO.14.6	Evaluation of Different Approaches for HJT Cells Metallization Based on Low Temperature Ag Pastes <i>M. Galiazzo, N. Frasson</i>	162
Oral PRESENTATIONS 2BO.15 TCO and Metallisation for Silicon Heterojunction Cells		
2BO.15.3	Low Temperature Post-Process Repassivation for Heterojunction Cut-Cells <i>S. Harrison, B. Portaluppi, P. Bertrand, V. Giglia, B. Martel, A. Sekkat, D. Munoz-Rojas</i>	167
Oral PRESENTATIONS 2CO.10 Characterisation of Crystalline Silicon Devices		
2CO.10.1	Analysis and Correction of Systematic Deviations in Measurements of the Spectral Irradiance of Solar Simulators <i>C. Schinke, D. Hinken, M. Wolf, K. Bothe, I. Kröger, M. Bagusch, S. Nevas, S. Winter</i>	172
2CO.10.2	Stable Reverse Bias or Integrated Bypass Diode in HIP-MWT+ Solar Cells Based on Different Industrial Rear Passivation <i>T. Schweigstill, A. Spribile, J.D. Huyeng, F. Clement, S.W. Glunz</i>	177
2CO.10.4	A Round Robin - HighLiting on the Passivating Contact Technology <i>T. Fellmeth, F. Feldmann, B. Steinhauser, H. Nagel, S. Mack, M. Hermle, F. Torregrosa, A. Ingenito, F.-J. Haug, A. Morisset, F. Buchholz, A. Chaudhary, T. Desrues, F. Haase, B. Min, R. Peibst, L. Tous</i>	181
Oral PRESENTATIONS 2DO.10 Defects in Silicon and their Characterisation		
2DO.10.1	Electronic Properties and Structure of Boron-Hydrogen Complexes in Crystalline Silicon <i>J.A.T. De Guzman, V.P. Markevich, J. Coutinho, N.V. Abrosimov, M.P. Halsall, A.R. Peaker</i>	186
2DO.10.4	Application of (Delta)n Normalised Time, (Gamma): Linear Injection-Level Dependence on LeTID and the Recovery in Crystalline Silicon <i>M. Kim, A. Ciesla, C. Sun, D. Chen, M. Abbott, B. Hallam</i>	191

2DO.10.6	Carrier Lifetime Measurements of Monocrystalline Silicon Ingots Using Upgraded Laser E-PCD Technique <i>D. Krisztian, F. Korsós, I. Saegh, G. Paráda, P. Tüttö, X. Dong, H. Deng, S. Wang, X. Chen</i>	194
Oral PRESENTATIONS 2EO.3 Feedstock and Wafer Processing / Thin-Film and Foil-Based Silicon Cells		
2EO.3.2	Efficiency Potential Analysis of p- and n-Type Epitaxially Grown Si Wafers <i>C. Rittmann, J. Dalke, M. Drießen, C. Weiss, F. Schindler, R. Sorgenfrei, M.C. Schubert, S. Janz</i>	198
2EO.3.3	Laser Cutting of Solar Cells by Using the Stress Cut Approach <i>S. Krause, S. Hensel, M. Meusel, S. Eiternick, M. Turek</i>	204
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 <i>H. Nasser, M. Zolfaghari Borra, E.H. Çiftpinar, B. Eldeeb, R. Turan</i>	208
2EO.3.5	Optimization of the Conductivity and Crystalline Fraction of p-Type μ -SiOx:H Films for Silicon Heterojunction Solar Cells <i>A.J. Olivares-Vargas, G. Kaur, M. Poplawski, A. Desthieux, P. Roca i Cabarrocas</i>	212
Visual PRESENTATIONS 2CV.1 Characterisation and Manufacturing of Crystalline Silicon Solar Cells		
2CV.1.2	The Empirical Digital Twin: Representation Learning on Solar Cell Images and Efficient Defect Detection with Human-in-the-Loop <i>P. Kunze, S. Rein, T. Müller, M. Hemsendorf, K. Ramspeck, M. Demant</i>	217
2CV.1.3	3D Finite Element Modelling of Micro Transfer Length Measurements in Contact Layers for Silicon Solar Cells Using Multiphysics Simulation <i>S. Lange, M. Rumiantcev, G. Yiding, G. Batista Caldeira, C. Luderer, A.N. Sprafke, V. Naumann, C. Hagendorf</i>	224
2CV.1.4	“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 <i>M. Kikelj, B. Lipovsek, M. Bokaličić, F. Buchholz, M. Topic</i>	229
2CV.1.5	Quantitative Contactless Determination of the Series Resistance of Silicon Solar Cells <i>H. Höffler, W. Wirtz, J.M. Greulich, S. Rein</i>	233
2CV.1.6	Spectroscopic Inline Characterisation of Partially Processed Epi Wafers after Porosification <i>S. Al-Hajjawi, H. Vahlman, J. Haunschild, S. Kumar, H. Schremmer, L. Jablonka, S. Rein</i>	237
2CV.1.8	Determination of Effect of Laser Cutting Method on the Performance of Bifacial PERC Cells <i>M. Çetmeli, B. Sekertekin, M. Çaliskan, F. Es</i>	242
2CV.1.10	Denoising of Image Data for DWS Wafer Characterization Using Generative Adversarial Networks <i>L. Kurumundayil, H. Schremmer, S. Rein, M. Demant</i>	246
2CV.1.11	Stability Studies and Characterisation of Silicon Solar Cells via In-Situ Temperature and Light Dependent Suns-Voc Measurements <i>M. Vaqueiro-Contreras, A. Teymour, A. Mahboubi Soufiani, C. Chan, A. Ciesla, H. Wilterdink, B. Hallam</i>	250
2CV.1.12	Impact of Cut Edge Recombination in High Efficiency Solar Cells – Measurement and Mitigation Strategies <i>N. Chen, D. Tune, F. Buchholz, A. Halm, V.D. Mihailescu</i>	253
2CV.1.14	Performance Enhancement of PERC Solar Cell with SiOxNy Back Surface Passivation by Low Temperature Annealing Process <i>A.E. Keçeci, G. Bektas, E.H. Çiftpinar, S. Koçak Büyüner, H. Asav, G. Kökbudak, H.H. Canar, B. Arıkan, R. Turan</i>	257
2CV.1.19	Development and Implementation of a Refined Model for Comprehensive Characterization and Optimization of Highly Efficient Silicon Solar Cells <i>A.V. Sachenko, V.P. Kostylov, V.M. Vlasiuk, I.O. Sokolovskyi, G. Perinparajah, A.I. Shkrebtii / Chkrebiti</i>	261
2CV.1.20	Light Trapping in Silicon Nanowire: Correlated Absorption Depth Profile, EM-Field Distribution and Exciton Generation Rate Distribution <i>M.K. Hossain, A. Wajeeh Mukhaimer</i>	265

2CV.1.21	The Effect Of Doping Profile On Contact Resistivity Between Screen Printed Ag/Al And Implanted Boron Emitter <i>E. Özmen, S. Seyrek, G. Bektaş, H.H. Canar, S. Koçak Büttiner, H. Asav, A.E. Keçeci, R. Turan</i>	268
2CV.1.22	Selective Emitter Formation via Laser Doping with Picosecond Pulsed Laser for High-Efficiency PERC Solar Cells <i>H. Asav, A.E. Keçeci, G. Bektaş, S. Koçak Büttiner, G. Kökbudak, H. Hüseyin Canar, B. Arıkan, R. Turan</i>	271
2CV.1.23	Investigation of the Potential Induced Degradation for PERC Solar Cells <i>M.-A. Tsai, Y.-S. Long, T.-C. Wu</i>	274
2CV.1.34	Influence of Diamond Wire Sawing Process Variation on Commercial Mono PERC Solar Cell Production Parameters <i>M.C. Raval, B. Güümüs, E. Toker, M. Ender, E. Muti, W. Jooss, F. Es, P. Fath</i>	276
2CV.1.35	Comparison of Electrical Performances of Fully Ion Implanted n-PERT Solar Cells Made of Different n-Type Wafer Feedstocks <i>G. Bektaş, H. Asav, H.H. Canar, O. Aydin, A.E. Keçeci, S. Ozdemir, S. Koçak Büttiner, S. Seyrek, F. Es, R. Turan</i>	281
2CV.1.37	Texturization of Monocrystalline Silicon by Metal-Assisted Chemical Etching: Analysis of Reaction Dynamics <i>D.M. Pera, I. Costa, F. Serra, A. Guerra, K. Lobato, J.M. Serra, J. Almeida Silva</i>	283
2CV.1.39	Optimization of Phosphorus Implant Dose and Activation Temperature for Emitter Formation of p-Type Silicon Solar Cells <i>G. Bektaş, A.E. Keçeci, S. Koçak Büttiner, R. Turan</i>	286
2CV.1.41	Investigation of the Rear Side Passivation Layer on Bifacial PERC Solar Cells <i>C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, L.-G. Wu, S.-C. Lin, C.-Y. Yu</i>	288
2CV.1.42	Effect of Surface Morphology on Passivation Quality of AL2O3/SiNx Stack Layer for PERC Solar Cell <i>S. Koçak Büttiner, G. Bektaş, G. Kökbudak, M. Zolfaghari Borrà, H. Asav, A.E. Keçeci, B. Arıkan, R. Turan</i>	291
2CV.1.43	Process Fabrication of Cost-Effective IBC Solar Cells Using APCVD Glass Layers <i>V. Kuruganti, R. Kopecek, S. Seren, V.D. Mihailescu</i>	293
2CV.1.48	Investigation of Effect of Poly-Si Impurities on Cz-Ingot to Solar Module Production <i>F. Çambay Kuban, E. Uçar, N. Yıldırım, F.S. Yıldırım, F. Es</i>	298
2CV.1.49	Investigation of the Current Induced Degradation for Gallium Doped Silicon Solar Cells <i>M.-A. Tsai, Y.-S. Long, C.-W. Kuo, T.-M. Kuan, C.-Y. Yu, T.-C. Wu</i>	302
2CV.1.50	Sol-Gel Method for Double Layer Coated Colored Silicon Solar Cells <i>M. Rudzikas, A. Setkus, N. Curmei, D. Serban, J. Donegliene, J. Ulbikas, A.G. Ulyashin</i>	304

Visual PRESENTATIONS 2DV.3 Technologies for High Temperature Passivating Contacts and Homo Junction Silicon Solar Cells / Low Temperature Routes for Silico

2DV.3.2	Firing-Stable PECVD SiOxNy/n-Poly-Si Passivating Contacts for High-Efficiency Silicon Solar Cells <i>M. Stöhr, J. Aprojanz, R. Brendel, T. Dullweber</i>	306
2DV.3.9	Interplay of IBC Cell's Front Surface Doping, Passivation Quality, and Stability under Ultraviolet Light Exposure <i>H. Chu, V. Kuruganti, R. Roescu, C. Peter, V.D. Mihailescu</i>	311
2DV.3.10	Novel Ag-Paste for Simultaneous Contacting of n+ and p+ Emitters through Contact-Supportive Well-Passivating Doped APCVD Layers for PERT and IBC Solar Cells <i>F. Geml, B. Gapp, M. Mehler, C. Ebert, J. Booth, P. Sutton, S. Johnson, B. Cela, H. Plagwitz, G. Hahn</i>	317
2DV.3.12	Novel Approach for Self-Aligned Local Polysilicon Layer Formation <i>Y. Cai, R. Chen, B.J. Hallam, F.E. Rougier</i>	321
2DV.3.27	Stable Copper Plated Metallization on SHJ Solar Cells & Investigation of Selective Al/AlOx Laser Patterning <i>T. Hatt, J. Bartsch, S. Schellinger, J. Schneider, A.A. Brand, S. Kluska, M. Glatthaar</i>	326
2DV.3.32	Edge Passivation of Heterojunction Solar Cells for Research Purposes	330

V. Boldrini, M. Canino, R. Rizzoli, E. Centurioni, F. Bonafé, S. Lombardo, A. Di Mauro, M. Sciuto, C. Colletti, C. Summonte

Visual PRESENTATIONS 2DV.4 Crystalline Silicon Technology / Thin-Film and Foil-Based Silicon Cells

- | | | |
|-----------------|---|-----|
| 2DV.4.2 | Pouring the Remaining Melt as a Method to Reduce the Red-Zone in the Top Region of mc-Silicon Ingots
<i>T. Bähr, M. Ghosh, M. Hamacher, C. Kranert, C. Reimann</i> | 334 |
| 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
<i>F. Mosel, A.V. Denisov, K. Hess, B. Klipp, N. Sennova, C. Kranert, M. Trempa, C. Reimann, J. Friedrich</i> | 339 |
| 2DV.4.4 | Comparison of the Oxygen Concentration in Czochralski Silicon Crystal Obtained by a Simple Lumped-Parameter Model and Sophisticated 2D-3D Simulations
<i>J. Friedrich, M. Trempa, H. Koch, F. Mosel, A. Mühe</i> | 347 |
| 2DV.4.5 | Processing of a High-Quality Single Crystal Silicon: Optimized Parameters for the Czochralski Method
<i>E. Uçar, N. Yıldırım, F.S. Yıldırım, N.D. Yıldırım, M. Çetmeli, M. Konyar, F. Es</i> | 352 |
| 2DV.4.25 | Towards Ultra-Thin Silicon Solar Cells for High Specific Power Applications
<i>Y. Lan, M. Delos Santos, D. Lai, X. Yan, A. Danner</i> | 355 |
| 2DV.4.26 | Dynamic HW-CVD Process Development for Very High-Rate Thin-Film Silicon Deposition
<i>S. Leszczynski, B. Leszczynska, C. Strobel, M. Albert, F. Stahr, J.W. Bartha</i> | 358 |

Oral PRESENTATIONS 3AO.4 Tandem Upscaling towards Industrialisation

- | | | |
|----------------|---|-----|
| 3AO.4.6 | Quantifying the Performance Gain of 6 Inch Bifacial 4T pk-Si Tandem Modules
<i>P. Manshanden, G. Coletti, V. Rosca, M.J. Jansen, K.M. de Groot, G.J. de Graaff, M. Creatore, K. Datta, R. Janssen, L. Simurka, D. Zhang, M. Najafi, V. Zardetto, I. Dogan, H. Fledderus, S.C. Veenstra</i> | 363 |
|----------------|---|-----|

Oral PRESENTATIONS 3AO.5 Tandem Solar Cells Process and Performance

- | | | |
|----------------|--|-----|
| 3AO.5.1 | Two-Terminal III-V//Si Triple-Junction Solar Cells with Power Conversion Efficiency of 35.9 % at AM1.5g
<i>P. Schygulla, R. Müller, O. Höhn, H. Hauser, B. Bläsi, F. Predan, J. Benick, M. Hermle, F. Dimroth, S.W. Glunz, D. Lackner</i> | 366 |
|----------------|--|-----|

Oral PRESENTATIONS 3AO.6 Organic and Dye-Sensitised Photovoltaics

- | | | |
|----------------|---|-----|
| 3AO.6.5 | Calibration of a Dye-Sensitized Photovoltaic Large Area Module
<i>G. Bardizza, D. Pavanello, H. Müllejans, E.D. Dunlop</i> | 371 |
|----------------|---|-----|

Oral PRESENTATIONS 3BO.8 Absorber Synthesis for Thin-Film Cells and Modules

- | | | |
|----------------|--|-----|
| 3BO.8.5 | Study of SnO ₂ /CdSexTe _{1-x} /CdTe Solar Cells Fabricated by Selenium Treatment of the Absorber Layer
<i>E. Artegiani, V. Kumar, P. Punathil, S. Zanetti, M. Bertoncello, M. Meneghini, A. Romeo</i> | 375 |
|----------------|--|-----|

Oral PRESENTATIONS 3BO.10 III-V Solar Cells and Related Compounds

- | | | |
|-----------------|--|-----|
| 3BO.10.2 | III-V Multijunction Solar Cells on Ultrathin Ge Si Virtual Substrates Grown at Low Temperature by RF-PECVD
<i>I. Garcia, M. Ghosh, V. Orejuela, P. Roca i Cabarrocas, I. Rey-Stolle</i> | 378 |
| 3BO.10.3 | 200 mm Germanium Wafers for Epitaxial Growth of III/V Space Grade Solar Cells
<i>T. Kubera, J. Strate, K. Möller, V. Khorenko, S. Sommer, C.N. Sao, J. Vanpaemel, K. Dessein</i> | 382 |

Oral PRESENTATIONS 3CO.6 Advanced Characterisation Applied to Perovskite Solar Cells

- | | | |
|----------------|---|-----|
| 3CO.6.2 | Electroluminescence Intensity Stabilization in Perovskite Solar Cells
<i>M. Bokalić, M. Jošt, K. Brecl, M. Topic</i> | 386 |
|----------------|---|-----|

3CO.6.4	On the Equilibrium Electrostatic Potential and Light-Induced Charge Redistribution in Halide Perovskite Structures <i>D. Regaldo, A. Bojar, S.P. Dunfield, P. Lopez-Varo, M. Frégniaux, V. Dufoulon, S.-T. Zhang, J. Alvarez, J.J. Berry, J.-B. Puel, P. Schulz, J.-P. Kleider</i>	389
Oral PRESENTATIONS 3CO.7 Large Area Perovskite Solar Cells and Modules		
3CO.7.5	Scalable Manufacturing of Multiple Cation Perovskite Solar Modules <i>L. Vesce, M. Stefanelli, L.A. Castriotta, J.P. Herterich, M. Kohlstädt, U. Würfel, A. Di Carlo</i>	395
Visual PRESENTATIONS 3BV.1 Perovskite Solar Cells and Modules		
3BV.1.2	Exploring the Use of Methylammonium Iodide to Improve the Uniformity of the MAPbI ₃ Layer in HTM-Free Perovskite Solar Cells Equipped with Back Contacts based on Pastes of Graphite and Black Carbon in a Polyvinylidene Fluoride in Toluene Solution <i>C. Montes, L. Ocaña, S. González-Pérez, B. González-Díaz, E. Llarena</i>	398
3BV.1.3	Evaporation Pressure Control on High Crystallization Perovskite Layer via Sandwich Evaporation Technique <i>H.-H. Shen, C.-H. Chang, W.-C. Lo, C.-F. Lin</i>	403
3BV.1.4	Testing Encapsulated Perovskite Solar Cells in a Climatic Chamber by Following the IEC 61215 and IEC 61646 Standards for the Thermal Cycling Test <i>L. Ocaña, C. Montes, S. González-Pérez, B. González-Díaz, E. Llarena</i>	406
3BV.1.5	Study of ALD-Grown SnO ₂ as an Electron Selective Layer for NIP Perovskite-Based Solar Cells <i>F. Gayot, E. Bruhat, M. Manceau, E. de Vito, S. Cros</i>	411
3BV.1.6	Characterization of Cesium Lead Bromide Iodide Mixed Perovskite (CsPbBr _{3-x} I _x) Prepared by Sequential Evaporation <i>G. Gordillo, J.C. Peña, O.G. Torres, M.C. Abella</i>	416
3BV.1.7	The Opportunity of Cadmium Stannate as Transparent Conducting Oxide for Perovskite-Based Concentrated Photovoltaic System <i>M. Khalid, A. Roy, S. Sundaram, T.K. Mallick</i>	420
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 <i>C. Montes, L. Ocaña, S. González-Pérez, B. González-Díaz, E. Llarena</i>	426
3BV.1.11	Synthesis and Defect Characterization of 2D Hybrid-Perovskites <i>G. Fischer, K. Klose, T. Kleint, H. Stöcker, J. Beyer, J. Heitmann, M. Müller</i>	430
3BV.1.19	A Study of Quenching Approaches to Optimize Ultrasonic Spray Coated Perovskite Layers Scalable for PV <i>J. Silvano, J. Sala, T. Merckx, Y. Kuang, T. Aernouts, B. Vermang, W. Deferme, P. Verding, J. D'Haen</i>	433
3BV.1.20	Minimizing the Interconnection Width of Laser Patterned Perovskite Solar Cells <i>C. Schultz, M. Fenske, J. Dagar, A. Bartelt, R. Schlatmann, E. Unger, B. Stegemann</i>	437
3BV.1.21	Outdoor Monitoring and Assessment of Perovskite Mini Modules <i>V. Paraskeva, M. Norton, M. Hadjipanayi, A. Hadipour, A. Aguirre, R. Ebner, G.E. Georghiou</i>	441
3BV.1.25	Optical and Electrical Characterization of Perovskite Mini-Modules <i>R. Ebner, G. Újvári, A. Mittal, M. Hadjipanayi, V. Paraskeva, M. Hadjikypris, G.E. Georghiou, A. Hadipour, A. Aguirre</i>	445
3BV.1.26	A Unified Capacitance Loss Mapping for Solar Cells Defects <i>J. Sala, T. Kohl, G. Brammertz, M. Ahmadpour, M. Sandholm Madsen, T. Aernouts, M. Daenen, B. Vermang</i>	448
Visual PRESENTATIONS 3BV.2 CIGSe, CdTe and Kesterites / OPV / III-V and Related Compounds / Tandems		
3BV.2.1	Two Local Built-in Potentials of CZTSe Ge Bi-Layers Devices by Modulus Spectroscopy <i>S. Lee, K.J. Price, E. Saucedo</i>	451
3BV.2.5	Analysis of Environmentally Friendly and Low Cost Non Vacuum Process for Cu ₂ ZnSn(S,Se)4 Solar Cells. <i>P. Punathil, S. Zanetti, E. Artegiani, V. Kumar, A. Romeo</i>	454

3BV.2.6	Alteration of PV Cell Parameters via n-Doped Graphene Quantum Dots Incorporation on Solution-Processed CIGS Thin Film-Based Photovoltaic Cells <i>F. Khan, J.H. Kim</i>	458
3BV.2.13	Cadmium Sulfide Thickness Reduction in CIGS Solar Cells by Application of ALD-Zinc Magnesium Oxide <i>D. Bagrowski, S. Spiering, T. Schnabel, J.-P. Becker</i>	462
3BV.2.16	A Study of Ag Paste Contacts on Various TCO Layers for Cu(In,Ga)Se ₂ Thin Film Modules <i>B. Sesli, J. Carolus, J. D'Haen, D. Reenaers, V.S. Gevaerts, S. Sente, M. Meuris, M. Daenen, B. Vermang</i>	467
3BV.2.26	PV Cell for Varied Angle Performance Under Indoor Lighting Simulator <i>Y.-S. Long, M.-A. Tsai, T.-C. Wu</i>	471
3BV.2.38	Growth and Structural Characterization of GaSb/GaAs Quantum Dots: Prospective Applications in Photovoltaic Cells <i>C.C. Ahia, E.L. Meyer, N. Tile</i>	476
3BV.2.54	Mechanically-Stacked and Electrically-Connected Two-Terminal Tandem Module <i>K. Nakamura, Y. Ohshita</i>	480
3BV.2.57	Bichromatic Light Source for Subcell Performance Analysis in Perovskite/Silicon Tandem Solar Cells <i>M. Jošt, G. Matic, E. Köhnen, B. Li, B. Glažar, M. Jankovec, S. Albrecht, M. Topic</i>	483
3BV.2.58	The Performance of Four-Terminal Perovskite-Silicon Tandem Solar Cells under Different Irradiance Levels <i>A.B. Nikolskaia, M.F. Vildanova, S.S. Kozlov, O.V. Alexeeva, O.K. Karyagina, O.I. Shevaleevskiy</i>	486
3BV.2.59	Advanced LED Solar Simulator: Flexible and Fast Characterisation Tool for Research and Industrialisation of Perovskite/Silicon Tandem Solar Cells <i>B. Mette, B. Mitchell, M. Scherff, P. Fuss-Kailuweit, L. Korte, E. Köhnen, S. Mariotti, S. Esefeller, T. Brammer</i>	490
3BV.2.60	The Impact of High Spectral Match: Using an LED Solar Simulator for Tandems <i>B. Mihaylov, B.C. Duck, C.J. Fell, T.W. Jones, K.F. Anderson, G.J. Wilson</i>	496
3BV.2.61	TCO Optimization of c-Si Heterojunction Solar Cells for Tandem Architecture by Optical Simulation <i>M. Canino, V. Boldrini, R. Rizzoli, E. Centurioni, A. Maurizi, S. Lombardo, A. Terrasi, C. Summonte</i>	501
3BV.2.62	Wide Bandgap Pure Sulfide CIGS Layers for Si/CIGS Tandem Cells from Metal Coevaporation Engineering and Sulfur Annealing <i>A. Crossay, H. Gloaguen, D. Cammilleri, J. Lontchi, A. Rebai, N. Barreau, D. Lincot</i>	505
3BV.2.64	Interface Engineering of Silicon/Perovskite Two-Terminal Tandem Solar Cells <i>A. Hadipour, J. Sala, Y. Kuang, H. Sivaramakrishnan Radhakrishnan, Y. Abdulraheem, T. Aernouts, J. Poortmans</i>	508
3BV.2.65	Optimizing Top-TCO for Perovskite-Silicon Tandem Solar Cells <i>H. King, V. Sittinger, T. Harig, D. Stoll</i>	511
3BV.2.66	Energy Yield and Performance Ratio of III-V on Silicon Dual Junction Solar Cells in Different Climate Zones <i>O. Höhn, M. Hanser, M. Steiner, E. Lorenz, B. Bläsi, S.W. Glunz, F. Dimroth</i>	515
3BV.2.68	Tunnel Junction Formation on Silicon P++ Emitters by Gas Immersion Laser Doping <i>G. Gaspar, A. Guerra, F.C. Serra, A.S. Viana, J. Arumughan, I. Costa, D.M. Pera, J. Almeida Silva, L. Vines, J.M. Serra, K. Lobato</i>	521
3BV.2.69	Dual Quantum Tunneling in a Monolithic n-i-p Perovskite/c-Si Tandem Device: Bottom Cell with Modified SQIS Structure <i>Z.Q. Ma, K.J. Wu, Z.X. Lan, Y.L. Wang, F. Xu, L. Zhao</i>	525

Plenary SESSION 4EP.1 Sustainability and Social Acceptance Preparing for the TW Era

4EP.1.2	A Framework for Implementing Requirements on the Carbon Footprint of Photovoltaic Modules under the Ecodesign Policy <i>D. Polverini, N. Espinosa, C. Klos, A. Arcipowska</i>	529
----------------	--	-----

Oral PRESENTATIONS 4BO.1 PV Module Design and Materials

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 <i>L. Tous, J. Govaerts, S. Harrison, C. Carrière, F. Buchholz, A. Halm, A. Faes, G. Nogay, A. Ingenito, F.-J. Haug, F. Feldmann, D. Raine, T. Fellmeth, M. Heinrich, M. Mittag, D. Reinwand, F. Haase, A. Morlier, M. Bokalić, K. Brecl, M. Topic, J.C.P. Kester, S. Wendlandt, M. Galiazzo, A. Voltan, G. Galbiati, L. Theunissen, F. Torregrosa, M. Grimm, J. Denafas, T. Radavicčius, P. Lukinskas, J. Kaakkunen, T. Savisalo, T. Regrettier</i>	533
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 <i>K.-A. Weiß, I. Kaaya, G. Oreski, L.S. Bruckman, R.H. French, T. Tanahashi</i>	538
4BO.1.5	Holistic Design Optimization of the PV Module Frame: CTM, FEM, COO and LCA Analysis <i>A. Tummalieh, A.J. Beinert, C. Reichel, M. Mittag, D.H. Neuhaus</i>	540
4BO.1.6	FoilMet®-Interconnect Shingling (FIS): Aluminum Foil Based Interconnection for Modules with Shingled Solar Cells <i>J. Paschen, O. John, T. Roessler, P. Baliozian, J.-F. Nekarda</i>	547
Oral PRESENTATIONS 4BO.2 PV Module Outdoor Performance and Energy Rating		
4BO.2.2	Comparison of Different Approaches to Determine the Nominal PV Module Operating Temperature (NMOT) <i>W. Herrmann, C. Monokroussos, K. Lee</i>	550
4BO.2.4	Energy Contribution of Rear-Side Irradiance for Bifacial Photovoltaic Modules <i>G.L. Martins, S. Dittmann, C.D. Rodríguez-Gallegos, H. Park, S.-Y. Oh, W.K. Kim, L. Burnham, B.W. Figgis, R. Rüther, R. Gottschalg</i>	556
4BO.2.6	Quantitative Evaluation of the Shading Resilience of PV Modules <i>N. Klasen, F. Lux, J. Weber, D. Weißer, T. Roessler, A. Kraft, D.H. Neuhaus</i>	560
Oral PRESENTATIONS 4BO.3 Induced Degradation in PV Modules		
4BO.3.1	Review of Induced Degradation Phenomena Affecting PV Modules <i>G. Hahn</i>	568
4BO.3.4	The Front and Rear Side Contributions to the Potential Induced Degradation of Bifacial Silicon Heterojunction Solar Modules <i>O. Arriaga Arruti, L. Gnocchi, F. Lisco, A. Virtuani, C. Ballif</i>	573
4BO.3.5	A Grey Box Model for Shunting-Type Potential Induced Degradation in Silicon Photovoltaic Cells under Environmental Stress <i>A. Schils, R. Breugelmans, J. Carolus, J. Ascencio-Vásquez, A. Wabbes, E. Bertrand, B. Aldalali, M. Daenen, E. Voroshazi, S. Scheerlinck</i>	578
Oral PRESENTATIONS 4BO.4 PV Module Testing and Characterisation		
4BO.4.2	Dependency of IAM Losses in Colored BIPV Products on the Refractive Index of Colorants <i>M. Babin, S. Thorsteinsson, A.A. Santamaría Lancia, P.B. Poulsen, A. Thorseth, C. Dam-Hansen, M.L. Jakobsen</i>	583
4BO.4.3	Dark IV-Curves as a Method for in Situ Module Characterisation <i>J. Fröbel, B. Jäckel, M. Pander, U. Zeller</i>	589
4BO.4.4	Interlaboratory Comparison of Voltage Sweep Methods Used for the Electrical Characterization of Encapsulated High-Efficiency c-Si Solar Cells <i>C. Monokroussos, M. Yoshita, K. Yamagoe, H. Müllejans, D. Pavanello, K. Ramspeck, D. Hinken, K. Bothe, Y. Fujita, G. Arnoux, F. Pinto, R. Ambigapathy, Q. Shi, H. Wilterdink, Y. Chen, Y. Ping, J.Q. Gao</i>	594
4BO.4.5	Effects of Inhomogeneous Snow Load on the Mechanics of a PV Module <i>P. Romer, A.J. Beinert</i>	602
4BO.4.6	Optical Strain and Temperature Sensing within Photovoltaic Laminates <i>P. Nivelle, L. Maes, J. Poortmans, M. Daenen</i>	607

Oral PRESENTATIONS 4BO.5 Interconnects and Soldering

4BO.5.2	Reliability Assessment for Industrial Soldered and Glued BJ-BC Solar Cell Interconnections <i>T. Timofte, S. Großer, R. Wade, T. Fischer, D. Rudolph, J. Linster, M.I. Devoto, D. Tune, R. Farneda, F. Köhler, A. Halm</i>	611
4BO.5.3	Corrosion Behavior of the Metallization Including Ternary Glass Frits in the High-Temperature and High-Humidity Test <i>T. Sembra, A. Masuda</i>	619
4BO.5.4	Thermomechanical Fatigue of Solder Joint and Interconnect Ribbon: Impact of Low Lamination Temperature <i>D. Lindholm, H.-Y. Li, G. Otnes, G. Cattaneo, S.E. Foss, H. Fjær</i>	622
4BO.5.6	Improved Measurement of the Contact Resistivity of ECA-Based Joints <i>M.I. Devoto, T. Timofte, A. Halm, D. Tune</i>	627

Oral PRESENTATIONS 4CO.1 Polymers and Encapsulation of PV Modules

4CO.1.4	Degradation Evaluation of Thermoplastic Polyolefin Encapsulant Used in c-Si PV Modules and Laminates <i>B. Adothu, F.R. Costa, S. Mallick</i>	631
----------------	--	-----

Oral PRESENTATIONS 4CO.2 PV Module Backsheets

4CO.2.4	Transparent Backsheets for Bifacial Photovoltaic Modules <i>X. Gu, S. Smith, L. Perry, S. Watson, S.L. Moffitt, S.-J. Shen, S. Mitterhofer, L.-P. Sung, P.-C. Pan, D. Jacobs</i>	640
4CO.2.6	Studying Time-Series of Wet Leakage Resistances for Modules with Various Backsheet Types <i>C. Buerhop-Lutz, O. Stroyuk, J. Zöcklein, J. Hauch, I.M. Peters</i>	646

Oral PRESENTATIONS 4CO.3 Performance of BOS Components

4CO.3.1	Performance Analysis of Shaded PV Module Power Electronic Systems <i>F.P. Baumgartner, R. Vogt, C. Allenspach, F. Carigiet</i>	650
4CO.3.2	Development of Mission Profiles for Humidity Models in the Reliability Testing of PV Inverters <i>R. Thiagarajan, P. Hacke, J. Flicker</i>	655
4CO.3.4	Module-Inverters (Microinverters): Influence of Module Size on Conversion Efficiencies and Energy Yields <i>S. Krauter, J. Bendfeld</i>	659
4CO.3.5	Analysis and Development of a Fault-Tolerant Power Converter for Solar PV Applications <i>A. Filba-Martinez, C. Cabré-Piquerias, L. Trilla, P. Paradell Sola, J.L. Domínguez-García</i>	664
4CO.3.6	Context-Sensitive PV Plant Components Benchmarking Based on Monitoring Data <i>W. Vanheusden, J. Ascencio-Vásquez, K. de Brabandere, S. Lindig, D. Moser, M. Richter</i>	667

Oral PRESENTATIONS 4CO.4 Recycling, Repair and Reuse of PV Modules

4CO.4.2	Re-Use of Decommissioned PV Modules: Opportunities and Technical Guidelines <i>A.S.H. van der Heide, L. Tous, K. Wambach, J. Poortmans, J. Clyncke, E. Voroshazi</i>	670
4CO.4.3	For a More Sustainable Future – Mylar® UVHPET™ Backsheets Containing Polymeric Post-Consumer Recycled Content <i>E. Parnham, S. Davies, D. Stratichuk-Dear, S. Kaeselau</i>	674
4CO.4.5	Energy Payback Time of Photovoltaic Electricity Generated by Passivated Emitter and Rear Cell (PERC) Solar Modules: A Novel Methodology Proposal <i>M. Salibi, F. Schönberger, Q. Makolli, E. Bousi, S. Almajali, L. Friedrich</i>	677
4CO.4.6	Terawatt Scale PV by 2050 and Competition for Minerals: The Case of Silver and Copper <i>P. Macé, E. Bosch, M. Aleman</i>	683

Oral PRESENTATIONS 4DO.11 Sustainability Aspects of PV

4DO.11.1	Eco-Design and Energy Labeling for Photovoltaic Modules, Inverters and Systems – Enabling a Sustainable Value Chain in the EU? <i>A. Wade, T.C. Sauer, H. Neuhaus, L. Probst, R. Taylor, D. Moser, C. Rohr, R. Rossi</i>	690
4DO.11.2	A Comparative Life Cycle Assessment of PV Modules – Influence of Database and Background System <i>S. Herceg, A.-K. Briem, M. Fischer, P. Brailovsky, T. Dannenberg, M. Held</i>	696
4DO.11.4	Sustainable Material Flows in the PV Sector: What Work Remains to be Done to Achieve SDG 12? <i>E. Gervais, S. Herceg, S. Nold, K.-A. Weiß</i>	701
4DO.11.5	Assessing Plausible Environmental Implications of a Ground-Mounted Perovskite/Si Tandem PV System <i>C. Salas-Redondo, C.-F. Blanco, J.-B. Puel, A. Julien, F. Soumane, S. Cucurachi, W.J.G.M. Peijnenburg, L. Oberbeck</i>	704
Visual PRESENTATIONS 4AV.1 PV Module Design, Components and Ageing		
4AV.1.5	The Impact of the Lamination Process on the Adhesion Properties at the Glass-Encapsulant Interface and Damp Heat Stability of PV Modules <i>A.K. Öz, C. Herzog, C. Wellens, D.E. Mansour, M. Heinrich, A. Kraft</i>	708
4AV.1.6	Performance Analysis and CTM Simulations of PV Modules with Various Encapsulant Materials <i>M. Çaliskan, F. Es</i>	715
4AV.1.8	Methodology for Evaluating Solar Module Encapsulant Materials <i>H.-H. Hsieh, S.-H. Chen, M.-T. Lai, C.-P. Huang, C.-W. Kuo, T.-M. Kuan, C.-Y. Yu</i>	719
4AV.1.11	Stability of Inks Used for Masking Metallic Interconnects in BIPV Modules <i>A. Borja Block, A. Virtuani, C. Ballif</i>	723
4AV.1.12	Three-Dimensional Multi-Ribbon Back-Contact Interconnection: Latest Results on Reliability Testing <i>R. Van Dyck, T. Borgers, J. Govaerts, A.S.H. van der Heide, L. Tous, J. Poortmans, A.W. Van Vuure</i>	728
4AV.1.13	Improved Eddy-Current Probe for Non-Destructive Characterization of Electrical Contacts in PV Modules <i>L. Neumaier, M. Lenzhofer, Ch. Hirschl, J. Kosel</i>	732
4AV.1.16	Electrically Conductive Adhesive Interconnects: How Low Can You Go? <i>D. Tune, K. Wienands, I. Ullmann, M. Ignacia Devoto, T. Timofte, A. Halm</i>	735
4AV.1.18	Production Process FMEA: Effective Procedure to Detect Major Process Related Reliability Risks and Better Specify Reliable Productions Windows <i>B. Jäckel, M. Pander, D. Philipp, K.-A. Weiß</i>	739
4AV.1.19	Advanced Degradation Modelling of Photovoltaic Modules and Materials <i>K.A. Berger, K. Knöbl, B. Brune, I. Ortner, S. Grubner, G. Oreski, C. Barretta, B. Kubicek, L. Neumaier, M. Feichtner, Y. Voronko, G.C. Eder</i>	745
4AV.1.20	Accelerated Acid Corrosion Testing of Solar Cells: Test to Failure <i>A. Fairbrother, L. Gnocchi, B. Bergerot, N. Rospars, A. Virtuani, C. Ballif</i>	749
4AV.1.23	Compatibility of Crosslinking Encapsulants with Smart Wire Connection Technology: Ways to Prevent Bubbles Formation <i>I. Dmitriev, S. Yakovlev, N. Glebova, A. Nechitailov, E. Terukova, D. Andronikov, D. Orekhov, I. Shakhryay</i>	754
4AV.1.25	Hot Cells in High-Power Photovoltaic Modules with Solar Cells from Larger Silicon Wafer Formats <i>R. Witteck, M. Siebert, I. Kunze, M. Köntges</i>	757
4AV.1.26	Approaches for a Lightweight Module with Laminated Materials <i>M. Heinrich, A.J. Beinert, P. Romer, L.C. Rendler, F. Basler, S. Wendlandt, D.H. Neuhaus</i>	761
4AV.1.27	Shingled Solar Module for BIPV Application <i>J. Zhu, N. Roosloot, G. Otnes, S.E. Foss</i>	765
4AV.1.28	Simulation Tool for the Performance Optimization of Colored PV Modules <i>C. Pfau, A.R. Bangash, C. Hagendorf, M. Turek</i>	769
4AV.1.29	Lightweight Glass-Free Solar Modules Based on Polycarbonate and Fiberglass Protective Sheets <i>S. Yakovlev, I. Dmitriev, E. Schebet, K. Emtsev, D. Andronikov, D. Orekhov, I. Shakhryay</i>	773

4AV.1.31	412 W Solar Module Using Silicon Heterojunction Cells and Shingle Interconnection <i>M. Foti, M. Galiazzo, L. Cerasti, E. Sovernigo, P. Fugolo, 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, F. Bizzarri</i>	776
4AV.1.35	Crosslinking Kinetics of Photovoltaic Module Encapsulants – Investigation of Selected EVA and POE Grades <i>B. Adothu, R. Pugstaller, M. Tiefenthaler, F.R. Costa, S. Mallick, G.M. Wallner</i>	779
4AV.1.36	PV Module Transportation in Trucks with Two Different Floor Designs <i>D.P. Vasudevan, A. Kottantharayil</i>	783

Visual PRESENTATIONS 4AV.2 PV Module Characterisation, Testing and Outdoor Performance

4AV.2.2	Investigations on the Temperature Dependency of the Shunt Resistance in CIGS Thin-Film Solar Modules Using Dark IV-Curve Measurements <i>L. Gerstenberg, P.K. Panda, V. Wesselak</i>	787
4AV.2.3	Complete Recovery of Crystalline Silicon Photovoltaic Modules by the Early Detection of Potential Induced Degradation <i>M. Florides, G. Makrides, G.E. Georgiou</i>	791
4AV.2.4	LeTID: Electrical Parameters Trend of Bifacial Silicon Modules Using Accelerated Aging Tests and Statistical Modelling <i>G. Plessis, J. Dupuis, O.L. Rhazi, E. Sandré, K. Radouane</i>	796
4AV.2.5	Potential Induced Degradation (PID) Free Module Design via Interruption of the Electric Field <i>K. Sporleder, B. Jäckel, S. Schindler, S. Dittmann, R. Gottschalg</i>	800
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 <i>L. Clasing, S. Schaaf, U. Blieske, N. Riedel-Lyngskær, A.A. Santamaria Lancia, N. Reiners</i>	803
4AV.2.9	The Impact of Real Albedo Values on Energy Estimation for Bifacial Modules <i>H. Sánchez, S. Dittmann, C. Meza, R. Gottschalg</i>	808
4AV.2.10	Efficiency Loss in Coloured Photovoltaics: Estimating the Contribution from Reflection Loss and Absorption Loss <i>A. Røyset, T. Kolås, M. Rudzikas, A.G. Ulyashin</i>	811
4AV.2.13	Angle of Incidence Study at Photovoltaic Modules with Polymer Front Sheet <i>S. Wendlandt, S. Heller, J. Govaerts, A.S.H. van der Heide, J. Kaakkunen, T. Savisalo, A. Morlier, D. Raine, D. Röder</i>	814
4AV.2.15	Beyond-Standard Equivalent Cell Temperature (ECT) Evaluation <i>G.H. Yordanov, M.G. Chowdhury, J.D. Moschner, A.S.H. van der Heide</i>	820
4AV.2.16	Design and Development of Solar Cell Integrated Moisture and Temperature Sensors for Photovoltaic Modules <i>J.N.B. Patel, E. Fokuhl, K.S. Prakash, A. Beinert, V. Wesselak, P. Gebhardt, D. Philipp</i>	825
4AV.2.18	Classification of Uncertain I-V Curves in PV Modules Based on Current and Voltage Evaluation <i>L. Feng, N. Amin, J. Zhang, K. Ding, F.U. Hamelmann</i>	830
4AV.2.19	Influence of Light, Temperature and Current on Stabilized Output Power and Energy Yield of CdTe PV Modules <i>M. Pander, B. Jäckel, M. Ebert</i>	834
4AV.2.23	Double-Sided Characterization of Full-Size Bifacial PV Modules Based on Low-Cost LED Bias Light <i>T.S. Lyubanova, R.P. Kenny, D. Shaw, D. Pavanello, J. Lopez-Garcia</i>	839
4AV.2.25	Development of Mobile Laboratory for Photovoltaic Testing Service <i>S.-X. Li, C.-J. Lin, W.-Y. Lin, C.F. Hsieh, T.-C. Wu, S.-T. Hsu</i>	845
4AV.2.26	Analysis of Performance and Deformation for Photovoltaic Module under Different Wind Speeds and Multi-Type Mechanical Loadings <i>S.-T. Hsu, W.-Y. Lin, S.-Y. Ting</i>	848

4AV.2.29	Multi-Criteria Analysis Method to Evaluate Different Encapsulation Materials for PV Modules and Proposing a Suitable Candidate <i>H.E. Hayati Soloot, A. Hayati Soloot, S. Moghadam</i>	852
4AV.2.31	Thermal Cycle Analysis on Shingled Glass – Glass Samples with SHJ Cells <i>S. Wendlandt, C. Carrière, V. Barth, S. Harrison, A. Bettinelli</i>	860
4AV.2.32	Enabling Measurement of PV Module Curvature: Towards Characterization of Thermomechanical Residual Stresses <i>I. Rahmoun, T. Le Carré, B. Chambion, E. Mofakhami, A. Derrier, J.-L. Bouvard, P.-O. Bouchard</i>	864
4AV.2.33	Analysis of the Thermomechanical Behaviour of Concrete Facade Elements with Integrated Photovoltaic Modules <i>P. Schenk, S. Schindler, M. Pander, U. Zeller, B. Jäckel, M. Ebert</i>	870
4AV.2.35	Spatially Resolved Leakage Current Density in Photovoltaic Modules <i>H. Nagel, M. Glatthaar, D. Philipp, H.D. Neuhaus, S.W. Glunz</i>	876
4AV.2.36	Electrical Bias Stabilisation of Power of the Photovoltaic Technologies <i>A. Mittal, N. Zechner, M. Rennhofer, G. Újvári</i>	880
4AV.2.37	New Developments in Accelerated Weathering Tests for Back-Contact Modules <i>G.J.W. Meijers, L. Pastukhov, R.H.C. Janssen, F. van Duijnhoven</i>	885

Visual PRESENTATIONS 4DV.2 BOS Components / Sustainability and Recycling of PV Modules

4DV.2.15	End-of-Life Management of Solar Photovoltaic Panels in India - Identification of Needs, Stakeholders & Challenges <i>K. Ganesan, C. Valderrama</i>	888
4DV.2.18	Greenhouse Gas Emissions Avoidance by Photovoltaic Plants on the Road to Carbon Neutrality <i>J. Tavora, M.J. Cortinhal, M. Meireles</i>	897
4DV.2.19	Carbon Footprint Analysis of CIGS Thin-Film PV Modules with Focus on Building-Integrated Applications <i>P. Borowski, F. Grömmmer, F. Karg</i>	901

Oral PRESENTATIONS 5BO.6 Solar Radiation Modelling and Instrumentation

5BO.6.1	Adapting PVGIS to Trends in Climate, Technology and User Needs <i>A.M. Gracia Amillo, N. Taylor, A.M. Martinez Fernandez, E.D. Dunlop, P. Mavrogiorgios, F. Fahl, G. Arcaro, I. Pinedo</i>	907
5BO.6.2	Improving the Prediction of DNI via Physics-Based Simulation of All-Sky Circumsolar Radiation <i>Y. Xie, J. Yang, M. Sengupta, Y. Liu</i>	912
5BO.6.3	Characterizing the Convergence and Robustness of the Kernel Density Mapping Method for Site-Adaptation of Global Horizontal Irradiation in Western Europe <i>L. Yezeguelian, C. Vernay, T. Carriere, P. Blanc</i>	915
5BO.6.4	Optimizing Methodology for Estimating Global Horizontal Irradiance (GHI) Using Solar Photovoltaics' Output AC Power Measurements <i>M.A. Khan, D.-E. Archer, N. Sommerfeldt</i>	923
5BO.6.5	Uncertainty of Tilted Irradiance Measurements Using Photodiodes and Reference Cells <i>A. Driesse, S. Wilbert, A. Forstinger</i>	929

Oral PRESENTATIONS 5BO.7 Forecasting Solar Radiation and PV Power

5BO.7.1	A Comparative Analysis of Forecasting Methods for Photovoltaic Power and Energy Generation with and without Exogenous Inputs <i>A. Starosta, K. Kaushik, P. Jhaveri, N. Munzke, M. Hiller</i>	938
5BO.7.2	Spatio-Temporal Machine Learning Methods for Multi-Site PV Power Forecasting <i>R.E. Carrillo Rangel, B. Schubnel, J. Simeunovic, R. Langou, P.-J. Alet</i>	946
5BO.7.3	Assessment of Cloud Mask Forecasts from the WRF-Solar Ensemble Prediction System	949

J. Yang, J.-H. Kim, M. Sengupta, P.A. Jimenez, Y. Xie

5BO.7.4	A Hybrid Solar Irradiance Nowcasting Approach: Combining All Sky Imager Systems and Persistence Irradiance Models for Increased Accuracy <i>B. Nouri, N. Blum, S. Wilbert, L.F. Zarzalejo</i>	952
5BO.7.5	Cloud Segmentation and Classification to Improve the Short-Term PV Forecasting Using Sky Imager <i>D.E. Melliti, D.L. Ha, P. Marechal, S. Ghalila-Sevestre, J. Lehaire, T. Capelle, G. Tremoy</i>	956

Oral PRESENTATIONS 5CO.9 Advanced Monitoring and Fault Detection in PV Systems

5CO.9.1	Analysis of Automatic Fault Detection Methods for Commercially Operated PV Power Plants <i>E.A. Sarquis Filho, K. Kiefer, N. Holland, B. Kollosch, B. Müller, P.J. Costa Branco</i>	961
5CO.9.2	Fault Detection in Operation and Maintenance of PV Systems <i>A. Louwen, D. Miorandi, C. Torrero, F. Venturini, D. Moser</i>	967
5CO.9.3	Failure Diagnosis and Trend-Based Performance Losses Routines for the Detection and Classification of Incidents in Large-Scale Photovoltaic Systems <i>A. Livera, M. Theristis, J.S. Stein, G.E. Georgiou</i>	973
5CO.9.4	Performance Imputation Techniques for Assessing Costs of Technical Failures in PV Systems <i>S. Lindig, A. Louwen, M. Herz, J. Ascencio-Vásquez, D. Moser, M. Topic</i>	979
5CO.9.6	Long-Term Degradation Assessment of Five Different Photovoltaic Technologies in Austria <i>R. Höller, K. Cérriku</i>	989

Oral PRESENTATIONS 5CO.12 PV Systems: Planning, Plant Optimisation Tools, Advanced Installation Criteria, Construction Issues

5CO.12.1	Predicting PV Self-Consumption in Villas with Machine Learning <i>F. Galli, N. Sommerfeldt</i>	993
5CO.12.2	The Role of Collective Self-Consumption in the Promotion of BIPV in Multi-Apartment Building Façades <i>R. Amaro e Silva, C. Gerçek, M. Centeno Brito, G.P. Luz</i>	998
5CO.12.6	How Digitalization can be a Driver for Supporting More and More the Solar Deployment? <i>E. Saretta, P. Bonomo, F. Frontini, V.K. Nguyen, W. Maeder</i>	1002

Oral PRESENTATIONS 5DO.1 Application of Machine Learning & Modelling in PV Systems

5DO.1.1	Advanced Analytics on IV Curves and Electroluminescence Images of Photovoltaic Modules Using Machine Learning Algorithms <i>V. Kumar, P. Maheshwari</i>	1005
5DO.1.2	Automatic Fault Detection and Classification in PV Systems by the Application of Machine Learning Algorithms <i>G.D. Rupakula, D. Daßler, S. Malik, M. Ebert, R. Schmidt</i>	1011
5DO.1.3	Research on Digital Twin System of Photovoltaic Array <i>K. Ding, X. Chen, J. Zhang, S. Weng, L. Feng, F.U. Hamelmann</i>	1018
5DO.1.4	Auto-Parametrizing the Digital Twin of Photovoltaic Power Systems <i>A. Tuomiranta, I.T. Horvath, A. Schils, K. de Brabandere, E. Voroshazi, E. Bertrand, B.S. Aldalali, I. Gordon, A. Wabbes, S. Scheerlinck</i>	1022
5DO.1.5	Application of Machine Learning to Assess the Thermal Behaviour of PV Modules in Different Climate Zones <i>J. Ascencio-Vásquez, I. Kaaya, K.-A. Weiß, M. Topic</i>	1028
5DO.1.6	Estimating Day Ahead Photovoltaic Production Distribution Functions for the Risk Assessment of Control Energy Provision <i>M. Steinbrecher, B. Kubicek, M. Rennhofer</i>	1033

Oral PRESENTATIONS 5DO.2 PV Systems Operation and Field Inspection

5DO.2.1	Quantifying Performance Loss Rates of Photovoltaic Modules Using Ground-Based vs Satellite-Based Meteorological Data <i>E. Özkalay, A. Virtuani, A. Fairbrother, A. Skoczek, G. Friesen, C. Ballif</i>	1037
5DO.2.2	Quality Assurance of the Photovoltaic Power Plants Installation Stage - a Complementary Strategy Based of Photoluminescence and Steady-State Thermography <i>L. Koester, A. Astigarraga, S. Lindig, A. Louwen, M. Antinori, D. Moser, G. Manzolini</i>	1042
5DO.2.6	Repair and Preventive Maintenance of PV Modules with Degrading Backsheets Using Flowable Silicone Sealant <i>G. Beaucarne, G.C. Eder, E. Jadot, Y. Voronko, W. Mühlleisen</i>	1051
Oral PRESENTATIONS 5DO.3 Performance of Field and BIPV Systems		
5DO.3.1	Advanced Method to Determine the Gain of Bifacial PV Systems <i>D. Stellbogen, P. Lechner, J. Kriening, O. Schanz, D. Geyer</i>	1054
5DO.3.3	Terrain-Following Single-Axis Tracking PV Systems: Advantages and Performance Analysis <i>A.A. Shishavan, V.R. Abbaraju, A. Dobos, F. Borrelli</i>	1060
5DO.3.4	Analysis of the Irradiance Non-Uniformity on the Performance of Vertical and Tilted Bifacial PV Module Arrays <i>M. Calcagnotto Mascarello, R.P. Kenny, T.S. Lyubenova, A.M. Gracia Amillo, J. Lopez-Garcia</i>	1065
5DO.3.5	Technical Performance Evaluation of BIPV and BAPV Systems <i>P. Ollas, J. Persson, P. Kovács</i>	1071
Oral PRESENTATIONS 5DO.4 The Effect of Soiling and Snow Cover on PV System Performance		
5DO.4.3	Data-Driven Assessment of Soiling Loss in Photovoltaic Plants <i>K. Yurtseven, E. Karatepe, E. Deniz</i>	1077
5DO.4.5	Estimation of Snow Loss for Photovoltaic Plants in Norway <i>M.B. Øgaard, H.N. Riise, J.H. Selsjø</i>	1081
5DO.4.6	Modelling and Impact of Solar Eclipses on PV Energy Production <i>J. Ascencio-Vásquez, R. Amaro e Silva, E. Urrejola, K. Brecl, M. Topic</i>	1088
Oral PRESENTATIONS 5EO.2 Concentrators and PV for Space Applications		
5EO.2.1	Suitable Silicon Solar Cell Technologies for Use in Space Applications <i>V.D. Mihailescu, C. Peter, L.J. Koduvelikulathu, R. Roescu, R. Kopecek, K. Rouhani, S.C. Pop, M. Okandan</i>	1092
5EO.2.4	Light Weight Interconnection Weave for Space PV <i>T. Borgers, J. Szlufcik, M. Van den Storme, G. Van den Storme, C. Brandt, D. Girolamo, S. Das, J. Verdonck, P. Nivelle, J. Govaerts, G. Doumen, L. Vastmans, S. De Vrieze, E. Voroshazi, J. Poortmans</i>	1096
5EO.2.5	First Mechanical Study on Lightweight Microconcentrators Systems for Space Applications <i>V. Vareilles, A. Bermudez-Garcia, J. Francois, Y. Veschetto, M. Amara, P. Voarino, F. Chabuel</i>	1101
5EO.2.6	What Is the Correct Efficiency for Terrestrial Concentrator PV Devices? <i>H. Müllejans, S. Winter, M.A. Green, E.D. Dunlop</i>	1106
Visual PRESENTATIONS 5BV.4 Solar Radiation and Forecasting		
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 <i>J. Remund, A. Habte, M. Sengupta, C.A. Gueymard, S. Wilbert</i>	1111
5BV.4.2	Combination of Physics Based Simulation and Machine Learning for PV Power Forecasting of Large Power Plants <i>N. Holland, X. Pang, W. Herzberg, J. Bor, E. Lorenz</i>	1114

5BV.4.3	Intraday Post Processing of Solar Irradiance Forecasts from WRF Model Using Satellite-Derived Data in French Guiana <i>M. Salloum, J. Macaire, S. Zermani, J. Bechet, A. Primerose, L. Linguet</i>	1121
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 <i>W.W. Ferreira Fonseca, F. Ramos Martins, R. Zilles</i>	1125
5BV.4.5	Post Processing of Day-Ahead Solar Irradiance Forecast Using Satellite Derived Data in French Guiana <i>J. Macaire, M. Salloum, J. Bechet, S. Zermani, L. Linguet</i>	1130
5BV.4.7	Novel Intraday Photovoltaic Production Forecasting Algorithm Using Deep Learning Ensemble Models <i>S. Theocharides, G. Makrides, M. Theristis, G.E. Georghiou</i>	1134
5BV.4.8	Solar Irradiance Forecasting Using Numerical Weather Prediction Model and INSAT-3D Based Satellite Model <i>A. Masoom, A. Bansal</i>	1138
5BV.4.11	Comparison and Validation of Irradiance Data: Satellite Meteorological Dataset MERRA-2 vs. Meteonorm and German Weather Service (DWD) <i>A. Khatibi, S. Krauter</i>	1141
5BV.4.12	The Long-Term of the Albedo Stability under Different Weather Conditions <i>S. Suarez, E. Ortega, J.C. Jimeno, J.R. Gutierrez, V. Fano, J.M. Rivas, G.A. Navas, I. Fernandez, S. Rodríguez-Conde</i>	1148
5BV.4.13	Open-Source Geospatial Data Service with an Application in Irradiance Modelling for VIPV <i>E. Sovetkin, N. Patel, A. Gerber, B.E. Pieters</i>	1152
5BV.4.14	PV 2-State: A Simple but Accurate Short-Term PV Power Forecasting Tool <i>M. Paulescu, N. Stefu, A. Sabadus, C. Dughir, S. Bojin</i>	1161
5BV.4.15	Cloud Height Estimation Using All Sky Imagers <i>J. Esteves, R. Pestana, Y. Cao, N. Pinho da Silva</i>	1165
5BV.4.17	Day-Ahead PV Generation Forecasting Based on Deep Learning Approach <i>D. Kothona, A. Zamanidou, I.P. Panapakidis, G.C. Christoforidis</i>	1170

Visual PRESENTATIONS 5CV.2 Operation, Performance and Maintenance of PV Systems

5CV.2.1	Using On-Site Measurement Data and Laboratory Test Data of PV Modules for Evaluating the Performance Degradation <i>M.-W. Chen, C.-H. Lin, C.-I. Chen</i>	1176
5CV.2.3	Temperature Coefficients of Photovoltaic Modules under Partial Shading Conditions <i>O.K. Segbefia, B.R. Paudyal, I. Burud, T.O. Saetre</i>	1180
5CV.2.6	Performance Analysis of PV Modules Installed in the Alpine Region <i>F. Carigiet, D. Grunauer, F.P. Baumgartner</i>	1187
5CV.2.7	PV Plant Monitoring Needs Both – Data Analysis and On-Site Inspection <i>W. Mühlleisen, L. Neumaier, J. Koserl, C. Hirsch, R. Rattenberger, P. Prasser</i>	1193
5CV.2.9	Impact of Dust on PV Performance in Nigeria <i>Y. N. Chanchangi, A. Ghosh, T.K. Mallick, S. Sundaram</i>	1196
5CV.2.10	Clouds Characterization and Simulation to Evaluate the Effect in the Stability of Photovoltaic Irrigation Systems <i>F.J. Guillén-Arenas, L. Narvarte Fernández, J. Fernandez-Ramos</i>	1202
5CV.2.11	Deep Learning Based Image Feature Extraction for Predicting Climate Related Degradation of PV Modules <i>L. Neumaier, J. Scherer, C. Schwarzmüller, B. Kubicek, F. Mödritscher, C. Hirsch</i>	1207
5CV.2.13	A Self-Referencing Method for Detecting Underperforming Strings in MWp-PV-Generators <i>C. Buerhop-Lutz, T. Pickel, J. Hauch, I.M. Peters</i>	1212
5CV.2.14	Performance Evaluation of a High-Power PV Irrigation System for a Two-Year Operation Period <i>J.I. Herráiz, R.H. Almeida, M. Castillo-Cagigal, L. Narvarte Fernández</i>	1216

5CV.2.16	A Decision Support System for Cost-Effective Operation and Maintenance of PV Plants <i>S. Gallmetzer, A. Louwen, P. Ingenhoven, D. Moser</i>	1222
5CV.2.18	Solar Photovoltaic Power Plant Inventory and Solar Modules Counting by Convolutional Neural Network from Aerial Imagery <i>Y.-R. Lin, C.-Y. Huang, J.-S. Zhang, H.-L. Chen</i>	1227
5CV.2.19	Comparison of Soiling Loss Between Framed and Frameless Photovoltaic Modules <i>H. Karakan, H.A. Ceyran, A. Yazici, M. Günöven</i>	1230
5CV.2.20	Modeling a Pothovoltaic Fault Detection Approach Considering Machine Learning for the EU PVSEC 2021 <i>P. Akharath, J. Altkrieger, H. Sahota, V. Herbst, H. te Heesen</i>	1234
5CV.2.24	Effects of the Biggest Snowfall of a Century in Madrid, on the Electricity Generation of Portrait Versus Landscape Layout Solar Panels <i>M.A. Muñoz-García, G.P. Moreda, M.C. Alonso-García</i>	1238
5CV.2.26	Soiling and Snow Impact on a PV Plant at a Farm in Norway <i>H.N. Riise, M.B. Øgaard, T.U. Nærland</i>	1241
5CV.2.27	Bifacial Gain for 1P and 2P Trackers <i>P. Merodio, F. Martínez-Moreno, E. Lorenzo</i>	1245
5CV.2.28	Ageing of Two 5kW PV Arrays at the IES-UPM after 8 Years of Operation <i>F. Martínez-Moreno, C. Rossa, P. Merodio, L. Fialho, N. Tuytyundzhiev</i>	1250
5CV.2.30	The Potential of the Rejected Brine as a Coolant for PV Temperature Reduction Purposes <i>S. Kamfroozi, H. Ebadi, H. Vahabi, R. Talebnejad, L. Savoldi, A.R. Sepaskhah, B. Ghobadian, S. Gorjian</i>	1255
5CV.2.38	Influence of Shading on Photovoltaic Generation from Winter to Summer in Vanderbijlpark, South Africa <i>J. Bekker</i>	1259
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 <i>K. Lappalainen, S. Valkealahti</i>	1264
5CV.2.40	Analysis of Temperature Inertia of PV Modules Using Different Temperature Estimation Models <i>A.K. Vidal de Oliveira, M. Braga, S.-Y. Oh, S. Dittmann, R. Gottschalg, C.D. Rodríguez-Gallegos, T. Reindl, K. Ettalbi, T.R. Betts, L. Burnham, R. Rüther</i>	1269
5CV.2.46	New Findings on the PV Fire Prevention - Firefighter Strategy for in-Roof PV Installations <i>U. Muntywyler, E. Schüpbach</i>	1275
5CV.2.47	State of the Art and Performance of the Photovoltaic (PV) System Fleet in Brussels: an Analysis of 8000 PV Installations <i>B. Sarr, J. Leloux, G. Neubourg, G. Declève, R. Tieterickx, J. de Lathouwer, R. Lambert</i>	1278
5CV.2.49	PV Fault Detection Threshold at the Module, String, and Inverter Levels <i>M. Matam, H. Seigneur</i>	1284
Visual PRESENTATIONS 5CV.3 PV Systems: Planning, Plant Optimisation Tools, Advanced Installation Criteria, Construction Issues / Concentrators and PV for S		
5CV.3.1	The Impact of Tracking Algorithms and Time Resolution on Energy Yield Modelling of Single Axis Tracker Systems <i>A. Neubert, M. Hamer, P. Rainey, M.A. Mikofski</i>	1290
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 <i>H.G. Beyer</i>	1294
5CV.3.4	Analysis of Electrical Shading Effects in PV Systems <i>M. Oliosi, B. Wittmer, A. Mermoud</i>	1299
5CV.3.8	Dynamic Simulation of the Shading Cast by a Wind Farm on an Adjacent Photovoltaic Plant <i>J. Robledo Bueno, J. Leloux, B. Sarr, C.A. Guemard, P. Darez</i>	1307

5CV.3.9	Dynamic and Visual Simulation of Bifacial Energy Gain for Photovoltaic Plants <i>J. Robledo Bueno, J. Leloux, B. Sarr, C.A. Guemard, A. Driesse</i>	1313
5CV.3.11	Experimental Evaluation of Performance Enhancement in a Bifacial PV System by a Highly Reflective Textile Ground Cover <i>J.D. Moschner, G.H. Yordanov, L. Dupé</i>	1320
5CV.3.17	Large Size Flexible and Laminated Space Photovoltaic Arrays <i>T. Guerin, C. Jamin, P. Voarino, D. Vergnet, P. Zevenbergen, R. Cariou</i>	1324
5CV.3.18	Optically Enhanced c-Si Solar Cells for Ephemeral Space Applications <i>D.M. Pera, I. Costa, F. Serra, A. Guerra, K. Lobato, J.M. Serra, J. Almeida Silva</i>	1329
5CV.3.19	Performance of Photovoltaic - Thermal (PVT) and Photovoltaic (PV) Systems under Various Weather Conditions <i>R.R. Vardanyan, V.K. Dallakyan, N.K. Badalyan</i>	1332

Oral PRESENTATIONS 6BO.17 Electrical Grid Integration / Solar Power Generation Coupling with Energy Storage

6BO.17.2	A Free Online Tool for the Simulation of Collective Self-Consumption in Brussels <i>B. Sarr, Z. Zhao, J. Leloux, P. Hendrick, J. Robledo Bueno</i>	1335
-----------------	---	------

Oral PRESENTATIONS 6CO.11 Solar PV in the Energy System

6CO.11.2	Optimized Machine Learning Method for PV Power Prediction <i>H. Heck, U. Muntwyler, E. Schüpbach</i>	1341
6CO.11.3	Energy Model for a Rural Region in Germany - Results and Balancing of Electricity Production and Consumption <i>J. Bunner, H. te Heesen</i>	1346
6CO.11.4	Hybrid PV-Systems for Electrification and Sector Coupling of Road Transport Sector in Norway <i>J. Fagerström, L. Kvalbein, J. Danebergs, T.U. Nærland, M.B. Øgaard, K. Espenzen</i>	1350
6CO.11.5	Sector Coupled Energy Model for the European Electricity, Heat and Transport Sectors - Methodology <i>A. Blinn, H. te Heesen</i>	1356
6CO.11.6	Energy Management System for Electric Bus Charging Hub with Local Storage and PV Energy Integration <i>S. Ranta, H. Huerta, D. Roggo, O. Huhtala, A. Heinonen, V. Lavonen, J. Pouget</i>	1364

Oral PRESENTATIONS 6CO.13 Solar Hydrogen

6CO.13.5	The Benefits of Coupling Solar Energy with Flexible Desalination and Electrolysis <i>M. Ginsberg, Z. Zhang, A.A. Atia, V. Fthenakis</i>	1370
-----------------	--	------

Oral PRESENTATIONS 6DO.6 BIPV Implementation: Design, Assessment and Performance

6DO.6.3	High Quality Solutions of Building-Integrated Photovoltaics (BIPV) – Results of a World Wide Competition in 2020 <i>G. Becker, F. Flade, R. Krippner, B. Schiebelsberger, W. Weber</i>	1376
6DO.6.4	Comparison of IEC 61853-1 Matrix Evaluations Based on Indoor and Outdoor Measurement Data from PVPS Task 15 BIPV Round-Robin <i>R.M.E. Valckenborg, K.A. Berger, G. Újvári, G.C. Eder, L. Gaisberger, M. Tabakovic, C.S. Polo López, S. Boddaert, M. Del Buono, N. Martín Chivelet, A. Sanz Martínez, J.T. Kim, A.G. Imenes</i>	1381
6DO.6.6	Long-Term Performance of Building Integrated Photovoltaic Systems and Shade Induced Degradation <i>A. Fairbrother, H. Quest, E. Özkalay, P. Wälchli, G. Friesen, C. Ballif, A. Virtuani</i>	1388

Oral PRESENTATIONS 6DO.7 BIPV Development and Customisation: Approaches and Experimental Results

6DO.7.1	Experimental Assessment and Data Analysis of Colored Photovoltaic in the Field of BIPV Technology Application <i>R. Roverso, M. Pelle, M. Dallapiccola, A. Astigarraga, E. Lucchi, P. Ingenhoven, L. Maturi</i>	1394
6DO.7.3	Outdoor Test Results and Model Verification of Aesthetics PV Façade <i>L.H. Slooff-Hoek, A.R. Burgers, K.M. de Groot, N.J.J. Dekker, T. Minderhoud, G. Gijzen, T. Sepers, Y. de Groot, W. van Strien, J.A.M. van Roosmalen</i>	1400
6DO.7.4	Development of a Neutral Color Photovoltaic Window Based on Luminescent Solar Concentrators <i>P. Bernardoni, G. Mangherini, A. Andreoli, M. Gjestila, D. Vincenzi, L. Gila, L. Caccianotti, C. Pesenti</i>	1404
Oral PRESENTATIONS 6DO.8 Vehicle Integrated PV: Potential Energy Yield Simulations		
6DO.8.1	Development of High-Efficiency Solar Cell Modules for PV-Powered Vehicles <i>M. Yamaguchi, K. Araki, Y. Ota, K. Nishioka, T. Takamoto, C. Thiel, A. Tsakalidis, A. Jäger-Waldau, T. Masuda, K. Okumura, T. Nakado, K. Yamada, Y. Zushi, T. Tanimoto, K. Nakamura, R. Ozaki, N. Kojima, Y. Ohshita</i>	1409
6DO.8.2	Yield Potential of Vehicle Integrated Photovoltaics on Commercial Trucks and Vans <i>C. Kutter, L.E. Alanis, D.H. Neuhaus, M. Heinrich</i>	1412
6DO.8.6	Energy Yield Simulation of 3D Curved VIPV Modules <i>S. Neven-du Mont, H. Alharthi, C. Kutter, D.H. Neuhaus, M. Heinrich</i>	1421
Oral PRESENTATIONS 6DO.9 Vehicle Integrated PV and Floating PV Applications		
6DO.9.1	Strategies for the Analysis of Shading Effects in Vehicle Integrated Photovoltaics <i>J. Macías Rodríguez, R. Herrero, R. Núñez, I. Antón Hernández</i>	1429
6DO.9.5	Opening Up New Land Resources for Vertical Bifacial Solar Modules Using a New “Nature-Conserving Agrivoltaics” Concept <i>N. Pannicke-Prochnow, J. Schneider, C. Gerhards, R. Stretz, B. Volz</i>	1433
Visual PRESENTATIONS 6BV.5 Power Electronics and Electrical Grid Integration / Storage / Energy System Integration		
6BV.5.1	Accurate Testing Methods of Grid-Connected PV Inverters by Means of Real-Time Based Hardware-in-the-Loop (HIL) Simulation Topologies for Validation, Testing, and Grid Integration of Solar Plants <i>G. Lauss, Z. Miletic, A. Banjac, C. Messner</i>	1439
6BV.5.3	Impact of Measurement Data Time Resolution on Predicted Lifetime of PV Inverters in Residential Solar Panel Systems <i>O. Alavi, W. Van De Sande, L. Van Cappellen, M. Daenen</i>	1445
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 <i>O. Alavi, W. Van De Sande, L. Van Cappellen, W. De Ceuninck, M. Daenen</i>	1449
6BV.5.15	Tariff Design and Economic Dispatch in a DC Microgrid <i>P. Ferreira Torres, J. Tavares Pinho, R. Zilles</i>	1452
6BV.5.16	Effect of Energy Storage on Self-Consumption and Self-Sufficiency: A Field Study in a Nordic Climate <i>P. Ollas, J. Persson, P. Kovács</i>	1459
6BV.5.17	Microgrid Energy Management Control with a Vanadium Redox Flow and a Lithium-Ion Hybrid Battery System for PV Integration <i>A.C. Neves Foles, L.A. Fialho, M.P.I. Collares-Pereira</i>	1464
6BV.5.27	Agent-Based Behaviors Model for Peer-to-Peer Energy Trading Linked to Blockchain <i>M. Sajjad, A. Boumaiza, A. Sanfilippo</i>	1470
6BV.5.29	Validation of a Technical Solution for a Stand-Alone PV Heat Pump System without Batteries <i>C. Lorenzo, R.H. Almeida, L. Narvarte Fernández</i>	1472
6BV.5.30	Regional Hydrogen Concept in the Commercial Sector for the Use of PV Yield <i>H. Prinz, H. te Heesen</i>	1477

6BV.5.31	Smart Energy Management for SME Using Digital Twins <i>J.S. da Costa Fernandes, M. Schmidt, R. Khatri, R. Gasper, N. Hartmann</i>	1482
6BV.5.33	Degradation of Supply Reliability in Stand-Alone Systems due to Modeling Strategies <i>L. Timaná, M. Gemignani, G. Rostegui, C.F.M. Almeida</i>	1488
6BV.5.34	The H2020 R&D Project SERENDI-PV: Innovating towards Improved Reliability, Higher Performance and Dispatchable Grid Integration for Photovoltaic Systems <i>J. del Pozo, E. Román Medina, R. Alonso, J.A. Tsanakas, C. Schill, M. Aleman, I. Lombardero, I. Weiss, J. Leloux, M. Suri, I. Lokhat, J. Berthelot, C. Monet, M. Crespo, C. Breyer, B. Idlbi, E. De Keyser, J. Reed, M. Puente, M. Resch, I. Landibar</i>	1494
6BV.5.35	Techno-Economic Analysis of Marine Ecosystem to Achieve Zero Carbon Emission <i>J.Z. Tee</i>	1499
6BV.5.37	Data Forecasting with Application to Blockchain-Based Local Energy Markets <i>A. Boumaiza, A. Sanfilippo</i>	1502
6BV.5.38	Load Data Acquisition in Rural East Africa for the Layout of Microgrids and Demand-Side-Management Measures <i>G. Hagile Philipo, J. Nakato Kakande, S. Krauter</i>	1505
6BV.5.39	Solar PV Powered United Nations Humanitarian Camps with Integrated Demand Flexibility and Tiered Resilience <i>M. Ray, S. Ray, I.D. Miller, U. Shankar</i>	1511

Visual PRESENTATIONS 6CV.4 PV on/in Buildings / PV in Infrastructure, on Water and on Vehicles; PV and Agriculture

6CV.4.1	The Inverse Lambertian Irradiation Method: An Optical Tool for PV Solar Concentrators and Urban Heat Islands Characterization <i>A. Parretta, M. Tucci</i>	1515
6CV.4.2	The Missing Link: Innovative Vertical PV Surfaces "Solar Windows" and "Solar Blinds" <i>U. Muntwyler, C. Renken, E. Schüpbach, A. Faes, T. Stöckli</i>	1521
6CV.4.3	When Aesthetics Meets Sustainability through SUNCOL: The CO2-Neutral Wohnüberbauung Männedorf Project <i>E. Luzi, E. Canosci</i>	1526
6CV.4.7	Machine Learning for BIPV Production <i>D. Granados-López, D. Gonzalez-Peña, A. García-Rodríguez, S. García-Rodríguez, M. García-Fuente</i>	1529
6CV.4.9	Simplified Prediction of the Impact of Building Integrated Photovoltaic Modules Ageing on Their Performance <i>Y.B. Assoa, A. Rhone, P. Thony, F. Chabuel</i>	1532
6CV.4.15	Be-Smart: Thermal Impact of Photovoltaic Modules Building Integration <i>Y.B. Assoa, D. Chavrier, I.A. Tsanakas, P. Thony, A. Mignonac, A. Blaise, J.V. Furtado Frazao de Medeiros, A. Rhone, L.-E. Perret-Aebi, F. Chabuel</i>	1535
6CV.4.19	Yield-Optimized Small Photovoltaic Module Solutions in Combination with Concrete Facade Elements <i>S. Schindler, S. Huth, J. Reise, F. Hülsmeier, A. Heller, P. Schenk, M. Ebert, K. Wilhelm, M. Butler, R. Grebe, C. Erban</i>	1538
6CV.4.20	Aesthetic Evaluation Criteria for Façade Integrated Photovoltaics in Urban Context <i>C. Xiang, C.T. Moscoso Paredes, B. Szybinska Matusiak</i>	1540
6CV.4.21	A State of the Art of Design Criteria for Façade Integrated Photovoltaics <i>C. Xiang, B. Szybinska Matusiak</i>	1545
6CV.4.30	Floating Photovoltaics: A SWOT Analysis <i>S. Moghadam, H.E. Hayati Soloot, A. Hayati Soloot, A. Jadhav</i>	1551
6CV.4.31	Key Performance Indices of Photovoltaic Carports <i>M. Loup, C. Allenspach, H. Hofmann, R. Vogt, F. Carigiet, F.P. Baumgartner</i>	1565

6CV.4.32	Geographical Distribution of Solar Urban Potential for Vehicle Integrated Photovoltaics <i>M.C. Centeno Brito, T. Santos, R. Amaro e Silva, D.M. Pera, F. Moura, J. Rocha</i>	1569
6CV.4.35	Sustainable Optimization of PV Value Chain for Electromotive Applications <i>F. Popescu, S. Wendlandt</i>	1574
6CV.4.37	Modeling and Simulation of Multipump Photovoltaic Irrigation Systems <i>J. Ramirez Ledesma, R.H. Almeida, L. Narvarte Fernández</i>	1579
6CV.4.39	Simulating the Energy Yield of Bifacial Photovoltaic Modules Installed on Carports or Canopies <i>J. Robledo Bueno, J. Leloux, B. Sarr, C.A. Gueymard, A. Driesse, P.-F. Drouin</i>	1583
6CV.4.41	Lessons Learned from Simulating the Energy Yield of an Agrivoltaic Project with Vertical Bifacial Photovoltaic Modules in France <i>J. Robledo Bueno, J. Leloux, B. Sarr, C.A. Gueymard, A. Driesse, P.-F. Drouin, S. Ortega, D. André</i>	1588
6CV.4.42	Ground Irradiance Modelling: of Key Importance for Designing Nature Inclusive Solar Parks and Agrivoltaics Systems <i>B.B. Van Aken, A. Binani, E. Barros, A.R. Burgers, F. van der Zee, A. Schotman, K. Cesar</i>	1596

Plenary SESSION 7EP.1 Sustainability and Social Acceptance Preparing for the TW Era

7EP.1.3	True Cost of Solar Hydrogen - Levelised Cost of Hydrogen in Europe 2021-2050 <i>E. Vartiainen, C. Breyer, D. Moser, E. Román Medina, C. Bustos, G. Masson, E. Bosch, A. Jäger-Waldau</i>	1601
----------------	---	------

Oral PRESENTATIONS 7DO.5 Integration of PV in the Local and Regional Context

7DO.5.2	Do North-Facing BIPV Facades in Europe Make Sense? <i>A. Virtuani, A. Fairbrother, F. Lisco, L.-E. Perret Aebi, N. Wyrsch, C. Ballif</i>	1608
7DO.5.3	SimZukunft - Energy Scenarios 2050 for a Small City in Switzerland <i>U. Muntrwyler, E. Schüpbach, N. Pfugradt</i>	1612
7DO.5.4	SocialRES Energy Innovation Framework: A Comparative Analysis of Existing Business Models for RES Cooperative, Aggregators and Crowdholders <i>I. Lizarralde, M. Hamwi, S. Caneva, S. Wilhelm, D. van der Zande, A. Abi Akle, B. Samir, V. Kromrey, D. Vedel, L. Lentzen, A. Schneller, J. Hoffmann, K. Kohl, J. Doerpinghaus, E. Schmid, C. Crippa, E. Denny, J. Carroll, H. Wu, M. Regidor, S. Mulero, I. Lacoste, R. Ruiz, S. Campos, E. Otero, N. Brito Jorge, F. Onofre, K. Harder, T. Šimek, D. Leonte, M. Policarp</i>	1618
7DO.5.5	Optimal Allocation Method for a Fair Distribution of the Benefits in an Energy Community <i>V. Casalicchio, G. Manzolini, M.G. Prina, D. Moser</i>	1620

Oral PRESENTATIONS 7DO.12 PV Business Opportunities Today and Tomorrow

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 <i>G. Masson, A. Jäger-Waldau, I. Kaizuka, J. Lindahl, J. Donoso Alonso</i>	1625
7DO.12.2	Potential BIPV Market in Key European Countries by 2030 <i>E. Bosch, P. Macé, A. van Rechem</i>	1628
7DO.12.3	Super PV Project Innovations - LCOE Assessment and Competitiveness <i>T. Haarberg, P. Macé, E. Bosch, J. Ulbikas, J. Denafas, A.G. Ulyashin</i>	1632
7DO.12.4	Cost Assessment of Future Tandem Perovskite-Silicon Modules and LCOE Comparison to Silicon Technologies in Europe <i>C. Moreno Castillo, M. Woodhouse, J.-B. Puel, A. Julien, L. Oberbeck, P.P. Grand</i>	1637
7DO.12.5	Projected Costs for Competing Photovoltaic Technologies Achieving over 30% Module Efficiency at Terawatt Scale in 2050 <i>T.M. Bruton</i>	1642

Oral PRESENTATIONS 7EO.1 Policies, Scenarios and Instruments for Large Scale PV Deployment

7EO.1.3	Smart Strategies for the Transition in Coal Intensive Regions <i>R. Mergner, R. Janssen, D. Rutz, C. Malamatenios, G. Veziryianni, D. Knoche, A. Rademacher, R. Schlepphorst, L. Fonseca, R. Michie, A. Nikolaev, C. Doczekal, G. Arrowsmith, N. de la Vega, G. Popescu, M. Dobrin, J. Mandic Lukic, M. Mesarovic, I. Volchyn, D. Bondzyk, M. Pietrzykowski, B. Wos, M. Chodak, J. Likus-Cieslik, R. Phillips, K. Palmer, J. Frouz, M. Hendrychova, S. Irimie</i>	1645
7EO.1.5	SOLAR-ERA.NET - European Cooperation in PV RTDI and Beyond - Highlights, Lessons Learned and Future Perspectives <i>S. Nowak, M. Gutschner, T. Biel, S. Oberholzer, C. Hünnekes, K. Chakanga, R. Horbelt, M. Dürr, E. Fernández, B. Gómez, I. Carlos, J. Marchamalo, M. Sopena, P.-J. Rigole, O. Bernsen, L. Polain, G. Carchon, E. Afentaki, I. Sergidou-Loizou, P. Rale, P. Bain, K. Karaösz, M. Bianco, E. Lutter, A. Hipfinger, G. Friedmann</i>	1650
7EO.1.6	Impact of Public and Private Funding on the Development of the Photovoltaic Sector and the Achievement of 2030 Energy Transition Targets <i>D. Moser, F. De Nigri, S. Pezzutto, S. Gantioler, M. Aleman, G. Masson</i>	1657

Visual PRESENTATIONS 7DV.1 Economics, Markets and Education

7DV.1.2	Evaluating the Impact of Climate Change on the Techno-Economic Performance of Building Integrated Photovoltaic Systems in Protected Contexts <i>M. Pelle, M. Dallapiccola, A. Tatti, F. Causone, L. Maturi, D. Moser</i>	1662
7DV.1.4	Demand-Aware Electricity Price Prediction Based on LSTM and Wavelet Transform <i>K. Iwabuchi, K. Kato, D. Watari, I. Taniguchi, F. Catthoor, E. Shirazi, T. Onoye</i>	1668
7DV.1.6	The Asset of Measurements for Project Finance and Project Value <i>S. Weber, R. Granados, R. Meyer, B. Westphal</i>	1671
7DV.1.7	Development of Conceptual Framework for Time of Generation Feed-in-Tariff for a Rooftop Photovoltaic System <i>R.R. Urs, M. Marzband, A. Al-Sumaiti, A.M. Abusorrah</i>	1676
7DV.1.8	How Innovative Citizen Financing Schemes Enable Large-Scale Energy Efficiency Measures in the Building Sector <i>S. Wilhelm, S. Caneva, D. van der Zande, J.-F. Marchand, M. Casas, F. Pause, M. Wimmer, J. Kamm, L. Couto, B. De Kezel, V. Segon, T. Šimek, R. Adomaviciene, K. Vaskeliene, A. Gladkauskienė, D. Juškevičienė, D. Banyte, Z. Kaciūška, C. Weber</i>	1681
7DV.1.18	Education and Awareness can Brand PV Technology Beautiful before Turning It Invisible <i>M. Ray, I. Majumdar, T. Ram, B. Chakraborty</i>	1683
7DV.1.20	A Brand New Training Platform Aimed at Upscaling Solar Capacity Building <i>B. Gaiddon, M. de l'Epine, P. Enjolras, O. Verdeil, S. Anquetin, D. Gagnaire</i>	1688
7DV.1.25	Strategies and Technologies to Achieve a European Fossil-Energy-Free Agriculture: The AgroFossilFree Project <i>D. Rutz, V. Hofmeier, C. Ma, R. Janssen, A. Balafoutis, K. Vaiopoulos, C.A. Grøn Sørensen, D. Manolakos, A. Koutsouris, G. Papadakis, M. Borzecka, V. Bisevac, D. Creupelandt, J. Román, F. Oudshoorn, D. Rossi, M. Próchniak, Z. Tsiropoulos, H. Brinks, B. Caslin, J. Sneij, M. Asin, M. Zaranz</i>	1691
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 <i>G. Măntescu, G. Gorghiu, M. Bizoi</i>	1694