EU PVSEC 2019

36th European Photovoltaic Solar Energy Conference and Exhibition

The Innovation Platform for the global PV Solar Sector

Conference Programme
Exhibition Catalogue

09 - 13 September 2019

Marseille Chanot Convention and Exhibition Centre, Marseille, France

www.photovoltaic-conference.com
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INSTITUTIONAL SUPPORT

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COORDINATION OF THE TECHNICAL PROGRAMME

JOINT RESEARCH CENTRE

INSTITUTIONAL PV INDUSTRY COOPERATION

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The content represents the status as of 14 August 2019

CHAIR'S MESSAGE

Photovoltaics: Writing the next chapter

EU PVSEC has a special meaning for me as it was my first experience of an international conference as a PhD student more than 20 years ago. It also has a special meaning for the Photovoltaic Energy actors as the unique European crossroad in between different specialties: scientific, technical, financial, policy and markets.

This 36th conference in Marseille of what has become a truly world-class event will be rich with opportunities to discover the latest research results and data and gain insights into one of the most promising advances in PV technologies- all in one of France's sunniest climates.

The transition to a sustainable energy future will not be possible without a carbon-free energy sector dominated by renewables. As a major contributor to a cleaner and safer future for the planet, PV technologies will play a key role in transforming our energy systems while enabling a massive shift to carbon-free energy. As costs have come down, renewable energy is being rolled out at record levels. However, because emission levels are still far from reaching the targets set in the Paris Agreement, there is still much progress to be made to get renewables into the energy mix at an even faster pace.

Global investment in renewable-energy projects dropped slightly in 2018. And yet, the same year, more than 100 GWp of PV power was installed worldwide, evidence of the maturity of PV technologies. To continue to speed up the energy transition, PV must be addressed holistically alongside grid-integration technologies. These include tools to enable greater grid flexibility, battery-based or hydrogen storage, and digital systems. The goal is to provide the backbone for tomorrow's massive "smart-grid-ready" PV power plants. Consumers will benefit from cost reductions, of course. But so will high-added-value applications like advanced building-integrated photovoltaics and emerging transportation concepts.

This expanded vision for the next chapter in PV history will call for innovative approaches beyond just PV production. The entire value chain will have to be addressed, from new materials through to system-level advances. Currently, the primary challenges are high-efficiency cells, modules offering extended lifespans, efficient power electronics, multiscale smart grid modelling, and, finally, eco-design to ensure recyclability and more economical use of critical materials.

A strong and coordinated worldwide industry needs to be the collector of all these innovation subjects and Europe has the challenge to play a role again. And the previously described technology ruptures should be an opportunity. Thus, more that an energy solution for the future PV production, integration and related services will represent a considerable worldwide potential for jobs and for increasing prosperity for all the countries.

EU PVSEC 2019 will be the place to start new conversations on these and other topics and get the latest updates on the PV advanced world.

I am looking forward to an impressive programme of this 36th EU PVSEC conference and I am confident that you will find ample learning and networking opportunities at an event orchestrated to unlock your creativity and broaden your vision.

Dr. Florence Lambert
EU PVSEC 2019 General Chair
Director of CEA Liten
(the Laboratory for Innovation in new
Energy Technologies and Nanomaterials)

WELCOME FROM THE TECHNICAL PROGRAMME CHAIR

I am pleased to welcome you to the 36th European Photovoltaic Solar Energy Conference. This week follows closely from a record-breaking hot summer in much of the world which has provided a timely reminder of the urgency of our task to rapidly grow the renewable energy sector. I hope you have all had a relaxing break and are refreshed and ready to take up the challenge once again. Personally, I attended a competition for masters (read older) sports enthusiasts, and can humbly vouch for the truth in the adage ‘you can’t teach an old dog new tricks’. Let us all together this week show the out-of date carbon emitting power industry that we have all the new tricks and it is time for them to retire.

The conference programme was updated in this year’s call for abstracts, with some additions. From the perspective of materials and devices, we have added topics to encourage further input in the fields of perovskite materials and tandem device concepts. At the system scale, we have included new topics on storage, professional applications of PV and grid integration issues. As well as closely following your own field’s oral and visual sessions, I also encourage you all to attend the plenary sessions that cover the broad range of all the thematic topics of the conference.

We have also introduced some novelties in the poster and student awards. To further highlight the importance of visual presentations, there will be a poster awards opening on Monday at which Poster Awards Committee members welcome and inform presenters. Additionally, a visual closing session on Thursday will provide delegates with the opportunity to follow short presentations of the winning posters. The student awards nominees have been shortlisted and the final selection of winners this year will be made taking the presentation delivery into consideration as well as the scientific content. Both awards ceremonies will be held during the closing session on Friday as usual.

I look forward to meeting you during an informative and stimulating week in Marseille.

Dr. Robert Kenny
European Commission Joint Research Centre
EU PVSEC Technical Programme Chair

WELCOME

CONFERENCE PROGRAMME

Plenary, Oral and Visual Sessions

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, 09 September 2019

CONFERENCE OPENING

08:30 - 09:30 Scientific Opening

PLENARY SESSION 1AP.1

08:30 - 09:30 Routes to High Efficiency in Photovoltaics

Chairpersons:

Robert Kenny
European Commission Joint Research Centre, Italy

Antonio Martí Vega
UPM, Spain

1AP.1.1 III-V//Si Three-Junction Solar Cells Reaching 30% Efficiency Using Smart Stack Technology

K. Makita, H. Mizuno, T. Tayagaki, T. Aihara, R. Oshima, Y. Shoji, H. Takato & T. Sugaya
AIST, Tsukuba, Japan
R. Müller, P. Beutel, D. Lackner, J. Benick, M. Hermle & F. Dimroth
Fraunhofer ISE, Freiburg, Germany

1AP.1.2 Interconnection 1, 2, 3, 4.0: Buildup towards a PV Technology Hero?

T. Borgers, J. Govaerts, A.S.H. van der Heide, E. Voroshazi, P. Manganiello, J. Szlufcik, J. Poortmans, L. Vastmans, R. Moors & G. Doumen
imec, Genk, Belgium
R. Van Dyck & I. El -Chami
KULeuven, Belgium
P. Nivelle
UHasselt, Diepenbeek, Belgium
R. Bervoets
IPTE, Genk, Belgium

1AP.1.3 Approaching Maximum Efficiency of Colored Opaque Photovoltaics with Real Photonic Structures

J. Halme & P. Mäkinen
Aalto University, Finland

09:30 - 10:00 Becquerel Prize Ceremony

Chaired by
Joachim Luther
Chair Becquerel Prize Committee

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

Laudatio
Stefan Glunz
Fraunhofer ISE, Freiburg, Germany

Delivery of the Prize by
Piotr Szymanski
European Commission Joint Research Centre, Director of Energy, Transport and Climate

10:00 - 11:00 Opening Addresses

- **Florence Lambert**
  EU PVSEC General Chair
  Director of CEA Liten,
  the Laboratory for Innovation in new Energy Technologies and Nanomaterials, France
- **Laurent Michel**
  Director General of Energy and Climate, Ministry for the Ecological and Inclusive Transition, France
- **Piotr Szymanski**
  European Commission Joint Research Centre, Director of Energy, Transport and Climate
- **Walburga Hemetsberger**
  Chief Executive Officer, SolarPower Europe

11:00 - 12:15 Moderated Panel Discussion (page 8)

11:00 - 12:15 Moderated Panel Discussion

Topic: The Future of PV Manufacturing in Europe

Panellists

- **Andreas Bett**
  Director, Fraunhofer ISE, Germany
- **Roch Drozdowski-Strehl**
  General Director, IPVF, France
- **Paolo Frankl**
  Head of Renewable Energy Division, IEA - International Energy Agency
- **Philippe Malbranche**
  General Director, CEA INES
- **Stefan Rinck**
  CEO, Singulus, Germany
- **Eicke Weber**
  prel. Chair ESMC (European Solar Manufacturing Council)
- **Heinz Ossenbrink,**
  Former European Commission Joint Research Centre
- **Representative French Industry / Developer** (i)

This programme reflects confirmations as of 26 August 2019. For the latest programme news please check www.photovoltaic-conference.com

Conference Programme
MONDAY, 09 SEPTEMBER 2019

PROGRAMME

Conference Programme
MONDAY, 09 SEPTEMBER 2019

PROGRAMME

Opening

Scientific Opening
1AP.1 (60 min plenary)
Auditorium 1
Becquerel Prize Ceremony

Opening Addresses

Moderated Panel Discussion

Lunch

1AO.1 T1.1 ***Audit 3***	**2AO.4 T2.1** ***Audit 4***	**3AO.7 T3.2** ***Audit 1***	**Poster Awards Kick-off**

Break

1AO.2 T1.1 ***Audit 3***	**2AO.5 T2.1** ***Audit 4***	**3AO.8 T3.2** ***Audit 1***	**4AV.1 T4.1** ***Poster Area***

Break

1AO.3 T1.2 ***Audit 3***	**2AO.6 T2.1/4** ***Audit 4***	**3AO.9 T3.2** ***Audit 1***	**4AV.2 T4.1/2/3** ***Poster Area***

1 New Materials and Concepts for Photovoltaic Devices
- T1.1 Fundamental Studies
- T1.2 New Materials and Concepts for Cells and Modules

2 Silicon Materials and Cells
- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices
- T3.1 Perovskites Based Photovoltaics
- T3.2 CI(G)S, CdTe and Related Thin Film Solar Cells
- T3.3 Organic and Dye-Sensitised Devices
- T3.4 III-V and Related Compound Semiconductor Based Devices
- T3.5 Tandems

4 Photovoltaic Modules and BoS Components
- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

ORAL PRESENTATIONS 1AO.1

13:30 - 15:00 Energy Conversion Mechanisms and Materials Characterisation

Chairpersons:

Daniel Ory
EDF R&D, France

Masafumi Yamaguchi
Toyota Technological Institute, Japan

1AO.1.1 From the Hot Carrier Solar Cell to the Intermediate Band Solar Cell, Passing through the Multiple-Exciton Generation Solar Cell and Then Back to the Hot Carrier Solar Cell: The Dance of the Electro-Chemical Potentials
A. Martí Vega
UPM, Madrid, Spain

1AO.1.2 Electrical Multi-Probe Investigation of Nanowires for Solar Energy Conversion
A. Nägelein, C. Timm, M. Steidl, P. Kleinschmidt & T. Hannappel
Ilmenau University of Technology, Germany

1AO.1.3 Simple Thermionic Model of Hot Carrier Solar Cell with Semi-Infinite Energy Filtering
I. Konovalov & B. Ploss
University of Applied Science, Jena, Germany

1AO.1.4 Carrier-Resolved Photo-Hall
O. Gunawan, D.M. Bishop, Y. Virgus & Y.S. Lee
IBM, Yorktown Heights, United States
S.R. Pae & B. Shin
KAIST, Daejeon, Republic of Korea
J.H. Noh
Korea University, Seoul, Republic of Korea
N.J. Jeon
KRICT, Daejeon, Republic of Korea

1AO.1.5 GaAs Subcell with Hybrid Quantum Objects for Triple-Junction Solar Cells
M.A. Mintairov, V.V. Evstropov, S.A. Mintairov, M.Z. Shvarts & N.A. Kalyuzhnyy
RAS / Ioffe, St. Petersburg, Russia

1AO.1.6 A Thermophotovoltaic (TPV) Micro-Combustor Using Selective Emitters
Y.-H. Li
NCTU, Tainan, Taiwan
P. Parashar, P. Yu & A. Lin
NCTU, Hsinchu, Taiwan
K.-H. Pen
NCKU, Tainan, Taiwan

ORAL PRESENTATIONS 2AO.4

13:30 - 15:00 Defects in Crystalline Silicon

Chairpersons:

Anis Jouini
CEATECH-INES, France

Ronald Sinton
Sinton Instruments, United States

2AO.4.1 Insights on the Electronic Parameterisation of Defects in Silicon Obtained from the Formation of the Defect Repository
M.K. Juhl & F.E. Rougieux
UNSW Australia, Sydney, Australia
F.D. Heinz, T. Niewelt & M.C. Schubert
Fraunhofer ISE, Freiburg, Germany
G. Coletti
ECN part of TNO, Petten, The Netherlands
C. Sun & D. Macdonald
ANU, Canberra, Australia
J.J. Krich
University of Ottawa, Canada

2AO.4.2 Investigating Defect States in Monocrystalline Silicon with Temperature and Injection Dependent Lifetime Spectroscopy
M. Syre Wiig, R. Søndenå, E.S. Marstein & H. Haug
Institute for Energy Technology, Kjeller, Norway

2AO.4.3 Assessing a Two-Step Approach to Eliminate LeTID in p-Type PERC Solar Cells
C. Sen, C. Chan, P. Hamer, M. Wright, U. Varshney, S. Liu, A. Samadi, A. Ciesla, C.M. Chong, B. Hallam & M. Abbott
UNSW Australia, Sydney, Australia

2AO.4.4 **Student Award Finalist Presentation: Impact of Silicon Nitride Film Properties on Hydrogen In-Diffusion into Crystalline Silicon**
D. Bredemeier, D.C. Walter & J. Schmidt
ISFH, Emmerthal, Germany
R. Heller
HZDR, Dresden, Germany

2AO.4.5 **On the Influence of Advection Cooling during Degradation and Regeneration of Boron-Oxygen Defects Using High Intensity Illumination**
A. Herguth, A. Graf & G. Hahn
University of Konstanz, Germany

2AO.4.6 **Light-Induced Degradation in Boron-Doped Cz Silicon PERC: Excessive Enhancement by Dark Annealing**
F. Fertig, R. Lantzsch, F. Kersten, F. Frühauf, J. Lindroos, C. Taubitz, M. Schütze & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

ORAL PRESENTATIONS 3AO.7

13:30 - 15:00 Progress in CIGS Modules

Chairpersons:

Alessandro Romeo
University of Verona, Italy

Bernhard Dimmler
NICE Solar Energy, Germany

3AO.7.1 **Absorber Optimization in CIGSSe Modules with a Sputtered ZnOS Buffer Layer at 19 % Efficiency**
M. Stölzel, M. Algasinger, A. Zelenina, A. Weber, M. Sode, C. Schubbert, P. Eraerds, R. Lechner, T. Dalibor & J. Palm
Avancis, Munich, Germany

3AO.7.2 **ZnMgO Buffer Deposition in Commercial-Size CIGS PV Modules**
P. Kratzert, T. Henke, J. Nowoczin, V.R. Gutlapalli, I. Ratschinski, S. Jander & R. Hunger
Solibro, Bitterfeld-Wolfen, Germany
O. Lundberg, J. Joel & L. Stolt
Solibro Research, Uppsala, Sweden

3AO.7.3 **Alkali Incorporation in High-Efficiency Cu(In,Ga)Se2 Solar Cells on Flexible Substrates**
R. Carron, S. Nishiwaki, T. Feurer, R. Hertwig, E. Avancini, J. Löckinger, S.-C. Yang, S. Buecheler & A.N. Tiwari
EMPA, Dubendorf, Switzerland

3AO.7.4 **Development of an Industrially Compatible Process for Light Weight CIGS Modules on Polymer Substrates by Optimizing Deposition Parameters**
V. Achard, M. Jubault, F. Donsanti & D. Cammilleri
IPVF, Palaiseau, France
R. Würz & F. Kessler
ZSW, Stuttgart, Germany
D. Lincot
CNRS, Palaiseau, France

3AO.7.5 **Fabrication of High-Efficient and Flexible Cu(In,Ga)Se2 Thin-Film Photovoltaics on Stainless Steel Substrates: Impacts of Various Impurity Barriers and Their Structures on Device Performances**
D. Shin, K. Kim, I. Jeong, Y.-J. Eo, S. Song, A. Cho, J.S. Yoo, S.K. Ahn, J.-S. Cho, J.H. Park, S.J. Ahn, Y. Cho, J.H. Yun & J. Gwak
KIER, Daejeon, Republic of Korea

3AO.7.6 **Humidity Barriers and Environmentally Stable Front Contacts for Flexible Thin Film Modules**
P.J. Bolt, F.J. van den Bruele, D. Roosen-Melsen, H. Steijvers & H. Linden
TNO, Eindhoven, The Netherlands
G. Torres Sevilla & Y.E. Romanyuk
EMPA, Dubendorf, Switzerland

13:30 - 15:00 POSTER AWARDS KICK-OFF

ORAL PRESENTATIONS 1AO.2

15:15 - 16:45 Conversion Efficiency Limits and Materials Characterisation

Chairpersons:

Jean-Francois Guillemoles
CNRS, France

Thomas Hannappel
Ilmenau University of Technology, Germany

1AO.2.1 Student Award Finalist Presentation: The Ultimate Potential of Reconfigurable Modules for Increasing the Energy Yield of Partially Shaded Urban Photovoltaics Systems
A. Calcabrini, R. Weegink, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

1AO.2.2 Efficiency Limits and Performance Limiting Factors of Inorganic, Organic and Hybrid Perovskite Solar Cells
Y. Kato, S. Fujimoto, M. Kozawa & H. Fujiwara
Gifu University, Japan

1AO.2.3 Effects of High Photon Gas Density and Radiative Efficiency on Upper Bounds of Energy Conversion Efficiency in Single-Crystal Solar Cells
S.J. Babcock, N.P. Irvin, C.B. Honsberg & R.R. King
Arizona State University, Tempe, United States

1AO.2.4 Multi-Dimensional Luminescence Imaging: Accessing to Transport Properties
D. Ory, A. Bercegol, O. Fournier & J. Rousset
EDF R&D, Palaiseau, France
D. Suchet & J.-F. Guillemoles
CNRS, Palaiseau, France
M. Legrand, J.-B. Puel, A. Michaud, A. Ben Slimane, S. Collin, S. Cacovich, A. Rebai & L. Lombez
IPVF, Palaiseau, France

1AO.2.5 Photocurrent Spectra and Transport Characterizations on Halide Perovskites Thin Films
H.-J. Lin, A. Rebai & S. Cacovich
IPVF, Palaiseau, France
J. Rousset
EDF R&D, Palaiseau, France
C. Longeaud
CNRS, Gif-sur-Yvette, France

1AO.2.6 C-AFM and KPFM Characterization of poly-Si/SiOx/c-Si Passivated Contact Structure
C. Marchat
IPVF, Palaiseau, France
A. Morisset & R. Cabal
CEA, Le Bourget du Lac, France
J. Alvarez, M.E. Gueunier-Farret & J.-P. Kleider
CNRS, Gif-sur-Yvette, France

ORAL PRESENTATIONS 2AO.5

15:15 - 16:45 Crystallizing Silicon for Photovoltaics

Chairpersons:

Brett Hallam
UNSW Australia, Australia

João M. Serra
University of Lisbon, Portugal

2AO.5.1 Silicon Ingot Growth from Nitride Crucibles Made from Kerf-Loss Silicon during Diamond Wire Sawing
C.-E. Liu, H.-T. Yu, H.-L. Yang & C.-W. Lan
NTU, Taipei, Taiwan

2AO.5.2 Solid State Diffusion of Metallic Impurities from Crucible and Coating Material into Crystalline Silicon Ingots for PV Application
F. Sturm, M. Trempa, S. Schwanke, K. Schuck, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany
C. Kranert
Fraunhofer THM, Freiberg, Germany

2AO.5.3 Enhanced Material Quality in SMART mono-Si Block Cast Ingots by Introduction of Functional Defects
S. Riepe, P. Krenckel, A. Hess, T. Trötschler, Y. Hayama, K. Kutsukake, F. Schindler & N. Usami
Fraunhofer ISE, Freiburg, Germany

2AO.5.4 Adopting Continuous Czochralski (CCz) Process in Production by Retrofitting Czochralski (Cz) Monocrystalline Puller in the Field
J. He & D. Wang
JA Solar, Xingtai, China
R. Malen, S. Keohane & H. Xu
GT Advanced Technologies, Hudson, United States

2AO.5.5 On the Progress in Data Science Approaches for High-Quality Multicrystalline Silicon Ingot for Solar Cells
N. Usami, K. Tajima, S. Kamibeppu, A.E. Boucetta, T. Kojima, T. Matsumoto, H. Kudo, Y. Noda & T. Yokoi
Nagoya University, Japan
K. Kutsukake
RIKEN, Tokyo, Japan
Y. Shimizu & Y. Ohno
Tohoku University, Sendai, Japan

2AO.5.6 Combined Experimental and Numerical Investigation of Cz Growth Conditions on Thermal Donors Generation
M. Albaric, M. Chatelain, J. Veirman, D. Pelletier & M. Benmansour
CEA, Le Bourget du Lac, France

ORAL PRESENTATIONS 3AO.8

15:15 - 16:45 New Concepts in Chalcogenides

Chairpersons:

Wiltraud Wischmann
ZSW, Germany

Marc Meuris
imec, Belgium

3AO.8.1 Ultrathin CIGS Solar Cells with Passivated and Highly Reflective Back Contacts – Results from the ARCIGS-M Consortium
M. Edoff & W.-C. Chen
Uppsala University, Sweden
I. Gordon
imec, Leuven, Belgium
B. Vermang
imec, Genk, Belgium
P.J. Bolt, J. van Deelen & M. Simor
TNO, Eindhoven, The Netherlands
D. Flandre & J. Lontchi
UCL, Louvain-la-Neuve, Belgium
M. Kovacic & J. Krc
University of Ljubljana, Slovenia
L. Gouillart, S. Collin & N. Naghavi
CNRS, Palaiseau, France
M. Jubault
EDF R&D, Palaiseau, France
R. Kotipalli & L. Fourdrinier
AC&CS, Liège, Belgium

Y. Zhou
Obducat Technologies, Malmö, Sweden
R. Vignal
Arcelor Mittal, Maizières-lès-Metz, France
V. Gusak
Solibro Research, Uppsala, Sweden
E. Niemi & K. Takei
Midsummer, Järfälla, Sweden
S. Bose, J.M.V. Cunha, T.S. Lopes, P.A. Fernandes, P. Anacleto, S. Sadewasser & P.M.P. Salomé
INL, Braga, Portugal

3AO.8.2 Student Award Finalist Presentation: Submicron CIGS Solar Cells: Feasibly towards the Absorption Limit
N. Rezaei, O. Isabella, P. Procel Moya & M. Zeman
Delft University of Technology, The Netherlands
Z. Vroon
TNO, Geleen, The Netherlands

3AO.8.3 Direct Fabrication of Ultrathin Cu(In,Ga)Se2 Solar Cells on Ag-Based Reflective Back Contacts
L. Gouillart, A. Cattoni, J. Goffard, N. Naghavi & S. Collin
CNRS, Palaiseau, France
W.-C. Chen, L. Riekehr, J. Keller & M. Edoff
Uppsala University, Sweden
M. Jubault
EDF R&D - IPVF, Palaiseau, France

3AO.8.4 Time-Resolved Photoluminescence Study of the Influence of Na on the Non-Radiative Recombination in Cu-Poor, Thermally Co-Evaporated Cu(In,Ga)Se2 Solar Cells
M. Morawski, M. Maiberg & R. Scheer
Martin Luther University Halle-Wittenberg, Halle (Saale), Germany

3AO.8.5 Co-Evaporated Cu(In,Ga)S2 Thin Films: Process Issues, Material Properties and Device Performance
A. Thomere & R. Bodeux
EDF R&D, Palaiseau, France
C. Guillot-Deudon, N. Barreau, M.T. Caldes & A. Lafond
University of Nantes, France

3AO.8.6 invited

VISUAL PRESENTATIONS 4AV.1

15:15 - 16:45 PV Module Design, Manufacture, Performance and Reliability (I)

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

ORAL PRESENTATIONS 1AO.3

17:00 - 18:30 Light Management and Spectral Conversion

Chairpersons:

Igor Konovalov
University of Applied Sciences Jena, Germany

James Patrick Connolly
CNRS/GeePs, France

1AO.3.1 Front Side Structures in TiO2 for Crystalline Silicon Solar Cells: Which Effects Can They Achieve?
L. Stevens, H. Hauser, O. Höhn, N. Tucher, C. Wellens & B. Bläsi
Fraunhofer ISE, Freiburg, Germany
C. Stauch & R. Jahn
Fraunhofer ISC, Würzburg, Germany
C. Müller
University of Freiburg, Germany

1AO.3.2 80% Average Absorption in Ultrathin Hot Carriers Solar Cells with Tetrahedron Nanostructures
J. Goffard, M. Giteau, A. Cattoni, N. Bardou, L. Lombez, J.-F. Guillemoles & S. Collin
CNRS, Palaiseau, France
S. Boyer-Richard, A. Beck, A. Le Corre & O. Durand
INSA-Rennes, France

1AO.3.3 Surface Nanostructuring and Physical Properties of In2S3 Flms Using Argon Plasma Treatment
V.F. Gremenok & E.P. Zaretskaya
NASB, Minsk, Belarus
S.P. Zimin, A.S. Pipkova & L.A. Mazaletskiy
Yaroslavl State University, Russia
A.N. Pyatlitski, V.A. Saladukha & T.V. Piatlitskaya
JSC "INTEGRAL", Minsk, Belarus

1AO.3.4 Inkjet-Printed Three-Dimensional Colloidal Photonic Crystals for Structural Coloration of Solar Cells
R. Speranza, T. Huhtamäki, S. Lepikko, R.H.A. Ras & J. Halme
Aalto University, Finland

1AO.3.5 Indoor Energy Micro-Sources for Energetically Autonomous Nomadic Devices
B. Politi, S. Parola, A. Gademer, Y. Cuminal, A. Foucaran & N. Camara
IES, Montpellier, France
M. Piquemil
Bureaux A Partager, Paris, France

1AO.3.6 Characterization of Spectral Conversion Layer Comprising Luminescent Down-Shifting Eu-Doped Phosphors Enhanced by Plasmonics Silver Nanoparticles
X.-Y. Chen, W.-J. Ho, J.-C. Chen, J.-J. Liu, D.-L. Lin, B.-Y. Pan & Y.H. Chen
NTUT, Taipei, Taiwan

ORAL PRESENTATIONS 2AO.6

17:00 - 18:30 Thin Silicon Solar Cells

Chairpersons:

Paola Delli Veneri
ENEA, Italy

Martin P. Bellmann
SINTEF, Norway

2AO.6.1 Sawing Damage Control for Thin Flexible Si Solar Cells
K. Onishi, R. Yokogawa, T. Nishihara, T. Kamioka & A. Ogura
Meiji University, Kawasaki, Japan
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
T. Kawatsu & T. Nagai
Komatsu NTC, Nanto, Japan
N. Yamada & Y. Miyashita
Nagaoka University of Technology, Japan

2AO.6.2 Correlating Template Properties with the Quality of Epitaxially Grown Silicon Wafers
M. Drießen, T. Fehrenbach, L. Kirste, C. Weiss & S. Janz
Fraunhofer ISE, Freiburg, Germany

2AO.6.3 Dopant-Free Asymmetric Thin Film Crystalline Silicon Heterojunction Solar Cells
J. He, W. Wang, S. Karuturi & Y. Wan
ANU, Canberra, Australia

2AO.6.4 Bifacial Amorphous Si Quintuple-Junction Solar Cells for IoT Devices with High Open-Circuit Voltage of 3.5V under Low Illuminance
M. Konagai & R. Sasaki
Tokyo City University, Japan

2AO.6.5 The Fabrication of Thin Film Silicon Radial Junction Solar Cells Built on the VLS Grown Silicon Nanowire Array
M. Müller, J. Stuchlík, M. Ledinsky, A. Fejfar & J. Kocka
ASCR, Prague, Czech Republic

2AO.6.6 Highly Efficient Transparent a-Si:H Solar Cells for Light Harvesting under Indoor Illumination using Collection Enhancing Layer
G. Kim, M.A. Park, S.H. Jang & J.W. Lim
ETRI, Daejeon, Republic of Korea
M. Shin
Korea Aerospace University, Goyang, Republic of Korea

ORAL PRESENTATIONS 3AO.9

17:00 - 18:30 Buffers, Absorbers and Interfaces in CIGS Devices

Chairpersons:

Thomas Dalibor
Avancis, Germany

Takahiro Wada
Ryukoku University, Japan

3AO.9.1 Special Introductory Presentation: Recent CIGS Photovoltaics Research Activity at AIST
S. Ishizuka, J. Nishinaga, Y. Kamikawa-Shimizu, S. Kim, T. Koida & H. Shibata
AIST, Tsukuba, Japan
N. Taguchi
AIST, Ikeda, Japan
S. Niki
NEDO, Kawasaki, Japan

3AO.9.2 Post-Sulfurization of Cu(In,Ga)Se2 Absorbers: General Observations and Effect of Cu Content on Solar Cell Performance
J. Keller, M. Edoff & C. Platzer-Björkman
Uppsala University, Sweden
O. Bilousov & O. Lundberg
Solibro Research, Uppsala, Sweden

3AO.9.3 Zn(O,S) Buffer Layers for Cu(In,Ga)Se2 Thin Film Solar Cells by Magnetron Sputtering
M. Zutter, J. Virtuoso, P. Anacleto, D. Colombara, L. Yasin, M. Alves, O. Bondarchuk & S. Sadewasser
INL, Braga, Portugal
D. Fuster, J.M. Garcia & F. Briones
CSIC, Madrid, Spain
R. Wächter
NICE Solar Energy, Schwäbisch Hall, Germany
O. Kiowski & D. Hariskos
ZSW, Stuttgart, Germany

3AO.9.4 Characterization of High Bandgap CIGS Solar Cells and Corresponding Absorber/Buffer Interfaces: Results of the EFFCIS Project
W. Witte, D. Hariskos, O. Kiowski, S. Paetel & M. Powalla
ZSW, Stuttgart, Germany
M. Maiberg, S. Zahedi-Azad, P. Pistor & R. Scheer
Martin Luther University, Halle, Germany
D. Hauschild, V. van Maris, L. Weinhardt, C. Heske, X. Jin, R. Schneider, D. Gerthsen, J. Seeger & M. Hetterich
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany
J. Keutgen & O. Cojocaru-Mirédin
RWTH Aachen University, Germany
E. Ghorbani & K. Albe
Technical University of Darmstadt, Germany
A. Nikolaeva, J. Marquez-Prieto, M. Krause, S. Schäfer, C.J. Hages, D. Abou-Ras, T. Unold & R. Mainz
HZB, Berlin, Germany
P. Eraerds, T.P. Niesen, R. Lechner, T. Dalibor & J. Palm
Avancis, Munich, Germany
M. Schweiger & B. Dimmler
NICE Solar Energy, Schwäbisch Hall, Germany
R. Hunger, T. Henke & P. Kratzert
Solibro, Bitterfeld-Wolfen, Germany

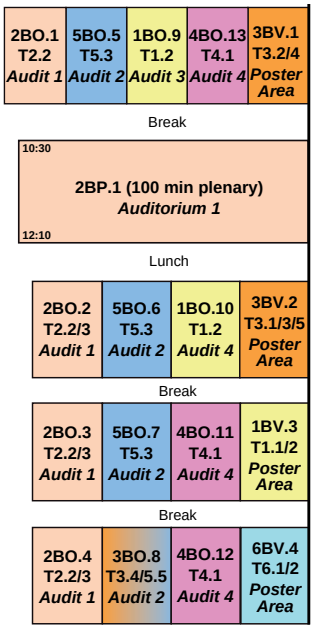
3AO.9.5 Modified Three-Stage Coevaporation Process for High Efficiency High-Ga Content CIGS Solar Cells
W. Li, J. Zheng, S. Xu, M. Chen, G. Zhong, W. Li, Y. Feng, H. Luo & C. Yang
CAS, Shenzhen, China

VISUAL PRESENTATIONS 4AV.2

17:00 - 18:30 PV Module Design, Manufacture, Performance and Reliability/ Inverters and Balance of System Components/ Sustainability and Recycling

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

NOTES



1 New Materials and Concepts for Photovoltaic Devices
- T1.1 Fundamental Studies
- T1.2 New Materials and Concepts for Cells and Modules

2 Silicon Materials and Cells
- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices
- T3.1 Perovskites Based Photovoltaics
- T3.2 CI(G)S, CdTe and Related Thin Film Solar Cells
- T3.3 Organic and Dye-Sensitised Devices
- T3.4 III-V and Related Compound Semiconductor Based Devices
- T3.5 Tandems

4 Photovoltaic Modules and BoS Components
- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

5 PV Systems and Storage – Modelling, Design, Operation and Performance
- T5.1 Solar Resource and Forecasting
- T5.2 Design and Installation of PV Systems
- T5.3 Operation, Performance and Maintenance of PV Systems
- T5.4 Storage
- T5.5 Concentrators and PV for Space Applications

6 PV Applications and Integration
- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

Conference Programme
TUESDAY, 10 SEPTEMBER 2019

PROGRAMME

ORAL PRESENTATIONS 2BO.1

08:30 - 10:00 PERX Silicon Solar Cells

Chairpersons:

Marco Ernst
ANU, Australia

Ralf Preu
Fraunhofer ISE, Germany

2BO.1.1 Optimization of Rear Al Fire-Through Contacts for Bifacial p-Type PERC with AlOx/SiNx Rear Passivation
D. Ourinson, T. Javaid, T. Fellmeth, M. Pospischil, G. Emanuel, F. Clement & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany
M. Dhamrin
Toyo Aluminium, Shiga, Japan

2BO.1.2 Deep Level Transient Spectroscopic Investigation of Carrier Trap Defects in p-Type mc-Si PERC Solar Cells After Elevated Temperature Light Soaking
C. Zhou, S. Zhou, F. Ji & W.J. Wang
CAS, Beijing, China

2BO.1.3 Impact of POCl3 Diffusion Process Parameters on Oxygen Precipitates and Impurity Gettering in Crystalline Silicon
S. Maus, S. Lohmüller, J. Schön & A. Wolf
Fraunhofer ISE, Freiburg, Germany

2BO.1.4 Towards 23% Screen-Printed Rear-Emitter Bifacial n-PERT Cells
P. Choulat, S. Singh, L. Tous, F. Duerinckx, I. Gordon & J. Szlufcik
imec, Leuven, Belgium
J. Chen & Z. Liu
Jolywood, Taizhou, China

2BO.1.5 APCVD Based Stacked Co-Diffusion for Multicrystalline Silicon p-PERT Solar Cells
F. Koschnick, J. Fichtner, A. Zuschlag & G. Hahn
University of Konstanz, Germany
H. Zunft
Gebr. Schmid, Freudenstadt, Germany

2BO.1.6 Undoped LPCVD PolySi Passivating Layer to Reduce Recombination Loss for Screen-Printed Contacts on Top of an Uniform Shallow Boron Emitter
X. Lu, M.K. Stodolny & J. Löffler
ECN part of TNO, Petten, The Netherlands
B.W.H. van de Loo & P.R. Venema
Tempress, Vaassen, The Netherlands

ORAL PRESENTATIONS 5BO.5

08:30 - 10:00 Performance of PV Systems

Chairpersons:

Gerhard Mütter
Alteso, Austria

Christian Thiel
European Commission JRC, Italy

5BO.5.1 International Collaboration Framework for the Calculation of Performance Loss Rates: Data Quality, Benchmarks, and Trends
D. Moser & S. Lindig
Eurac Research, Bolzano, Italy
D. Bertani
RSE, Milan, Italy
A.J. Curran & R.H. French
Case Western Reserve University, Cleveland, United States
M. Herz
TÜV Rheinland Energy, Cologne, Germany
G. Makrides
University of Cyprus, Nicosia, Cyprus
B. Müller
Fraunhofer ISE, Freiburg, Germany
M. Richter
3E, Brussels, Belgium
M. Van Iseghem
EDF R&D, Moret-sur-Loing, France
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
J.S. Stein
Sandia National Laboratories, Albuquerque, United States

5BO.5.2 Performance Analysis of Mechanistic and Machine Learning Models for Photovoltaic Energy Yield Prediction
A. Livera, M. Theristis, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
J. Sutterlueti
Gantner Instruments, Schruns, Austria
S. Ransome
Steve Ransome Consulting, Kingston upon Thames, United Kingdom

5BO.5.3 PV O&M Optimization by AI Practice
M.Y. Chang, K.H. Chen, T.P. Hsu, K. Wei & K. Chuang
Sinogreenergy, Taipei, Taiwan
C.-C. Hsu
YunTech, Douliou, Taiwan

5BO.5.4 General, Robust and Scalable Methods for String Level Monitoring in Utility Scale PV Systems
A. Skomedal, M.B. Øgaard, J.H. Selj, H. Haug & E.S. Marstein
Institute for Energy Technology, Kjeller, Norway

5BO.5.5 Automated Performance Monitoring of Multiple Rooftop Systems Using a Single Machine Learning Algorithm
K. Shetty, Y. Kaushal, R. Dhavan & V. Murthy
Tata Power Solar Systems, Bangalore, India

5BO.5.6 Review of PV Array Interconnection Schemes for Maximum Power Operation under Partial Shading
M. Etarhouni, B. Chong & L. Zhang
The University of Leeds, United Kingdom

ORAL PRESENTATIONS 1BO.9

08:30 - 10:00 Novel Concepts for PV Modules

Chairpersons:

Francesco Roca
ENEA, Italy

Richard King
Arizona State University, United States

1BO.9.1 Preparation of 8.5% Sub-Module out of 5% Dye Sensitized Solar Cells by Omnidirectional Light Trapping and 3D Cell Array
Y.H.C. Sim
University of Science and Technology, Daejeon, Republic of Korea
M.J. Yun, S.I. Cha & D.Y. Lee
KERI, Changwon, Republic of Korea

1BO.9.2 Student Award Finalist Presentation: Wearable and Washable Photovoltaic Fabrics
A. Satharasinghe, T. Hughes-Riley & T. Dias
Nottingham Trent University, United Kingdom

1BO.9.3 Automation of Silicone Solar Module Production with Low-Cost Tape Interconnection Method
J. Buddgård, T. Lagerstedt & A. Machirant
JB EcoTech, Lidingö, Sweden

1BO.9.4 Accelerated Test Method of Environment-Induced PID for Encapsulation Materials of PV Modules
L.-C. Yu, Y.-T. Li, H.-L. Wu & H.-H. Hsieh
ITRI, Hsin-Chu, Taiwan

1BO.9.5 Lightweight PV Module Approach - Field Test Study and Yield Evaluation
S. Schindler, D. Götz & D. Daßler
Fraunhofer CSP, Halle (Saale), Germany

1BO.9.6 Modelling and Optimization of Phase Change Materials (PCM) for Photovoltaic Module Cooling
J.C. Ortiz Lizcano, C. van Nierop y Sanchez, Z. Haghighi, P. Luscuere, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

ORAL SESSION 4BO.13

08:30 - 10:00 Module Aging and Degradation

Chairpersons:

Christos Monokroussos
TÜV Rheinland, China

Stefan Winter
PTB, Germany

4BO.13.1 Photovoltaic Climate Zones: The Global Distribution of Climate Stressors Affecting Photovoltaic Degradation
T. Karin & A. Jain
Lawrence Berkeley National Laboratory, United States
C. Birk Jones
Sandia National Laboratories, Albuquerque, United States

4BO.13.2 Durable PV Modules - Requirements for the Module Design and Aspects of Reliability Testing Techniques
G. Mathiak, W. Herrmann & F. Reil
TÜV Rheinland Energy, Cologne, Germany
A. Morlier & M. Köntges
ISFH, Hamelin, Germany
S. Großer, M. Pander, S. Schindler, M. Turek & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4BO.13.3 Error Analysis of Aged Modules with Cracked Backsheets
G.C. Eder & Y. Voronko
OFI, Vienna, Austria
W. Mühleisen & C. Hirschl
CTR, Villach, Austria
G. Oreski
PCCL, Leoben, Austria
H. Sonnleitner
ENcome Energy Performance, Klagenfurt, Austria

4BO.13.4 Measurement of the Changes in Elastic Properties of Polymeric Layers in a PV Module After Accelerated Aging Using Nanoindentation and Scanning Acoustic Microscopy
D.E. Mansour, L. Verissimo Mesquita, D. Philipp & L. Pitta Bauermann
Fraunhofer ISE, Freiburg, Germany
P. Christoefl
PCCL, Leoben, Austria

4BO.13.5 Weathering Stability of Alternative Polyolefin Encapsulants in Glass-Glass Modules
A. Omazic & G. Oreski
PCCL, Leoben, Austria
G.C. Eder
OFI, Vienna, Austria
L. Neumaier & C. Hirschl
CTR, Villach, Austria
M. Edler
ISOVOLTAIC Solinex, Lebring, Austria
G. Pinter
University of Leoben, Austria
M. Erceg
University of Split, Croatia

4BO.13.6 Development of Inhomogeneities in Multi-Crystalline Silicon PV Modules over Two Years of Real Operating Conditions
M. Bokalic, K. Brecl & M. Topič
University of Ljubljana, Slovenia

VISUAL PRESENTATIONS 3BV.1

08:30 - 10:00 CI(G)S, CdTe and Related Thin Film Solar Cells / III-V and Related Compound Semiconductor Based Devices

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

PLENARY SESSION 2BP.1

10:30 - 12:10 Silicon PV Highlights

Chairpersons:

Francesca Ferrazza
eni spa, Italy

Giso Hahn
University of Konstanz, Germany

2BP.1.1 Bulk Defects in Monocrystalline Silicon, Multicrystalline Silicon and Mono-Like Silicon Materials
H.C. Sio, S.P. Phang, H.T. Nguyen & D. Macdonald
ANU, Canberra, Australia

2BP.1.2 The Versatility of Passivating Carrier-Selective Silicon Thin Films for Diverse High-Efficiency Heterojunction-Based Solar Cells
A. Descoeudres, J. Horzel, B. Paviet-Salomon, L.-L. Senaud, G. Christmann, J. Geissbühler, P. Wyss, N. Badel, J.-W. Schüttauf, C. Allebé, A. Faes, S. Nicolay, C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

2BP.1.3 Both Sides Contacted Silicon Solar Cells: Options for Approaching 26% Efficiency
A. Richter, J. Benick, F. Feldmann, A. Fell, B. Steinhauser, J.-I. Polzin, N. Tucher, J.N. Murthy, M. Hermle & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2BP.1.4 Approaching 23 % and Mass Production of Bifacial p-Cz Q.ANTUM PERC Solar Cells
F. Stenzel, B.G. Lee, J. Cieslak, A. Schwabedissen, D. Wissen, S. Geißler, T. Rudolph, B. Faulwetter-Quandt, R. Hönig, R. Bakowskie, M. Schaper, A. Mette & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

2BP.1.5 Development of Industrial n-Type Bifacial TOPCon Solar Cells and Modules
W. Wu, H. Xia, S. Huang, J. Bao, L. Ma, X. Yuan, C. Chen, J. Chen, N. Yang, R. Liu, Z. Qiao, J. Chen & Z. Liu
Jolywood, Taizhou, China

ORAL PRESENTATIONS 2BO.2

13:30 - 15:00 PolySi Passivating Contacts (I)

Chairpersons:

Yukimi Ichikawa
Tokyo City University, Japan

Jean-Paul Kleider
CNRS/GeePs, France

2BO.2.1 Efficiency Potential of the "Both Polarities Poly-Si Front Side Structured" (Boss) Cell and Its Elegant Realization by LPCVD
R. Peibst, C. Kruse, S. Schäfer, V. Mertens, T. Dullweber & R. Brendel
ISFH, Emmerthal, Germany

2BO.2.2 Industrial Solar Cells Featuring Carrier Selective Front Contacts
J. Stuckelberger, D. Yan, P. Phang & D. Macdonald
ANU, Canberra, Australia
J. Yang, P. Zheng & X. Zhang
Jinko Solar, Haining, China

2BO.2.3 Electrical and Mechanical Characterization of Plated Ni/Cu/Ag Contacts on Polysilicon
B. Grübel, G. Cimiotti, V. Arya, F. Feldmann, B. Steinhauser & S. Kluska
Fraunhofer ISE, Freiburg, Germany

2BO.2.4 Integration Avenues in Solar Cells Implementing Passivating Contacts
J.J. Diaz Leon, C. Allebé, J. Horzel, G. Nogay, A. Descoeudres, G. Christmann, L. Ding, N. Badel, M. Despeisse & S. Nicolay
CSEM, Neuchâtel, Switzerland
A. Ingenito & C. Ballif
EPFL, Neuchâtel, Switzerland

2BO.2.5 High Quality Passivating Contacts with Very Thin p+ or n+ Polysilicon Layers for Large-Area Crystalline Silicon Solar Cells
P.C.P. Bronsveld, A. Gutjahr, S.L. Luxembourg, E.G. Hoek, M.K. Stodolny, A.A. Mewe & J. Löffler
ECN part of TNO, Petten, The Netherlands

2BO.2.6 Screen Printed Double-Side Contacted POLO-Cells with Ultra-Thin Poly-Si Layers
Y. Larionova, H. Schulte-Huxel, B. Min, M. Turcu, R. Brendel & R. Peibst
ISFH, Emmerthal, Germany
T. Kluge & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany

ORAL PRESENTATIONS 5BO.6

13:30 - 15:00 Imaging and Fault Detection in PV Systems

Chairpersons:

Peter Lechner
ZSW, Germany

Ulrike Jahn
TÜV Rheinland Energy, Germany

5BO.6.1 Field Experience of UVFL Inspection with Drone
J. Lin, B. Ku & S. Chen
PV Guider, Taipei, Taiwan

5BO.6.2 Photovoltaic Defect Classification through Thermal Infrared Imaging Using a Deep Learning Approach
C.W. Dunderdale, W.J. Brettenny, C.M. Clohessy & E.E. van Dyk
Nelson Mandela University, Port Elizabeth, South Africa

5BO.6.3 Quantification of Yield Losses in Large-Scale Photovoltaic Power Plants Using Infrared Thermography
A. Chaudron, Q. van Nieuwenhoven, A. Lambert & S. Scheerlinck
ENGIE Laborelec, Linkebeek, Belgium
T.-L. de Lophem & V. Punamiya
Sitemark, Leuven, Belgium

5BO.6.4 Student Award Finalist Presentation: Automatic Fault Detection of Photovoltaic Array by Convolutional Neural Networks during Aerial Infrared Thermography
A.K. Vidal de Oliveira & R. Rüther
UFSC, Florianópolis, Brazil
M. Aghaei
Albert-Ludwigs-University, Freiburg, Germany

5BO.6.5 Real-Time Fault Detection in Massive Multi-Array PV Plants Based on Machine Learning Techniques
C.-C. Hsu & J.-L. Li
YunTech, Douliou, Taiwan
Y.-S. Chen
Reforecast, Taichung, Taiwan

5BO.6.6 New Four-Stage Classification Method for Fault Detection and Diagnosis Applied to Photovoltaic Power Plants
A. Migan-Dubois & D. Diallo
GeePs, Gif-sur-Yvette, France
C. Delpha
University of Paris Sud, France

ORAL PRESENTATIONS 1BO.10

13:30 - 15:00 Novel Concepts for Materials and Solar Cells

Chairpersons:

Jozef (Jef) Poortmans
imec, Belgium

Pere Roca I Cabarrocas
CNRS, France

1BO.10.1 Direct Growth of III-V on Si for Tandem Solar Cells: Fabrication and Characterization of a GaAs Nanowire Top-Cell
R. de Lépinau, O. Lafont, B. Berenguier & L. Lombez
IPVF, Palaiseau, France
A. Scaccabarozzi, F. Oehler, H.-L. Chen, S. Collin & A. Cattoni
CNRS, Marcoussis, France

1BO.10.2 Selective Passivation and Doping at Surfaces and Grain-Boundaries of Polycrystalline Ga0.37In0.63P
A. Chikhalkar, N.M. Kumar & R.R. King
Arizona State University, Tempe, United States

1BO.10.3 High Open-Circuit Voltage CuSbS2 Solar Cells Achieved through the Formation of Epitaxial Growth of CdS/CuSbS2 Hetero-Interface by Post-Annealing Treatment
Y. Zhang, J. Huang, M.A. Green & X. Hao
UNSW Australia, Sydney, Australia

1BO.10.4 2D Transition Metal Dichalcogenide MoS2 for Fingerless Cell Application
T. Kamioka, T. Nishihara, Y. Hibino & A. Ogura
Meiji University, Kawasaki, Japan
Y. Hayashi, H. Lee, K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan

1BO.10.5 Naturally Formed Nanostructured Cu-In-Se Bulk Pn Homojunctions for Photovoltaic Devices
S. Menezes
InterPhases Solar, Moorpark, United States
A. Samantilleke
University of Minho, Braga, Portugal

1BO.10.6 Silicon Nanowire Based Hybrid Nanomaterials as Counter Electrodes for Dye-Sensitized Solar Cells
J. Kim, S.H. Jung, G.S. Choi, Y.B. Kim & S.M. Kim
GERI, Gumi, Republic of Korea

VISUAL PRESENTATIONS 3BV.2

13:30 - 15:00 Perovskites Based Photovoltaics / Organic and Dye-Sensitised Devices / Tandems

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

ORAL PRESENTATIONS 2BO.3

15:15 - 16:45 PolySi Passivating Contacts (II)

Chairpersons:

Arthur W. Weeber
ECN part of TNO, The Netherlands

Rasit Turan
METU, Turkey

2BO.3.1 Modelling of Passivation and Conductivity of n-Type Poly-Si Layers Adapting Machine Learning
S. Bordihn, B. Min, R. Peibst & R. Brendel
ISFH, Emmerthal, Germany

2BO.3.2 LPCVD in-Situ n-Type Doped Polysilicon Process Throughput Optimization and Implementation into an Industrial Solar Cell Process Flow
R.C.G. Naber & J.M. Luchies
Tempress, Vaassen, The Netherlands

2BO.3.3 Polysilicon Layers Doped by Plasma Immersion Ion Implantation (PIII): New Paths for Industrial Processing of Passivated Contacts Solar Cells
A. Veau, T. Desrues, C. Oliveau, A. Morisset, B. Martel & S. Dubois
CEA, Le Bourget-du-Lac, France
F. Torregrosa & L. Roux
Ion Beam Services, Peynier, France
A. Kaminski-Cachopo & Q. Rafhay
IMEP-LAHC, Grenoble, France

2BO.3.4 Inkjet-Printing of Phosphorus and Boron Dopant Sources for Tunnel Oxide Passivating Contacts
Z. Kiaee, C. Reichel, M. Nazarzadeh, R. Keding, F. Feldmann, J.D. Huyeng, M. Jahn, R. Singh, M. Hermle & F. Clement
Fraunhofer ISE, Freiburg, Germany

2BO.3.5 SiOxNyB and SiNxP for Ex-Situ Doping of Poly-Si Passivated Contacts
R. Cabal, A. Morisset, B. Grange & S. Dubois
CEA, Le Bourget du Lac, France

2BO.3.6 The Roles of Poly-Si Layer in Poly-Si Passivating Contact Solar Cells
H. Park, S.J. Park, S.H. Bae, J.Y. Hyun, C.H. Lee, D. Choi, D. Kang, H. Han, Y. Kang, H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea

ORAL PRESENTATIONS 5BO.7

15:15 - 16:45 Soiling, Degradation and Failure Diagnosis PV Systems

Chairpersons:

Franck Al-Shakarchi
CEATECH-INES, France

Steve Ransome
Steve Ransome Consulting, United Kingdom

5BO.7.1 Soiling Reduction by Modified PV Tracker
B. Figgis
QEERI, Doha, Qatar
K. Ilse
Fraunhofer CSP, Halle (Saale), Germany

5BO.7.2 SOLEIL Inno-PV Project Outputs: PV Modules Soiling Assessment and Development of Innovative Low Cost Cleaning Solutions
A. Barhdadi, D. Dahlioui, B. Laarabi, S.M. Alaoui, M. Rhourri, Y. Rouas & A. Said
Mohammed V University, Rabat, Morocco
J. Boardman, G. Dambrine & E. Menard
HeliosLite, Le Bourget-du-Lac, France

5BO.7.3 Improving Soiling Extraction: From Yearly to Monthly Soiling Rates
L. Micheli, F. Almonacid & E.F. Fernández
University of Jaén, Spain

5BO.7.4 Evaluation of Risk for Potential-Induced Degradation in Floating PV Systems
H. Liu, W. Luo, A. Kumar & T. Reindl
SERIS, Singapore, Singapore
P. Hacke
NREL, Golden, United States

5BO.7.5 Degradation in PV Power Plants: Theory and Practice
K. Kiefer, B. Farnung & B. Müller
Fraunhofer ISE, Freiburg, Germany
K. Reinartz & I. Rauschen
Pohlen Solar, Geilenkirchen, Germany

5BO.7.6 Analysis of Digitized PV-Module/System Data for Failure Diagnosis
C. Buerhop-Lutz, T. Pickel, J. Teubner & J. Hauch
HI ERN, Erlangen, Germany
C.J. Brabec
FAU, Erlangen, Germany

ORAL PRESENTATIONS 4BO.11

15:15 - 16:45 PV Module Design / Wind Load / Soiling

Chairpersons:

Ana Rosa Lagunas
CENER, Spain

Eszter (Esther) Voroshazi
imec, Belgium

4BO.11.1 Thermomechanical Evaluation of New PV Module Designs by FEM Simulations
A.J. Beinert, P. Romer, M. Heinrich, M. Mittag & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany
J. Aktaa
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

4BO.11.2 Digital Prototyping – Application of Numerical Methods in Module Development
M. Pander, U. Zeller, B. Jaeckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4BO.11.3 Boosting PV Module Efficiency Beyond the Efficiency of Its Solar Cells – An Optical Simulation Study
M.R. Vogt, R. Witteck, T. Gewohn, H. Schulte-Huxel,
M. Köntges, K. Bothe & R. Brendel
ISFH, Emmerthal, Germany
C. Schinke
Leibniz University of Hannover, Germany

4BO.11.4 Non-Uniform Wind Loads Test for Photovoltaic Module
S.-T. Hsu, W.-Y. Lin & C.F. Hsieh
ITRI, Hsinchu, Taiwan

4BO.11.5 Student Award Finalist Presentation: Physics of Soiling and Dust Adhesion - Lessons Learnt from Laboratory Soiling Tests
K. Ilse, M.Z. Khan, V. Naumann & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany

4BO.11.6 Test Protocol for PV Module Cleaning Equipment
N. Ferretti, A. El-Issa & L. Podlowski
PI Berlin, Germany

VISUAL PRESENTATIONS 1BV.3

15:15 - 16:45 Fundamental Studies / New Materials and Concepts for Cells and Modules

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

ORAL PRESENTATIONS 2BO.4

17:00 - 18:30 Advanced Concepts for Si-based Solar Cells

Chairpersons:

Joachim John
imec, Belgium

Ronald C.G. Naber
Tempress, The Netherlands

2BO.4.1 Diffused Thin LPCVD poly-Si Emitter and Surface Field for High Efficiency c-Si Solar Cell
G. Yang, A.W. Weeber, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

2BO.4.2 Electrode Design for Wire Interconnected Back Contact Solar Cells
A. Spribille, J.D. Huyeng, T. Schweigstill, I. Franzetti,
L.C. Rendler & F. Clement
Fraunhofer ISE, Freiburg, Germany

2BO.4.3 High-Resolution THz Imaging for Optimized polySi Patterning Process
A. Mewe, M. Stodolny, P. Manshanden, A. Gutjahr,
I. Cesar & J. Löffler
ECN part of TNO, Petten, The Netherlands

2BO.4.4 Development of Very Thin Rib Structure Si Hetero-Junction Solar Cells
Y. Ichikawa, Y. Osawa, H. Noge & M. Konagai
Tokyo City University, Setagaya-ku, Japan

2BO.4.5 Tunnel Contact IBC Cells: An Industrial Process Using Shadow Masking
B. Legradic, D. Lachenal, D.L. Bätzner, P. Papet, R. Kramer, T. Kössler, L. Andreetta, S. Pitteloud, N. Holm, C. Aeby, W. Frammelsberger & B. Strahm
Meyer Burger Research, Hauterive, Switzerland

2BO.4.6 Implementation and Characterization of Tunnel-Oxide Passivating Contacts for Single Junction c-Si and Perovskite/c-Si Tandem Solar Cells
A. Ingenito, F. Mayer, P. Wyss, M. Lehmann, A. Savoy, F. Sahli, J. Werner, Q. Jeangros, F.-J. Haug & C. Ballif
EPFL, Neuchâtel, Switzerland
C. Allebé, G. Nogay, J.J. Diaz Leon, J. Horzel, S. Nicolay & M. Despeisse
CSEM, Neuchâtel, Switzerland
S. Eswara, N. Valle & T. Wirtz
LIST, Belvaux, Luxembourg

ORAL PRESENTATIONS 3BO.8

17:00 - 18:30 III-V Cells for Space and Terrestrial Applications

Chairpersons:

Carsten Baur
European Space Agency, The Netherlands

Gianluca Timò
RSE, Italy

3BO.8.1 Bragg Reflector within Triple-Junction Solar Cells for Spectrum Splitting Applications
Y. Jiang, M.J. Keevers, N. Ekins-Daukes & M.A. Green
UNSW Australia, Sydney, Australia
P. Pearce
Imperial College London, United Kingdom
A. Berg, F. Wolf, W. Guter & M. Meusel
Azur Space, Heilbronn, Germany

3BO.8.2 Growth and Structure Optimization of 1.73eV MBE-Grown AlGaAs/InGaP Heterostructure Solar Cells
A. Ben Slimane, A. Bercegol, L. Lombez, J.-B. Puel & A. Julien
IPVF, Palaiseau, France
A. Michaud
Total New Energies, Palaiseau, France
O. Mauguin & X. Lafosse
CNRS, Paris, France
J.-F. Guillemoles, J.-C. Harmand & S. Collin
CNRS, Palaiseau, France

3BO.8.3 Status and Recent Results from the Development of Dynamic Hydride Vapor Phase Epitaxy toward Low-Cost, High-Efficiency III-V Solar Cells
A.J. Ptak, J. Simon, K.L. Schulte, W. Metaferia & A. Cavalli
NREL, Golden, United States

3BO.8.4 MIS Structures for Solar Cells Perimeter Passivation
A. Delamarre & J.-F. Guillemoles
CNRS, Palaiseau, France
H. Sodabanlu, K. Watanabe & M. Sugiyama
University of Tokyo, Japan

3BO.8.5 Overview of Concentrator Solar Cells and Analysis for Their Non-Radiative Recombination
M. Yamaguchi, K. Araki, K.-H. Lee & N. Kojima
Toyota Technological Institute, Nagoya, Japan

3BO.8.6 Photovoltaic Operation in the Low Atmosphere and at the Surface of Venus
J. Grandidier, P. Gogna & J.A. Cutts
NASA, Pasadena, United States
A.P. Kirk & M.L. Osowski
MicroLink Devices, Niles, United States
P. Jahelka & H.A. Atwater
Caltech, Pasadena, United States
M.A. Stevens & T.E. Vandervelde
Tufts University, Medford, United States

ORAL PRESENTATIONS 4BO.12

17:00 - 18:30 Induced Degradation

Chairpersons:

Hartmut Nussbaumer
ZHAW, Switzerland

Roland Einhaus
Apollon Solar, France

4BO.12.1 Special Introductory Presentation: Prediction of Potential Power/Yield Loss from LeTID Susceptible Modules
M. Pander, B. Jaeckel, D. Daßler, U. Zeller & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4BO.12.2 LeTID - A Comparison of Test Methods on Module Level
E. Fokuhl, T. Naeem, A. Schmid, P. Gebhardt, T. Geipel & D. Philipp
Fraunhofer ISE, Freiburg, Germany

4BO.12.3 Field Performance of the Industrial Si Mono-Crystalline PERC Solar Module Arrays with the Use of Advanced Hydrogenation Technologies
S. Wang & K.N. Lim
NTU Singapore, Singapore
C.M. Chong
UNSW Australia, Sydney, Australia
M. Tan
CEC Energy, Singapore, Singapore

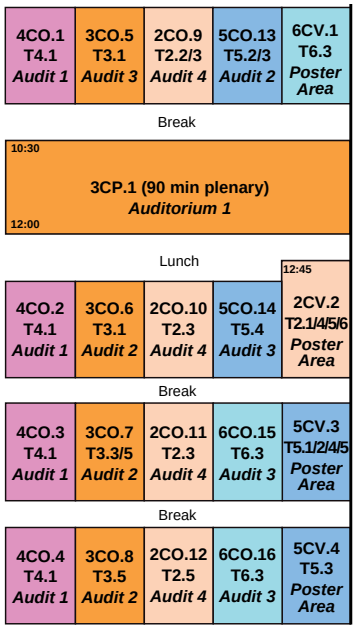
4BO.12.4 Towards a Complete Prediction of PID in Crystalline Silicon Modules in Real Field Conditions
E. Annigoni, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland

4BO.12.5 Potential-Induced Degradation of n-Type Front-Emitter Crystalline Silicon Photovoltaic Modules with Different Degradation Stages
K. Ohdaira, Y. Komatsu, T. Suzuki & S. Yamaguchi
JAIST, Ishikawa, Japan
A. Masuda
AIST, Tsukuba, Japan

VISUAL PRESENTATIONS 6BV.4

17:00 - 18:30 PV on/in Buildings, Infrastructure, Landscape, Water and Nature / Professional Applications of PV

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



2 Silicon Materials and Cells
- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices
- T3.1 Perovskites Based Photovoltaics
- T3.2 CI(G)S, CdTe and Related Thin Film Solar Cells
- T3.3 Organic and Dye-Sensitised Devices
- T3.4 III-V and Related Compound Semiconductor Based Devices
- T3.5 Tandems

4 Photovoltaic Modules and BoS Components
- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

5 PV Systems and Storage – Modelling, Design, Operation and Performance
- T5.1 Solar Resource and Forecasting
- T5.2 Design and Installation of PV Systems
- T5.3 Operation, Performance and Maintenance of PV Systems
- T5.4 Storage
- T5.5 Concentrators and PV for Space Applications

6 PV Applications and Integration
- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

ORAL PRESENTATIONS 4CO.1

08:30 - 10:00 Imaging Techniques and Characterisation

Chairpersons:

Yoshihiro Hishikawa
AIST, Japan

Henning Nagel
Fraunhofer ISE, Germany

4CO.1.1 Quantitative Mapping of PV Modules Performance Using Electroluminescence-Based Imaging
G. El Hajje, J. Dupuis, D. Binesti & P. Dupeyrat
EDF R&D, Ecuelles, France

4CO.1.2 Applying Deep Learning Algorithms to EL-Images for Predicting the Module Power
C. Buerhop-Lutz, T. Pickel & J. Hauch
HI ERN, Erlangen, Germany
M. Hoffmann, L. Reeb, C.J. Brabec & A. Maier
FAU, Erlangen, Germany

4CO.1.3 Method for Automatic Calculation of the Exposure Time in Electroluminescence Imaging of Photovoltaic Modules
S.V. Spataru, D. Sera & H.R. Parikh
Aalborg University, Denmark
G.A. dos Reis Benatto, C. Mantel, P.B. Poulsen &
S. Forchhammer
Technical University of Denmark, Roskilde, Denmark

4CO.1.4 Application of Suns-Photoluminescence to Extract Implied I-V Curves of Individual Cells in Modules Installed in the Field
R. Bhoopathy, O. Kunz, R. Dumbrell, T. Trupke & Z. Hameiri
UNSW Australia, Sydney, Australia

4CO.1.5 Procedures for Angular Mismatch Correction – Development of an International Standard Proposal
F. Plag & S. Winter
PTB, Braunschweig, Germany

4CO.1.6 Test Method for Current-Voltage Performance Measurement and the Analysis of Hysteresis Effect of Perovskite PV Modules
J.Q. Gao, E. Lee, C. Monokroussos & C. Zou
TÜV Rheinland, Shanghai, China

ORAL PRESENTATIONS 3CO.5

08:30 - 10:00 Perovskite Based Photovoltaics (I)

Chairpersons:

Blagovest Mihaylov
CSIRO, Australia

Christopher Case
Oxford PV, United Kingdom

3CO.5.1 The Physics of Ion Migration in Perovskite Solar Cells: Insights into Hysteresis, Device Performance and Characterisation
D. Lan & M.A. Green
UNSW Australia, Sydney, Australia

3CO.5.2 Student Award Finalist Presentation: Multidimensional Luminescence Imaging of Electron/Hole Transport in Triple Cation Perovskite
A. Bercegol, S. Cacovich & L. Lombez
IPVF, Palaiseau, France
D. Ory, S. Jutteau & J. Rousset
EDF R&D, Palaiseau, France
C. Longeaud
CNRS, Gif-sur-Yvette, France
J.-F. Guillemoles
CNRS, Palaiseau, France

3CO.5.3 Textured Perovskite Single-Junction Solar Cells for Improved Optics
P. Fiala, J. Werner, F. Fu, T.-C. Yang, M. Bräuninger,
F. Sahli, R. Razera, Q. Jeangros & C. Ballif
EPFL, Neuchâtel, Switzerland
B. Ruhstaller
ZHAW, Winterthur, Switzerland

3CO.5.4 Pb Free and Pb Less Perovskite Solar Cells with Narrow Band Gap- Aiming at High Efficiency and All Perovskite Tandem Solar Cells
S. Hayase, K.M. Akmal, K. Nishimura, D. Hirotani, C.H. Ng,
K. Hamada & S. Iikubo
Institute of Technology, Kitakyushu, Japan
G. Kapil & H. Segawa
University of Tokyo, Japan
Q. Shen
University of Electro-Communication, Chofu, Japan
T. Minemoto
Ritsumeikan University, Kusatsu, Japan
K. Yoshino
University of Miyazaki, Japan

3CO.5.5 Slot-Die Coating of Double-Cation Perovskite Solar Cells from Ink Tuning to High Efficiency Devices
M. Fievez, C. Roux, M. Manceau, F. Ardiaca, S. Cros & S. Berson
CEA, Le Bourget du Lac, France

3CO.5.6 Methylammonium-Free, High-Performance, and Stable Perovskite Solar Cells on a Planar Architecture
S.H. Turren Cruz
HZB, Berlin, Germany
A. Hagfeldt
EPFL, Lausanne, Switzerland
M. Saliba
Adolphe Merkel Institute, Fribourg, France

ORAL PRESENTATIONS 2CO.9

08:30 - 10:00 TCOs and Surface Passivation

Chairpersons:

Yoshio Ohshita
Toyota Technological Institute, Japan

Stefan W. Glunz
Fraunhofer ISE, Germany

2CO.9.1 Student Award Finalist Presentation: Fired Hydrogenated AZO Layers: A New Passivation Approach for High Temperature Passivated Contact Solar Cells
E. Bruhat, T. Desrues, B. Martel, R. Cabal & S. Dubois
CEA, Le Bourget du Lac, France
D. Blanc-Pélissier
INSA Lyon, France

2CO.9.2 Phosphorus Oxide / Aluminum Oxide Stacks: A Highly Promising Passivation Scheme for n-Type Si Regions in Solar Cells
J. Melskens, R.J. Theeuwes, S.H. Tempel, M. Dielen, L.E. Black, W.-J.-H. Berghuis, B. Macco & W.M.M. Kessels
Eindhoven University of Technology, The Netherlands
E. Hoek & P.C.P. Bronsveld
ECN part of TNO, Petten, The Netherlands

2CO.9.3 Field-Effect Passivation Enhancement by Introducing Nanopyramid Gratings for Light Management in Homojunction Silicon Solar Cells
A. Razzaq, V. Depauw, J. John, I. Gordon, J. Szlufcik & J. Poortmans
imec, Leuven, Belgium

2CO.9.4 Impact of TCO Sputtering Parameters on Silicon Heterojunction Solar Cell Passivation Properties
A. Cruz, A.B. Morales-Vilches, E.C. Wang, S. Neubert, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany
B. Szyszka
Berlin University of Technology, Germany

2CO.9.5 Bringing Tungsten-Doped Indium Oxide to Manufacturing Maturity for High Efficiency Silicon Heterojunction Solar Cells
J.-F. Lerat, M. Tomassini, V. Barth & D. Muñoz
CEA, Le Bourget du Lac, France
G. Christmann, L. Ding, J.J. Diaz Leon & S. Nicolay
CSEM, Neuchâtel, Switzerland

2CO.9.6 Improving Organic-Silicon Heterojunction Solar Cells through the Admixture of Sorbitol to PEDOT:PSS
M.-U. Halbich & J. Schmidt
ISFH, Emmerthal, Germany
R. Sauer-Stieglitz & W. Lövenich
Heraeus, Leverkusen, Germany

ORAL PRESENTATIONS 5CO.13

08:30 - 10:00 Microgrids, Grid Integration and Simulation of PV Systems

Chairpersons:

Mauricio Richter
3E, Belgium

Dirk Stellbogen
ZSW, Germany

5CO.13.1 Full-Scale Simulation and Experimentation Platforms for PV-Diesel Microgrid Control and Design: From Design to Stability Studies
T.-P. Do, X. Le Pivert & F. Bourry
CEA, Le Bourget-du-Lac, France
J. Colas
Cap Vert Energie, Marseille, France

5CO.13.2 Sizing of a PV/Battery System through Stochastic Control and Plant Aggregation
T. Carriere, F.-P. Neirac & G. Kariniotakis
Mines ParisTech, Sophia-Antipolis, France
C. Vernay & S. Pitaval
SOLAÏS, Sophia-Antipolis, France

5CO.13.3 Ramp Rate Control for PV Plant Integration: Experience from Karratha Airport's PV Farm
G. Dickeson, L. McLeod, L. Frearson & B. Herteleer
Ekistica, Alice Springs, Australia
A. Dobb
ARENA, Canberra, Australia

5CO.13.4 Testing of Microgrid Control Systems According to IEEE 2030.8 – Experiences and Learnings from Laboratory Tests
C. Messner, C. Seitl & T.I. Strasser
AIT, Vienna, Austria
J. Jimeno, A. Perez-Basante, J. Merino & E. Rodríguez
Tecnalia, San Sebastián, Spain
J. Hashimoto
AIST, Tsukuba, Japan

5CO.13.5 Photovoltaic (PV) Winter Electricity in the Swiss Energy Strategy 2050
U. Muntwyler, T. Schott & E. Schüpbach
BUAS, Burgdorf, Switzerland

5CO.13.6 Cross-Validation of PV System Simulation Software
A. Driesse & N. Patel
PV Performance Labs, Freiburg, Germany

VISUAL PRESENTATIONS 6CV.1

08:30 - 10:00 PV Driven Energy Management and System Integration

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

PLENARY SESSION 3CP.1

10:30 - 12:00 Perovskite, Organic, CIGS and III-V Multi-Junction Devices

Chairpersons:

Ayodhya Nath Tiwari
EMPA, Switzerland

Christophe Ballif
EPFL, Switzerland

3CP.1.1 Keynote Presentation: Research and Innovation in CIGS and its Alloys - Which are the Next Bottlenecks?
M. Edoff
Uppsala University, Sweden

3CP.1.2 Towards Highly Efficient Monolithic Tandem Devices with Perovskite Top Cells
M. Jost, E. Köhnen, A. Al-Ahouri, L. Korte, B. Stannowski & S. Albrecht
HZB, Berlin, Germany

3CP.1.3 Recent Progress of Solar Cell Development for CPV Applications at AZUR SPACE
R. van Leest, D. Fuhrmann, A. Frey & M. Meusel
Azur Space, Heilbronn, Germany
G. Siefer & S.K. Reichmuth
Fraunhofer ISE, Freiburg, Germany

3CP.1.4 Power Performance and Thermal Operation of Organic Photovoltaic Modules in Real Operating Conditions: Performance of Emerging PV Materials
G. Bardizza, E. Salis & E.D. Dunlop
European Commission JRC, Ispra, Italy
C.A. Toledo Arias
UPCT, Cartagena, Spain

VISUAL PRESENTATIONS 2CV.2

12:45 - 15:00 Feedstock, Crystallisation, Wafering, Defect Engineering / Thin Film and Foil-Based Si Solar Cells / Characterisation & Simulation of Si Cells

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

ORAL PRESENTATIONS 4CO.2

13:30 - 15:00 Outdoor Performance

Chairpersons:

Werner Herrmann
TÜV Rheinland Energy, Germany

Tom Betts
Loughborough University, United Kingdom

4CO.2.1 Performance Assessment of Various PV Module Types under Desert Conditions through Device Simulations and Outdoor Measurements
T. Katsaounis & A. Tzavaras
KAUST, Thuwal, Saudi Arabia
K. Kotsovos, I. Gereige, A. Basaheeh, M. Abdullah, A. Khaiyat, E. Al Habshi & A. Al Saggaf
Saudi ARAMCO, Thuwal, Saudi Arabia

4CO.2.2 Outdoor Performance Quantification and Understanding of Various PV Technologies using the IEC 61853 Matrix
R.M.E. Valckenborg
SEAC, Eindhoven, The Netherlands
B.B. Van Aken
ECN part of TNO, Petten, The Netherlands

4CO.2.3 Improving the Yield by Designing the Module for a Climatic Region
S. Ramesh, G.J.M. Janssen & B.B. Van Aken
ECN part of TNO, Petten, The Netherlands

4CO.2.4 Thermal Modelling of Photovoltaic Modules in Operation and Production
M. Mittag, L. Vogt, C. Herzog & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4CO.2.5 Energy Yield of Coloured PV Modules in the Field
G. Friesen & R.R. Molinero
SUPSI, Canobbio, Switzerland

4CO.2.6 Assessment of the Rear Irradiance on Bifacial Silicon PV Modules
J. Lopez-Garcia, R.S.R. Gali, E. Grau-Luque, R.P. Kenny & T. Sample
European Commission JRC, Ispra, Italy

ORAL PRESENTATIONS 3CO.6

13:30 - 15:00 Perovskite Based Photovoltaics (II)

Chairpersons:

Giorgio Bardizza
European Commission JRC, Italy

Wolfgang Tress
EPFL, Switzerland

3CO.6.1 Perovskite Meta-Stability Effects in Hysteresis-Free Measurements
B. Mihaylov, B.C. Duck, K.F. Anderson, T.W. Jones, J. Wang, N.W. Duffy, C.J. Fell & G.J. Wilson
CSIRO, Mayfield West, Australia

3CO.6.2 Energy Rating for Evaluating Performance of Perovskite and Perovskite-on-Silicon Tandem Devices in Real-World Conditions
J.C. Blakesley & G. Koutsourakis
NPL, Teddington, United Kingdom

3CO.6.3 In Situ Metrology for Degradation Studies of Perovskite Solar Cells
G. Koutsourakis, S. Wood, Y. Cao, J.C. Blakesley, S. Ravi & F. Araujo de Castro
NPL, Teddington, United Kingdom
K.D.G. Imalka Jayawardena, I.R.M. Bandara & P. Silva
University of Surrey, Guildford, United Kingdom

3CO.6.4 Processing of Large Area Perovskite-Based Solar Devices: High Efficiency and Stability Assessment
M. Manceau, C. Roux, N. Nguyen, F. Ardiaca, S. Cros, M. Matheron, N. Lemaitre & S. Berson
CEA, Le Bourget du Lac, France

3CO.6.5 Enhancing Performance of CH3NH3PbI3 Perovskite Solar Cell with Low-Pressure Control via Sandwich Evaporation Technique
C.-H. Kuan, P.-T. Kuo, H.-C. Hsu, W.C. Chang & C.-F. Lin
NTU, Taipei, Taiwan

3CO.6.6 Efficient Stable Semi-Transparent p-i-n Perovskite Solar Cells and Module via Up-Scalable Deposition Methods
F. Di Giacomo, V. Zardetto, D. Zhang, H. Fledderus, I. Dogan, W. Verhees, M. Najafi, H. Lifka, Y. Galagan, P. Poodt, S.C. Veenstra & R. Andriessen
TNO, Eindhoven, The Netherlands
C. Burgess & M. Creatore
Eindhoven University of Technology, The Netherlands
T. Aernouts
imec, Genk, Belgium

ORAL PRESENTATIONS 2CO.10

13:30 - 15:00 Heterojunction Solar Cells (I)

Chairpersons:

Delfina Muñoz
CEA, France

Barbara Terheiden
University of Konstanz, Germany

2CO.10.1 Final Report of the EU H2020 Project - NextBase: An European Collaboration for Cost Competitive and High Efficiency Interdigitated Back-Contact Silicon Heterojunction Solar Cell Technology

K. Ding, A. Gad, M. Pomaska & S. Haas
Forschungszentrum Jülich, Germany
B. Paviet-Salomon, L.-L. Senaud, N. Badel, A. Faes,
J. Champliaud & M. Despeisse
CSEM, Neuchâtel, Switzerland
E. Voroshazi, T. Borgers,
H. Sivaramakrishnan Radhakrishna & I. Gordon
imec, Leuven, Belgium
L. Korte & B. Stannowski
HZB, Berlin, Germany
A. Tomasi, A.N. Fioretti, M. Boccard & C. Ballif
EPFL, Neuchâtel, Switzerland
J. Bartsch & M. Glatthaar
Fraunhofer ISE, Freiburg, Germany
P.A. Procel Moya, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands
R. Vasudevan, S. Harrison & D. Muñoz
CEA, Le Bourget du Lac, France
A. Fejfar & M. Ledinsky
FZU, Prague, Czech Republic
D. Lachenal & B. Strahm
Meyer Burger Research, Neuchâtel, Switzerland
A. Canino & D. Proietti
ENEL Green Power, Catania, Italy
I.J. Bennett & J. Gaury
DSM Innovation, Urmond, The Netherlands
S. Senkader
Norwegian Crystals, Oslo, Norway
F. Versluis, I. Claassen & A. Molinari
Uniresearch, Delft, The Netherlands

2CO.10.2 Student Award Finalist Presentation: Bottom-Up vs Top-Down Approaches for Identifying and Mitigating the Transport Losses in High-Efficiency Silicon Heterojunction Solar Cells

L.-L. Senaud, A. Descoeudres, G. Christmann,
J. Geissbühler, N. Badel, P. Wyss, J.-W. Schüttauf,
C. Allebé, S. Nicolay, M. Despeisse,
C. Ballif & B. Paviet-Salomon
CSEM, Neuchâtel, Switzerland

2CO.10.3 Passivation vs. Microstructural Properties of Dual Intrinsic a-Si:H Layers for SHJ

J. Temmler, L. Bodlak, A. Moldovan & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

2CO.10.4 Exploring Solar Cell Efficiency Limits Using Thin CZ-Quality Substrates

A. Augusto, P. Balaji, J. Karas, W.J. Dauksher &
S.G. Bowden
Arizona State University, Tempe, United States

2CO.10.5 Impact of Wafer Thickness on Temperature Coefficients in Silicon Heterojunction Solar Cells

H. Sai, T. Oku, Y. Sato, M. Tanabe & T. Matsui
AIST, Tsukuba, Japan

2CO.10.6 Bifaciality Optimization of Silicon Heterojunction Solar Cells

A. Danel, J. Eymard, F. Pernoud, J. Diaz, M. Debourdeau,
A. Bettinelli, L. Basset, S. Harrison, R. Varache,
E. Gerritsen, P.-J. Ribeyron & C. Roux
CEA, Le Bourget du Lac, France

ORAL PRESENTATIONS 5CO.14

13:30 - 15:00 Storage

Chairpersons:

Pascal Lalanne
HydroClapeyron, France

Francesco Dolci
European Commission JRC, The Netherlands

5CO.14.1 Short Term Power Fluctuation Smoothing with a Flywheel Energy Storage System

E. Toutain & J. Callec
EDF R&D, Moret-sur-Loing, France

5CO.14.2 Experience on MW-Sized Hybrid PV, Battery Storage and Genset System; Case Study of St. Eustatius Island
E. Garralaga Rojas, H. Sadri & W. Krueger
SMA Sunbelt Energy, Niestetal, Germany

5CO.14.3 Demonstration of a Novel HBr-Flow Battery for Grid Integration of PV
J. Kester
ECN part of TNO, Petten, The Netherlands
J. Lauret
ELESTOR, Arnhem, The Netherlands
R. van de Kar
Gemeente Noordoostpolder, Emmeloord, The Netherlands
S. Tuinstra
Bij ZON, Spanbroek, The Netherlands
P. Puttkammer
Witteveen+Bos, Deventer, The Netherlands

5CO.14.4 Sizing of Grid-Connected PV-Battery Systems: Technical and Economical Simulator
J.C. Solano
Universidad Nacional de Loja, Ecuador
E. Caamaño-Martín & L. Olivieri
UPM, Madrid, Spain
M.C. Brito
University of Lisbon, Portugal

5CO.14.5 Data-Driven Approach for SOH Estimation and Alarms Generation for Complex On-Grid Energy Storage Systems
F. Karoui, D.-L. Ha & T. Delaplagne
CEA, Le Bourget du Lac, France
M.-F. Bouaziz
Sogeti High-Tech, Montbonnot Saint-Martin, France

5CO.14.6 Everflow® Redox Flow Batteries: Technology Status and Field Experience
M. Schönleber
Schmid-Group, Freudenstadt, Germany

ORAL PRESENTATIONS 4CO.3

15:15 - 16:45 Interconnects and Soldering

Chairpersons:

Tony Sample
European Commission JRC, Italy

Mike Van Iseghem
EDF R&D, France

4CO.3.1 Electrically Optimized Module Concepts to Compensate Transient Shading Situations by Means of Passive Elements
H. Hanifi, C. Reyhe & B. Jaeckel
Fraunhofer CSP, Halle (Saale), Germany
J. Schneider
Fraunhofer IMWS, Halle (Saale), Germany

4CO.3.2 High Efficiency Module Using Improved Anti-Reflective Coating and Based on Multi-Wire Interconnection of Back-Contacted Silicon Heterojunction Solar Cells
A. Faes, B. Paviet-Salomon, L.-L. Senaud, C. Wütrich, P. Wyss, C. Allebé, G. Christmann, A. Descoeudres, J. Geissbühler, J. Champliaud, N. Badel, E. Muliqi, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland
D. Lachenal, P. Papet & B. Strahm
Meyer Burger Research, Hauterive, Switzerland
N.E. Voicu & I.J. Bennett
DSM Innovation, Geleen, The Netherlands
B. Bonnet-Eymard & R. Grischke
Meyer Burger, Gwatt, Switzerland

4CO.3.3 Industrialization of the Ribbon Interconnection of Silicon Heterojunction Solar Cells with Electrically Conductive Adhesives
T. Geipel, V. Nikitina, L. Pitta Bauermann, E. Fokuhl, E. Schnabel, D. Erath, A. Krieg & A. Kraft
Fraunhofer ISE, Freiburg, Germany
T. Fischer, R. Lorenz & D. Breitenbücher
teamtechnik, Freiberg, Germany

4CO.3.4 Effect of Solder Configurations on Finger Breakages in Photovoltaic Modules under Thermal Cycling Conditions
S. Kumar, S. Roy & R. Gupta
IIT Bombay, Mumbai, India

4CO.3.5 Quantitative Evaluation of Soldering Contacts during Thermal Cycling Magnetic Field Imaging (MFI)
M. Patzold, K. Kaufmann, C.-M. Lin, M. Rudolph & D. Lausch
DENKweit, Halle (Saale), Germany

4CO.3.6 Module Integration of SHJ Cells by Soldering
B. Commault, P. Lefillastre, S. Bernardis, A. Bettinelli, J. Diaz, M. Debourdeau & F. Pernoud
CEA, Le Bourget du Lac, France

ORAL PRESENTATIONS 3CO.7

15:15 - 16:45 Organic and Dye-Sensitised Devices / Optimization of Perovskite Silicon Tandems

Chairpersons:

Sjoerd Veenstra
ECN part of TNO, The Netherlands

Hubert Hauser
Fraunhofer ISE, Germany

3CO.7.1 Tailoring Indium-Free Electrodes for Increased Intrinsic Absorption in the Active Layer of Organic Solar Cells
M.A. Cherif, D. Barakel & P. Torchio
Aix Marseille University, France
S. Touihri
ENSIT, Tunis, Tunisia

3CO.7.2 Applying Lessons from Leaf Anatomy and Array Structure to the Development of Solar Cells Exhibiting Enhanced Electricity Production
M.J. Yun, Y.H. Sim, S.I. Cha & D.Y. Lee
KERI, Changwon, Republic of Korea

3CO.7.3 Development of Flexible CIGS and Flexible Perovskite-CIGS 4-Terminal Tandem
M. Simor, V. Zardetto, M. Najafi, M. van der Vleuten, S. Veenstra & H. Linden
TNO, Eindhoven, The Netherlands
T. Aernouts
imec, Genk, Belgium

3CO.7.4 Energy Yield Modelling of Perovskite-Based Tandem Photovoltaics
M. Langenhorst, R. Schmager, U.W. Paetzold, J. Lehr, U. Lemmer & B.S. Richards
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany

3CO.7.5 Design Rules to Fully Benefit from Bifaciality in Two-Terminal Tandem Solar Cells
O. Dupré, A. Tuomiranta, Q. Jeangros, M. Boccard & C. Ballif
EPFL, Neuchâtel, Switzerland
P.-J. Alet
CSEM, Neuchâtel, Switzerland

3CO.7.6 Optical Assessment of Perovskite-Enhanced Bifacial Silicon Solar Modules
K. Jäger, P. Tillmann, L. Korte, E. Unger & C. Becker
HZB, Berlin, Germany
A. Tejada
PUCP, Lima, Peru
A. Karsenti & L. Kreinin
SolAround, Jerusalem, Israel
I. Visoly-Fisher & E.A. Katz
BGU, Beer-Sheva, Israel

ORAL PRESENTATIONS 2CO.11

15:15 - 16:45 Heterojunction Solar Cells (II)

Chairpersons:

Jan Schmidt
ISFH, Germany

Matthieu Despeisse
CSEM, Switzerland

2CO.11.1 Design and Characterization of High-Efficiency Silicon Heterojunction Solar Cells
J. Dréon, M. Boccard, L. Antognini, J. Cattin, O. Dupré, A.N. Fioretti, J. Haschke, V. Paratte, S. Zhong & C. Ballif
EPFL, Neuchâtel, Switzerland

2CO.11.2 Challenges and Performances in SHJ Solar Cell Area Upscaling: Effects of Cell Active Area vs. Aperture Area on IV Parameters and Understanding Edge Losses
S. Janke, E.C. Wang, A.B. Morales-Vilches, T. Henschel, A. Cruz, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany

2CO.11.3 Developing Low-Cost p-Type Homo-Heterojunction Solar Cells
D. Chen, A.H. Soeriyadi, M. Kim, M. Wright, B. Vicari Stefani & B. Hallam
UNSW Australia, Sydney, Australia
J. Shi, W. Weigand & Z.C. Holman
Arizona State University, Tempe, United States

2CO.11.4 Interconnection of Silicon Heterojunction Solar Cells by Infrared Soldering - Solder Joint Analysis and Temperature Study
A. De Rose, T. Geipel, D. Eberlein & A. Kraft
Fraunhofer ISE, Freiburg, Germany
M. Nowottnick
University of Rostock, Germany

2CO.11.5 Development and Manufacturing of Silicon Heterojunction Solar Cells
J. Wang & H. Yan
Beijing University of Technology, China
C. Yu, W. Long, C.-W. Peng, G. Dong, M. Qu, M. Yang, C.-H. Lu, Y. Li & X. Xu
Hanergy Thin Film Power, Chengdu, China

2CO.11.6 The Race for High Efficiency in Production: Why Heterojunction in Now Ready for Market
D. Muñoz & C. Roux
CEA, Grenoble, France

ORAL PRESENTATIONS 6CO.15

15:15 - 16:45 Smart PV and Prosumers

Chairpersons:

Ingrid Weiss
WIP Renewable Energies, Germany

Bruno Gaiddon
HESPUL, France

6CO.15.1 An Online Multi-Scale Optimization Framework for Smart PV Systems
D. Watari, I. Taniguchi & T. Onoye
University of Osaka, Suita, Japan
P. Manganiello, H. Goverde & F. Catthoor
imec, Heverlee, Belgium

6CO.15.2 Washing with the Sun; Two Residential Smart Grid Pilots in The Netherlands
C. Gerçek & A. Reinders
University of Twente, Enschede, The Netherlands

6CO.15.3 Impact of Behavior on Using Photovoltaics to Charge Electric Vehicles: Systematic Analysis
N. Pflugradt & U. Muntwyler
BUAS, Burgdorf, Switzerland

6CO.15.4 From Solitary Pro-Sumers to Energy Community: Quantitative Assesment of the Benefits of Sharing Electricity
M. Lovati, J. Adami, M. Dallapiccola, L. Maturi & D. Moser
Eurac Research, Bolzano, Italy

6CO.15.5 Self-Consumption Rate Achieved by the Bifacial East West Vertical PV System Compared to the Conventional South Facing System in Nordic Conditions
S. Ranta, H. Huerta & A. Heinonen
TUAS, Turku, Finland
J.S. Stein
Sandia National Laboratories, Albuquerque, United States
E. Whitney
UAF, Fairbanks, United States

6CO.15.6 Long Term EV Parking Spaces for Behind-the-Meter Storage of Solar Energy - A Simulation Study
R. Ghotge & A.J.M. van Wijk
Delft University of Technology, The Netherlands

VISUAL PRESENTATIONS 5CV.3

15:15 - 16:45 Solar Resource and Forecasting / Design and Installation of PV Systems / Storage / Concentrators and PV for Space Applications

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

NOTES

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ORAL PRESENTATIONS 4CO.4

17:00 - 18:30 Module Materials

Chairpersons:

Gernot Oreski
PCCL, Austria

William J. Gambogi
DuPont, United States

4CO.4.1 Special Introductory Presentation: Analysis of Fielded PV-Modules with Backsheet Issues
P. Lechner, H. Wirth, J. Schnepf, S. Hummel & D. Geyer
ZSW, Stuttgart, Germany
B. Weinreich & R. Haas
HaWe Engineering, Gauting-Hausen, Germany

4CO.4.2 Dual Sorption Modelling of Water Ingress in PV Encapsulants Using a Heterogeneous Mesh in Finite Element Simulations
S. Mitterhofer, M. Jankovec & M. Topič
University of Ljubljana, Slovenia
C. Barretta, L.F. Castillon Gandara & G. Oreski
PCCL, Leoben, Austria
D. Moser
Eurac Research, Bolzano, Italy

4CO.4.3 Post-Processing Thickness Variation of PV Module Materials and Its Impact on Temperature, Mechanical Stress and Power
A. Pfreundt, D. Yucebas, A.J. Beinert, P. Romer & M. Mittag
Fraunhofer ISE, Freiburg, Germany

4CO.4.4 Double Layer Encapsulation Film for PV Modules Operating at High Voltage
S.C. Pop
SCP SYS, San Francisco, United States
J. Kapur
DuPont, Wilmington, United States
P. Hacke & M. Kempe
NREL, Golden, United States
R.N. Schulze
Sunrun, San Francisco, United States
X. Wang
Yingli Green Energy, Philadelphia, United States

4CO.4.5 Incidence Angle Modifier Evaluation for DSM Coating Technologies
P. Pasmans & P. Tummers
DSM Materials Science, Geleen, The Netherlands
N. Voicu
DSM Advanced Solar, Geleen, The Netherlands
A. Faes, J. Levrat, J. Champliaud & M. Despeisse
CSEM, Neuchâtel, Switzerland
M. Caccivio
SUPSI, Canobbio, Switzerland
B. Custodio
Enertis Solar, San Francisco, United States
F. Dross
DSM Innovation, Parsippany, United States

ORAL PRESENTATIONS 3CO.8

17:00 - 18:30 Perovskite Silicon Tandem Devices

Chairpersons:

Steve Albrecht
HZB, Germany

Shuzi Hayase
Institute of Technology, Japan

3CO.8.1 High-Efficiency Monolithic Perovskite/Silicon Tandem Solar Cells
F. Sahli, J. Werner, F. Fu, V. Paratte, R. Monnard, P. Fiala, T.-C. Yang, M. Bräuninger, R.A.Z. Razera, M. Boccard, A. Ingenito, Q. Jeangros & C. Ballif
EPFL, Neuchâtel, Switzerland
G. Nogay, A. Walter, S. Rafizadeh, B.A. Kamino, M. Despeisse & S. Nicolay
CSEM, Neuchâtel, Switzerland

3CO.8.2 Unravelling Degradation of Perovskite Solar Cells and Long-Term Impact on Pervoskite/Silicon Tandem Modules
M. Ernst, J. Qian, N. Wu & A. Blakers
ANU, Canberra, Australia

3CO.8.3 Student Award Finalist Presentation: Capacitance-Voltage Characterization Technique Adapted to Tandem Solar Cell
C. Leon, S. Le Gall, M.E. Gueunier-Farret, A. Brezard-Oudot, A. Jaffré, C. Longeaud & J.-P. Kleider
GeePs, Gif-sur-Yvette, France
L. Vauche, K. Medjoubi & E. Veinberg Vidal
Université Grenoble Aples, France

3CO.8.4 Perovskite Silicon Photovoltaics: The Joule in the Crown of Low-Cost Electricity
C. Case
Oxford PV, United Kingdom

3CO.8.5 Four-Terminal Bifacial Tandem with 30% Equivalent Efficiency
G. Coletti, L.A.G. Okel, M.J.H. Kloos, S.L. Luxembourg, Y. Wu, J.M. Kroon, F.J.K. Danzl & L.J. Geerligs
ECN part of TNO, Petten, The Netherlands
F. Di Giacomo, M. Najafi, D. Zhang, R.A.J.M. Andriessen & S.C. Veenstra
ECN part of TNO, Eindhoven, The Netherlands
T. Aernouts
imec, Genk, Belgium
J. Hüpkes
Forschungszentrum Jülich, Germany
C. Burgess & M. Creatore
Eindhoven University of Technology, The Netherlands

3CO.8.6 Scale-Up Technologies towards Large Area 2-Terminal Perovskite-Silicon Tandems
B.A. Kamino, A. Paracchino, S.-J. Moon, A. Walter, J.J. Diaz Leon, G. Christmann, M. Dussouillez, L. Ding, H.-Y. Li, S. Rafizadeh, B. Paviet-Salomon, N. Badel, A. Faes, J. Levrat, M. Despeisse, C. Ballif & S. Nicolay
CSEM, Neuchâtel, Switzerland

ORAL PRESENTATIONS 2CO.12

17:00 - 18:30 Characterisation & Simulation of Si Cells (I)

Chairpersons:

Marko Topič
University of Ljubljana, Slovenia

Karsten Bothe
ISFH, Germany

2CO.12.1 Accurate Measurement of Bifacial Solar Cells with Single- and Both-Sided Illumination
M. Rauer, F. Guo & J. Hohl-Ebinger
Fraunhofer ISE, Freiburg, Germany

2CO.12.2 Localized Blistering Defects as Root Cause of Potential Induced Degradation (PID) at the Rear Side of Bifacial PERC Solar Cells
K. Sporleder, J. Bauer, M. Turek, V. Naumann & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany

2CO.12.3 Optimising Fill Factor for Bifacial Energy Yield and LCoE
B.B. Van Aken, S. Ramesh, L.A.G. Okel, K.J.J. Tool, J. Löffler, A.W. Weeber & G.J.M. Janssen
ECN part of TNO, Petten, The Netherlands

2CO.12.4 Advanced Suns-Photoluminescence Technique for the Optimization of Crystalline Silicon Solar Cells
J.P. Seif, A.H.T. Le, R. Dumbrell & Z. Hameiri
UNSW Australia, Sydney, Australia
T.G. Allen
KAUST, Thuwal, Saudi Arabia
C. Samundsett
ANU, Canberra, Australia

2CO.12.5 Upgrade PERC with TOPCon: Efficiency Potential by Taking into Account the Electrical Gains and Optical Losses
C. Messmer
University of Freiburg, Germany
F. Feldmann, A. Fell, J. Schön & M. Hermle
Fraunhofer ISE, Freiburg, Germany

2CO.12.6 On the Correlation between Contact Resistivity and High Efficiency (IBC-) SHJ Solar Cells
P. Procel Moya, H. Xu, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands
L.-L. Senaud, B. Paviet-Salomon & M. Despeisse
CSEM, Neuchâtel, Switzerland
H. Sivaramakrishnan Radhakrishna, M. Filipic, M. Xu & I. Gordon
imec, Leuven, Belgium
M. Boccard, A. Fioretti, R. Monnard & C. Ballif
EPFL, Neuchâtel, Switzerland
J.-C. Stang, P. Wagner, D. Meza & L. Korte
HZB, Berlin, Germany
D. Lachenal & B. Strahm
Meyer Burger Research, Hauterive, Switzerland
W. Duan, A. Lambertz & K. Ding
Forschungszentrum Jülich, Germany
A. Fejfar
Czech Academy of Sciences, Prague, Czech Republic

ORAL PRESENTATIONS 6CO.16

17:00 - 18:30 PV Systems Optimization

Chairpersons:

Franz P. Baumgartner
ZHAW, Switzerland

Bert Herteleer
KU Leuven, Belgium

6CO.16.1 Machine Learning Approach to a Low-Cost Day-Ahead PV Power Prediction Based on Publicly Available Weather Reports for Automated Energy Management Systems
N. Maitanova, J.-S. Telle, B. Hanke, T. Schmidt,
K. von Maydell & C. Agert
DLR, Oldenburg, Germany
M. Grottke
Hammer Real, Munich, Germany

6CO.16.2 From Day-Ahead PV Forecast to PV Regulation: Imbalance Mitigation Strategies for the Italian Case Study
M. Pierro & D. Moser
Eurac Research, Bolzano, Italy
R. Perez
SUNY, Albany, United States
M. Perez
Pace University, New York, United States
C. Cornaro
University of Rome, Italy

6CO.16.3 Voltage Control in Grids with High PV-Penetration
Q.T. Tran, T. Le, F. Bourry & F. Al-Shakarchi
CEA, Le Bourget du Lac, France

6CO.16.4 Digital System in Order to Evaluate Different Photovoltaic Energy Solutions Taking into Account the Energy Demand of the Critical Industrial Processes Involved
A. Rubio Rico, R. Gero Ciudad & V. Fuster Roig
ITE, Valencia, Spain

6CO.16.5 Optimal Design and Supervision of Wind-PV-Diesel Hybrid Microgrid System
M. Boussetta, R. El Bachtiri, S. Motahhir & M. Khanfara
EST-USMBA, Fez, Morocco
Y. Chaibi
ENSAM, Fez, Morocco

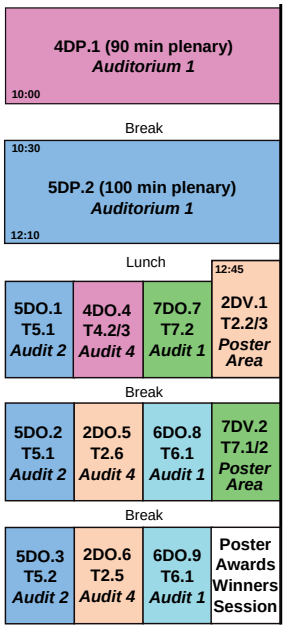
6CO.16.6 Tailoring PV to an Island Supply System - Uncertainties If "Autonomy" Is Requested
H.G. Beyer
University of the Faroe Islands, Torshavn, Faroe Islands

VISUAL PRESENTATIONS 5CV.4

17:00 - 18:30 Operation, Performance and Maintenance of PV Systems

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

EU PVSEC Dinner



2 Silicon Materials and Cells
- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

4 Photovoltaic Modules and BoS Components
- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

5 PV Systems and Storage – Modelling, Design, Operation and Performance
- T5.1 Solar Resource and Forecasting
- T5.2 Design and Installation of PV Systems
- T5.3 Operation, Performance and Maintenance of PV Systems
- T5.4 Storage
- T5.5 Concentrators and PV for Space Applications

6 PV Applications and Integration
- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

7 Finance, Markets and Policies
- T7.1 Costs, Economics, Finance and Markets
- T7.2 Policies and Scenarios for Renewables, Societal and Global Challenges

PLENARY SESSION 4DP.1

08:30 - 10:00 Measurement, Reliability and Sustainability

Chairpersons:

Karsten Wambach
Wambach-Consulting, Germany

Claudia Buerhop-Lutz
HI ERN, Germany

4DP.1.1 Keynote Presentation: From Sunlight to Power: The History of Achieving a Globally Harmonised Approach to Photovoltaic Measurement
H. Müllejans, W. Zaaiman & E.D. Dunlop
European Commission JRC, Ispra, Italy

4DP.1.2 Keynote Presentation: An Overview of Module Reliability
M. Van Iseghem
EDF R&D, Moret-sur-Loing, France

4DP.1.3 Keynote Presentation: PV in the Circular Economy: A Research Agenda
G. Heath
NREL, Golden, United States

PLENARY SESSION 5DP.2

10:30 - 12:10 PV Systems and Storage

Chairpersons:

Heinz Ossenbrink
Band Gap, Germany

Laurent Torcheux
EDF R&D, France

5DP.2.1 Keynote Presentation: Status of Battery Energy Storage
F. Lambert
CEA, Grenoble, France

5DP.2.2 Keynote Presentation: Next Generation Tools for Accurate Energy Yield Estimation of Bifacial PV Systems – Best Practices, Improvements and Challenges
I.T. Horvath, H. Goverde, A.S.H. van der Heide & J. Govaerts
imec, Genk, Belgium
P. Manganiello, E. Voroshazi, F. Catthoor & J. Poortmans
imec, Leuven, Belgium
G.H. Yordanov & J. Moschner
KU Leuven, Belgium
I. Oroutzoglou & D. Soudris
NTUA, Athens, Greece
L.A. Radkar
University of Twente, Enschede, Belgium
N.-P. Harder
Total New Energies, San Jose, United States
T. Mueller, A. Lambert & S. Scheerlinck
ENGIE Laborelec, Linkebeek, Belgium
B. Aldalali
Kuwait University, Khaldiya, Kuwait
A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands

5DP.2.3 Performance Optimization through Advanced Data Analytics - Practical Applications Covering More Than 2GWp in Europe and India
G. Mütter & B. Eizinger
Alteso, Vienna, Austria

5DP.2.4 Development and Outdoor Characterization of Hybrid Bifacial HCPV Module
J.F. Martinez Sanchez, M. Steiner, M. Wiesenfarth, T. Fellmeth, T. Doersam, M. Wiese, S.W. Glunz & F. Dimroth
Fraunhofer ISE, Freiburg, Germany

VISUAL PRESENTATIONS 2DV.1

12:45 - 15:00 Homojunction Solar Cells / Heterojunction Solar Cells

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

ORAL PRESENTATIONS 5DO.1

13:30 - 15:00 Solar Resource

Chairpersons:

Christos Protogeropoulos
EEPS, Greece

Jan Remund
Meteotest, Switzerland

5DO.1.1 Assessing Spectral Mismatch Factors from Solar Spectral Measurements under Clear and Hazy Conditions
G. López
UHU, Huelva, Spain
C.A. Gueymard
Solar Consulting, Colebrook, United States
J. Polo, N. Martín Chivelet & N. Vela
CIEMAT, Madrid, Spain
J. Alonso-Montesinos, F.J. Batlles & J. Barbero
UAL, Almeria, Spain
A. Marzo
University of Antofagasta, Chile

5DO.1.2 Constructing 1-Second Resolution Irradiance Datasets Using Clearness Index Samples
G. Dickeson, L. McLeod, B. Herteleer & L. Frearson
Ekistica, Alice Springs, Australia

5DO.1.3 Assessment and Improvement of Ground-Based Irradiance Measurements
F. Mariottini, M. Bliss & T.R. Betts
Loughborough University, United Kingdom
G. Belluardo
Eurac Research, Bolzano, Italy
I.R. Cole
University of Cyprus, Nicosia, Cyprus

5DO.1.4 Comparative Analysis of Albedo Measurements (Plane-of-Array, Horizontal, Satellite) at Multiple Sites Worldwide
S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
L. Burnham
Sandia National Laboratories, Albuquerque, United States
S.-Y. Oh
Yeungnam University, Gyeongsan, Republic of Korea
A. Benlarabi
IRESEN, Rabat, Morocco
J.-H. Choi
KTL, Seoul, Republic of Korea
M. Ebert & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

B. Figgis
QEERI, Doha, Qatar
K.S. Kim
KIER, Yuseong-gu, Republic of Korea
T. Reindl
SERIS, Singapore, Singapore
R. Rüther
UFSC, Florianópolis, Brazil

5DO.1.5 Data of Value, Valuing Data: Open-Access Bankable Resource Data Project in Australia's NT
S. Ong, B. Herteleer, L. McLeod, G. Dickeson, H. Norris & L. Frearson
Ekistica, Alice Springs, Australia

5DO.1.6 The Impact of Plane-of-Array Based Tmy's on Solar Resource for PV Applications
M. Sengupta & A. Habte
NREL, Golden, United States

ORAL PRESENTATIONS 4DO.4

13:30 - 15:00 Inverter Design and Integration / Sustainability of PV Systems

Chairpersons:

Andreas Wade
First Solar, Germany

Ralph Gottschalg
Fraunhofer CSP, Germany

4DO.4.1 The Inverter: A Multi-Purpose Control Element
P.-J. Alet
CSEM, Neuchâtel, Switzerland
N. Henze & M. Jung
Fraunhofer IEE, Kassel, Germany
G. Adinolfi & G. Graditi
ENEA, Portici, Italy
G. Barchi
Eurac Research, Bolzano, Italy
R. Bründlinger
AIT, Vienna, Austria
A. Stavrou
Electricity Authority of Cyprus, Nikosia, Cyprus
G. Yang
Technical University of Denmark, Kongens Lyngby, Denmark

4DO.4.2 The Borgna-Converter - A New Topology for Highly Efficient PV Inverters

D. Gfeller, L. Borgna & U. Muntwyler
BFH, Burgdorf, Switzerland

4DO.4.3 Development and Evaluation of Open-Source IEEE 1547.1 Test Scripts for Improved Solar Integration

N. Ninad, E. Apablaza-Arancibia & M. Bui
CanmetENERGY, Varennes, Canada
J. Johnson & S. Gonzalez
Sandia National Laboratories, Albuquerque, United States
T. Moore & R. Heidari
CSIRO Energy Technology, Newcastle, Australia
W. Son
KERI, Gyeongsangnam-do, Republic of Korea
R. Bründlinger, R. Ablinger, C. Messner, C. Seitl & Z. Miletic
AIT, Vienna, Austria
J. Hashimoto & K. Otani
AIST, Fukushima, Japan
I. Vidaurrazaga Temez
Tecnalia, San Sebastián, Spain
F.P. Baumgartner & F. Carigiet
ZHAW, Winterthur, Switzerland
B. Fox
SunSpec Alliance, San Jose, United States
S. Kumar & J. Kumar
Central Power Research Institute, Bangalore, India

4DO.4.4 Active Façades: Life Cycle Environmental Impacts and Savings of Photovoltaic Power Plants Integrated into the Building Envelope

R. Itten & M. Stucki
ZAHW, Wädenswil, Switzerland
A. Clua Longas
EPFL, Lausanne, Switzerland
G. Cattaneo
CSEM, Neuchâtel, Switzerland

4DO.4.5 Combining Region-Specific Supply Chains with Geo-Located PV Electricity Production for Life Cycle Assessment of Worldwide Silicon Photovoltaic Systems in ENVI-PV v2.0

P. Perez-Lopez, B. Gschwind & I. Blanc
MINES ParisTech, Sophia-Antipolis, France
R. Frischknecht & P. Stolz
Treeze, Uster, Switzerland
C. Mehl & M. Payeur
ADEME, Paris, France
G. Heath
NREL, Golden, United States

4DO.4.6 Towards a Circular Supply Chain for PV Modules: Review of Today's Challenges in PV Recycling, Refurbishment and Re-Certification

J.A. Tsanakas, A.S.H. van der Heide, E. Voroshazi & J. Poortmans
imec, Genk, Belgium
E. Lemaire
CEA, Le Bourget du Lac, France
K. Wang
VITO, Mol, Belgium

ORAL PRESENTATIONS 7DO.7

13:30 - 15:00 Lessons from Around the World

Chairpersons:

Philippe Malbranche
CEA, France

Maria Getsiou
European Commission DG RTD, Belgium

7DO.7.1 Student Award Finalist Presentation: Shared Solar Cooperatives in Brazil: Context, Overcoming Barriers and Lessons to Be Drawn from Previous European Countries Experiences

K. Schneider & R. Rüther
UFSC, Florianópolis, Brazil
M.O.M. de Oliveira
OCB, Brasília, Brazil

7DO.7.2 Lessons from Utility-Scale PV in Australia: Experience from ARENA's LSS Portfolio

L. McLeod, G. Dickeson, C. Paynter, B. Herteleer & L. Frearson
Ekistica, Alice Springs, Australia
A. Dobb
ARENA, Canberra, Australia

7DO.7.3 Solar-Era.Net - European Network of National and Regional Research and Innovation Programmes: Latest Developments of Transnational Cooperation, Project Results and Opportunities

S. Nowak, M. Gutschner & T. Biel
NET Nowak Energy & Technology, St. Ursen, Switzerland
S. Oberholzer
Swiss Federal Office of Energy, Bern, Switzerland
C. Hünnekes, R. Horbelt, K. Chakanga & M. Schulte
Forschungszentrum Jülich, Germany
E. Fernández
MINECO, Madrid, Spain
D. Ruiz
FECYT, Coruña, Spain
G. del Rio
CDTI, Madrid, Spain
P.-J. Rigole & T. Walla
Swedish Energy Agency, Eskilstuna, Sweden
O. Bernsen
RVO, Den Haag, The Netherlands
P. Leptos
RPF, Lefkosia, Cyprus
T. Carrere
ADEME, Paris, France
P. Bain
ANR, Paris, France
E. Afentaki
GSRT, Athens, Greece
A. Covello
MIUR, Rome, Italy
G. Friedmann
Ministry of Energy, Jerusalem, Israel
K. Karaösz
TUBITAK, Gebze, Turkey
E. Lutter
Climate and Energy Fund, Vienna, Austria
A. Hipfinger
FFG, Vienna, Austria

7DO.7.4 PV Performance Assessment Methods for the Implementation of European Sustainability Policy Instruments

A.M. Gracia Amillo, E.D. Dunlop, E. Salis, T. Sample & N. Taylor
European Commission JRC, Ispra, Italy
D. Polverini
European Commission DG GROWTH, Brussels, Belgium

7DO.7.5 Development of an Academic Living-Labs as Sociotechnical Imaginaries to Facilitate the Uptake of Solar Technologies in the 2Seas Region

T.E. Motoasca
KU Leuven, Ghent, Belgium

7DO.7.6 Open Science: New Challenges and Opportunities for the PV Sector

A.B. Cristobal Lopez, C. del Cañizo & A. Martí Vega
UPM, Madrid, Spain
G. Revuelta
UPF, Barcelona, Spain
L. Fialho
University of Évora, Portugal
M. Molina
EIC, Madrid, Spain
N. Tyutyundzhiev
Bulgarian Academy of Sciences, Sofia, Bulgaria
M. Ackermann
INSOLIGHT, Lausanne, Switzerland
I. Cuenca Fernández
Consejería de Medio, Seville, Spain
E. Unger
HZB, Berlin, Germany
S. Haas
Reiner Lemoine Institut, Berlin, Germany
R. Zilles
University of São Paulo, Brazil

ORAL PRESENTATIONS 5DO.2

15:15 - 16:45 Forecasting

Chairpersons:

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

Ana Maria Gracia Amillo
European Commission JRC, Italy

5DO.2.1 Nowcasting of Irradiance Using a Network of All-Sky-Imagers

N. Blum, B. Nouri & S. Wilbert
DLR, Tabernas, Spain
T. Schmidt & D. Heinemann
DLR, Oldenburg, Germany
T. Schmidt
CSP Services, Cologne, Germany
P. Kuhn
Energie Baden-Württemberg, Karlsruhe, Germany
L.F. Zarzalejo
CIEMAT, Madrid, Spain
R. Pitz-Paal
DLR, Cologne, Germany

5DO.2.2 Potential for Crowdsourced Weather Stations to Assess Intra-Hourly Variability of Photovoltaic Systems
J. Lopez Lorente, X. Liu, D.J. Morrow & P. Brogan
Queen's University Belfast, United Kingdom

5DO.2.3 Adjoint Sensitivity of Farms to the Forecasting Variables of WRF-Solar
J. Yang, M. Sengupta & Y. Xie
NREL, Golden, United States
P.A. Jimenez & J.-H. Kim
National Center for Atmospheric Research, Boulder, United States

5DO.2.4 Short-Term Photovoltaic Generation Forecasting Using Multiple Heterogenous Sources of Data
K. Bellinguer , R. Girard & G. Kariniotakis
Mines ParisTech, Sophia-Antipolis, France
G. Bontron
CNR, Lyon, France

5DO.2.5 Performance Test of New PV-Forecasting Models in Realistic Environments
P. Gaisberger, L. Gaisberger & R. Höller
FH-OOE, Wels, Austria
W. Traunmüller
Blue Sky, Attnang, Austria
N. Diewald
Fronius, Wels, Austria
P. Praher
SCCH, Hagenberg, Austria
M. Ehrlinger
Energie AG Trading, Linz, Austria
S. Moser
Energieinstitut an der JKU, Linz, Austria

5DO.2.6 Invited

ORAL PRESENTATIONS 2DO.5

15:15 - 16:45 Production Processes Silicon Solar Cells

Chairpersons:

Peter Fath
RCT-Solutions, Germany

Peter Wohlfart
Singulus Technologies, Germany

2DO.5.1 „Project FINALE“ - Screen and Screen Printing Process Development for Ultra-Fine-Line Contacts below 20µm Finger Width
F. Clement, M. Linse, S. Tepner, N. Wengenmeyr, L. Ney, K. Krieg, A. Lorenz, M. Pospischil & R. Preu
Fraunhofer ISE, Freiburg, Germany
S. Bechmann
Koenen, Ottobrunn-Riemerling, Germany
K. Oehrle
Kissel + Wolf, Wiesloch, Germany
S. Steckemetz
SolarWorld Innovations, Freiberg, Germany

2DO.5.2 The Influnce of Diffusion Condtion to Passivation Quality of SiOx/Poly-Silicon Layer
W. Deng, X. An, H. Chen, F. Jiang & G. Xing
Canadian Solar, Suzhou, China

2DO.5.3 PULSION®-Solar, an Efficient and Cost Effective Implantation Solution for High Efficiency Silicon Solar Cells Manufacturing
A. Lanterne, T. Desrues, A. Veau, P. Bellanger, C. Lorfeuvre & S. Dubois
CEA, Le Bourget du Lac, France
B. Barthe
University Grenoble Alpes, France
F. Torregrosa & L. Roux
Ion Beam Services, Peynier, France

2DO.5.4 Defect Engineering of n-Type Bifacial Silicon Using Dark Annealing
X. Tan, R.L. Chin, D. Chen, R. Chen & F.E. Rougieux
UNSW Australia, Sydney, Australia

2DO.5.5 Selective Patterning of PVD-Metal Stacks by Electrochemical Screen Printing for Back-Contact Solar Cells
K. Gensowski, M. Kamp, R. Efinger, G. Mikolasch & J. Bartsch
Fraunhofer ISE, Freiburg, Germany
S. Bechmann & R. Weber
KOENEN Solar, Ottobrunn, Germany

2DO.5.6 Interpretable Machine Learning for Production Optimization
S. Wasmer & B. Klöter
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

ORAL PRESENTATIONS 6DO.8

15:15 - 16:45 PV for Buildings

Chairpersons:

Urs Muntwyler
BUAS, Switzerland

Francoise Burgun
CEA, France

6DO.8.1 Investigating the Thermal Behaviour and Degradation Rate of BIPV Modules: Case Study of a High-Rise Office Building under Different Climatic Conditions
J. Goncalves, T. van Hooff & D. Saelens
KU Leuven, Heverlee, Belgium

6DO.8.2 Monitoring the Outdoor Operating Temperature of Glass-Free Lightweight Solar Modules for Building Integrated Photovoltaics
A.C. Oliveira Martins, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland
V. Chapuis
CSEM, Neuchâtel, Switzerland

6DO.8.3 PV Chimney Concept: Modelling and Demonstration of Photovoltaic Systems Integration in Double Skin Façades
Z. Haghighi, S. Wapperom, J.C. Ortiz Lizcano, C. Infante Ferreira, A. van den Dobbelsteen, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

6DO.8.4 Demonstration of a Novel Low Concentration and Solar Control Photovoltaic System for Building Integration
D. Valencia, M. Machado & A. Sanz Martinez
Tecnalia, San Sebastián, Spain
Y.B. Assoa & F. Burgun
CEA, Le Bourget du Lac, France
J. Escribano Troncoso
Acciona Infraestructuras, Madrid, Spain
E. Rico
Onyx Solar Energy, Avila, Spain
T. Reijenga
BEAR-iD, Gouda, The Netherlands
P. Brassier
Nobatek, Anglet, France
P. Surguy & L. Chan
Film Optics, Watchfield, United Kingdom
V. Francisco
CTCV, Coimbra, Portugal
P. Alonso & I. Weiss
WIP Renewable Energies, Munich, Germany

6DO.8.5 Methodology and Tool for the Electrical Layout of BIPV-Modules with Novel Design Features
J. Eisenlohr, S. Gasparotto, A. Mondon, M. Heinrich & T.E. Kuhn
Fraunhofer ISE, Freiburg, Germany

6DO.8.6 BIM – A Booster for Energy Transition and BIPV Adoption
P. Alamy
Enerbim, Seilh, France
V.K. Nguyen
CADCAMation, Onex, Switzerland
M. Machado
Tecnalia, San Sebastián, Spain
P. Alonso
WIP Renewable Energies, Munich, Germany

VISUAL PRESENTATIONS 7DV.2

15:15 - 16:45 Costs, Economics, Finance and Markets / Policies and Scenarios for Renewables, Societal and Global Challenges

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

ORAL PRESENTATIONS 5DO.3

17:00 - 18:30 Designing Systems for Specific Environments

Chairpersons:

Angèle Reinders
University of Twente, The Netherlands

Daniela Guida
ENEL Green Power, Italy

5DO.3.1 Photovoltaics in the Urban Environment: Towards a Fast, Accurate and Remote 3D-Based Energy Potential Simulation Framework
O. Isabella, A. Calcabrini, H. Ziar & M. Zeman
Delft University of Technology, The Netherlands

5DO.3.2 Analysis and Investigation of BIPV Operating Performance Based on the PV Installations at the ZSW Research Building
D. Geyer, D. Stellbogen, P. Lechner, S. Hummel, J. Schnepf & D. Huschenhöfer
ZSW, Stuttgart, Germany

5DO.3.3 Half-Cell Module Behaviour and Its Impact on the Yield of a PV Plant
M. Chiodetti, J. Dupuis & P. Dupeyrat
EDF R&D, Moret Loing et Orvanne, France
D. Boublil & K. Radouane
EDF EN, Paris La Defense, France

5DO.3.4 Bifacial PV System Mismatch Loss Estimation and Parameterization
C. Deline & S. Ayala Pelaez
NREL, Golden, United States
S. MacAlpine
Juwi Solar, Boulder, United States
C. Olalla
URV, Tarragona, Spain

5DO.3.5 A Year in the Life of Vertical Bifacial Systems on Land and Water
A.J. Carr & B.B. Van Aken
ECN part of TNO, Petten, The Netherlands
H. Lok, L.S. Bosma & T. Jansma
Hanze University, Groningen, The Netherlands

5DO.3.6 Student Award Finalist Presentation: Simulation of Performance Differences between Off-Shore and Land-Based Photovoltaic Systems
S.Z. Mirbagheri Golroodbari & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

ORAL PRESENTATIONS 2DO.6

17:00 - 18:30 Characterisation & Simulation of Si Cells (II)

Chairpersons:

Dominic Walter
ISFH, Germany

Ivan Gordon
imec, Belgium

2DO.6.1 Student Award Finalist Presentation: Importance of the Injection Level for Studies on Light- and Elevated Temperature- Induced Degradation in Crystalline Silicon
M. Kim, S. Liu, D. Chen, C. Chan, M. Abbott & B. Hallam
UNSW Australia, Sydney, Australia

2DO.6.2 Extracting Metal and Edge Recombination Parameters which are Compatible with Multi-Dimensional Cell Simulations
P. Saint-Cast, D. Herrmann, P. Baliozian, H. Stolzenburg, H. Höffler & A. Fell
Fraunhofer ISE, Freiburg, Germany

2DO.6.3 A Simplified Model to Simulate Passivating & Selective Hole-Collecting Contacts
G.J.M. Janssen, M.T.S.K. Ah Sen & P.C.P. Bronsveld
ECN part of TNO, Petten, The Netherlands

2DO.6.4 Vignetting in Luminescence Imaging Setups
G. Dost, H. Höffler & J. Greulich
Fraunhofer ISE, Freiburg, Germany

2DO.6.5 The Angular Distribution of Scattered Reflectance from Textured Silicon
D. Payne, B. Puthen-Veettill & D.M. Bagnall
Macquarie University, Sydney, Australia
M. Abbott, T.H. Fung, M.U. Khan, Y. Zhang, S. Wang, G. Scardera, B. Hoex & M.E. Pollard
UNSW Australia, Sydney, Australia

2DO.6.6 Electrical Characterization of Micro-Colloids in Si Solar Cell Screen-Printed Contacts by Conductive Atomic Force Microscopy (C-AFM)
K. Ren, D. Han & A. Ebong
UNC Charlotte, United States

ORAL PRESENTATIONS 6DO.9

17:00 - 18:30 PV Integration in Non Conventional Application

Chairpersons:

Alessandra Scognamiglio
ENEA, Italy

Alessandro Virtuani
EPFL, Switzerland

6DO.9.1 Influence of Wave Induced Movements on the Performance of Floating PV Systems
M. Dörenkämper, D. van der Werf, K. Sinapis, M.M. de Jong & W. Folkerts
TNO-SEAC, Eindhoven, The Netherlands

6DO.9.2 The Performance of a Floating PV Plant at the West Coast of Norway
I.H. Lereng, E.S. Marstein & J.H. Selj
Institute for Energy Technology, Kjeller, Norway
P. De Paoli
UMB, Ås, Norway
S. Bragstad & B. Bjørneklett
Ocean Sun, Lysaker, Norway

6DO.9.3 Dynamic Agrivoltaics: A Breakthrough Innovation
A.-L. Gorge, F. Sourd & J. Garcin
Sun'R, Paris, France
C. Dugué & G. Goaer
Photowatt, Lyon, France

6DO.9.4 Lightweight, Flexible and High Efficiency c-Si Photovoltaic Modules for the Stratobus TM
J. Gaume, H. Robin & M. Joanny
CEA, Le Bourget du Lac, France
R. Chaix
Thales Alenia Space, Cannes, France

6DO.9.5 Urban Microclimate in Street Canyons with Façade PV Using ENVI-met
S.R. Freitas
Energy and Environment Agency of Lisbon, Portugal
R. Ferreira & M.C. Brito
University of Lisbon, Portugal

6DO.9.6 Angle-Dependent Optical Performance of Spectrally Selective Solar Cells for Building Integrated Applications
N. Osterthun, N. Neugebohrn, K. Gehrke, M. Vehse & C. Agert
DLR, Oldenburg, Germany

17:00 - 18:30 POSTER AWARDS WINNERS SESSION

Chairpersons:

Julio Cárabe
CIEMAT, Spain

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

2EO.1 T2.6 *Audit 1*	6EO.2 T6.2 *Audit 3*	7EO.3 T7.1 *Audit 2*

Break

6EP.1 / 7EP.2
(joint session 100 min plenary)
Auditorium 1

Closing Session
Key note, Highlights of the Conference, Poster Awards, Student Awards, Farewell

2 Silicon Materials and Cells
- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

6 PV Applications and Integration
- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

7 Finance, Markets and Policies
- T7.1 Costs, Economics, Finance and Markets
- T7.2 Policies and Scenarios for Renewables, Societal and Global Challenges

ORAL PRESENTATIONS 2EO.1

08:30 - 10:00 Manufacturing of Silicon Solar Cells

Chairpersons:

Weiwei Deng
Canadian Solar, China

Martijn Lenes
Tempress, The Netherlands

2EO.1.1 The Vision of Large Scale PV Manufacturing in Europe: A Dream or Chance for Execution?
P. Fath & W. Jooss
RCT-Solutions, Constance, Germany
A.W. Bett, S. Nold & J. Rentsch
Fraunhofer ISE, Freiburg, Germany
J. Trube
VDMA, Frankfurt am Main, Germany

2EO.1.2 Toward 25% Silicon Cell Efficiency in Mass-Production: Strategies and Prospects Based on Industrial Data
Y. Chen, D. Chen, P.P. Altermatt, G. Xu, Z. Wang, C. Liu, Y. Zou, Y. He, Y. Wang, J. Gong, L. Yuan, W. Liu, Y. Chen, M. Deng, Y.Y. Hu, S. Chen, J. Xiang, H. Shen, S. Zhang, L. Wang, X. Zhang, Y. Yang & Z. Feng
Trina Solar Energy, Changzhou, China
P.J. Verlinden
Amrock, McLaren Vale, Australia

2EO.1.3 'HJT 2.0' Performance Improvements and Cost Benefits for Silicon Heterojuntion Cell Production
D.L. Bätzner, P. Papet, B. Legradic, D. Lachenal, R. Kramer, T. Kössler, L. Andreetta, S. Pitteloud, N. Holm, C. Aeby, J.-P. Cardoso, W. Frammelsberger & B. Strahm
Meyer Burger Research, Hauterive, Switzerland

2EO.1.4 Large Area TOPC on Cells Realized by a PECVD Tube Process
F. Feldmann, T. Fellmeth, B. Steinhauser, J.-I. Polzin, H. Nagel, S. Mack, J. Benick, A. Richter, A. Moldovan, M. Bivour, F. Clement, J. Rentsch, M. Hermle & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2EO.1.5 Characterization of Passivated Contacts Formed with Different Metal Pastes on LPCVD Poly-Si Based monoPoly(TM) Solar Cells
P. Padhamnath, J.K. Buatis, L.M. Ortega, N. Nandakumar, V. Shanmugam & S. Duttagupta
SERIS, Singapore, Singapore

2EO.1.6 Automatic Defect Detection in Electroluminescence Images for PV Mass Production Using Deep Learning
M. Patzold, K. Kaufmann, C.-M. Lin, M. Rudolph, T. Burwig & D. Lausch
DENKweit, Halle (Saale), Germany

ORAL PRESENTATIONS 6EO.2

08:30 - 10:00 Professional Applications of PV

Chairpersons:

Gaetan Masson
Becquerel Institute, Belgium

Hubert A. Aulich
SC Sustainable Concepts, Germany

6EO.2.1 A Feasibility Study of Solar PV Powered Electric Cars Using an Interdisciplinary Modeling Approach for the Electricity Balance, CO2 Emissions and Economic Aspects - The Cases of The Netherlands, Norway and Brazil
T. de Santana & A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands
N.J. Ekins-Daukes
UNSW Australia, Sydney, Australia

6EO.2.2 VIPV: c-Si Modules Design, Manufacturing and Integration on a Solar Car Demonstrator
V. Maneval, T. Duigou, J. Gaume, L. Serra, H. Robin, S. Guillerez & M. Joanny
CEA, Le Bourget du Lac, France

6EO.2.3 Some Approaches of PV-Powered Vehicles Applications
M. Yamaguchi, K. Araki, K.-H. Lee & N. Kojima
Toyota Technological Institute, Nagoya, Japan
T. Masuda & A. Satou
Toyota, Susono, Japan
M. Hasegawa & H. Yamada
NEDO, Kawasaki, Japan

6EO.2.4 Efficient Si Photovoltaics for Electrically Powered Utility Vehicles – STREET

R. Peibst, F. Haase, H. Schulte-Huxel, S. Blankemeyer, M. Köntges, C. Hollemann & R. Brendel
ISFH, Emmerthal, Germany
G. Wetzel & J. Krügener
MBE, Hannover, Germany
H.-J. Nonnenmacher & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany
M. Stein & R. Wecker
a2solar, Erfurt, Germany
A. Schiessl & J. Süss
Continental CPT Group, Regensburg, Germany
F. Metzger & C. Schreibmüller
StreetScooter, Aachen, Germany
K. Ding, A. Lambertz, W. Duan, A. Mikosch & B. Pieters
Forschungszentrum Jülich, Germany
B. Stannowski & L. Korte
HZB, Berlin, Germany

6EO.2.5 Feasibility of Hydroponic Solar Sharing System without Liquid Fertilizer

H. Kubo & K. Okoso
Chiba Institute of Technology, Narashino-city, Japan
S. Maeno
mSe Corporation, Chiba-city, Japan

6EO.2.6 Solar Powered Electrolitic Water Treatment for Industrial Application

S. Shimura
IFSP, São Paulo, Brazil
R. de Paula Diver
UNICAMP, Campinas, Brazil

ORAL PRESENTATIONS 7EO.3

08:30 - 10:00 Economic and Market Analisys

Session Chair:

Silvia Caneva
WIP Renewable Energies, Germany

Izumi Kaizuka
RTS Corporation, Japan

7EO.3.1 A Snapshot of Global PV Markets - The Latest Survey Results on PV Markets and Policies from the IEA PVPS Programme in 2018

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

7EO.3.2 Impact of WACC and Other Parameters on Future Utility-Scale PV LCOE

E. Vartiainen
Fortum Growth, Finland
G. Masson
Becquerel Institute, Brussels, Belgium
C. Breyer
LUT University, Lappeenranta, Finland
D. Moser
Eurac Research, Bolzano, Italy
E. Román Medina
Tecnalia, San Sebastian, Spain

7EO.3.3 IPVF's PV Technology Vision 2030

L. Oberbeck
Total Gas, Renewables and Power, Paris, France
K. Alvino & B. Goraya
IPVF, Palaiseau, France
M. Jubault
EDF R&D, Palaiseau, France
D. Lincot
CNRS, Palaiseau, France

7EO.3.4 **PV LCOE for Different Market Segments in Italy with and without Storage Systems**
E. Veronese & D. Moser
Eurac Research, Bolzano, Italy
G. Manzolini
Polytechnic University of Milan, Italy

7EO.3.5 **Analysis for Low Market Uptake of BIPV**
S. Broß, E. Grommes, A. Krenz & U. Blieske
Cologne University of Applied Sciences, Germany
F. Flade & G. Becker
Bavarian Association for the Promotion of Solar Energy, Munich, Germany

7EO.3.6 **Modules at a Price of 10 $ct/Wp - Dream or Reality?**
W. Hoffmann
ASE, Hanau, Germany
A. Metz
VDE Renewables, Alzenau, Germany

PLENARY SESSION 6EP.1 / 7EP.2

10:30 - 12:10 PV Impacting Society

Chairpersons:

Francesco Frontini
SUPSI, Switzerland

Stefan Nowak
NET Nowak Energy & Technology, Switzerland

6EP.1.1 **Solar Electricity and Safe Drinking Water: Global Opportunities and Challenges**
H.A. Aulich
Sustainable Concepts, Erfurt, Germany
A. Goldmaier & P. Otter
AUTARCON, Kassel, Germany
A.O. Ighodaro
KXN, London, United Kingdom

6EP.1.2 **Lesson Learnt from Multi Megawatt Projects Integrated into Landscapes and Buildings**
E. Scotto
Akuo Energy, Paris, France

7EP.2.1 **The Role of Photovoltaics in a Sustainable European Energy System under Variable CO2 Emissions Targets, Transmission Capacities, and Costs Assumptions**
M. Victoria, K. Zhu, G.B. Andresen & M. Greiner
Aarhus University, Denmark
T. Brown
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany

7EP.2.2 **PV Technologies: How Might These Evolve?**
M.A. Green
UNSW Australia, Sydney, Australia

7EP.2.3 **Mass-Scale Solar Hydrogen: How PV is Set to Become the New Oil**
T. Lepercq
Solairestream, Paris, France

NOTES

12:10 – 13:10 CONFERENCE CLOSING

Keynote, Highlights of the Conference, Poster Awards, Student Awards, Farewell

Welcome:

Florence Lambert
EU PVSEC 2019 General Chair
Director of CEA Liten (the Laboratory for Innovation in new Energy Technologies and Nanomaterials)

Highlights of the Conference Week

Robert Kenny
EU PVSEC Technical Programme Chair
European Commission Joint Research Centre

Ceremony of the Student Awards

Arno Smets
EU PVSEC Student Awards Coordinator
Delft University of Technology, The Netherlands

Ceremony of the Poster Awards

Julio Cárabe
EU PVSEC Poster Awards Coordinator
CIEMAT, Spain

Announcement upcoming PV events

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

Florence Lambert
EU PVSEC 2019 General Chair
Director of CEA Liten (the Laboratory for Innovation in new Energy Technologies and Nanomaterials)

At the time of printing the detailed Programme of the Closing Event is under final preparation. Please visit *www.photovoltaic-conference.com* for all information.

Monday, 09 September 2019

13:30 - 15:00 POSTER AWARDS KICK-OFF

VISUAL PRESENTATIONS 4AV.1

15:15 - 16:45 PV Module Design, Manufacture, Performance and Reliability (I)

Chairpersons:

Ralph Gottschalg
Fraunhofer CSP, Germany

Ulrike Jahn
TÜV Rheinland Energy, Germany

4AV.1.3 Corrosion Mechanism of Anodized PV Frame in the Accelerated Salt Spray Test
H.-H. Hsieh
ITRI, Hsinchu, Taiwan
W. Kai
National Taiwan Ocean University, Keelung, Taiwan
J.-F. Wen
United Renewable Energy, Hsinchu, Taiwan

4AV.1.4 Power Stabilization of Crystalline PV Modules
R. Ebner & G. Újvári
AIT, Vienna, Austria
W. Mühleisen & C. Hirschl
CTR, Villach, Austria

4AV.1.5 Measurement of Water Vapor Transmission Rate of PV Backsheet with Highly Accelerated Stress Test
Y.T. Li, C.F. Hsieh & S.-H. Chen
ITRI, Hsinchu, Taiwan
H.-L. Wu & P. Yu
National Chiao Tung University, Hsinchu, Taiwan

4AV.1.6 Experimental Benchmarking of Partial Shading Effect on Thin-Film and Crystalline-Silicon Solar Photovoltaic Modules
K.A.K. Niazi, Y. Yang, S.V. Spataru, M.U. Mutarraf & D. Sera
Aalborg University, Denmark

4AV.1.7 **Optimization and Design Issues of Bifacial PV Modules and Systems**
W. Mühleisen, L. Neumaier & C. Hirschl
CTR, Villach, Austria
B. Pletz & G. Safran
PVP Photovoltaik, Wies, Austria
G. Újvári, A. Mittal, M. Schwark & S. Zamini
AIT, Vienna, Austria

4AV.1.8 **Accelerated TC Test in Comparison with Standard TC Test for PV Modules**
C.H. Schiller, L.C. Rendler, S. Stecklum, D. Eberlein, A. Kraft & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.9 **The Analysis of Electrical Characteristics of Separated Solar Cell by Laser Scribing for High Performance Shingled PV Module**
Y.-J. Kim, Y.-K. Min, J.-W. Kang, J.-W. Baik, E.-J. Lee, D.-S. Kim, C.-S. Park & K.-K. Hong
Shinsung E&G, Jeungpyeong-gun, Republic of Korea

4AV.1.10 **Contributing to the Quality of PV Solar Modules in West Africa**
N. Wyrsch
EPFL, Neuchâtel, Switzerland
M.L. Ndiaye, A. Ndiaye & C.M.F. Kebe
ESP, Dakar Fann, Senegal

4AV.1.12 **Optimisation of Bifacial Photovoltics Module with Reflective Layer in Outdoor Performance**
E. Sng
REC Solar, Singapore, Singapore
S. Channabasappa Devihosur, R. Swaminathan, S. Roy & I.L.H. Lim
University of Glasgow, United Kingdom
M. Kurinji
Ngee Ann Polytechnic, Singapore, Singapore

4AV.1.14 **Investigating Partial Shadowing of PV Module at Solar Cell Level**
L. Feng, S. Hempelmann, M. Grüneis, G. Behrens & F.U. Hamelmann
University of Applied Sciences Bielefeld, Minden, Germany

4AV.1.15 **Differential Scanning Calorimetry for Simulation and Optimization of PV Module Lamination**
C. Herzog, T. Müller, M. Heinrich & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.16 **Additive Analysis in Encapsulant Materials and Correlation to Encapsulant Degradation Modes**
C. Barretta & G. Oreski
PCCL, Leoben, Austria
K. Resch-Fauster
University of Leoben, Austria

4AV.1.17 **Parallel Natural Weathering of Backsheets across Europe**
L. Castillon & G. Oreski
PCCL, Leoben, Austria
J. Ascencio-Vásquez & M. Topič
University of Ljubljana, Slovenia
A. Panos & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4AV.1.18 **Assessment and Evolution of Initial Mono-PERC Module Degradation Using Light Induced Degradation, Carrier Induced Degradation and Outdoor Exposure**
J. Dupuis, G. El Hajje & P. Dupeyrat
EDF R&D, Moret-sur-Loing, France
E. Sandre & K. Radouane
EDF Renewables, Paris, France

4AV.1.19 **Influence on the CASS Testing for Module Materials**
C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, Y.-H. Chao, L.-G. Wu & C.-Y. Yu
TSEC, Hsinchu, Taiwan
M.-A. Tsai & H.-H. Hsieh
ITRI, Hsinchu, Taiwan

4AV.1.20 **Techno-Economic Analysis of Half-Cell Modules - The Impact of Half-Cells on Module Power and Costs**
M. Mittag, A. Pfreundt, J. Shahid & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.22 **Mechanical Stability of the Semi-Flexible HJT Solar Panels**
S. Yakovlev, K. Emtsev, D. Andronikov, A. Abramov & D. Orekhov
R&D Center TFTE, St. Petersburg, Russia
I. Shakhray
Avelar Solar Technology, Moscow, Russia

4AV.1.23 **Determination of Depth-Dependent Variations in the Degree of Crosslinking of EVA due to Changing Lamination Parameters Using Raman Spectroscopy**
K. Harms, L. Neumaier & C. Hirschl
CTR, Villach, Austria

4AV.1.24 Direct Measurement of Moisture Ingress in PV Laminates
N. Kyranaki & T.R. Betts
CREST, Loughborough, United Kingdom
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

4AV.1.25 Analysis of Drivers for PV-Material Yellowing Upon Artificial Aging
Y. Voronko & G.C. Eder
OFI, Vienna, Austria
M. Edler
ISOVOLTAIC Solinex, Lebring, Austria
G. Oreski
PCCL, Leoben, Austria
W. Mühleisen
CTR, Villach, Austria

4AV.1.26 Pathways of Uncertainties in Service Lifetime Prediction (SLP) Models for PV Modules: How to Improve the Accuracy?
I. Kaaya & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4AV.1.27 Characterisation of the Reverse DC Resistance due to Potential Induced Degradation (PID) in Crystalline PV Cells
M. Florides, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

4AV.1.28 Qualification of Polyolefin Backsheet for PV Modules
P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany
P. Hülsmann
Bischof + Klein, Lengerich, Germany

4AV.1.29 Impact of Highly Breathable Polyolefin Backsheet on EVA Yellowing
P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany
F. Rummens
RENOLIT, Oudenaarde, Belgium

4AV.1.30 Performance and Reliability of Bifacial Modules Using a Transparent Backsheet
W.J. Gambogi, M. Demko, T. Felder, S. MacMaster, B.-L. Yu & K. Roy-Choudhury
DuPont, Wilmington, United States
A. Borne
DuPont, Geneva, Switzerland
H. Hu & Z. Pan
DuPont, Shanghai, China

Conference Programme
VISUAL PRESENTATIONS

PROGRAMME

4AV.1.31 H2020: Solar Train MSCA Fellowship Combined Effect of UV, Temperature and Humidity on Mono-Crystalline Mini-Modules Ageing Using UV LED Lamps at Specific Wavelengths
A. Nairi, J. Bengoechea, M.J. Rodriguez & A.R. Lagunas
CENER, Sarriguren-Navarra, Spain
D.E. Mansour & L. Pitta Bauermann
Fraunhofer ISE, Freiburg, Germany

4AV.1.32 Artificial Soiling Testing and Performance Determination of Functional Coatings
E. Klimm, C. Siess, T. Kaltenbach & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4AV.1.33 The Effect of Shadows from People and Cleaning Tools on the STC Power of CIGS Thin-Film PV Modules
M. Kitze
Avancis, Torgau, Germany
S. Grünsteidl, P. Borowski, T. Dalibor & J. Palm
Avancis, Munich, Germany

4AV.1.34 Modelling the Generation and Diffusion of Acetic Acid in Aged Ethylene-Vinyl Acetate-Based Encapsulants Used in Solar Modules
L. Gnocchi, A. Virtuani, E. Annigoni & C. Ballif
EPFL, Neuchâtel, Switzerland
H.-Y. Li
CSEM, Neuchâtel, Switzerland

4AV.1.36 Investigation of Stabilization Procedures for Power Determination of Thin-Film Modules
T. Weber, L. Schmidt, M. Grieb, N. Pongthanacharoenkul, L. Podlowski, P. Grunow & S. Xuereb
PI Berlin, Germany

4AV.1.37 Development of Ultra-Accelerated Ageing Tests for Improved Reliability and Durability of Bifacial Photovoltaic Modules in Harsh Desert Conditions
J.-F. Lelièvre, B. Hladys, D. Muñoz & A. Derrier
CEA, Le Bourget du Lac, France
E. Cabrera
ISC Konstanz, Germany
V. Gutierrez
Fraunhofer Chile Research, Santiago, Chile
P. Ferrada
University of Antofagasta, Chile

4AV.1.38 Influence of Large Periods of DC Current Injection in c-Si Photovoltaic Panels
A. Moreton-Fernandez, M.M. Jiménez-Martín, O. Martinez-Sacristan, M.A. González-Rebollo, J. Jiménez-López, S. Gallardo-Saavedra, V. Alonso-Gómez, L. Hernández-Callejo & J.I. Morales-Aragonés
University of Valladolid, Spain

4AV.1.39 Light Management Coatings for Solar Modules by Large-Area Nanoimprinting
L.W. Veldhuizen & R.A.J.M. van Erven
Morphotonics, Veldhoven, The Netherlands

4AV.1.40 Optimising SHJ Solar Cell Bifaciality towards a Monolithic Module Architecture
J. Eymard, V. Barth, L. Basset, E. Gerritsen & A. Danel
CEA, Le Bourget du Lac, France
M. Hebert & R. Clerc
University of Lyon, Saint-Etienne, France

4AV.1.41 Coupled Multi-Physics Model for Simulating Thermal Behavior, Electrical Yield and Structural Reliability of Monofacial and Bifacial Photovoltaic Modules under Desert Environment
S. Ahzi, S.P. Aly & N. Barth
QEERI, Doha, Qatar

4AV.1.42 Numerical and Experimental Investigations on the Effect of Different Frame and Mounting Configurations of poly-c-Si PV Modules for Crack Propagation and Degradation
L. Papargyri, M. Theristis, P. Papanastasiou & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
B. Kubicek
AIT, Vienna, Austria

4AV.1.45 One Step towards General Mathematical Formulation of Shading Tolerability for Photovoltaic Modules
H. Ziar, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

4AV.1.46 Acceptable Volume of Investment for "Combined Stress Testing"
T. Tanahashi & K. Sakurai
AIST, Tsukuba, Japan
M. Woodhouse & P. Hacke
NREL, Golden, United States

4AV.1.47 Superhydrophillic Self Cleaning SiO2/TiO2 Thin Film Coating for Solar Glass Cover Application
A. Abhinav & S. Mallick
IIT Bombay, Mumbai, India

4AV.1.48 Cell Strength Test in Laminates – Findings and Practical Relevance
M. Pander , U. Zeller, B. Jaeckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4AV.1.49 Development of Conductive Back-Sheet for Manufacture of PV Modules with Back-Contact Cells
G.J.W. Meijers & I.J. Bennett
DSM, Geleen, The Netherlands

4AV.1.50 Improvements in Energy Yield and Financial Benefits for Next-Generation DSM AR Coatings
P. Pasmans, T. Besseling, G. Draaisma, X. Paquez, P. Tummers, N. Voicu, L. Zheng & I. Goudswaard
DSM, Geleen, The Netherlands
Y. Lei
DSM, Shanghai, China
F. Dross
DSM, Parsippany, United States

4AV.1.51 Laser-Assisted Bonding (LAB) and Hybrid Underfill Technology for Module Fabrication Based on Silicon Back Contact Solar Cell
K.-S. Choi, J. Joo, S.H. Moon & Y.-S. Eom
ETRI, Daejeon, Republic of Korea

4AV.1.54 Reliability and Durability Infulence of Different Backsheet for PV Modules in High Humiduty Enviroment
H. Gong, M. Gao & Y. Guo
Suntech Power, Wuxi, China

4AV.1.55 Experimental Validation of a Numerical Model of the Mechanical Behaviour of Photovoltaic Modules
E. Boyère, A. Grousset, J.-C. Le Roux & D. Binesti
EDF R&D, Ecuelles, France
L. Flandi
EDF R&D, Palaiseau, France
J.-N. Jaubert
Canadian Solar, Suzhou, China

4AV.1.56 Perfromance Degradation of Solar Modules for Solar Roadways
J.H. Kim
DGIST, Daegu, Republic of Korea
F. Khan
KFUPM, Dhahran, Saudi Arabia

4AV.1.58 **From Degradation Kinetics in PV Modules to Residual Lifetime Prognostics**
H. Hieber & H. Gropius
ICR, Weimar, Germany

4AV.1.59 **Numerical Calculation for Internal Heat Flow through Applying a Heat Dissipation Structure to the Rear Side of PERC Solar Module**
S.H. Jung, J. Kim, Y. Kim & S.M. Kim
GERI, Gumi, Republic of Korea
M.G. Kang & H.-E. Song
KIER, Daejeon, Republic of Korea

4AV.1.60 **Failure Mechanisms in PID Resistant PV Modules Under Enhanced Environmental Humidity and Soiling Stress**
V. Naumann, K. Ilse, M. Pander & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany

4AV.1.61 **Study of PID Mechanism for n-Type Bifacial Solar Cells**
I. Devoto & A. Halm
ISC Konstanz, Germany

VISUAL PRESENTATIONS 4AV.2

17:00 - 18:30 **PV Module Design, Manufacture, Performance and Reliability/ Inverters and Balance of System Components/ Sustainability and Recycling**

Chairpersons:

Werner Herrmann
TÜV Rheinland Energy, Germany

Nicola Pearsall
Northumbria University, United Kingdom

Mariska de Wild-Scholten
SmartGreenScans, The Netherlands

4AV.2.1 **Correlation Analysis of Environmental Variables for Pb Free p-PERC Bifacial c-Si PV Module in Floating and Marine PVs**
H.K. Ahn, J.-H. Choi, S.Y. Park, B.G. Bhang & W.B. Lee
Konkuk University, Seoul, Republic of Korea
G.-G. Kim
Chungbuk Technopark, Jincheon, Republic of Korea
C.-S. Won
Floating PV Team, Gyeonggi-Do, Republic of Korea
O. Kwon & H. Jo
K-water, Daejeon, Republic of Korea
H.J. Go
Koenergy, Gyeongsangnam-Do, Republic of Korea

4AV.2.2 **The Development of Moisture Monitoring for Photovoltaic Module**
H.-L. Wu & P. Yu
National Chiao Tung University, Hsinchu, Taiwan
Y.T. Li, C.F. Hsieh & S.-Y. Ting
ITRI, Hsinchu, Taiwan

4AV.2.3 **Characterization and Optimization of an Inline PV Module Flash Tester in Terms of Realistic Bifacial Module Assessment in the Manufacturing Line**
L. Neumaier, W. Mühleisen, A. Frank & C. Hirschl
CTR, Villach, Austria
G. Safran
PVP Photovoltaik, Wies, Austria

4AV.2.4 **Power Performance of Bifacial c-Si PV Module at Low Irradiance Environments for Rooftop Applications**
H.K. Ahn, B.G. Bhang, J.-H. Choi, S.Y. Park & W.B. Lee
Konkuk University, Seoul, Republic of Korea
C.-S. Won
Scotra, Pyeongtaek, Republic of Korea
Y.K. Kwon
Korea Testing Laboratory, Ansan, Republic of Korea
C.Y. Cho
Sun engineering, Daejeon, Republic of Korea
H. Jo & O. Kwon
K-water, Daejeon, Republic of Korea
H.J. Go
Koenergy, Jinju, Republic of Korea

4AV.2.5 **LED-Based Differential Spectral Responsivity Measurements of PV Modules**
H. Sträter, S. Riechelmann, F. Plag & S. Winter
PTB, Braunschweig, Germany

4AV.2.6 **Quantitative Analysis of Electroluminescence Imaging of a PV Module with Different Mismatch Levels**
J.D. Santos, A. Valverde & M.C. Alonso-García
CIEMAT, Madrid, Spain

4AV.2.8 **The Electrochemical Reactions in Crystalline Silicon Solar Modules**
H. Yyang & H. Wang
Xi'an Jiaotong University, China

4AV.2.9 **Statistical El-Image Evaluation for Describing the Degradation of PV-Modules after a Hailstorm**
C. Buerhop-Lutz, T. Pickel & J. Hauch
HI ERN, Erlangen, Germany
T. Winkler & C.J. Brabec
FAU, Erlangen, Germany

4AV.2.10 In Situ Contactless Phosphor Thermometry of Encapsulated Photovoltaic Devices
Y. Cao, G. Koutsourakis, G.J.M. Sutton, J.W.E. Kneller, S. Wood, J.C. Blakesley & F. Araujo de Castro
National Physical Laboratory, Teddington, United Kingdom

4AV.2.11 Characterizing the Angular Distribution of an LED-Based Solar Simulator for PV Modules
S. Riechelmann
PTB, Braunschweig, Germany

4AV.2.12 Multiple Linear Regression Model for Evaluation of Indoor and Outdoor Measurements of Chalcopyrite Thin Film Modules
G.A. Farías Basulto, P. Reyes-Figueroa, M. Aghaei, C. Ulbrich, R. Schlatmann & R. Klenk
HZB, Berlin, Germany
B. Szyszka
Berlin University of Technology, Germany

4AV.2.13 Development of Industrial Automation PLC Based Modeling for PV Module
Y. Ouberri, H. Yatimi & E. Aroudam
Abdelmalek Essaadi University, Tetouan, Morocco

4AV.2.14 Making the Most of Module Matrix Measurements - IEC 61853-1
A. Driesse
PV Performance Labs, Freiburg, Germany
J.S. Stein
Sandia National Laboratories, Albuquerque, United States

4AV.2.15 First Results from a High Precision Indoor & Outdoor PV Module Monitoring Campaign
C. Reise, U. Kräling, E. Schnabel & K. Kiefer
Fraunhofer ISE, Freiburg, Germany
U. Bohnert
Munich Re, Germany

4AV.2.16 Reducing Measurement Uncertainty of Temperature Coefficients
T. Slikker, E. Garcia Goma & S. Roest
Eternal Sun, The Hague, The Netherlands

4AV.2.17 Highly Accurate Irradiation and Temperature Control for Next-Generation PV Module Characterisation
A. van der Heide, J. Govaerts, J.A. Tsanakas, M. Aleman & E. Voroshazi
imec vzw, Genk, Belgium
N. Harder
Total, Paris la Defense, France

4AV.2.18 Degradation Analysis of PV Module Technologies in a Moderate Subtropical Climate
J. Lopez-Garcia, E. Grau-Luque, R.S.R. Gali, R.P. Kenny, D. Pavanello & T. Sample
European Commission JRC, Ispra, Italy

4AV.2.19 Energy Yield Analysis of Bifacial PV Modules: Different Technologies and Configurations
A.M. Gracia Amillo, J. Lopez-Garcia, R.P. Kenny & T. Sample
European Commission JRC, Ispra, Italy

4AV.2.20 Failure Diagnosis on Photovoltaic Modules Using Visual Inspection, Thermography, Electroluminescence and I-V Techniques
S. Gallardo-Saavedra, V. Alonso-Gómez, L. Hernández-Callejo, J.I. Morales-Aragonés, A. Moreton-Fernandez, M.M. Jiménez-Martín, O. Martinez-Sacristan, M.A. González-Rebollo & J. Jiménez-López
University of Valladolid, Spain

4AV.2.21 Evaluation of Tilt Angle Effect on Soiling of PV Modules in Dubai, UAE
A. Elnosh, A. Safieh, J.J. John & A. Alnuaimi
DEWA, Dubai, United Arab Emirates

4AV.2.22 Investigation on Shunt Severity in PV Modules by Electroluminescence Imaging and Lock-in Thermography
S. Roy, S. Kumar, R. Meena & R. Gupta
IIT Bombay, Mumbai, India

4AV.2.23 Determination of Temperature Coefficient of Photovoltaic Modules
O. Bazkir & S. Meric
TUBITAK-UME, Kocaeli, Turkey

4AV.2.24 Energy Yield Comparison between Bifacial and Monofacial PV Modules- Real World Measurements in Desert Climate (BWh)
J. Saal, J. Bonilla Castro & M. Schweiger
TÜV Rheinland, Cologne, Germany

4AV.2.25 Real Condition Characterization of Five Photovoltaic Technologies: What Is the Impact of the Environment?
A. Migan-Dubois
GeePs, Gif-sur-Yvette, France
J. Badosa
CNRS, Palaiseau, France
V. Bourdin
LIMSI, Orsay, France

4AV.2.26 Dozens of GWp with Structured Ribbons, Films, Multiwire and No Robust Method for Angular Response Characterization: New Hemispheric IAM (HIAM) Test for an IEC 61853-2 Amendment
M. Falsini
Florence, Italy

4AV.2.27 Angular Response Measurement of Thin-Film PV Modules with Solar Simulators
W. Herrmann, L. Rimmelspacher, J. Bonilla & M. Schweiger
TÜV Rheinland Energy, Cologne, Germany

4AV.2.28 Quantitative Electroluminescence Imaging of PV Modules: Low-Frequency Blur Removal
K.G. Bedrich, Y. Wang & Y. S. Khoo
SERIS, Singapore, Singapore

4AV.2.29 Temperature Reduction in Infinite Photovoltaic Solar Arrays
A. Glick, N. Ali, J. Bossuyt, G. Recktenwald & R.B. Cal
Portland State University, United States
M. Calaf
University of Utah, Salt Lake City, United States

4AV.2.30 In-Depth Degradation Analysis of Polyamide-Based Backsheets in Fielded Modules under Different Climates
Y. Lyu, A. Fairbrother, J.H. Kim & X. Gu
NIST, Gaithersburg, United States
M.D. Kempe
NREL, Golden, United States
S. Julien & K.-T. Wan
Northeastern University, Boston, United States
S. Napoli, A. Hauser & G. O'Brien
Arkema, King of Prussia, United States
Y. Wang, L. Bruckman & R.H. French
CWRU, Cleveland, United States
L. Ji & K. Boyce
Underwriters, Northbrook, United States

4AV.2.31 Effect of Curing Temperature on Properties of Ethylene Vinyl Acetate (EVA) Used for c-Si Solar Module Encapsulation
B. Adothu, A. Abhinav, S. Zele & S. Mallick
IIT Bombay, Mumbai, India
A.K. Singh
Renewsys, Bangalore, India

4AV.2.32 PV Module Design, Manufacture, Performance and Reliability
C. Beitel & C. Kedir
Renewable Energy Test Center, Fremont, United States

4AV.2.33 A Study on the Relationship Between Factors Affecting Peel Strength and Efficiency in Half Cell Multi-Wires Photovolatics Module
S.H. Kim, H.J. Son & J.H. Kim
KETI, Seongnam, Republic of Korea

4AV.2.34 New PV System Concept - Wireless PV Module Prototype
F. Carigiet, R. Knecht, T. Baumann & F.P. Baumgartner
ZHAW, Winterthur, Switzerland
C.J. Brabec
FAU, Erlangen, Germany

4AV.2.35 A New Dual-Buck Five-Level Inverter with Coupled Inductors for PV System Application
H.-T. Yang, J.-T. Liao & M.-K. Chuang
National Cheng Kung University, Tainan, Taiwan

4AV.2.36 Validated Testing of Grid-Connected PV Inverters for LV Grids by Means of Controller-Hardware-in-the-Loop (CHIL) Setup
G. Lauss, Z. Miletic, C. Messner, F. Leimgruber & C. Seitl
AIT, Vienna, Austria

4AV.2.37 Operating Temperature Development of Overcommitted Inverters
U. Muntwyler, M. Lanz & T. Schott
BUAS, Burgdorf, Switzerland
M. Bolliger
BKW, Bern, Switzerland

4AV.2.38 Converter Based PV-Emulator Using Artificial Neural Network Control Strategy
M. Bolouky, J. Milimonfared & A. Eskandari
Amirkabir University of Technology, Tehran, Iran
M. Aghaei
Albert-Ludwigs-University of Freiburg, Germany

4AV.2.39 PV Connectors a Crucial Part of the Reliability of PV Installations – Computer-Tomography (CT) as a Promising Method to Detect Cross Connections of PV Connectors
U. Muntwyler & E. Schüpbach
BUAS, Burgdorf, Switzerland
S. Schielly
Stäubli Electrical Connectors, Allschwil, Switzerland

4AV.2.46 Technological and Ecological Assessment of Concepts for Sustainable Photovoltaics
G. Oreski, A. Omazic & A. Wolfberger
PCCL, Leoben, Austria
G.C. Eder
OFI, Vienna, Austria
L. Neumaier & C. Hirschl
CTR, Villach, Austria
M. Wellacher & T. Dobra
University of Leoben, Austria
N. Lenck
VDE Renewables, Hanau, Germany

4AV.2.47 Ecological Footprint of PV Electricity: Influence of Waste Management, Degradation and Lifetime
K.-A. Weiß, S. Herceg & S. Pinto
Fraunhofer ISE, Freiburg, Germany

4AV.2.48 Sustainability Performance of Industrial Scale Heterojunction Technology (HJT) for Solar Photovoltaics (PV): Using Life Cycle Assessment (LCA) Methods to Assess Environmental and Social Impacts and Benefits of the AMPERE Project
D. Reid
ERM, Oxford, United Kingdom
B. Hartlin, C. Poulopoulos & E. Bauguen
ERM, London, United Kingdom

4AV.2.49 A Parameterized Model for the Estimation of Life-Cycle Environmental Impacts of Crystalline PV Systems
S. Tannous, R. Besseau, I. Blanc & P. Perez-Lopez
MINES ParisTech, Sophia-Antipolis, France
A. Prieur-Vernat & J. Clavreul
ENGIE, Paris, France
M. Payeur
ADEME, Valbonne, France

4AV.2.50 Update of the Projection of the Photovoltaic Waste in Spain until 2050
J.D. Santos & M.C. Alonso-García
CIEMAT, Madrid, Spain

4AV.2.51 Recycling Silver from Decommissioned Silicon Photovoltaic Solar Cells
R. Deng, J. Jiang, S. Wang, J. Ji & C.M. Chong
UNSW Australia, Sydney, Australia

4AV.2.52 An Universal Recycling Technology for Thin Film and Silicon Based Photovoltaic Modules as an Example for Circular Economy
W. Palitzsch, A. Killenberg & I. Röver
Loser Chemie, Freiberg, Germany

4AV.2.53 Recycling Process of c-Si Photovoltaic Modules by Chemical and Thermal Operations
S. Paneliya, S. Khanna, V. Pandya, V. Bhavsar, M. Lad,
A. Ray & I. Mukhopadhyay
PDP University, Gujarat, India

4AV.2.54 Electrochemical Method for Silicon Photovoltaic Module Recycling
J.W. Ko, S.J. Park, H. Park, S.H. Bae, Y. Kang,
H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea

4AV.2.55 Innovative Recycling of End of Life Silicon PV Panels: Materials Recovering and Glass Re-Use
C. Audoin & J.P. Rakotoniaina
CEA, Grenoble, France
P. Cerchier, K. Brunelli, L. Pezzato & M. Dabala
University of Padua, Padova, Italy
M. Tammaro
ENEA, Portici, Italy
G. Sabia
ENEA, Bolongna, Italy
A. Attanasio
CETMA, Brindisi, Italy
A. Nisi
I.T.O., Galatone, Italy
T. Sessa
Relight, Rho, Italy
H. Suitner
PROKO, Salzburg, Austria

4AV.2.56 Environmental and Social Impact Assessment of High-Efficient Double Side Contacted Cells with Innovative Carrier Selective Contacts
C. Poulopoulos, B. Hartlin & E. Bauguen
ERM, London, United Kingdom
D. Reid
ERM, Oxford, United Kingdom
S. Galley
ERM, Manchester, United Kingdom

4AV.2.57 Measuring the Incidence Angle Modifier of Optically Uncoupled Glass for PV Application
K. Meisenzahl, N. Schneble, M. Volk, U. Blieske,
L. Clasing & J. Müller-Ost
Cologne University of Applied Sciences, Germany
J. Münzberg & P. Hakenberg
paXos Consulting & Engineering, Cologne, Germany

NOTES

Tuesday, 10 September 2019

VISUAL PRESENTATIONS 3BV.1

08:30 - 10:00 CI(G)S, CdTe and Related Thin Film Solar Cells / III-V and Related Compound Semiconductor Based Devices

Chairpersons:

Volker Sittinger
Fraunhofer IST, Germany

Gianluca Timò
RSE, Italy

3BV.1.3 Comparison of Accelerated Ageing and Metastabilities between CIGS Based Solar Cells and Thin-Film Modules
R. Vidal Lorbada, T. Lavrenko, D. Mücke & T. Walter
Ulm University of Applied Sciences, Germany

3BV.1.4 Novel Two-Stage Processing Technique towards Wide Spreading of CIGS Solar Cell Industry with Materially Efficient Fabrication
Y. Cho, S. Song, S. Lee, A. Cho, S.K. Ahn, K. Kim, J.H. Yun, I.Y. Jeong, J.S. Yoo, J.S. Cho, S.J. Ahn, J.H. Park, D.H. Shin, Y.J. Eo & J. Gwak
KIER, Daejeon, Republic of Korea

3BV.1.6 A European Thin Film Tandem Device Proficiency Test - Practical Outcomes and Preliminary Results
I. Lauermann
HZB, Berlin, Germany
E. Salis, D. Pavanello & H. Müllejans
European Commission JRC, Ispra, Italy
A. Gerber
Forschungszentrum Jülich, Germany
J. Wenzel Andreasen & S.A. Gevorgyan
Technical University of Denmark, Roskilde, Denmark
T.R. Betts, M. Blagovest & R. Gottschalg
Loughborough University, United Kingdom
A.O. Kodolbas & O. Yilmaz
TUBITAK, Gebze, Turkey
R. Leidl, M. Rennhofer & S. Zamini
AIT, Vienna, Austria
M. Acciarri & S. Binetti
UNIMIB, Milan, Italy
E. Lotter
ZSW, Stuttgart, Germany
K. Bakker, J.M. Kroon & W.J. Soppe
ECN part of TNO, Petten, The Netherlands

G. Razongles
CEA, Le Bourget du Lac, France
L.V. Mercaldo, F. Roca & A. Romano
ENEA, Portici, Italy
J. Hohl-Ebinger & W. Warta
Fraunhofer ISE, Freiburg, Germany
J.L. Balenzategui & J.F. Trigo
CIEMAT, Madrid, Spain
S. Neubert
PVcomB, Berlin, Germany

3BV.1.7 Increased PID Immunity of Cu(In,Ga)Se2 Solar Cells

O. Salomon, W. Hempel, O. Kiowski, E. Lotter & W. Witte
ZSW, Stuttgart, Germany
A. Ferati, A. Schneikart, G. Kaune & R. Schäffler
NICE Solar Energy, Schwäbisch Hall, Germany
D. Mücke & T. Walter
HSU, Ulm, Germany
R. Vidal Lorbada
UPM, Madrid, Germany

3BV.1.9 Light Management in Ultra-Thin Cu(In, Ga)Se2 Photovoltaic Devices

M. Kovacic, J. Krc, B. Lipovsek & M. Topič
University of Ljubljana, Slovenia
W.-C. Chen & M. Edoff
Uppsala University, Sweden
P.J. Bolt & J. van Deelen
TNO, Eindhoven, The Netherlands
M. Zhukova, J. Lontchi & D. Flandre
UCLouvain, Louvain-la-Neuve, Belgium

3BV.1.10 CIGS Device Processing on Insulated (Stainless) Steel Foils

F. Kessler, S. Spiering & R. Würz
ZSW, Stuttgart, Germany

3BV.1.11 Effects of Selenium Partial Pressure on Cu(In,Ga)Se2 Solar Cells

L.-H. Tu, W.-C. Huang & C.-H. Lai
NTHU, Hsinchu, Taiwan

3BV.1.12 The “Absolute” Quantification of Solar Absorber via a Cross-Characterization Method: The Example of Cu(In,Ga) Se2

M. Bouttemy, J. Vigneron, D. Aureau, M. Frégnaux,
F. Jomard & A. Etcheberry
UVSQ, Versailles, France
S. Béchu, A. Loubat & D. Messou
IPVF, Palaiseau, France
B. Theys
CNRS-IPVF, Palaiseau, France
S. Gaiaschi, J. Marciano & P. Chapon
HORIBA, Palaiseau, France

PROGRAMME

3BV.1.13 Air Reactivity of CIGS and CdTe Solar Absorbers Characterized by XPS Measurements

S. Béchu
IPVF, Palaiseau, France
M. Bouttemy, J. Vigneron, D. Aureau, M. Frégnaux &
A. Etcheberry
UVSQ, Versailles, France
D. Lincot & J.-F. Guillemoles
CNRS, Palaiseau, France

3BV.1.14 Tailoring the Properties of Indium Sulfide by Doping

M. Mathew
St. Joseph‘s College, Kozhikode, India

3BV.1.15 Improving Light Absorption in Cu2ZnSn(S,Se)4 Solar Cells by Down-Shifting Quantum Dot Layer

W.-L. Jeong, K.-P. Kim & D.-S. Lee
GIST, Gwangju, Republic of Korea

3BV.1.16 Optimization of Sodium and Zinc Composition of a Flexible CZTSSe on Molybdenum Foil for High Photoconversion Efficiency

K. Kim, W.-L. Jeong & D.-S. Lee
GIST, Gwangju, Republic of Korea

3BV.1.17 Experimental Study on Band Gap Discrepancies of Sputtered Cu2ZnSn(S,Se)4 Thin Films: Using Different Characterization Techniques

G. Siddharth, B.S. Sengar, V. Garg & S. Mukherjee
IIT, Indore, India

3BV.1.18 Bias Dependent Reversibility of Degradation of CIGS Solar Cells under Damp Heat and Illumination

M. Theelen, F. Hakka, F. Lanfranchi, H. Steijvers &
K. Bakker
TNO/Solliance, Eindhoven, The Netherlands
E. Haverkamp
ReRa Solutions, Nijmegen, The Netherlands
N. Barreau
IMN-UMR, Nantes, France

3BV.1.19 Investigations of Accelerated In-Line CIGS Co-Evaporation

R. Hünig, W. Hempel, T. Magorian-Friedlmeier & S. Paetel
ZSW, Stuttgart, Germany

3BV.1.20 Materials Design of Cu(In,Ga)(S,Se)2 Absorber in CIGSSe Solar Cells by Using 3D Mapping of Electronic Structures

T. Wada, M. Yanagita & T. Maeda
Ryukoku University, Otsu, Japan

3BV.1.21 The Influence of Copper Thickness on the Defects Formation in CdTe Solar Cells
E. Artegiani, V. Kumar & A. Romeo
University of Verona, Italy

3BV.1.22 Influence of Doping Density on the Back Contact of Cu(In,Ga)Se2 Solar Cells
D. Mücke, R. Vidal Lorbada & T. Walter
Ulm University of Applied Sciences, Germany

3BV.1.23 The Investigation of the Effect of Copper Content on the Kinetics of Microwave Photoconductivity in CIGS Solid Solution
G.F. Novikov, E.V. Rabenok & M.V. Gapanovich
RAS, Chernogolovka, Russia
I.N. Odin
Lomonosov Moscow State University, Russia
V.F. Gremenok
NASB, Minsk, Belarus

3BV.1.24 Improved Photovoltaic Parameters in CdTe Solar Cells by Insertion of a i-CdO Layer
A.Q. Amjad, L. Gagara & T. Potlog
Moldova State University, Chisinau, Moldova
V. Fedorov & V. Suman
Institute of Electronic Engineering and Nanotechnologies, Chisinau, Moldova

3BV.1.25 Investigating and Improving Performance Ratio of Cu(In,Ga)(S,Se)2 Photovoltaic Devices
A. Weber, R. Lechner, S. Grünsteidl, P. Borowski,
C. Schubbert & T. Dalibor
Avancis, Munich, Germany
S.J. Heise, J. Ohland, I. Savchenko, H. Ahmed,
H. Hirwa & J. Parisi
University of Oldenburg, Germany
R. Klenk, P. Reyes-Figueroa, G. Farias, M. Aghaei,
C. Ulbrich & E. Waack
HZB, Berlin, Germany
R. Hock, J. Dallmann, U. Künecke,
M. Schuster & P. Wellmann
FAU, Erlangen, Germany

3BV.1.26 Thinner Front and Reflective Rear Contact for Increased Light Conversion of CIGS Solar Cells on Flexible Substrates
R. Hertwig, S. Nishiwaki, R. Carron, J. Löckinger, T. Feurer,
S. Buecheler & A.N. Tiwari
EMPA, Dubendorf, Switzerland

3BV.1.27 Tunable Iron-Based Kesterite Thin Films for Tandem Solar Cells
V. Trifiletti, A. Spinardi & S. Binetti
University of Milan, Italy
V. Mikli, M. Danilson & M. Grossberg
Tallinn University of Technology, Estonia

3BV.1.28 Copper Electroplating on Aluminum Zinc Oxide
A. Lachowicz, C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

3BV.1.30 Improved Performance of Sputtered Cu2ZnSnSe4 Solar Cell by Ge Doping Strategy
M. He, C. Yan, J. Huang & X. Hao
UNSW Australia, Sydney, Australia

3BV.1.31 Synthesis and Study of Loss Kinetics of Photogenerated Current Carriers in Cu2ZnSn(SxSe1-x)4 Solid Solutions
E.V. Rabenok, V.V. Rakitin, B.I. Golovanov & G.F. Novikov
RAS, Chernogolovka, Russia
V.F. Gremenok
NASB, Minsk, Belarus
V.V. Khoroshko
BSUIR, Minsk, Belarus

3BV.1.32 Effect of Ag Alloying on Band Offsets, Grading, and Alkali Incorporation in CIGS Solar Cells
K. Sopiha, J. Keller, M. Edoff & J.J.S. Scragg
Uppsala University, Sweden
C. Persson
University of Oslo, Norway

3BV.1.33 Back End Monolithic Interconnection of CIGS Using Shunt-Free Laser Scribing and Inkjet Printing of Dielectric and Conductive Inks
V.S. Gevaerts, A.F.K.V. Biezemans, H. Het Mannetje,
H. Linden & J. Bosman
TNO, Eindhoven, The Netherlands

3BV.1.34 Spatial Atomic Layer Deposition (SALD) Studies for Buffer and Window Layers in CIGS Solar Cells towards in-Line Manufacturing Technologies
M. Balestrieri & D. Lincot
CNRS, Palaiseau, France
S. Lakhdar Chaouche, V. Huong Nguyen, J. Resende,
A. Sekkat, C. Jimenez, D. Bellet & D. Munoz-Rojas
Grenoble INP, France

3BV.1.35 Optical and Electrical Design of ZnO Nanorod-Based CdTe Solar Cells with CdS and MgxZn1-xO Buffer Layers
C. Özcan, D. Türkay & S. Yerci
METU, Ankara, Turkey

3BV.1.36 Wide Band Gap CuGaSe2 Solar Cells for Tandem Application
K. Bouras
IPVF, Palaiseau, France
M. Sood, A. Lomuscio, F. Babbe & S. Siebentritt
University of Luxembourg, Belvaux, Luxembourg
D. Lincot
CNRS, Palaiseau, France

3BV.1.37 Cu2SnS3 Thin Films Using Chelating Effect of Hybrid Ink
A. Cho, S.J. Ahn, J.H. Yun, J. Gwak, S.K. Ahn, Y.J. Eo, J.S. Cho, J.H. Park, J.S. Yoo, K. Kim, D.H. Shin & I. Jeong
KIER, Daejeon, Republic of Korea

3BV.1.38 Investigations and Performance Optimisation of Windowless CdTe:Se/CdTe Solar Cells
B. Späth, V. Krishnakumar, G. Papageorgiou, C. Drost, D. Menossi, R. Magiera, S. Böhnisch, G. Fu & B. Siepchen
CTF Solar, Dresden, Germany
O. Zywitzki, T. Modes, D. Hirsch, T. Kopte & C. Metzner
Fraunhofer FEP, Dresden, Germany
S. Peng
CTIEC, Shanghai, China

3BV.1.39 Analysis of Growth Mechanism in Ga-Rich Cu(In,Ga)Se2 Thin Films
K. Nakada, T. Kobayashi, T. Shimoyama & A. Yamada
Tokyo Institute of Technology, Japan

3BV.1.40 Atomic Layer Deposition of Highly Stoichiometric Cu2SnS3 Films as Absorber Materials for Photovoltaic Applications
T.-M. Chung, R.E. Agbenyeke, B.K. Park, Y.K. Lee, C.G. Kim, J.H. Han
KRICT, Daejeon, Republic of Korea

3BV.1.42 Comparison of Light Induced Metastabilities on Different Thin Film Technologies
A. Mittal & M. Rennhofer
AIT, Vienna, Austria
V. Schlosser
University of Vienna, Austria

3BV.1.44 Aluminum-Based Back Reflectors for Ultrathin Cu(In,Ga) Se2 Solar Cells with ITO Diffusion Barrier
T. Schneider & R. Scheer
Martin Luther University, Halle (Saale), Germany

3BV.1.46 High Speed MOVPE for InGaP/GaAs Multijunction Solar Cells
H. Sodabanlu, K. Watanabe, Y. Nakano & M. Sugiyama
University of Tokyo, Japan
A. Ubukata
TNSC, Ibaraki, Japan
T. Sugaya
AIST, Ibaraki, Japan

3BV.1.48 Analysis of Spatial Inhomogeneity in Multi-Junction Solar Cells Using Transport Efficiency Mapping
H. Xu, K. Watanabe, Y. Nakano & M. Sugiyama
University of Tokyo, Japan
A. Delamarre & J.-F. Guillemoles
CNRS, Palaiseau, France

3BV.1.49 Roll-Based Transfer Process of Flexible Multi-Junction Solar Cells for Mobile Applications
K.-S. Kim, B.-I. Choi, B. Jang, S.-M. Kim & J.-H. Kim
KIMM, Daejeon, Republic of Korea
S.H. Jung & H.K. Kang
KANC, Suwon, Republic of Korea

3BV.1.50 Optimization of Ion Beam Sputtered Ta2O5 Anti-Reflective Coatings for III-V Multi-Junction Solar Cells
J. Reuna, V. Polojärvi, M. Raappana, T. Aho, R. Isoaho, A. Aho, A. Tukiainen, E. Anttola, S. Mäkelä & M. Guina
TUT, Tampere, Finland

3BV.1.51 Development of Inverted-Growth 3-Junction Solar Cells with 1.0 eV Bulk GaAsBi Bottom Cell
T. Paulauskas, V. Pacebutas, R. Butkuté, A. Geizutis & A. Krotkus
Center for Physical Sciences and Technology, Vilnius, Lithuania
R. Jakiela
Institute of Physics PAS, Warsaw, Poland

3BV.1.52 Optical in situ Quantification of the As versus P Content during GaAsP Graded Layer Growth for III-V-on-Si Tandems
O. Supplie, A. Heinisch, A. Paszuk, A. Tummalieh & T. Hannappel
Ilmenau University of Technology, Germany
M. Sugiyama
University of Tokyo, Japan

3BV.1.53 Characterization and Pseudo-3D Modeling of GaSb Solar Cells for High Concentration Photovoltaics
J. Kret, S. Parola, A. Vauthelin, F. Martinez, J. Tournet, J. El Husseini, R. Vaillon, Y. Rouillard, E. Tournié & Y. Cuminal
University of Montpellier II, France

3BV.1.54 **MOCVD Grown InGaAsP-Based Single Junction Solar Cells with Bandgap-Voltage Offsets Approaching Radiative-Recombination-Only Limit**
L. Li
State Key Lab of Space Powersources, Shanghai, China

3BV.1.55 **Multijuction Solar Cell Electroluminescence: Method for Subcells IV-Curve Obtaining**
M.A. Mintairov, V.V. Evstropov, S.A. Mintairov, M.Z. Shvarts & N.A. Kalyuzhnyy
RAS / Ioffe, St. Petersburg, Russia

3BV.1.56 **Ultrafast Carrier Dynamics of Coupling Effects in InGaP/InGaAs/Ge Multi-Junction Solar Cells**
V. Paraskeva, M. Hadjipanayi, A. Othonos & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

3BV.1.57 **New Results on SiGeSn MOVPE Grown for Multi-Junction Solar Cells**
G. Timò, G. Abagnale, M. Calicchio, M. Cornelli, N. Armani, F. Trespidi, E. Malvisi & E. Achilli
RSE, Piacenza, Italy
F. Annoni
IMEM-CNR, Parma, Italy
B. Schineller
AIXTRON, Herzogenrath, Germany
R. Couderc
CEA-INES, Le Bourget du Lac, France
G. Siefer
Fraunhofer ISE, Freiburg, Germany
E. Achilli
University of Pavia, Italy

3BV.1.60 **Influence of Temperature on Evolution of Properties of Ammonia-Free Chemical Bath Deposited CdS Thin Films**
I. Gupta & B.C. Mohanty
Thapar University, Patiala, India

3BV.1.61 **A Facile Route for Synthesis of Copper Iron Tin Sulfide Thin Films**
A. El Kissani, D. Ait Elhaj, F. Welatta, H. Ait Dads, L. Nkhaili, K. El Assali & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

3BV.1.62 **High Fill Factor CIGS Solar Modules by Evaporated Metal Grid: Numerical Simulation and Module Analysis**
S. Lin & H. Shan
NICE, Beijing, China
D. Zhuang
Tsinghua University, Beijing, China
R. Wächter, T. Repmann, T. Freund & N. Zancan
NICE Solar Energy, Schwäbisch Hall, Germany

3BV.1.63 **Bifacial and Flexible CIGS Solar Cell by Mechanical Lift-Off Process**
T. Masuda & N. Hamada
Toyota, Susono, Japan
M. Inoue, J. Chantana, T. Nishimura & T. Minemoto
Ritsumeikan University, Shiga, Japan

3BV.1.64 **Alternative Buffer Layer for Reducing Optical Losses in Cu(In,Ga)(Se,S)2 Solar Cells**
R. Kamada, Y. Yasaki, Y. Hirai, S. Imanishi, T. Kato & H. Sugimoto
Showa Shell Sekiyu, Atsugi, Japan

VISUAL PRESENTATIONS 3BV.2

13:30 - 15:00 **Perovskites Based Photovoltaics / Organic and Dye-Sensitised Devices / Tandems**

Chairpersons:

Giorgio Bardizza
European Commission JRC, Italy

Wolfgang Tress
EPFL, Switzerland

Alessandro Virtuani (i)
EPFL, Switzerland

3BV.2.1 **Time Dependent Electroluminescence in Planar and Mesoporous Methylammonium Lead Iodide Solar Cells**
M.A. Córdoba, A. Koffman-Frischknecht & K. Taretto
National University of Comahue, Neuquén, Argentina
W. Herrera & M.D. Perez
CNEA, San Martín, Buenos Aires, Argentina

3BV.2.3 **Interfaces and Stability in Halide Perovskite Solar Cells**
P. Schulz
CNRS, Palaiseau, France

3BV.2.6 **Reduced Dimensional Perovskites: In-Situ Investigation of Film Formation and Morphological Studies Affecting the Device Performance**
R. Munir, A. Merdasa, K. Hirselandt, O. Shargaieva, J. Dagar & E. Unger
HZB, Berlin, Germany

3BV.2.8 Fabrication of Smooth, Mirror-Like and PbI2-Free Thin Film Perovskite Layers in Ambient Conditions
C. Montes, L. Ocaña, L. De Sousa-Vieira, J.S. Moreno-Ramírez, M. Friend & M. Cendagorta
ITER, Granadilla de Abona, Spain
S. González-Pérez, B. González-Diaz & C. Hernandez-Rodriguez
ULL, La Laguna, Spain

3BV.2.9 Layer Structure and Pseudo-Halide Perovskite Solar Cells
Y.-A. Chen, M.-H. Li, Y.-Y. Chiu, P.-T. Hsieh, I.-G. Chen & P.-C.-Y. Chen
National Cheng Kung University, Tainan, Taiwan

3BV.2.10 On the Stability of Planar CH3NH3PbI3 Perovskite Solar Cells Produced on under Ambient Conditions by Using Polymer Encapsulates
L. Ocaña, C. Montes, L. De Sousa-Vieira, M. Friend & M. Cendagorta
ITER, Granadilla de Abona, Spain
B. González-Diaz, R. Guerrero-Lemus & C. Hernandez-Rodriguez
ULL, La Laguna, Spain

3BV.2.11 Synthesis and Thermal Stability Analysis of Lead-Free Cs2AgBiBr6 Double Perovskites
T. Burwig, K. Heinze & R. Scheer
Martin Luther University, Halle (Saale), Germany
V. Izquierdo-Roca, M. Guc & P. Pistor
IREC, Sant Adrià de Besòs, Spain

3BV.2.12 2D Modeling of MAPbI3-Based Perovskite Solar Cell with Textured Surface
J.-Y. Huang, E.-W. Chang & Y.-R. Wu
NTU, Taipei, Taiwan

3BV.2.13 Inorganic-Organic Hybrid Perovskite Solar Cells Using Spinel Cobaltites Based Hole Transport Layers
J. Ge, R. Scheer & Y. Zhang
Martin Luther University, Halle (Saale), Germany

3BV.2.15 Low Temperature Wet Processing of SnO2: High Efficiency Device, Thermal Stability and Scalability Considerations
R. Couderc, C. Roux, M. Manceau & S. Berson
CEA, Le Bourget du Lac, France

3BV.2.16 Comparison Study of Optical, Structural and Morphological Properties of CsPbBr3 Thin Films Grown Using Different Vacuum Based Routes
G. Gordillo, C.A. Otálora, E.A. Ramírez Pérez & O.G. Torres
National University of Colombia, Bogotá, Colombia

3BV.2.17 Studying the Use of Mixed Binders Made with Epoxy Resin and Collodion for Producing Conductive Inks for the Metallization of Perovskite Solar Cells via Screen Printing Techniques
C. Montes, L. Ocaña, L. De Sousa-Vieira, M. Friend & M. Cendagorta
ITER, Granadilla de Abona, Spain
S. González-Pérez & B. González-Diaz
ULL, La Laguna, Spain

3BV.2.19 Wet (CBD, Spin-Coating) and Dry (ALD, CVD) Deposition of Tunable Metal Hybrid Perovskites MASnxPb1-x(IxBr1-x)3 and Oxides for Tandem Application
M. Kozolinsky, T. Hildebrandt & F. Donsanti
EDF R&D, Palaiseau, France
F. Rousseau
ParisTech, France

3BV.2.20 Efficient and Stable Fully Slot Die Coated Perovskite Solar Cell
A. Verma, J. Heier, R. Schneider & F. Nüesch
EMPA, Dubendorf, Switzerland
D. Martineau & T. Meyer
Solaronix, Aubonne, Switzerland

3BV.2.22 Tailoring the 2D/3D Structure of Perovskite Film for Its Integration on Highly Textured c-Si Bottom Cell
F. Hilt & E. Drahi
TOTAL, Paris la Défense, France
C. Aider
IPVF, Palaiseau, France
J. Rousset
EDF R&D, Palaiseau, France

3BV.2.23 Optical Perovskite Test for Optimisation of Perovskite Solar Module Encapsulation Procedures
E.P. Booker, M. Majorel, M. Matheron, N. Nguyen, S. Cros & S. Berson
CEA, Le Bourget du Lac, France
J.B. Boutin
Arkema, Pierre-Benite, France

3BV.2.24 PZN-4.5pt Perovskites Nanoparticles Thin Films for High Light Absorption and Ferrophotovoltaics Application
R. Ndioukane, N.C.Y. Fall, M. Touré & D. Kobor
Assane Seck University, Ziguinchor, Senegal
L. Lebrun
INSA, Lyon, France

3BV.2.25 Photovoltaic Properties of PZN-4.5PT Perovskite Nanoparticles Thin Film Deposited on Silicon Nanowires Substrate
R. Ndioukane & D. Kobor
UASZ, Ziguinchor, Senegal
L. Motte & J. Solard
University of Paris 13, France

3BV.2.26 Investigation of the Reliability of the Perovskite Photovoltaic Module
Z. Tang, H. Zhang, Y. Wang, W. Guo, C. Jian, Y. Li & X. Xu
Hanergy Thin Film Power, Chengdu, China
X. Hao & J. Zhang
Sichuan University, Chengdu, China

3BV.2.27 Structural Properties of Solution Processed FAPbI3 Perovskites Combined with DFT Calculations
K. Sekar, J.J. Ríos - Ramírez & V. Subramaniam
CINVESTAV, Ciudad de Mexico, Mexico
J. Bouclé
University of Limoges, France

3BV.2.28 The Effects of Thickness and Interface of CuSCN on the Performance of Perovskite Solar Cells
H. Gao
Beijing University of Technology, China

3BV.2.29 Device Design Rules and Operation Principle of Perovskite Solar Cells for High-Power Indoor Applications
M.H. Ann, N.Y. Ha & J. Kim
Ajou University, Suwon, Republic of Korea
J. Kim
KETI, Seongnam-si, Republic of Korea
M. Kim, J. Seidel & J.S. Yun
UNSW, Sydney, Australia
N. Park
KETI, Gyeonggi-do, Republic of Korea

3BV.2.30 Effect of ZnO Seed Layer in Perovskite Solar Cell
D.K. Jarwal, A. Kumar, A. Mishra, D.C. Upadhaya, C.K.S. Jit & M.R. Tripathy
IIT(BHU) Varanasi, India

3BV.2.35 Air-Stable Semi-Transparent Organic Solar Cells Based on Innovative Donor Polymer and Graphene Electrode
G. Bianchi, C. Carbonera, A. Cominetti, F. Ferrazza & R. Po eni, Novara, Italy
M.M. Tavakoli & J. Kong
MIT, Cambridge, United States

3BV.2.36 Lifetime of Inkjet Printing OPV Modules for Indoor Applications
H. Alkhatib, M. Pasquinelli, L. Escoubas & J.J. Simon
Aix Marseille University, France
P. Pierron & S.B. Dkhil
Dracula Technologies, Valence, France

3BV.2.39 Co-Sensitization of Ruthenizer with MOF for Increasing Power Conversion Efficiency in DSSCs
M. Younas, A. Helal, A. Al-Ahmed & F.A. Al-Sulaiman
KFUPM, Dhahran, Saudi Arabia
M. Afzaal
Higher Colleges of Technology, Sharjah, United Arab Emirates

3BV.2.41 Highly Efficient Halogen-Free Solvent Processed Large Area Polymer Solar Cell Module Enabled via Molecular Engineering of Copolymers
S. Rasool, C.E. Song, H.K. Lee, S. K. Lee, J.-C. Lee, S.-J. Moon & W. S. Shin
KRICT, Daejeon, Republic of Korea

3BV.2.45 CuGaSe2 / c-Si Tandem Solar Cells with an Optimized CuGaSe2 Co-Evaporation Process
A. Rivalland, L. Arzel & N. Barreau
IMN, Nantes, France
P. Bellanger & S. Dubois
CEA, Le Bourget du Lac, France

3BV.2.46 Polymer-Based Rear Side Light Trapping Structures for Silicon-Based Tandem Solar Cells
H. Hauser, O. Höhn, R. Müller, N. Tucher, K. Mühlbach, R.M. da Silva Freitas, J. Benick, M. Hermle & B. Bläsi
Fraunhofer ISE, Freiburg, Germany

3BV.2.47 Atomic Structure of As-Modified Si(100) Surfaces Prepared in CVD Ambience for III-V/Si Tandems
A. Paszuk, O. Supplie, M. Nandy, P. Kleinschmidt & T. Hannappel
Ilmenau University of Technology, Germany
O. Romanyuk
ASCR, Prague, Czech Republic

3BV.2.49 Building Blocks Development for Defect-Free Growth of GaAs on Silicon for Tandem Solar Cells
D. Mencaraglia, A. Jaffré, J. Alvarez, J.-P. Kleider & J.P. Connolly
CNRS, Gif sur Yvette, France
C. Renard, G. Hallais, L. Vincent & D. Bouchier
C2N, Palaiseau, France
N. Cherkashin
CEMES, Toulouse, France

3BV.2.50 Towards a GaAs/AlGaAs Nanowires-on-Silicon Tandem Solar Cell

M. Vettori, P. Regreny & M. Gendry
Ecole Centrale de Lyon, Ecully, France
X. Li, C. Chevalier, M. Lemiti & A. Fave
INSA Lyon, Villeurbanne, France
V. Piazza, A. Cattoni, A. Scaccabarozzi, G. Patriarche & M. Tchernycheva
CNRS, Palaiseau, France

3BV.2.51 Composite-Cell Current Matching for Higher Efficiency Tandem Solar Cells

R. Garrison & R.N. Kleiman
McMaster University, Hamilton, Canada

3BV.2.52 Rational Design of Recombination Junction for Efficient Monolithic Tandem Integration of Perovskite and Standard Si Solar Cells

Y.H. Jang, H.S. Seo, H.S. Yun, I. Kim & D.-K. Lee
KIST, Seoul, Republic of Korea

3BV.2.53 Optical Characterizations and Modelling of Semitransparent Perovskite Solar Cells for Tandem Applications

E. Raoult, R. Bodeux, S. Jutteau, S. Rives, A. Yaiche & J. Rousset
EDF R&D, Palaiseau, France
D. Coutancier & S. Collin
CNRS, Palaiseau, France

3BV.2.54 Monolithic Perovskite/Silicon Tandem Solar Cells with Nanocrystalline Silicon Oxide Recombination Junction

E. Lamanna, E. Calabrò, F. Matteocci & A. Di Carlo
University of Rome II, Italy
M.L. Addonizio, E. Bobeico, M. Della Noce, V. La Ferrara, A. De Maria, G. Rametta, L. Lancellotti, L.V. Mercaldo, I. Usatii & P. Delli Veneri
ENEA, Portici, Italy

3BV.2.55 Low Temperature Activation of B Implantation for Si Subcell Fabrication in III-V/Si Tandem Solar Cells

Y.-T. Sun, M.C. Chen, G. Omanakuttan, A. Strömberg & S. Lourdudoss
KTH Royal Institute of Technology, Kista, Sweden
R. Hansson & M. Rinio
Karlstad University, Sweden

3BV.2.56 Fabrication Procedure of c-Si Tunnel Junction for Tandem Photovoltaic Cells

X. Li, A. Fave & M. Lemiti
INSA Lyon, Villeurbanne, France

3BV.2.57 CIGS Growth on a III-V/Si(001) Platform: Towards CIGS/Si Tandem Solar Cells

O. Durand, A. Létoublon, C. Cornet & A. Zhou
INSA-Rennes, France
N. Barreau & E. Gautron
University of Nantes, France
M. Balestrieri, D. Coutancier & D. Lincot
CNRS, Palaiseau, France
A. Ben Slimane & S. Béchu
IPVF, Palaiseau, France
T. Bidaud & S. Collin
CNRS, Orsay, France
M. Feifel & F. Dimroth
Fraunhofer ISE, Freiburg, Germany
M. Bouttemy, A. Etcheberry, M.A. Pinault-Thaury & F. Jomard
UVSQ, Versailles, France

3BV.2.58 Time-Response Analysis of Perovskite/Silicon Tandem Solar Cells

V. Paraskeva, M. Hadjipanayi & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
A.W.Y. Ho-Baillie, N.J. Ekins-Daukes & J. Zheng
UNSW Australia, Sydney, Australia

3BV.2.59 Optimization of the Transparent Conductive Adhesive Layer for Two Terminal Multijunction Solar Cells

C. Li, P. Zhang, Z. Liu, X. Hao & M.A. Green
UNSW Australia, Sydney, Australia

3BV.2.60 Designing Carrier Selective Perovskite on Silicon 3T Tandems

J.P. Connolly, J.P. Kleider, M.E. Gueunier-Farret, Z. Djebbour, J. Alvarez & D. Mencaraglia
CNRS, Gif sur Yvette, France
M.K. Nazeeruddin
EPFL, Lausanne, Switzerland
V.D. Mihailetchi
ISC Konstanz, Germany
P. Baranek
EDF R&D - IPVF, Palaiseau, France
P. Schulz
CNRS, Palaiseau, France

3BV.2.61 Monolithic CZTS/Si Tandem Cells with MoS2/TCOs Intermediate Contact

C. Malerba, M. Valentini, M. Izzi, L. Serenelli, E. Salza, M. Tucci & A. Mittiga
ENEA, Rome, Italy

VISUAL PRESENTATIONS 1BV.3

15:15 - 16:45 Fundamental Studies / New Materials and Concepts for Cells and Modules

Chairpersons:

Antonio Martí Vega
UPM, Spain

Jean-Francois Guillemoles
CNRS, France

1BV.3.1 Analysis for Efficiency Potential of Perovskite Solar Cells and Perovskite/Si Tandem Solar Cells
M. Yamaguchi, K.-H. Lee, Y.-C. Wang, K. Araki & N. Kojima
Toyota Technological Institute, Nagoya, Japan

1BV.3.2 Hot Carrier Approach to the Efficiency of a Solar Cell
S. Ašmontas, J. Gradauskas, A. Sužiedelis, A. Šilenas, E. Širmulis, V. Vaicikauskas, V. Švedas & O. Žalys
CPST, Vilnius, Lithuania

1BV.3.4 Comparison among Models for Lambertian Light Trapping in Textured Si Solar Cells
L. Abenante
ENEA, Rome, Italy

1BV.3.5 Internal Rear Reflectance at Lambertian Light Trapping in Textured Si Solar Cells
L. Abenante
ENEA, Rome, Italy

1BV.3.7 Improved Efficiency of Organic Solar Cells by Embedded Colloidal Crystals and Nano-Texturing Surfaces
F.C Díaz-Granados, F.E. Rojas Tarazona, H. Méndez, J.C. Salcedo, H. Rodríguez, A. Mejía & G. Yamhure
Pontifical Xavierian University, Bogotá, Colombia

1BV.3.8 Absorption of Light by a Particulate Monolayer: Effect of Ordering, Concentration, and Size of c-Si Particles
V.A. Loiko, A.A. Miskevich & N.A. Loiko
NASB, Minsk, Belarus

1BV.3.9 Synthesis of CuO Nanowires with Controlled Density
L. Nkhaili, A. Narjis, A. El Kissani, A. Agdad & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

1BV.3.10 Towards a Low-Cost High-Power LED Array for Solar Cells Characterization
M.M. Hassan, S.O. Abdellatif & H.A. Ghali
The British University in Egypt, Cairo, Egypt

1BV.3.11 Study of an Acquisition Chain for the Thermal Characterisation of Thin Film – An Inverse Method to Estimate Material Parameters
S. Peillon, C. Rodiet & Y. Cuminal
IES / EPF, Montpellier, France

1BV.3.12 Analytical Framework for the Assessment and Modelling of Single- and Multi-Junction Solar Cells
C.S. Schuster
University of York, United Kingdom

1BV.3.13 Functionalized Graphene Quantum Dots Embedded Polymer: Photon Downshifter for CIGS Photovoltaics
F. Khan & A. Al-Ahmed
KFUPM, Dhahran, Saudi Arabia
J.H. Kim
DGIST, Daegu, Republic of Korea

1BV.3.14 Research on Flexible GaInP/GaInAs/Ge/Bi2Te3/Sb2Te3 PV-TE Integrated Systems
P. Gao, H. Wang, Q.-M. Zhang, C. Xue & Q. Sun
Tianjin Institute of Power Sources, China
C.-Y. Hou
Donghua University, Shanghai, China

1BV.3.20 Photocurrent Measurements and Deep Level Transient Spectroscopy on In2S3:V Intermediate Band Solar Cells
T. Jawinski, R. Pickenhain, M. Grundmann & H. von Wenckstern
University of Leipzig, Germany
L.A. Wägele & R. Scheer
Martin Luther University, Halle (Saale), Germany

1BV.3.22 Strained Quantum Well Superlattice Solar Cells
S.M. Hubbard, M. Kacharia & S.J. Polly
Rochester Institute of Technology, United States
R. Welser & A. K. Sood
Magnolia Optical Technologies, Woburn, United States

1BV.3.23 Oxide Solar Cell Devices Based Cu2O/ZnO Deposited via Open Air Spatial Atomic Layer Deposition towards Building Integrated Photovoltaic Application
A. Sekkat, V.H. Nguyen, C. Masse de la Huerta, D. Bellet, A. Kaminski-Cachopo, G. Chichignoud & D. Munoz-Rojas
Grenoble INP, France

1BV.3.25 Increasing Photovoltaic Module Sustainability through UV-Curable Self-Healing Polymer Layers
D. Ehrhardt, B. Van Mele & N. Van den Brande
VUB, Brussels, Belgium
K. Van Durme & J. Jansen
DSM, Geleen, The Netherlands

1BV.3.28 Copper Doped TiO2 Nano Crystallites for Dye-Sensitized Solar Cell (DSSC) Applications
S. Chahid, R. Alcántara & D.M. de los Santos
UCA, Puerto Real, Spain

1BV.3.30 Pseudo-Phase Transition Behavior in CuSbS2 Thin Films by S Flux
A. Cho, S. Banu, Y. Cho, S.J. Ahn, J.H. Yun, J. Gwak, S.K. Ahn, Y.J. Eo, J.S. Cho, J.H. Park, J.S. Yoo, K. Kim, D.H. Shin & I. Jeong
KIER, Daejeon, Republic of Korea

1BV.3.32 SnS Thin Films Grown by Successive Layer Adsorption and Reaction Method at Room Temperature
M. Mathew
St. Joseph's College, Kozhikode, India

1BV.3.33 Light Trapping in Commercial Silicon Solar Cell Structures Using Silver Nano Particles
M. Mathew
St. Joseph's College, Kozhikode, India

1BV.3.35 Reaching Entire Solar Spectrum Absorption through Micro-Textured Metal Thin Film Induced Strong Localized Surface Plasmon Resonance
H.-J. Syu, H.-C. Chuang, M.-J. Lin & C.-F. Lin
NTU, Taipei, Taiwan

1BV.3.36 Antimony Selenide Based Solar Cells by Vacuum Evaporation
V. Kumar, E. Artegiani & A. Romeo
University of Verona, Italy

1BV.3.37 Fabrication of Uniform Silicon Nanowires Array via Chemical Controlled Silica Template for Enhancing Light Trapping Properties
S. Khanna, S. Paneliya, V. Bhavsar, P. Marathey, R. Banerjee & I. Mukhopadhyay
PDP University, Gandhinagar, India
D. Roy
DRDO, Kanpur, India

1BV.3.38 Investigation of Al2O3 –SiO2 Antireflection Coatings for Silicon Solar Cells
V.F. Gremenok
NASB, Minsk, Belarus
V.V. Khoroshko
BSUIR, Minsk, Belarus
S.X. Suleymanov, V.G. Dyskin, M.U. Djanklich, N.A. Kulagina & O.A. Dudko
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan
A.N. Pyatlitski, V.A. Saladukha & T.V. Piatlitskaya
JSC "INTEGRAL", Minsk, Belarus

1BV.3.39 Upconversion Nanophosphors (Er:Yb:Y8V2O17 and Y2Te4O11) for Solar Cell
A.K. Dikshit, A. Singh & P. Chakrabarti
IIT, Varanasi, India
Y. Dwivedi
Kurukshetra University, India
N. Mukherjee
IIEST Shibpur, Howrah, India

1BV.3.41 Electrodeposited Cuprous Oxide Based Thin Film Heterojunction Solar Cells
P. Marathey, B. Patel, S. Khanna, I. Mukhopadhyay & A. Ray
PDP University, Gandhinagar, India

1BV.3.42 Nanocomposite Solar Cells Based on Organic/Inorganic Heterojunction Clonidine/Si
S.V. Mamykin, A.V. Korovin, N.V. Kotova, T.R. Barlas, O.S. Kondratenko, I.B. Mamontova, V.R. Romanyuk, P.S. Smertenko & N.M. Roshchina
NAS ISP, Kyiv, Ukraine

1BV.3.44 Texture and Bandgap Tuning of Phase Pure Cu2O Thin Films Grown by a Simple Potentiostatic Electrodeposition Technique
S.F.U. Farhad, M.M. Hossain & N.I. Tanvir
BCSIR Labs, Dhaka, Bangladesh

1BV.3.45 Structural Study of Nickel Silicide Formation Using Ni/a-Si/c-Si and a-Si/Ni/a-Si/c-Si Multilayers Prepared by RF Sputtering for Photovoltaic Application
A. Agdad, A.-I. El Khalfi, A. Tchenka, M. Azizan, E.M. Ech-Chamikh & Y. Ijdiyaou
Cadi Ayyad University, Marrakech, Morocco

1BV.3.46 Synthesis and Characterization of Cu2NiSnS4 Thin Films Solar Cells via Sol-Gel Method
D. Ait El Haj, A. El Kissani, H. Chaib & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

1BV.3.47 Front Interface Modification for Efficient Sb2Se3 Thin-Film Solar Cells
K. Shen, C. Ou & Y. Mai
Jinan University, Guangzhou, China
Z. Li
Hebei University, Baoding, China

1BV.3.48 Modelling Acceptor Composition Dependent Voc in Ternary Organic Solar Cells
A. Singareddy & P.R. Nair
IIT Bombay, Mumbai, India

1BV.3.49 Designing a Wet Solar Cell Composed of Titanium Dioxide Anode and Copper Oxides Cathode
H. Nay Wunn, S. Motoda & M. Morita
Kaiyodai, Tokyo, Japan

1BV.3.50 Experimental Results of Testing Different PV Receivers for Laser Wireless Energy Transfer System for UAV
V. Kapranov, D. Ovchinnikov, V. Tugaenko & A. Razuvaev
powerin.space, Moscow, Russia

1BV.3.51 Multifunctional Coated Composite Material for Encapsulation of Photovoltaic Devices
N. Yurrita, J. Aizpurua, J.M. Vega de Seoane,
G. Imbuluzketa, I. Arrizabalaga, W. Cambarau & F.J. Cano
Tecnalia, San Sebastián, Spain

VISUAL PRESENTATIONS 6BV.4

17:00 - 18:30 PV on/in Buildings, Infrastructure, Landscape, Water and Nature / Professional Applications of PV

Chairpersons:

Alessandra Scognamiglio
ENEA, Italy

Urs Muntwyler
BUAS, Switzerland

6BV.4.2 CONIPHER: Performance Analysis of an Innovative Facade Solution for Renovation Market Photovoltaic Integration Enhancement
Y.B. Assoa, P. Thony & P. Messaoudi
CEA, Le Bourget du Lac, France
E. Schmitt
Vicat, L'Isle-d'Abeau, France
O. Bizzini
ARaymond, Saint-Egrève, France

6BV.4.3 Transformative Techniques for Photovoltaic Integration in Building Roofs and Facades
G. Cattaneo, K. Söderström, L. Hengyu, J. Escarre Palou,
U. Fuerholz, P. Heinstein, S. Pittet, P. Duvoisin,
L.-E. Perret-Aebi, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland

6BV.4.4 The Key to a Sustainable Building Façade: Demonstration and Results
Q. van Nieuwenhoven & S. Scheerlinck
Laborelec, Linkebeek, Belgium
S.C. Veenstra
ECN part of TNO, Eindhoven, The Netherlands
T. Aernouts
imec, Leuven, Belgium

6BV.4.5 Classification of Building Parts in Real City Point Clouds
S. Schiffel, G. Behrens & F. Fehring
University of Applied Sciences Bielefeld, Minden, Germany

6BV.4.6 Performance Assessment of BIPV Systems: From Current Normative Framework to Next Developments
P. Bonomo, F. Parolini, F. Frontini, E. Saretta,
M. Caccivio & G. Bellenda
SUPSI, Canobbio, Switzerland
M. Machado
Tecnalia, San Sebastián, Spain
S. Boddaert
CSTB, Sophia-Antipolis, France

6BV.4.7 BIPV Round Robin Action of IEA PVPS Task 15
P. Illich
UAS Technikum Wien, Vienna, Austria
P. Gaisberger
FH-OOE, Wels, Austria
G.C. Eder
OFI, Vienna, Austria
K.A. Berger & G. Újvári
AIT, Vienna, Austria
D. Moor
Ertex Solar, Amstetten, Austria
S. Boddaert
CSTB, Sophia-Antipolis, France
R.M.E. Valckenborg & J. van den Brand
SEAC, Eindhoven, The Netherlands
P. Bonomo & C.S. Polo López
SUPSI, Canobbio, Switzerland
M. del Buono
Eurac Research, Bolzano, Italy
A.G. Imenes
University of Agder, Grimstad, Norway
N. Martín Chivelet & H. Gonzáles
CIEMAT, Madrid, Spain
A. Sanz Martinez & M. Machado
Tecnalia, San Sebastián, Spain
J.T. Kim
Kongju National University, Cheonan, Republic of Korea
A. Masolin & M. Ritzen
ZUYD, Heerlen, The Netherlands

6BV.4.8 The Relation between Partial Shadings and Irradiation Losses in BIPV Systems in Different Locations Around the World

C.D. Zomer & R. Rüther
UFSC, Florianópolis, Brazil

6BV.4.9 Design Applications of Bifacial c-Si PV Module for BIPV Environments

H.K. Ahn, S.Y. Park, J.-H. Choi, B.G. Bhang & W.B. Lee
Konkuk University, Seoul, Republic of Korea
C.-S. Won
Scotra, Pyeongtaek, Republic of Korea
S.C. Woo
Woodo Energy, Busan, Republic of Korea
S.H. Lee
KETEP, Seoul, Republic of Korea
H.J. Go
Koenergy, Jinju, Republic of Korea
H. Jo & O. Kwon
K-water, Daejeon, Republic of Korea

6BV.4.10 Comparison of Crystalline Silicon and CIGS BIPV in Desert Environment of Dubai, UAE

O.M. Albadwawi, J.J. John & A. Alnuaimi
DEWA, Dubai, United Arab Emirates

6BV.4.11 Energy Yield Analysis of a Heat Pipe Based Photovoltaic Thermal Solar Collector for Building Integrated Applications

M.P. Bellmann
SINTEF, Trondheim, Norway
S.P. Lester
Flint Engineering, Mayfield, United Kingdom
H. Jouhara
Brunel University, London, United Kingdom
R. Einhaus
Apollon Solar, Lyon, France

6BV.4.12 Numerical Study for the PV Potential and Integration in Urban Areas

B. Raybaud & P. Thony
CEA, Grenoble, France
E. Vergnault, L. Merlier & J.J Roux
INSA-Lyon, Villeurbanne, France

6BV.4.13 EnergyMatching Project – Adaptable and Adaptive RES Envelope Solutions to Maximize Energy Harvesting and Optimize EU Building and District Load Matching

L. Maturi, S. Giona, D. Moser, R. Lollini & M. Lovati
Eurac Research, Bolzano, Italy
P. Alonso & I. Weiss
WIP Renewable Energies, Munich, Germany
C. Bales
Dalarna University, Borlänge, Sweden
J.M. Vega de Seoane
Tecnalia, San Sebastián, Spain
A. Becker
Ferroamp Elektronik, Spånga, Sweden
S. Hallbeck
NIBE, Markaryd, Sweden
E. Widlak
Tulipps, Waalwijk, The Netherlands
D.-J. Bles
Plastica Plaat, Waalwijk, The Netherlands
V. Zanon
Eurofinestra, Governolo, Italy
E. Rico
Onyx Solar Energy, Avila, Spain
L. Papaiz
Pellini, Codogno, Italy
A. Perez Carballo
Solarwall, Madrid, Spain
C. de Nacquard
Bouygues, Paris, France
O. Caboni
R2M Solution, Pavia, Italy
V. Esposito
Casa, Florence, Italy
J. Hedberg
LudvikaHem, Sweden
S. Metayer
Habitat76, Rouen, France

6BV.4.14 On the Feasibility of Solar Fuelled Electric Ferries

M. Jomâa
SINTEF, Oslo, Norway

6BV.4.16 Design and Optimization for Seawater Desalination Plant by Reverse Osmosis, Using Photovoltaic Solar Energy

L. Luciano de la Cruz
National University of Engineering, Lima, Peru

6BV.4.17 Evaluation of Thermal Properties for BIPV in Façade - Experimental Results of G Value for Crystal Silicon BIPV Module According to ISO 19467

H. Ishii
LIXIL, Tokyo, Japan

6BV.4.18 Comparison of the Outdoor Performance of Cylindrical and Rectangular-Parallelepiped PV Modules
H. Noge & M. Konagai
Tokyo City University, Japan
T. Masuda & A. Satou
Toyota, Shizuoka, Japan

6BV.4.20 Operational Power Performance Analysis of Various BIPV Systems in Republic of Korea
H. Lee, J. Yoon, M. Choi & D. Shin
Hanbat National University, Daejeon, Republic of Korea

6BV.4.21 Steps Towards an Optimized Building-Integrated Photovoltaics Value Chain in The Netherlands
E. van der Poel, Y. Aartsma & E. Teunissen
Berenschot, Utrecht, The Netherlands
A. De Vries
Celstar, Brussels, Belgium
W.G.J.H.M. van Sark
Utrecht University, The Netherlands

6BV.4.22 Design Evaluation of Customized Building Integration Photovoltaic Prototypes in Hot Climates
D. Efurosibina Attoye, K.A. Tabet Aoul & A. Hassan
UAEU, Al Ain, United Arab Emirates

6BV.4.23 A Solar Cell with Switchable Colour
N. Neugebohrn, M. Götz, K. Gehrke, M. Vehse & C. Agert
DLR, Oldenburg, Germany

6BV.4.24 Output Characteristic of Thin-Film Solar Cell Assuming Various Greenhouse Installation Forms
Y. Hirata & Y. Watanabe
Suwa University of Science, Nagano, Japan

6BV.4.25 An Easy-to-Mount BIPV Roof System
J. Oscarsson, P. Neretnieks, M. Ljunggren, A. Eriksson, K. Theelen, J. Endrell & L. Stolt
Solibro Research, Uppsala, Sweden

6BV.4.26 Direct Determination of Total Hemispherical Emittance of Perovskite and Silicon Solar Cells
L. Granados, J. Bing, S. Huang, H. Mehrvarz & A.W.Y. Ho-Baillie
UNSW, Sydney, Australia
N. Takamure & D.R. McKenzie
University of Sydney, Australia

6BV.4.27 Experimental Study on the Performance Evaluation of Building Integrated Photovoltaic (BIPV) Generated Curtain-Wall for Reliability Verification
E. Ryu, S. Lee, D. Kim, K.-J. Kim & J. Park
KCL Korea Conformity Laboratories, Chungbuk, Republic of Korea

6BV.4.28 Increasing Coverage of Heating Demand by PVs Electricity Generation through Geometrical Modification in a Medium Sized Building
A. Rahmani & R. Wagner
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

6BV.4.31 Design and Technoeconomic Optimization of Grid-Connected Hybrid PV-System for the Agricultural Sector
J. Fagerstrøm, I.H. Lereng & J.H. Selj
Institute for Energy Technology, Kjeller, Norway
A.-G. Hjelkrem & A.K. Bakken
NIBIO, Ås, Norway

6BV.4.32 An Innovative PVT Hybrid Module for Positive Energy Buildings - An Example of Implementation in France
L. Brottier & J.-M. Drap
DualSun, Marseille, France
R. Bennacer
LMT/ENS, Cachan, France

6BV.4.34 Solar Streetlights Using Vertical Bifacial Solar Modules: A Case Study for India
E. Gerritsen
CEA, Le Bourget du Lac, France

6BV.4.35 Wind-Solar Hybrid Systems May Raise Project IRR by up to 10%
S. Dayal
Sunil Dayal, Delhi, India

6BV.4.36 Extended Battery Life in Wearable Device Using Quantum Dot Embedded Flexible Photovoltaic Harvester and Low Power Conversion System
C. Lee, Y. Park, Y. Ryu & S. Yeo
Samsung Electronics, Seoul, Republic of Korea

NOTES

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Wednesday, 11 September 2019

VISUAL PRESENTATIONS 6CV.1

08:30 - 10:00 PV Driven Energy Management and System

Chairpersons:

Franz Baumgartner
ZHAW, Switzerland

Ingrid Weiss
WIP Renewable Energies, Germany

6CV.1.1 Power Flow Monitoring at Substations of Low Voltage Distribution Grids with High Penetration of PV Installation
H. Behrends, R. Völker & S. Geißendörfer
DLR, Oldenburg, Germany
T. Kumm
EWE, Oldenburg, Germany

6CV.1.2 Development of Advanced Control Using Forecast Data for PV-Diesel Hybrid Systems on a Simulation Platform
A. Wantier & T.-P. Do
CEA, Le Bourget du Lac, France
C. Grellier & J. Colas
CVE, Marseille, France

6CV.1.4 Energy Management for Energy Community Sharing Based on Particle Swarm Optimization and Alternating Direct Method of Multiplier (ADMM)
M.A. Albachrony, D.L. Ha, Q.T. Tran & A. Brun
CEA, Le Bourget du Lac, France
M. Petit
Supelec, Gif-sur-Yvette, France

6CV.1.5 Incentive-Based Solutions for High Photovoltaic Penetration in Distribution Grid
L. Bloch, J. Holweger, C. Ballif & N. Wyrsch
EPFL, Neuchâtel, Switzerland

6CV.1.6 Photovoltaic Energy Yield Prediction Using an Irradiance Forecast Model Based on Machine Learning
S. Wendlandt
PI Berlin, Germany
F. Popescu
Fraunhofer FOKUS, Berlin, Germany

6CV.1.7 Day-Ahead Scheduling of Household Electricity Consumption Based on a Genetic Algorithm
C. Lucas, M. Guemri & Q.T. Tran
CEA, Le Bourget du Lac, France

PROGRAMME

6CV.1.8 Spatio-Temporal Forecasting of PV Power Generation for High Integration in the Grid
M. Malvoni & N. Hatziargyriou
ICCS/NTUA, Zografou, Greece

6CV.1.9 A Systematic Approach to Development of a Sustainable Monitoring and Evaluation Framework for PV Hybrid Mini-Grids
B. Ravanbach, M. Kühnel, B. Hanke, K. von Maydell & C. Agert
DLR, Oldenburg, Germany
O. Weigel & S. Maebe
GIZ, Hamburg, Germany
A. McMaster
DEDEAT, East London, South Africa

6CV.1.11 A Solar PV/T Living Laboratory as a Cyber-Physical System
A. Rachid
UPJV, Amiens, France

6CV.1.12 Fuel Consumption Decrease in Hybrid-Power Systems Using PV Power Monitoring and Forecast Solution
L.-E. Boudreault, E. Buessler, O. Liandrat & S. Cros
Reuniwatt, Sainte-Clotilde, France

6CV.1.13 Simulation of Multi-Agent Systems Coordination for Load Management in MicroGrid
M. Ait Benali & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

6CV.1.14 Complementarity of Renewable Energy for Rural Zones, Study Case Cundinamarca-Colombia
A. Aldana-Urrea, D.J. Rodriguez & J.A. Hernández
District University of Bogotá, Colombia

6CV.1.15 Prototype of Electric Car for Physically Disabled People Integrated with Residential Solar Power System in Sao Paulo, Brazil
S. Shimura & D. Deotti
IFSP, São Paulo, Brazil
R. de Paula Diver
UNICAMP, Campinas, Brazil
J.O. Motta Pompeu e Silva
UFRJ, Rio de Janeiro, Brazil

6CV.1.16 A Framework on Spatiotemporal Shifting of Solar Energy Based on EV Aggregator
K. Kato, D. Watari, I. Taniguchi & T. Onoye
University of Osaka, Suita, Japan

6CV.1.17 Load Management Strategies for Weak Grids with High Penetration of Electric Vehicles
P. Klement, J. Helms, B. Hanke & K. von Maydell
DLR, Oldenburg, Germany

6CV.1.18 Modelling the PV Opportunities to Power E-Mobility
H. Ossenbrink
Band Gap, Bad Feilnbach, Germany

6CV.1.19 Preparing the Massive Introduction of Intermittent Energies and Electric Vehicles in Insular Territories: First Steps in Martinique and in Malta
A. Guerin de Montgareuil
CEA, St-Paul-lez-Durance, France
B. Azzopardi
MCAST Energy, Paola, Malta
L. Bellemare
AME, Ducos, Martinique

6CV.1.20 Preliminary Weather Forecast Tracking and Modelling of Electromobility
J. Ascencio-Vásquez & M. Topič
University of Ljubljana, Slovenia

6CV.1.21 Artificial Neural Network Based Decision Support System for the Present Power Grid Accounting for the Successful Integration of Renewable Energy Sources such as PV Systems
M. Linke, T. Meßmer, G. Micard, A. Wenzel & G. Schubert
University of Applied Sciences, Constance, Germany
M. Kindl
Smart Infrastructure, Stuttgart, Germany
A. Minde
ISC Konstanz, Constance, Germany

NOTES

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VISUAL PRESENTATIONS 2CV.2

12:45 - 15:00 Feedstock, Crystallisation, Wafering, Defect Engineering / Thin Film and Foil-Based Si Solar Cells / Characterisation & Simulation of Si Cells

Chairpersons:

Stephan Riepe
Fraunhofer ISE, Germany

Marco Topič
University of Ljubljana, Slovenia

Stefan Peters
Hanwha Q CELLS, Germany

Francesca Ferrazza
eni, Italy

Timothy Bruton
Progress in Photovoltaics, United Kingdom

2CV.2.2 Key Structures in Silicon Heterojunction Solar Cells for the Complete Regeneration of BO-Related Defects in n-Type Upgraded Metallurgical-Grade Czochralski Silicon
C. Sun, R. Basnet, S.P. Phang & D. Macdonald
ANU, Canberra, Australia
W. Weigand, Z. Yu & Z.C. Holman
Arizona State University, Tempe, United States
D. Chen & B. Hallam
UNSW Australia, Sydney, Australia

2CV.2.3 Bulk Degradation of n-Type Czochralski-Grown Upgraded Metallurgical-Grade Silicon Wafers during the Processing of Phosphorus-Doped Poly-Silicon Cells
R. Basnet, S.P. Phang, C. Samundsett, D. Yan, C. Sun, H.T. Nguyen & D. Macdonald
ANU, Canberra, Australia
F.E. Rougieux
UNSW Australia, Sydney, Australia

2CV.2.4 Degradation and Regeneration of n+-Poly-Si on Oxide Surface Passivation under Illumination and Dark Annealing on p-Type Cz-Si
M. Winter, S. Bordihn, R. Peibst & J. Schmidt
ISFH, Emmerthal, Germany

2CV.2.5 Light and Elevated Temperature Induced Degradation in p- and n-Type Mono-Like Silicon and Float Zone Silicon Materials and Their Correlation with Silicon Nitride Film Properties
D. Kang, H.C. Sio & D. Macdonald
ANU, Canberra, Australia
X. Zhang, T. Zhang & H. Jin
Jinko Solar, Haining, China

2CV.2.6 LeTID Studied by Hyperspectral Photoluminescence Imaging
T. Mehl, J.-F.-B. Cappelen, I. Burud & E. Olsen
NMBU, Ås, Norway
R. Søndenå
Institute for Energy Technology, Kjeller, Norway

2CV.2.7 Trapping in Multi-Crystalline Silicon Wafers: Capture Cross Section and Impact of Laser Treatment and Firing
S. Jafari, Y. Zhu, F. Rougieux & Z. Hameiri
UNSW Australia, Sydney, Australia

2CV.2.8 Influence of Deep Level Defects on Photoelectrical Processes in p-n Junction Solar Cells with Porous Silicon Antireflection Coating
V. Tregulov, V. Litvinov, A. Ermachikhin & A. Maslov
RSREU, Ryazan, Russia

2CV.2.9 Investigations of Grain Boundary Defects and Precipitates in Multi-Crystalline Silicon Wafers with EBSD, TEM, and Hyperspectral Photoluminescence Imaging
A. Thøgersen & I.T. Jensen
SINTEF, Oslo, Norway
T. Mehl, I. Burud & E. Olsen
NMBU, Ås, Norway
J. Zhu, S.E. Foss & R. Søndenå
IFE, Kjeller, Norway

2CV.2.11 Investigation of the Influence of Solar Cell Processing on Structural Defects in HPMC-Si Wafers by Photoluminescence Image Analysis
H. Haug, M. Syre Wiig & C.R. Søndenå
Institute for Energy Technology, Kjeller, Norway

2CV.2.12 Investigation of Spectral Dependence of Efficiency and Deep-Level Defects in Active Layers of Multicrystalline Silicon Solar Cells
S.M. Karabanov, V.G. Litvinov, N.V. Vishnyakov,
A.V. Ermachikhin, A.S. Karabanov & S.P. Vikhrov
RSREU, Ryazan, Russia

2CV.2.13 Control of Oxygen Concentration at the Top- and End-Position of Ingot to Improve Efficiency of Commercial p-Type PERC
W. Nam, J.C. Park & B. Lee
Woongjin Energy, Daejeon, Republic of Korea

2CV.2.14 Mathematical Modeling of Electromagnetic Stirring of Silicon Melt under the Conditions of a Travelling Magnetic Field
S.M. Karabanov, D.V. Suvorov, D.Y. Tarabrin & E.V. Slivkin
RSREU, Ryazan, Russia
A.S. Karabanov & O.A. Belyakov
Helios-Resource, Saransk, Russia

2CV.2.15 Generation and Propagation of Dislocation Clusters Originated from Multicrystallization by S.3n Rotation and in Quasi-Monocrystalline Silicon
T. Kojima, K. Tajima, T. Matsumoto, H. Kudo & N. Usami
Nagoya University, Japan
P. Krenckel & S. Riepe
Fraunhofer ISE, Freiburg, Germany

2CV.2.16 Further Tests of Methods to Reduce the Red Zone in the Top Region of MC - Silicon Ingots
T. Bähr & M. Ghosh
Access, Aachen, Germany
C. Kranert
Fraunhofer THM, Freiberg, Germany
C. Reimann
Fraunhofer IISB, Erlangen, Germany
C. Morche
ALD Vacuum Technologies, Hanau, Germany

2CV.2.17 Evaluation of Improvement Strategies of Grain Structure Properties in High Performance Multi-Crystalline Silicon Ingots
M. Trempa, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany
C. Kranert & I. Kupka
Fraunhofer THM, Freiberg, Germany

2CV.2.18 The Development of 3D Visualization of Ingot Structure Based on Digital Processing of Photoluminescent Wafer Images of Multicrystalline Silicon
S.M. Karabanov, A.E. Serebryakov & D.V. Suvorov
RSREU, Ryazan, Russia
O.A. Belyakov & A.S. Karabanov
Helios-Resource, Saransk, Russia

2CV.2.19 Reduced Oxygen Contamination in Directionally Solidified Multi-Crystalline Silicon Ingots by Adjusted Silicon Nitride Coating
S. Schwanke, M. Trempa, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany
M. Kuczynski, G. Schroll & J. Sans
AlzChem, Trostberg, Germany

2CV.2.20 Cost Effective Growth of Silicon Mono Ingots by the Application of Active Crystal Cooling in Combination with Large Melt Volumes in Cz-Puller
F. Mosel, A.V. Denisov, B. Klipp & N. Sennova
PVA Crystal Growing Systems, Wettenberg, Germany
R. Kunert & P. Dold
Fraunhofer CSP, Halle (Saale), Germany

2CV.2.21 Mono-Like Silicon Ingot Casting Based on Simulation Result in Electron-Beam Melting System
J.-K. Lee, J.S. Lee, Y.S. Ahn & G.-H. Kang
KIER, Daejeon, Republic of Korea

2CV.2.22 An Approach for Implementing Machine Learning in the Solar Industry
A. Schlezinger
Applied Materials, Santa Clara, United States

2CV.2.23 On the Mechanical Strength of Diamond-Sawn Monocrystalline, Multicrystalline and Quasi-Monocrystalline Silicon Wafers: Influence of Thickness and Saw Mark Orientation
L. Carton, R. Riva, F. Coustier & A. Chabli
CEA-LITEN, Le Bourget du Lac, France
D. Nelias & M. Fourmeau
INSA Lyon, Villeurbanne, France

2CV.2.24 Variation of Silicon Wafer Strength and Edge Chipping Induced by Residual Stresses at the Brick Bonding Interface
R. Koepge, F. Kaule, F. Herbst, A. Langhans & S. Meyer
Fraunhofer CSP, Halle (Saale), Germany
E. Velispahic
Jowat, Detmold, Germany

2CV.2.31 Adoption of Wide-Bandgap Microcrystalline Silicon Oxide and Dual Buffers for Semitransparent Solar Cells in Building-Integrated Photovoltaic Window System
J. Yang & J.-D. Kwon
KIMS, Changwon, Republic of Korea
D.-W. Kang
Chung-Ang University, Seoul, Republic of Korea
M. Shin
Korea Aerospace University, Goyang, Republic of Korea

2CV.2.32 Power Increase of Transparent a-Si:H Solar Cells Using Albedo Effects
J.W. Lim, M.A. Park & K. Kim
ETRI, Daejeon, Republic of Korea

2CV.2.33 Analysis of the Bowing Phenomenon Using 100um Scale Partially Processed c-Si Solar Cells
J.-R. Lim, W.G. Shin, S.H. Ko, H. Hwang, Y.-C. Ju & G.-H. Kang
KIER, Daejeon, Republic of Korea

2CV.2.38 Performance Characterization for Bifacial Photovoltaic Modules
G.H. Wang, L. Zhao, C.L. Zhou, H.W. Diao & W.J. Wang
CAS, Beijing, China

2CV.2.42 Investigation of the Accelerated Light Soaking Testing for p-Type PERC Cell with and without Laser LIR Technology
C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, Y.-H. Chao, L.-G. Wu & C.-Y. Yu
TSEC, Hsinchu, Taiwan
Y.-C. Lee, M.-A. Tsai & H.-H. Hsieh
ITRI, Hsinchu, Taiwan

2CV.2.43 Analysis of Degradation in Metallization Process with E-Beam Evaporation in High-Efficiency n-Type Silicon Solar Cells
D. Choi, S.J. Park, C. Lee, S. Bae, Y. Kang, H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea

2CV.2.44 Non-Destructive Approach for Measuring Base Resistivity of Emitter Diffused Wafers
V. Kuruganti, J. Haunschild, A. Brand, S. Al-Hajjawi & S. Rein
Fraunhofer ISE, Freiburg, Germany

2CV.2.45 Evidence of Solute PEDOT:PSS as an Efficient Passivation Material
V.H. Nguyen, K. Gotoh, Y. Kurokawa & N. Usami
Nagoya University, Japan
S. Kato
Nagoya Institute of Technology, Koriyama, Japan

2CV.2.46 A Simulation Approach for Device Structure and Thickness Optimization of Silicon Heterojunction Solar Cells Featuring TiO2 as Carrier-Selective Contact
D.K. Gorle & N. Chander
IIT, Bhilai, India

2CV.2.47 Investigation of Deep Energy Level Spectra in Active Layer of Si Heterostructure (HIT) Solar Cell
A. Maslov, V. Litvinov, N. Vishnyakov, V. Gudzev, A. Ermachikhin & S.P. Vikhrov
RSREU, Ryazan, Russia

2CV.2.49 Improving the Analysis of Contact Recombination by Photoluminescence Imaging
P. Manshanden
ECN part of TNO, Petten, The Netherlands

2CV.2.50 Sublayer-Resolved Structure Analysis of Passivation Layers for PERC Cells Deposited by a High-Throughput Inline PECVD Process
S. Großer, S. Richter, A. Hähnel & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany
G. Köhler, H.-P. Sperlich, T. Große & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany

2CV.2.51 Point-by-Point Parameter Mapping of a mc-Si Solar Cell
N. Kwarikunda & W. Okullo
Makerere University, Kampala, Uganda
E.E. van Dyk & F.J. Vorster
Nelson Mandela University, Port Elizabeth, South Africa

2CV.2.52 A New Measurement of Voc Temperature Coefficients at Very Large Temperature Range
M. Amara, B. Guillo Lohan & M. Lemiti
INSA Lyon, Villeurbanne, France
A. Kaminski-Cachopo
IMEP-LAHC, Grenoble, France

2CV.2.53 Effects of Si Bulk Defects Generated by SiNx:H PECVD on Light Induced Degradation
Y. Ohshita, K. Watanabe, R. Wakita, H. Lee & K. Nakamura
Toyota Technological Institute, Nagoya, Japan
T. Kamioka & A. Ogura
Meiji University, Kawasaki, Japan

2CV.2.54 FDTD Simulations of Structures Created by the Black-SiN Method to Optimize the Reflection Reduction of Solar Cells
M. John & N. Bernhard
Anhalt University of Applied Sciences, Köthen, Germany
J. Hirsch
Fraunhofer CSP, Halle (Saale), Germany

2CV.2.55 Powerful Topographic Analysis Method Using Fast Fourier Transform for c-Si Solar Cells and Emerging Technologies
K. Saliou & G. Fischer
IPVF, Palaiseau, France
F. Hilt & E. Drahi
TOTAL, Paris La Défense, France
T. Hildebrandt & P.P. Grand
EDF R&D, Palaiseau, France

2CV.2.56 Life(Time) at the Limits – Very High Lifetimes in Crystalline Silicon Measured by Photoconductance and Photoluminescence
B. Steinhauser, T. Niewelt, A. Richter, J. Polzin,
F. Feldmann, M.C. Schubert & M. Hermle
Fraunhofer ISE, Freiburg, Germany

2CV.2.57 Opto-Electronic Properties of Dislocations in Cast-Mono Silicon for Solar Cells
D. Ory, N. Paul & V. Le-Guen
EDF R&D, Palaiseau, France
T. Bidaud & S. Collin
CNRS, Palaiseau, France
L. Lombez
IPVF, Palaiseau, France

2CV.2.58 Porous Silicon Low Dielectric Constant Thin Films and Its Application in Solar Cell
K. Rahmoun
University of Tlemcen, Algeria

2CV.2.59 Accurate Performance Measurement of c-Si Solar Cells Adopting Advanced Metallization Technologies
S.K. Ahn, K. Kim, J.H. Yun, A. Cho, Y.J. Eo, J.S. Cho,
S.J. Ahn, J.H. Park, J.S. Yoo, D.H. Shin, I. Jung, S. Lee,
S. Song, A. Lee & J. Gwak
KIER, Daejeon, Republic of Korea

2CV.2.60 Comparing Near-Field Calculations and Effective Medium Models for Light Reflection and Absorption of Black Silicon Nano-Textures
T.P.N. Veeken & A. Polman
AMOLF, Amsterdam, The Netherlands
T.H. Fung & M. Abbott
UNSW Australia, Sydney, Australia
D. Payne
Macquarie University, Sydney, Australia

2CV.2.61 Impact of AlO and SiN Thickness on Field-Effect Passivation of AlO/SiN Dielectric Stacks on Crystalline Silicon
T. Mochizuki, K. Tanahashi, K. Shirasawa & H. Takato
AIST, Koriyama, Japan
A. Ito & H. Nakanishi
SCREEN, Kyoto, Japan
I. Kawayama & M. Tonouchi
Osaka University, Japan

2CV.2.62 The Development of the Probe Bar for the Newest c-Si PV Cell with the Unique Electrode Design Such as Busbar-Less, Multi Busbar and Complicated Busbar
Y. Nakamichi, H. Kojima, T. Morishima, Y. Takeda,
R. Tomioka, T. Murata & K. Iwamoto
KOPEL, Kyoto, Japan

2CV.2.63 Analysis of Laser Boron Doping and Laser Damage
N. Yang, S. Li, C. Liu, X. Yuan, X. Ye & H. Li
ECUST, Shanghai, China

2CV.2.64 Investigation of the Temperature Dependence of the Optical Properties of Silicon Nitride Anti-Reflection Coating on Silicon Photovoltaic Modules
S. Zhang, R. Bhoopathy & Z. Hameiri
UNSW Australia, Sydney, Australia
A. Gentle
University of Technology Sydney, Ultimo, Australia

2CV.2.65 Light Trapping with Free-Floating Arrays of Subwavelength Trumpet Non-Imaging Light Concentrators
A. Prajapati, A. Chauhan, D. Keizman & G. Shalev
BGU, Beer-Sheva, Israel

2CV.2.72 Key Aspects for Industrial Efficiency above 22% PERC Solar Cells Based on Double-Side AlOx Passivation
Y. Cui, S. Yuan, Y. Wang, Y. Hu, W. Zhang, X.W. Zhang, Z. Niu, S. Peng, Y. Ke, Y. Wan & Q. Huang
Risen Energy, Changzhou, China
Y. Ren & L. Zhu
Fusion New Material, Changzhou, China

2CV.2.73 Simplify Printed-ALOx PERC Cell Process: A PDA-Free Process
T.-C. Chen, C.-C. Lin, C.-H. Ku, J. Yu, S.-L. Lee, T.-W. Kuo & C.-C. Wen
E-TON Solar Tech, Tainan, Taiwan
J.-Y. Hung
New E Materials, Kaohsiung, Taiwan
Z.-P. Yang
National Chiao Tung University, Tainan, Taiwan
I.-S. Yu
National Dong Hwa University, Hualien, Taiwan

2CV.2.74 The AMPERE Project Key Exploitable Result: A Bifacial Heterojunction Cell and Module Industrial Automated Manufacturing Plant in Europe
C. Colletti, C. Gerardi & D. Iuvara
ENEL Green Power, Catania, Italy
F. Bizzarri
ENEL Green Power, Rome, Italy
B. Strahm
Meyer Burger Research, Hauterive, Switzerland
A. Richter
Meyer Burger Technology, Gwatt, Switzerland
J.-F. Lerat & D. Muñoz
CEA, Le Bourget du Lac, France
M. Izzi
ENEA, Rome, Italy

J. Levrat & C. Ballif
CSEM, Neuchâtel, Switzerland
O. Nielsen
NorSun, Oslo, Norway
B. Hartlin
ERM, London, United Kingdom
B. Melzer
Jonas & Redmann, Berlin, Germany
M. Tallián
SEMILAB, Budapest, Hungary
S. Lombardo
CNR, Catania, Italy
M. Balucani
RISE Technology, Ostia, Italy
J. Rentsch
Fraunhofer ISE, Freiburg, Germany

2CV.2.75 23% Efficient Industrial Bifacial n-Type Crystalline Silicon Solar Cells with Electron-Selective Polysilicon Passivating Contacts
Z. Ma, Z. Ma, W. Gu, X. Qian, J. Sheng, C. Zhang & W. Wang
GCL System Integration Technology, Suzhou, China

2CV.2.76 Inverted Pyramid Texturing of Monocrystalline Silicon Wafer
A. Sutejo, H.P. Hsu & C.-W. Lan
NTU, Taipei, Taiwan

2CV.2.77 Influence of the Acidic Texturing Structure on the Different Surface Roughness for Solar Cell
Y. Jung, S.H. Bae, Y. Kang, H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea

2CV.2.78 Simultaneous Front-Side Texturing and Rear-Side Polishing of Monocrystalline Silicon Wafer by Spray-Etching with HF-HCl-Cl2 Mixtures
K. Halbfaß, B. Neubert, A. Stapf & E. Kroke
Freiberg University of Technology, Germany

2CV.2.79 Industrially MCCE Textured Cells on Monolike Substrates
Z. Xu, H. Wang, Y. Wang, F. Li, J. Shi & D. Song
Yingli Green Energy, Baoding, China

2CV.2.81 Metal Assisted Texturing on Micro Pyramids for Enhanced Anti Reflective Properties
O. Aydin, M.Z. Borra, E. Semiz & F. Es
METU, Ankara, Turkey

2CV.2.82 Uniformity of Black Silicon Texture and Its Impact on Cell Performance
M.U. Khan, T.H. Fung, G. Scardera, S. Wang, U. Varshney, D. Payne & M. Abbott
UNSW Australia, Sydney, Australia
S. Zou, X.-S. Wang & G. Xing
Canadian Solar, Suzhou, China

2CV.2.83 Process Optimization for Inline Black Silicon Based Solar Cell Production Line
M.C. Raval, I. Melnyk, A. Teppe, S. Madugula, W. Jooss & P. Fath
RCT-Solutions, Constance, Germany
S. Gok, T. Eren, M. Comak & M. Ender
BereketEnerji, Pamukkale, Turkey
B. Hu & J. Zhou
RCT Automation Equipment, Suzhou, China

2CV.2.85 Investigation of Laser Damage for Selective Emitter Silicon Solar Cells
J. Dong, W, Wang, Z. Zhang, Z. Ma, Q. Ye, J. Sheng & C. Zhang
GCL System Integration Technology, Suzhou, China

2CV.2.86 Hydrosilane-Free Low-Cost APCVD of SiO2 Films for Crystalline Si Solar Cell Applications
H. Nagel, E. Issa, M. Glatthaar & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany
T. Nagel
Freiburg Seminar, Germany

2CV.2.87 Plasma Oxidation for the Front Side Passivation of PERC Solar Cells
A. Mohamed Okasha Mohamed Okasha, B. Kafle, B. Torda, C. Teßmann, A. Moldovan & M. Hofmann
Fraunhofer ISE, Freiburg, Germany

2CV.2.88 Multivariate Statistical Modelling to Correlate PECVD Layer Properties with Plasma Chemistry during Silicon Nitride Deposition
L. Rachdi & M. Hofmann
Fraunhofer ISE, Freiburg, Germany

2CV.2.89 LPCVD In-Situ Doped Phosphorus Polysilicon Layers for Passivated Contact Solar Cells
B. Martel, T. Blevin, H. Lignier, S. Benguesmia & M. Hayes
CEA, Le Bourget du Lac, France
J. Yang & S. Tran
SEMCO Technologies, Montpellier, France

2CV.2.90 Highly Transparent and Highly Conductive Magnetron Sputtered TCO-Layers for Industrial Production of Heterojunction Silicon Solar Cells
S. Hübner, R. Korn, M. Huber & P. Wohlfart
Singulus Technologies, Kahl am Main, Germany

2CV.2.91 Development of Nanostructured FTO Films as Transparent and Diffuse Electrodes and Their Integration in Silicon Solar Cells
S. Lakhdar Chaouche, D. Bellet & C. Jimenez
Grenoble INP, France
A. Fave
INSA Lyon, Villeurbanne, France
S. Daniele
University of Lyon 1, Villeurbanne, France

2CV.2.92 Low-Energy Plasma-Assisted Deposition of ITO Thin Films for Si Cells by Sublimation in an Anodic Vacuum Arc Discharge
B. Scheffel, T. Preußner, O. Zywitzki, T. Modes & T. Kopte
Fraunhofer FEP, Dresden, Germany

2CV.2.93 FolMet-Connect: Progress of Al-Foil Based Metallization Technology for PERC Cells
J. Paschen, A.A. Brand, T. Fellmeth & J. Nekarda
Fraunhofer ISE, Freiburg, Germany

2CV.2.94 Plated Front Side Metallization on Transparent Conducting Oxide Utilizing Low-Cost APCVD SiO2 Insulating Layer
E. Issa, H. Nagel, M. Glatthaar & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2CV.2.95 A Solution for In-Situ Spatially-Resolved Intensity Measurements in Belt Furnaces
A. Herguth, C. Derricks & G. Hahn
University of Konstanz, Constance, Germany

2CV.2.96 Photoluminescence Imaging for Inline Detection of Organic Residues on Silicon Wafers
B. Ahrens & S. Schweizer
University of Applied Sciences, Soest, Germany
P.-T. Miclea, S. Wahl & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany
R. Schäfer
S & I Spectroscopy & Imaging, Warstein, Germany

2CV.2.97 Contacting New Solar Cell Metallization Layouts and Contact Quality Surveillance in Production
K. Ramspeck, S. Schenk, M. Alt, P. Waleska, S. Zimmermann & M. Meixner
h.a.l.m. elektronik, Frankfurt, Germany

2CV.2.98 Sorting Criteria for Bifacial PERC Cells for Improved Module Classification

N. Wöhrle, A. Krieg, T. Fellmeth, A. Alapont Sabater, A. Schmid & S. Rein
Fraunhofer ISE, Freiburg, Germany
K. Ramspeck
h.a.l.m. elektronik, Frankfurt am Main, Germany

2CV.2.99 Industry 4.0 PV Factory of the Future: Installing a Test-Bed in a Solar Research Facility

S. Sasidharan, R. Harney & R. Marczak
ISC Konstanz, Germany

2CV.2.100 New Approach for a Combined Process of an Ultrafast Boron-Oxygen Defect Regeneration and Thermal Contact Treatment on Ni-Cu-Ag Plated Cells

S. Roder, V. Arya, A. Brand & J. Nekarda
Fraunhofer ISE, Freiburg, Germany
D. Pysch & N. Bay
RENA, Freiburg, Germany
K. Krauß
Rehm Thermal Systems, Blaueuren, Germany

2CV.2.101 Comparing Cz-Si PERC Solar Cells from Various Manufacturers Regarding BO-Related Light-Induced Degradation and Regeneration

D.C. Walter, L. Helmich & J. Schmidt
ISFH, Emmerthal, Germany
O. Romer & T. Pernau
centrotherm international, Blaubeuren, Germany

2CV.2.102 Micro- and Macrotextured Foils for Solar Cells Application

O. Sergeev, H. Meddeb & M. Vehse
DLR, Oldenburg, Germany
R. Warmers, G. Jenke & R. Schlegel
SAUERESSIG, Vreden, Germany
S. Brüning
Schepers, Vreden, Germany
P. Veldhuizen & R. van Erven
Morphotonics, Veldhoven, The Netherlands

VISUAL PRESENTATIONS 5CV.3

15:15 - 16:45 Solar Resource and Forecasting / Design and Installation of PV Systems / Storage / Concentrators and PV for Space Applications

Chairpersons:

Carsten Baur
European Space Agency, The Netherlands

Francesco Dolci
European Commission JRC, The Netherlands

Kari Lappalainen
Tampere University, Finland

Christos Protogeropoulos
EEPS, Greece

5CV.3.1 A Comparison of Two Models for the Separation of Direct and Diffuse Irradiance in Plane of Array

D.E. Guzman Razo, S. Halilovic, S. Killinger, B. Müller & C. Wittwer
Fraunhofer ISE, Freiburg, Germany

5CV.3.3 Spectroradiometer Comparison under Outdoor DNI and Indoor High-Power AM0-Like Conditions

R. Galleano, D. Pavanello & W. Zaaiman
European Commission JRC, Ispra, Italy
G. Jüngst
INTA, Torrejon de Ardoz, Spain
M. Halwachs & M. Rennhofer
AIT, Vienna, Austria
A.A. Santamaria Lancia
Technical University of Denmark, Roskilde, Denmark
E.J. Haverkamp & D. Van der Woude
Radboud University, Nijmegen, The Netherlands
A. Minuto & E. Celi
RSE, Piacenza, Italy
M. Theristis
University of Cyprus, Nicosia, Cyprus
R. Couderc & P. Voarino
CEA, Le Bourget du Lac, France

5CV.3.6 Improving Solar Irradiance Forecast Using Ensemble Method in French Guiana

M. Salloum, M. Diallo, A. Primerose & L. Linguet
University of French Guiana, Cayenne, French Guiana

5CV.3.7 BQC: A Website to Quality Control Solar Radiation Measurements with Satellite-Based and Reanalysis Databases

R. Urraca Valle, A. Sanz & F.J. Martinez-de-Pison
University of La Rioja, Logrono, Spain
A.M. Gracia Amillo
European Commission JRC, Ispra, Italy

5CV.3.8 Best Practices for Solar Resource Assessment: A Reliable Maintenance, Calibration and Traceability Procedures

A. Amar & M.H. Bouhamidi
MASEN, Rabat, Morocco

5CV.3.9 Insight from a Detailed Comparison between the Solar Irradiance Measured in the North of France, and Its Satellite-Based and Simulation-Based Estimates

N. Ferlay, G. Chesnoiu, P. Dubuisson, F. Auriol,
G. Brogniez & F. Parol
University of Lille, Villeneuve d'Ascq, France
T. Elias, M. Compiègne & D. Ramon
HYGEOS, Lille, France

5CV.3.10 Field Evaluation of Mars™ Optical Soiling Sensor

M. Gostein & W. Stueve
Atonometrics, Austin, United States
F. Farina & B. Bourne
SunPower, Richmond, United States

5CV.3.11 Intra-Day Solar Irradiance Forecasting for PV Power Generation Utilising Machine Learning Models

S. Theocharides, G. Makrides, M. Theristis &
G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

5CV.3.12 Uncertainty Estimation of Deterministic Solar Irradiance Forecasts for Microgrid Energy Management Using the Analogs Ensemble Method

F. Calderon-Obaldia & A. Migan-Dubois
GeePs, Gif-sur-Yvette, France
J. Badosa
LMD, Palaiseau, France
V. Bourdin
LIMSI, Orsay, France

5CV.3.13 Influence of Cloud Cover on Power Fluctuations of Photovoltaic Systems

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

5CV.3.14 Photovoltaic Power Forecasting with Ensemble of Learners: Large Test Case from PV Plants in Italy, Zambia and Australia

M. Tucci
University of Pisa, Italy
A. Betti, L. Gigoni, F. Ruffini, A. Piazzi & C. Lanzetta
I-EM, Livorno, Italy

5CV.3.15 Supporting the Global Growth of PV: An International Collaborative to Improve Data Quality and Minimize Measurement Uncertainty

L. Burnham
Sandia National Laboratories, Albuquerque, United States
S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
S.-Y. Oh
Yeungnam University, Gyeongsan, Republic of Korea
A. Benlarabi
IRESEN, Rabat, Morocco
J.-H. Choi
KTL, Seoul, Republic of Korea
M. Ebert & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
B.W. Figgis
QEERI, Doha, Qatar
K.S. Kim
KIER, Yuseong-gu, Republic of Korea
T. Reindl
SERIS, Singapore, Singapore
R. Rüther
UFSC, Florianópolis, Brazil

5CV.3.16 Physical and Statistical Solar Power Forecasting for an Arbitrary Oriented Panel

N. Boyouk & N. Munzke
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

5CV.3.17 Evaluation of Mars™ Optical Soiling Sensor at a Commercial-Scale PV Power Plant

M. Gostein & B. Stueve
Atonometrics, Austin, United States
S. Kagan, F. Zureick, E. Giosa & R. Flottemesch
Constellation Energy, Baltimore, United States

5CV.3.18 Fast Physical Radiative Transfer Code to Compute Solar Radiation Effectively Collected by a Photovoltaïc Panel

E. Thierry, D. Ramon & M. Compiègne
HYGEOS, Lille, France
N. Ferlay
LOA, Villeneuve d'Ascq, France

5CV.3.19 Comparative Study of the Photovoltaic Productivity of the Three Silicon Technologies in Ouarzazate City
Y. Darmane
University Ibn Zohr, Ouarzazate, Morocco

5CV.3.30 Practical Comparison between View Factor Method and Ray-Tracing Method for Bifacial PV System Yield Prediction
J. Kang & C. Reise
Fraunhofer ISE, Freiburg, Germany
J. Jang & K. Lee
Korea Polytechnic University, Siheung, Republic of Korea

5CV.3.31 A Comparison of Ray Tracing and View Factor Simulations of Locally Resolved Rear Irradiance with the Experimental Values
D. Berrian & J. Libal
ISC Konstanz, Germany

5CV.3.32 Bifacial Performance Optimization Studies Using Bifacial Radiance and High Performance Computing
J.S. Stein
Sandia National Laboratories, Albuquerque, United States
C. Deline & S. Ayala Pelaez
NREL, Golden, United States

5CV.3.33 Analysis of Bifacial PV System Energy Performance and Module Mismatch Depending on Atmospheric Environment and System Installation Condition
J. Jang & K. Lee
Korea Polytechnic University, Siheung, Republic of Korea

5CV.3.34 An Empirical Model for Assessing the Bifacial Energy Gain (BEG) of PV Modules
J. Leloux
UPM, Madrid, Spain
J. Robledo
LuciSun, Sart-Dames-Avelines, Belgium
C. Tjendgdrawira & D. Vaduda
Tractebel Engineering, Brussels, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, United States

5CV.3.35 A Ray-Tracing Based 3D Tool for Accurate Prediction of PV Plants Yield
M. Chiodetti, E. Boyère & O. Lgheit Rhazi
EDF R&D, Moret-sur-Loing, France
M. Bila & G. Terrom
EDF Renewables, Paris La Defense, France

5CV.3.36 Explicit Model Based on Approximated I-V Curves for Partial Shading Modelling of Photovoltaic Systems
M. Dallapiccola, P. Ingenhoven, M. Lovati & D. Moser
Eurac Research, Bolzano, Italy

5CV.3.38 Study of PV Systems for Self-Consumption at the UPC
S. Silvestre & D. Fontanilles
UPC, Barcelona, Spain

5CV.3.40 A Comparative Study between Classical and Linear PV Power Plant Architectures
T. Le, T. Tran & H. Colin
CEA, Le Bourget du Lac, France

5CV.3.41 Designing PV Systems below 50 cents/Wp
G.J. Schaeffer
Dutch Solar Energy, Tilburg, The Netherlands

5CV.3.43 Benefits of Adapted PV Module Interconnection Layouts for Mobile Applications - Simulation Results and Outdoor Solar Yield Measurements
H. Hanifi, D. Hahn, D. Götz & S. Schindler
Fraunhofer CSP, Halle (Saale), Germany

5CV.3.44 DC- Versus AC-Based Power Systems for Cost-Effective Electrification of Rural Sub-Saharan Africa
N. Opiyo
Ulster University, Londonderry, United Kingdom

5CV.3.45 Solar Cogeneration a Innovative Technology of CSP and PV a Developing in Morocco Country
S.E. Lachhab, E.A. Ibrahmi & L. Dlimi
Ibn Tofail University, Kenitra, Morocco

5CV.3.51 Fight Global Warming with Solar Energy + Multi-Storage Resilient Island Nano-Grid Smart Home/Building
J. Borland
J.O.B. Technologies, Aiea, United States

5CV.3.52 Legal, Technical and Operational Feedback from a PV System with Storage for Self-Consumption Installed in France
N. Lebert & B. Gaiddon
HESPUL, Lyon, France
J. Buffiere & F. Lagut
ALEC, Grenoble, France
S. Fraisse
Epices Energie, Lyon, France

5CV.3.53 Techno-Economic Analysis and Battery Storage Placement in Grid-Connected Photovoltaic (PV) System
J.Z. Tee, L.H.I. Lim, E.Z.D. Chia & K.H. Tan
University of Glasgow, Singapore, Singapore

5CV.3.54 Diagnosis and Prognosis of Li-Ion Battery State-Of-Health Based On Electrode Potential Shifts
J.-L. Koné & M. Montaru
CEA, Le Bourget du Lac, France
Y. Bultel
LEPMI, Grenoble, France
S. Fiette
CEA, Grenoble, France

5CV.3.55 Simulation of Grid-Tied PV Systems with Battery Storage in PVsyst
B. Wittmer & A. Mermoud
PVsyst, Satigny, Switzerland

5CV.3.56 Grid Flexible Solar: Unlocking Solar's Full Potential
M. Morjaria
First Solar, Scottsdale, United States

5CV.3.57 Parallel Operation of Battery-Based Storage Systemsin Applications to Low-Voltage Nanogrids
Y.-C. Chen & Y.-Y. Tzou
NCTU, Hsinchu, Taiwan

5CV.3.58 CO2 UPHES (Underground Pumped-Hydro Energy Storage) in LRC (Lined Rock Cavern) as Short/Medium-Duration Storage, as Efficient Heat Pump, Alternatively as Long-Duration Storage When Used as Hybrid PTES (Pumped Thermal Electricity Storage)
P. Lalanne
HydroClapeyron, Dinard, France
P. Byrne
University of Rennes, France

5CV.3.62 Electron and Proton Irradiation of GaAs Solar Cells
N. Gruginskie, G.J. Bauhuis, P. Mulder, E. Vlieg & J.J. Schermer
Radboud University, Nijmegen, The Netherlands
F. Cappelluti
Polytechnic University, Turin, Italy

5CV.3.64 MicroFlex: Optical Modeling and Characterization of PseudoMorphic Glass (PMG)
A. Bermudez Garcia, V. Maneval, R. Cariou, P. Voarino, O. Raccurt & Y. Roujol
CEA, Grenoble, France

5CV.3.65 Modelling the Efficiency of Solar Cells for Concentrating Photovoltaic and Thermal Systems
R.R. Vardanyan, D.G. Arstamyan & H.S. Petrosyan
National Polytechnic University of Armenia, Yerevan, Armenia

5CV.3.66 CPV-T Receiver Concepts with Spectral Splitting
A. Resch & R. Höller
University of Applied Sciences Upper Austria, Wels, Austria

5CV.3.67 "Current Pinching" Effect in Multijunction Solar Cells
S.V. Pushko & N.T. Vagapova
JSC Kvant, Moscow, Russia
M.Z. Shvarts, M.A. Mintairov & M.V. Nakhimovich
RAS / Ioffe, St. Petersburg, Russia

5CV.3.68 High-Efficiency Planar Micro-Tracking Photovoltaic Modules with Hybrid Direct/Diffuse Light Collection for Rooftop Installations
G. Nardin, A.F. Aguilar, L. Anglade, F. Gerlich, M. Ackermann & L. Coulot
Insolight, Ecublens, Switzerland
D. Petri, J. Levrat, J. Champliaud, A. Faes & M. Despeisse
CSEM, Neuchâtel, Switzerland
S. Askins, N. Jost, C. Domínguez & I. Antón Hernández
UPM, Madrid, Spain

VISUAL PRESENTATIONS 5CV.4

17:00 - 18:30 Operation, Performance and Maintenance of PV Systems

Chairpersons:

Gerhard Mütter
Alteso, Austria

Joshua Stein
Sandia National Laboratories, United States

5CV.4.1 Power Curtailment and PV Panel Operating Voltage
M. Järvelä & S. Valkealahti
Tampere University, Finland

5CV.4.2 How Many Performance Parameters Do You Need to Know If a Module Is Failing?
J.C. Jimeno, E. Ortega, G. Aranguren & J.R. Gutiérrez
UPV/EHU, Bilbao, Spain
O. Kunz
UNSW Australia, Sydney, Australia

5CV.4.3 The VAR Method: A Less Environment-Sensitive and Data-Based Approach to Evaluate the Performance Loss Rate of PV Power Plants

M. Meftah
EDF R&D, Chatou, France
E. Lajoie-Mazenc & M. Van Iseghem
EDF R&D, Écuelles, France
R. Perrin
EDF Renouvelables, Colombiers, France
D. Boublil & K. Radouane
EDF Renouvelables, Paris, France

5CV.4.4 Advanced Fault Detection for PV Plants: An Enhanced Adimensional Approach

V. Barone, D. Bertani, S. Guastella & G. Maugeri
RSE, Milan, Italy

5CV.4.5 Defect Recognition and Power Loss Estimation of PV Systems Using Infrared Thermography

B.L. Aarseth
University of Oslo, Kjeller, Norway
E.S. Marstein
Institute for Energy Technology, Kjeller, Norway

5CV.4.6 Student Award Finalist Presentation: Fault Inspection of CIGS PV Plant Using Aerial Infrared Thermography

D. Amstad & A. Häberle
University of Applied Sciences, Rapperswil, Switzerland
A.K. Vidal de Oliveira & R. Rüther
UFSC, Florianópolis, Brazil

5CV.4.7 Field Tests of Soiling Detection System for PV Modules

M. Korevaar, T. Bergmans, J. Mes & X. van Mechelen
Kipp & Zonen, Delft, The Netherlands
A. Alami Merrouni
IRESEN, Rabat, Morocco
F. Wolfertstetter & S. Wilbert
German Aerospace Center, Tabernas, Spain

5CV.4.8 Operation of PV Arrays at the Largest MPP Voltage Instead of the Global MPP Voltage during Irradiance Transitions Caused by Clouds

K. Lappalainen & S. Valkealahti
Tampere University, Finland

5CV.4.9 PVs under Harsh Dust Soiling: Modeling and Prediction of the Performance for a Broad Range of Soiling State

N. Barth, B.W. Figgis, S.P. Aly & S. Ahzi
QEERI, Doha, Qatar

5CV.4.10 PV Module Diagnosis with Automatic Online IV Curve Measurement

A. Plissonnier, S. Lespinats, M. Amhal & H. Colin
CEA, Le Bourget du Lac, France

5CV.4.11 Remote Monitoring of PV Station for Rain Stimulation System

D.V. Aghabekyan, L.M. Lakhoyan & A.A. Vardanyan
NPUA, Yerevan, Armenia

5CV.4.12 Identification of Series Resistance from the Measured PV Panel Electrical Characteristics

H. Kalliojärvi-Viljakainen & S. Valkealahti
Tampere University, Finland
G. Spagnuolo
University of Salerno, Fisciano, Italy

5CV.4.13 Development of a Big Data Bank for PV Monitoring Data, Analysis and Simulation in COST Action 'PEARL PV'

A.H.M.E. Reinders & F. van Slooten
University of Twente, Enschede, The Netherlands
D. Moser
Eurac Research, Bolzano, Italy
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
G. Oreski
PCCL, Leoben, Austria
N.M. Pearsall
Northumbria University, Newcastle upon Tyne, United Kingdom
M. Devetakovicc
University of Belgrade, Serbia
J. Leloux
UPM, Madrid, Spain
D. Capeska Bogatinoska
UIST, Ohrid, Macedonia
A. Driesse
PV Performance Labs, Freiburg, Germany

5CV.4.14 PV|Harvester – A Tool for PV Power Plant Performance Evaluation and Economical Optimization

R. Höller, A. Högl, M. Birajdar & A. Royes Moreno
FH OOE, Wels, Austria
D. Gudopp
deea solutions, Frankfurt am Main, Germany

5CV.4.15 Performance, Faults and Energy Losses of Photovoltaic Power Plants in France: Methodology and Feedback

J. Sayritupac, M. Amhal & H. Colin
CEA, Le Bourget du Lac, France

5CV.4.16 Application of an Efficiency-Degradation Model to a 34-Year Field-Exposed Si-Module Array
L. Abenante, F. De Lia, R. Schioppo & S. Castello
ENEA, Rome, Italy

5CV.4.18 Effective False Detection Methods for Safety Predictable Power Performance of PV Power Station
H.K. Ahn, N. Park, G.-G. Kim, B.G. Bhang, S.Y. Park, W.B. Lee, H.J. Choi & J.-H. Choi
Konkuk University, Seoul, Republic of Korea

5CV.4.19 Optimization of the Cost Priority Number (CPN) Methodology to the Needs of a Large O&M Operator
G. Oviedo Hernández & P. Chiantore
BayWa, Rome, Italy
S. Lindig & D. Moser
Eurac Research, Bolzano, Italy

5CV.4.20 A Machine Learning-Based Predictive Maintenance System for Solar Inverters
G. Guerra & P. Mercade Ruiz
GreenPowerMonitor, Barcelona, Spain
L. Landberg
DNV GL, Hellerup, Denmark

5CV.4.21 Characterization and Modelling of the Soiling Effect on the PV Generation under Urban Mediterranean Conditions
N. Martín Chivelet, J. Polo, M. Alonso-Abella, C. Sanz & N. Vela
CIEMAT, Madrid, Spain
F.J. Batlles, J. Alonso-Montesinos, J.L. Bosch & J. Barbero
UAL, Almeria, Spain
G. López
UHU, Huelva, Spain

5CV.4.22 Results and Lessons Learned from the Field Deployment of DUSST, a Low-Maintenance PV Soiling Sensor
L. Micheli, F. Almonacid & E.F. Fernández
University of Jaén, Spain
J. Morse & M. Muller
NREL, Golden, United States

5CV.4.23 Experimental Comparison of the Soiling Effect on Different PV Technologies
J.G. Bessa, L. Micheli, E.F. Fernández & F. Almonacid
University of Jaén, Spain

5CV.4.24 Opportunities to Improve Photovoltaic Plant Maintenance Informed by Data Analytics of Commercially-Operating Large-Scale Plants
M.L. Bolen & S. Hackett
EPRI, Charlotte, United States
T. Gunda
Sandia National Laboratories, Albuquerque, United States

5CV.4.25 Detailed Loss Analysis for Wall Mounted Photovoltaic Systems at High Latitude; A Comparison of Multicrystalline Si- to CIGS- Modules
G. Otnes, M.B. Øgaard, L.T. Milde, S.E. Foss & J.H. Selj
Institute for Energy Technology, Kjeller, Norway

5CV.4.26 Failure Modeling for Detection and Diagnostic Studies of Large-Scale Grid-Connected Photovoltaic System
M. Malvoni
NTUA, Zografou, Greece
Y. Chaibi
ENSAM, Fes, Morocco

5CV.4.27 Comparative Analysis of a Very Large CIS and Small c-Si PV Systems under Tropical Climate
K. Kunaifi & A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands
D. Kaharudin, A. Harmanto & K. Mudiarto
PT PJB, Surabaya, Indonesia

5CV.4.28 Solar Power Forecasting with LSTM Network Ensemble
M. Emamian, J. Milimonfared, A. Eskandari & R. Hosseini Abardeh
Amirkabir University of Technology, Tehran, Iran
M. Aghaei
Albert-Ludwigs-University of Freiburg, Germany

5CV.4.29 Performance and Electroluminescence Analysis on Reliability and Lifetime of Thin-Film Photovoltaics (PEARL TF-PV)
E. Sovetkin & V. Huhn
Forschungszentrum Jülich, Germany
A.W. Weeber
Delft University of Technology, The Netherlands
A. Martin
Crystalsol, Vienna, Austria
B. Rau
HZB, Berlin, Germany
E.J. Achterberg
Solar Tester, Schinnen, The Netherlands
M. Rennhofer
AIT, Vienna, Austria
M. Theelen
TNO, Eindhoven, The Netherlands
T. Weber
PI Berlin, Germany

5CV.4.30 Performance Evaluation of Monitoring Algorithms for Photovoltaic Systems
M.B. Øgaard, A. Skomedal & J.H. Selj
Institute for Energy Technology, Kjeller, Norway

5CV.4.31 Mapping Annual and Seasonal Soiling in Western Europe
L. Micheli, J.G. Bessa, F. Almonacid & E.F. Fernández
University of Jaén, Spain
J. Leloux
UPM, Madrid, Spain

5CV.4.32 Identifying Order of ARIMA Model Using Different Criteria Selection for Forecasting of Degradation Rates
A. Kyprianou, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

5CV.4.33 GOVP: A Global Approach to Reduce PV Electricity Cost
S. Guillerez & B. Commault
CEA, Le Bourget du Lac, France
A. Apraiz
Mondragon Assembly, Aretxabaleta, Spain
A. Virtuani
EPFL, Neuchâtel, Switzerland
A. Canino
ENEL Green Power, Rome, Italy
G. Demofonti
Convert, Rome, Italy
R. Alonso
Tecnalia, San Sebastián, Spain
G. Maugeri
RSE, Milan, Italy
X. Rodriguez
LEITAT, Terrassa, Spain
I. Savych
GXC Coatings, Goslar, Germany

5CV.4.34 A Comparative Study of the Performance Features of Heterojunction and Diffusion Si Modules in Humid Continental and Subarctic Climates
A. Titov, K. Emtsev, D. Andronikov, A. Abramov & D. Orekhov
R&D Center TFTE, St. Petersburg, Russia
B. Bulygin, A. Dubrovskiy & I. Shakhray
Hevel Solar, Novocheboksarsk, Russia

5CV.4.35 Quantifying Long Term PV Performance and Degradation under Real Outdoor and IEC 61853 Test Conditions Using High Quality Module IV Measurements
S. Ransome
Steve Ransome Consulting, Kingston upon Thames, United Kingdom
J. Sutterlueti
Gantner Instruments, Schruns, Austria

5CV.4.36 The Influence of Module Tilt on Snow Shadowing of Frameless Bifacial Modules
A.M. Petersson, J. Narvesjö, P. Toth & J. Petersson
RISE, Piteå, Sweden

5CV.4.37 Sunlight Variation Study for Drone-Based Daylight Electroluminescence Imaging of PV Modules
G.A. dos Reis Benatto, C. Mantel, A.A. Santamaria Lancia, N. Riedel, S. Thorsteinsson, P.B. Poulsen & S. Forchhammer
Technical University of Denmark, Roskilde, Denmark
H.R. Parikh, S.V. Spataru & D. Sera
Aalborg University, Denmark

5CV.4.38 Monitoring of a PV-Hybrid and Two Grid Connected Systems in Three Countries
A. Jiménez Franco, A. Thönnes, C.A. Mayorga Sánchez, C. Jürißen, L. Clasing, R. Gecke & U. Blieske
Cologne University of Applied Sciences, Germany

5CV.4.39 Effect of Dust on Solar Photovoltaic Modules in Shiraz
S.A. Bahreini & M. Yaghoubi
Shiraz University, Iran

5CV.4.40 Software Correction of Angular Misalignments of Tilted Reference Solar Cells Using Clear-Sky Satellite Open Data
T. Barbier
Optimum Tracker, Meyreuil, France
P. Blanc & Y.-M. Saint-Drenan
MINES ParisTech, Sophia-Antipolis, France

5CV.4.41 A Probabilistic Approach to Predict the Degradation of a PV System
M. Malvoni
ICCS/NTUA, Zografou, Greece
N.M. Kumar
City University of Hong Kong, China

5CV.4.42 Impact of Defective Modules on the Characteristics of a Large-Scale Grid-Connected PV Power Plant
T. Finsterle, L. Cerná, P. Hrzina & V. Benda
CTU, Prague, Czech Republic

5CV.4.43 Soiling Ratios and Management Strategies in Utility Scale PV Plants in the Atacama Desert
P. Darez & C. Darr
350renewables, Las Condes, Chile

5CV.4.44 A New Optical Device for PV Soiling Monitoring
A. Azouzoute & A. Ghennioui
IRESEN, Rabat, Morocco
M. Chouitar
Lycée Technique Mohammedia, Morocco
M. Garoum
University Mohammed V in Rabat, Morocco

5CV.4.45 Design of an Application for the Estimation of the PV Power Plant Production in Real Time
J. Alonso-Montesinos, J. Barbero & F.J. Batlles
UAL, Almeria, Spain
G. López
UHU, Huelva, Spain
J. Polo, N. Martín Chivelet, M. Alonso-Abella & N. Vela
CIEMAT, Madrid, Spain

5CV.4.46 Hyperspectral Photoluminescence Imaging as a Tool to Studying Degradationof Outdoor Silicon Solar Panels
M. Vukovic, A.S. Flø, E. Olsen, T. Mehl & I. Burud
NMBU, Ås, Norway

Thursday, 12 September 2019

VISUAL PRESENTATIONS 2DV.1

12:45 - 15:00 Homojunction Solar Cells / Heterojunction Solar Cells

Chairpersons:

Arthur Weeber
ECN part of TNO, The Netherlands

Matthieu Despeisse
CSEM, Switzerland

Delfina Muñoz
CEA, France

Joachim John
imec, Belgium

2DV.1.1 Surface Passivation of Atmospheric Pressure Dry Etched Multicrystalline Silicon Surfaces
A.I. Ridoy, B. Kafle, M. Klitzke, N.W. Khan & M. Hofmann
Fraunhofer ISE, Freiburg, Germany
L. Clochard & E. Duffy
Nines Photovoltaics, Dublin, Ireland

2DV.1.2 Functionalized Oxides for Bifacial Solar Cells with Passivated Contacts: First Results of the OXYGEN Project
T. Desrues, A. Morisset, E. Bruhat, A. Veau, M. Hayes, P. Bellanger, R. Cabal & S. Dubois
CEA, Le Bourget du Lac, France
A. Kaminski-Cachopo, Q. Rafhay, N. Ait-Abdelkader & Y. Kalboussi
IMEP-LAHC, Grenoble, France
J.P. Kleider, J. Alvarez & M.E. Gueunier-Farret
CNRS, Gif-sur-Yvette, France
C. Marchat
IPVF, Palaiseau, France
D. Blanc-Pélissier, P. Schutz, C. Chevalier & M. Lemiti
INSA Lyon, Villeurbanne, France
D. Munoz-Rojas & V.H. Nguyen
LMGP, Grenoble, France
G. Borvon & F. Torregrosa
Ion Beam Services, Peynier, France

2DV.1.3 **Simultaneous Contacting of Boron and Phosphorus Doped Surfaces with a Single Screen Printing Paste**
J.D. Huyeng, A. Spribille, M.G. Prince, L.C. Rendler & U. Eitner
Fraunhofer ISE, Freiburg, Germany
C. Ebert
SCHMID Group, Freudenstadt, Germany

2DV.1.4 **Optimization of Boron Doping Paste for Simplified Fabrication of Interdigitated Back Contact Solar Cells**
A. Aliefendioglu, E.H. Çiftpinar & R. Turan
METU, Ankara, Turkey

2DV.1.5 **A Comparison Study of Front and Rear Surface Passivation Techniques of Nitric Acid Oxidation of Silicon on Phosphorus-Diffused and Non-Diffused Texture Surfaces for p-Type Bifacial PERC**
S. Joonwichien, Y. Kida, M. Moriya, S. Utsunomiya, K. Shirasawa & H. Takato
AIST, Koriyama, Japan

2DV.1.6 **532 nm Laser Treated Selective Emitter Profiles Study with SIMS and ECV Technics**
A. Moussi, S. Meziani, L. Benharrat & S. Chaouchi
CRTSE, Algiers, Algeria
M. Slimane
CDTA, Algiers, Algeria

2DV.1.7 **Development of an Industrially-Relevant Process for Passivating Contacts on p-Type Silicon Wafers**
A. Desthieux, J. Posada & P.P. Grand
EDF R&D, Palaiseau, France
C. Broussillou, B. Bazer-Bachi & G. Goaer
EDF ENR PWT, Bourgoin Jallieu, France
E. Drahi
TOTAL, Palaiseau, France
P. Roca i Cabarrocas
CNRS, Palaiseau, France

2DV.1.8 **Investigation on the Surface Texturing of the Casting Quasi-Single Crystal Silicon**
D. Hu, W. Lian, Q. Wei & Z. Ni
Talesun Solar, Changshu, China

2DV.1.9 **Stability of the Regenerated p-Type Multi-Crystalline PERC Solar Cells after Light and Evaluated Temperature Induced Degradation**
J. Zhu, R. Søndenå & S.E. Foss
Institute for Energy Technology, Kjeller, Norway
B. He
Donghua University, Shanghai, China
Q. Wei, H. Qian & Z. Ni
Talesun Solar, Suzhou, China

2DV.1.10 **High Voltage Solar Cells Based on Nanostructured Ultra-Thin Silicon**
N. Moulin, M. Amara, F. Mandorlo & M. Lemiti
INSA Lyon, Villeurbanne, France

2DV.1.11 **Characteristics of Reaction Kinetics on Light-Induced Degradation and Regeneration Process with Passivation Properties in p-Type PERC Solar Cell**
S.M. Kim, S.H. Jung, J. Kim, G. Choi & Y.B. Kim
GERI, Gumi, Republic of Korea
M.G. Kang & H.-E. Song
KIER, Daejeon, Republic of Korea

2DV.1.13 **A Novel Method of Rear-Side Alkaline Polishing for Low-Cost and High-Efficiency PERC Solar Cells**
J. Yu, C.-H. Ku, S.-L. Lee, T.-W. Kuo, T.-C. Chen, C.-C. Lin & C.-C. Wen
E-TON Solar Tech, Tainan, Taiwan

2DV.1.14 **Effects of Particle Size of Aluminum Powder in Silver/Aluminum Paste on n-Type Solar Cells**
T. Aoyama
Noritake, Miyoshi, Japan
M. Aoki & I. Sumita
Asada Mesh, Matsubara, Japan
A. Ogura
Meiji University, Kawasaki, Japan

2DV.1.15 **Si Surface Passivation by GaOx Films Deposited Using a Mist Chemical Vapor Deposition Process**
Y. Adachi, T. Harada, Y. Hotta, H. Yoshida, K. Maeda & K. Arafune
University of Hyogo, Himeji, Japan

2DV.1.16 **Comparative Study on Temperature Coefficients of Different Kinds of Industrial Silicon Solar Cells**
H. Wang, X. Cheng & H. Yyang
Xi'an Jiaotong University, China

2DV.1.17 **Enhanced TiO2 Surface Passivation and Thermal Stability with Al Doping**
W. Liang, K.C. Fong & J. Tong
ANU, Canberra, Australia
K.R. McIntosh
PV Lighthouse, Coledale, Australia

2DV.1.18 **Optimization of Triple-Layer Antireflection Coating with SiOx on Black Silicon PERC Solar Cell**
S. Zhang, Y. Yao, H. Qian, Y. Li, Q. Wei, Z. Ni & W. Lian
Talesun Solar, Changshu, China
J. Jie & X. Zhang
Soochow University, Suzhou, China

2DV.1.19 A Study on Aluminum Pastes for Rear Emitter in n-Type Silicon Solar Cells

M. Aoki & I. Sumita
Asada Mesh, Matsubara, Japan
T. Aoyama
Noritake, Miyoshi, Japan

2DV.1.20 Investigating the Performance of Molybdenum Oxide-Silicon Nanowires Solar Cells

C. Lu, A.B. Prakoso & R. Rusli
NTU Singapore, Singapore

2DV.1.21 Low Temperature p-n Junction Fabrication by PECVD for n-PERT Solar Cells: An Alternative to Boron Diffusion

M. Chrostowski & E. Drahi
TOTAL, Paris, France
J. Alvarez & J.-P. Kleider
CNRS, Gif sur Yvette, France
K.-H. Kim
Cheongju University, Republic of Korea
P. Roca i Cabarrocas
CNRS, Palaiseau, France

2DV.1.22 PECVD Grown SiOx/Poly-Si for TOPCon Solar Cell Application

L. Zhang, Z. Shu, C.H. Shin, C.-P. Ouyang, Y. Chae & S.H. Cho
Applied Materials, Santa Clara, United States

2DV.1.23 Understanding of UV-ps Laser Ablation Mechanisms on Bifacial n-PERT Silicon Solar Cells and Impact on Ni/Cu Plating

C. Molto, J.E. Lee & S. Béchu
IPVF, Palaiseau, France
J. Nekarda & V. Arya
Fraunhofer ISE, Freiburg, Germany
M. Bouttemy, A. Etcheberry & A.-M. Goncalves
UVSQ, Versailles, France
E. Drahi
TOTAL, Paris, France
P.P. Grand
EDF R&D, Palaiseau, France

2DV.1.24 Ultra-Fine Contact Finger Achieved by Pattern Transfer Printing (PTP) Technology for Silicon Solar Cells – Recent Development

A. Adrian, D. Rudolph & J. Lossen
ISC Konstanz, Germany
M. Matusovsky & A. Noy
Utilight, Yavne, Israel

2DV.1.25 Efficient Sprayed Al2O3 Surface Passivation for Multicrystalline Silicon Solar Cells

L. Zougar, S. Sali, S. Kermadi & M. Boumaour
CRTSE, Algiers, Algeria
M. Kechouane
USTHB, Algiers, Algeria

2DV.1.26 Excellent Silicon Surface Passivation with Atomic Layer Deposited SiO2 Thin Films

S. Li, J. Xu, N. Yang, X. Yuan, C. Liu & H. Li
East China University of Science and Technology, Shanghai, China

2DV.1.27 Laser Enhanced Contact Optimization as a Multi-Faceted Approach to Improved LCOE via Increased Efficiency and Increased Yield

R.W. Mayberry & K. Myers
Heraeus, West Conshohocken, United States
A. Henning
Heraeus, Hanau, Germany
H. Zhao & E. Hofmüller
Cell Engineering, Kabelsketal, Germany

2DV.1.35 Recent Results for the Deployment of Silicon Heterojunction Production Lines at ENEL Green Power: Effect of the Number of Busbars

W. Favre, L. Sicot, V. Barth, A. Bettinelli, A. Danel, J.-F. Lerat & P.-J. Ribeyron
CEA, Le Bourget du Lac, France
M. Sciuto, G. Condorelli, A. Ragonesi, A. Canino, M. Foti & C. Gerardi
ENEL Green Power, Catania, Italy

2DV.1.36 Identification of the Source of Degradation of Silicon Heterojunction Solar Cells from the Shape of the I-V Characteristics Linked to Its Dependence on the Doping Level in a-Si:H: Theory and Experimental Case Study

Y. Abdulraheem & M.Y. Ghannam
Kuwait University, Safat, Kuwait
H. Sivaramakrishnan Radhakrishna & I. Gordon
imec, Leuven, Belgium

2DV.1.37 Power Loss Mechanisms of Ultra-Thin a-Si:H/c-Si Heterojunction Solar Cells with over 20% Efficiencies

Y. Imai, M. Kozawa & H. Fujiwara
Gifu University, Japan
H. Sai, M. Tanabe & T. Matsui
AIST, Tsukuba, Japan

2DV.1.38 Si-Based Heterojunction Solar Cells Passivated by a-SiOx:H Thin Film
K. Saito
Fukushima University, Japan
T. Takamura, Y. Ichikawa & M. Konagai
Tokyo City University, Japan

2DV.1.39 Silicon Heterojunction Solar Cells with Electroplated Copper Grid Electrodes
X. Shu, L. Xu, C. Liu, B. Liu, L. Liu, H. Wang, W. Long, S. Yin, H. Wu, C. Yu, Y.M. Li & X. Xu
Hanergy Thin Film Power, Chengdu, China

2DV.1.40 Development of Transparent Conductive Oxide for Silicon Heterojunction Solar Cell
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
K. Muramatsu
Namics, Niigita City, Japan
T. Nishihara & A. Ogura
Meiji University, Kawasaki, Japan

2DV.1.41 Effect of Argon-Hydrogen Gas Mixture on Properties of ITO Layers and Performance of Silicon Heterojunction Solar Cells
P. Ishmuratov, V. Yakovlev, V. Tarasov & A. Dubrovskiy
Hevel Solar, Novocheboksarsk, Russia
I. Nyapshaev, S. Abolmasov, D. Andronikov, K. Emtsev & A. Abramov
R&D Center TFTE, St. Petersburg, Russia

2DV.1.42 Progress in In2O3-Based Transparent Conductive Oxide Films for Solar Cells
T. Koida, Y. Ueno & H. Shibata
AIST, Tsukuba, Japan

2DV.1.43 Overview of Deposition Methods for Heterojunction Solar Cells with High Deposition Rates
S. Leszczynski, C. Strobel, B. Leszczynska, M. Albert & J.W. Bartha
Technical University of Dresden, Germany
F. Stahr & J. Kuske
FAP, Dresden, Germany

2DV.1.44 DC Sputtering of TCO Layers in Neon Atmosphere and Its Application to Silicon Heterojunction Solar Cells
S. Abolmasov, V. Verbitskiy, I. Nyapshaev, A. Abramov, D. Andronikov & E. Terukov
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Hevel LLC, Moscow, Russia

2DV.1.45 17.25%-Efficient, All Room-Temperature Silicon Solar Cells
S.-H. Kim, J.Y. Jung & J.-H. Lee
Hanyang University, Ansan, Republic of Korea
R.B. Wehrspohn
Fraunhofer IWM, Halle (Saale), Germany

2DV.1.46 Room Temperature Dopant Free Carrier Selective Contact Solar Cells on Industrially Viable Cz Wafers
M. Nayak, K. Singh, S. Mudgal, S. Mandal, S. Singh & V.K. Komarala
IIT Delhi, New Delhi, India

2DV.1.47 Study of the Influence of Defects in Doped Thin-Film Layers in Heterojunction Silicon Solar Cells Employing Opto-Electrical Simulations
J. Balent, J. Krc, F. Smole & M. Topič
University of Ljubljana, Slovenia

2DV.1.48 Transport Losses at the TCO/a-Si:H/c-Si Heterojunction: Influence of Different Layers and Annealing
C. Luderer, M. Bivour & M. Hermle
Fraunhofer ISE, Freiburg, Germany

2DV.1.49 Impact of Interfacial SiOx on Carrier Selectivity and Thermal Stability of Transition Metal Oxide
J. Tong , W. Liang, M. Ernst, D. Walter, M. Stocks, A. Blakers & K.C. Fong
ANU, Canberra, Australia
K.R. McIntosh
PV Lighthouse, Coledale, Australia

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M.L. Addonizio, A. Spadoni & A. Antonaia
ENEA, Portici, Italy

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A. Fischer, A. Moldovan & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

2DV.1.52 The Economic Case for IBC Silicon Heterojunction Solar Cells
R. Vasudevan, S. Harrison, P. Guillaume, P.J. Ribeyron, D. Muñoz & C. Roux
CEA, Le Bourget du Lac, France

2DV.1.53 Improved Front Contact for Silicon Heterojunction Solar Cells with n-Type Nanocrystalline Silicon Oxide Window Layer
W. Duan, D. Qiu, A. Lambertz, M. Pomaska & K. Ding
Forschungszentrum Jülich, Germany

2DV.1.54 Graphene Application as Non Conventional Transparent Conductive Electrode in c-Si Based Heterojunction Solar Cells
L. Lancellotti, E. Bobeico, M. Della Noce, L.V. Mercaldo, I. Usatii & P. Delli Veneri
ENEA, Portici, Italy
G.V. Bianco, A. Sacchetti & G. Bruno
CNR - IMIP, Bari, Italy

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S. Güler, E. Donercark, A.E. Aytaç, A.C. Erçelebi & R. Turan
METU, Ankara, Turkey

2DV.1.56 Development of Phosphorus Thin Doped Layers by Plasma Immersion for Homo- Hetero Junction Solar Cells Application
J. Jourdan, T. Desrues, A. Lanterne, D. Muñoz, R. Varache, A. Danel, P. Carroy, C. Roux & S. Dubois
CEA, Le Bourget du Lac, France

2DV.1.57 Application of Different Gas Mixtures Types in p-Doped Layers of Silicon Heterojunction Solar Cells in the Rear Emitter Configuration
A. Abramov, D. Andronikov, K. Emtsev, G. Ivanov, A.V. Semenov & E.I. Terukov
RAS / Ioffe, St. Petersburg, Russia
I. Shakhray
Hevel Solar, Moscow, Russia

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V. Giglia, J. Veirman & R. Varache
CEA, Le Bourget du Lac, France
E. Fourmond
INSA Lyon, Villeurbanne, France

2DV.1.60 Optoelectronic Properties of Sputtered TCOs and Their Application in Silicon Heterojunction Solar Cells
Z. Yao, W. Duan, A. Mikosch, A. Lambertz, J. Hüpkes, M. Pomaska, K. Bittkau & K. Ding
Forschungszentrum Jülich, Germany
H. Shen
Sun Yat-sen University, Guangzhou, China

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A. Lachowicz, C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

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

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P. Ishmuratov & A. Dubrovskiy
Hevel Solar, Novocheboksarsk, Russia
I. Nyapshaev, S. Abolmasov, D. Andronikov, A. Abramov, E.I. Terukov & D. Orekhov
R&D Center TFTE, St. Petersburg, Russia
I. Shakhray
Avelar Solar, Novocheboksarsk, Russia
M. Dimer, U. Graupner, M. Thumsch & E. Schneiderlöchner
VON ARDENNE, Dresden, Germany

2DV.1.64 A Proposed Flexible p-Si/n-ZnO Heterojunction Based All Solid-State Solar Cell
A.K. Dikshit, A. Singh & P. Chakrabarti
IIT, Varanasi, India
K. Kamal
MNNIT, Prayagraj, India
Y. Dwivedi & N. Mukherjee
NIT, Kurukshetra, India

2DV.1.65 Investigation of Silicon Films for Heterojunction Solar Cells Deposited by Hot-Wire CVD
M. Justianto, M. Höfer, T. Harig & V. Sittinger
Fraunhofer IST, Braunschweig, Germany
F. Schoerg
RENA, Gütenbach, Germany
M. Dimer
VON ARDENNE, Dresden, Germany
O. Astakhov
Forschungszentrum Jülich, Germany

2DV.1.66 Integrating Nanopyramid Gratings into Crystalline Silicon Solar Cells: Augmenting the Absorption of Infrared Photons
A. Razzaq, V. Depauw, H. Sivaramakrishnan Radhakrishna, I. Gordon, J. Szlufcik & J. Poortmans
imec, Leuven, Belgium

2DV.1.67 Limits of the Open-Circuit Voltage and Fill Factor in Thin Silicon Heterojunction Solar Cells
O. Astakhov, T. Merdzhanova, D. Weigand, V. Buga, A. Gad, K. Ding & U. Rau
Forschungszentrum Jülich, Germany

2DV.1.68 Interplay of Intrinsic and Doped Amorphous Silicon Layer and ITO Properties and Process Conditions on Contact Passivation in Silicon Heterojunction Cells
T.S. Yadav & A. Kottantharayil
IIT Bombay, Mumbai, India
H. Sivaramakrishnan Radhakrishna, I. Gordon & J. Poortmans
imec, Leuven, Belgium

2DV.1.69 Poly-Si Passivated Solar Cells Fabricated by Firing Contact Metallization with the Shallow Silver Penetration
H.-C. Chang, C.-C. Lo, S.-T. Liao, B.-C. Kung, C.-J. Huang & M.-T. Kuo
ITRI, Hsinchu, Taiwan
C.-L. Cheng
TeraSolar Energy Materials, Hsinchu, Taiwan

2DV.1.71 Development and Characterization of Silicon-Rich Nitride Layers for Silicon Solar Cell Passivating Contacts
R. Sharma, M. Recamán Payo, H. Sivaramakrishnan Radhakrishna & J. Poortmans
imec, Leuven, Belgium

2DV.1.72 Plasma Oxidation for Polycrystalline Silicon-Based Passivated Contact
C.-Y. Lee, S. Deng, T. Zhang, K. Khoo, U. Romer & B. Hoex
UNSW Australia, Sydney, Australia

2DV.1.73 Effect of a-Si: H Layer Thickness on the Passivation of the c-Si Wafers in the Heterojunction Solar Cells
A. Trad-Khodja, F. Kezzoula, S. Nouali & H. Menari
CRTSE, Algiers, Algeria

VISUAL PRESENTATIONS 7DV.2

15:15 - 16:45 Costs, Economics, Finance and Markets / Policies and Scenarios for Renewables, Societal and Global Challenges

Chairpersons:

Gaetan Masson
Becquerel Institute, Belgium

Maria Getsiou
European Commission DG RTD, Belgium

7DV.2.1 Super PV Project – Innovative and High-Quality PV Systems to Regain Leadership of European PV Businesses on the World Market
J. Ulbikas & V. Ulbikaite
PROTECH, Vilnius, Lithuania
J. Denafas
SOLITEK R&D, Vilnius, Lithuania
R. Witteck & M. Köntges
ISFH, Emmerthal, Germany
M. Topič
University of Ljubljana, Slovenia
F. Frontini, P. Bonomo & E. Saretta
SUPSI, Canobbio, Switzerland
P. Macé
Becquerel Institute, Brussels, Belgium
P.J. Bolt
TNO, Eindhoven, The Netherlands
A.G. Ulyashin
SINTEF, Oslo, Norway
T. Haarberg
BNW-Energy, Trondheim, Norway
W. Palitzsch
Loser Chemie, Freiberg, Germany
B. Terheiden
University of Konstanz, Constance, Germany
I. Weiss & A. Fuentes Cano
WIP Renewable Energies, Munich, Germany
J.L. Domínguez-García
IREC, Barcelona, Spain

7DV.2.5 **CitizEE Project - Scaling Up Public Sustainable Investments via Citizen Financing Schemes**
P. Alonso & S. Caneva
WIP Renewable Energies, Munich, Germany
J.-F. Marchand, L. Vanstraelen & M. Casas
ENERGINVEST, Brussels, Belgium
F. Pause & M. Wimmer
Stiftung Umweltenergierecht, Würzburg, Germany
N. Brito-Jorge
GoParity, Lisbon, Portugal
E. Steyaert & H. Ruttens
VEB, Brussels, Belgium
V. Segon
REGEA, Zagreb, Croatia
R. Adomaviciene, K. Vaskelien & G. Zakevicius
Public Investment Development Agency, Brussels, Belgium
L. Della-Sala
European Crowdfunding Network, Brussels, Belgium

7DV.2.6 **Residential PV Prosumers: Analysis of the Reality in Chile**
J.C. Osorio-Aravena
Universidad Austral de Chile, Coyhaique, Chile
E. Muñoz-Cerón
University of Jaén, Spain

7DV.2.7 **An Overview of Patent Application Data in the Field of Photovoltaics**
N. Persat & M.-A. Le Meur
European Patent Office, Berlin, Germany
M. Boero & C. Königstein
European Patent Office, Rijswijk, The Netherlands

7DV.2.8 **Web Tool for Early Stages of Techno-Economical Analysis of Shared Solar Cooperatives in the Brazilian Context**
K. Schneider & R. Rüther
UFSC, Florianópolis, Brazil
M.O.M. de Oliveira
OCB, Brasília, Brazil

7DV.2.9 **Financial Investment in off Grid Solar PV for Rural Households**
E.L. Meyer & S. Zuma
University of Fort Hare, Alice, South Africa

7DV.2.10 **Technical-Economic Analysis of Photovoltaic Based Distributed Generation Systems for the Mexican Industrial Sector**
N.R. Leon Rodriguez
UNAM, Temixco, Mexico

7DV.2.11 **Brazilian Business Models in Distributed Photovoltaic Generation: International Experiences and New Opportunities**
J.P. Correa da Costa e Silva, M. Mortari Carrilho,
F. Luiz Cyrino Oliveira & R. Flora Calili
PUC-Rio, Rio de Janeiro, Brazil

7DV.2.12 **Most Recent Bottom-Up Costs Analysis from NREL for the PV Module Supply Chain and Systems Coupled with Storage**
M. Woodhouse
NREL, Golden, United States

7DV.2.13 **System Contribution of Residential Photovoltaic (PV) Self-Consumption**
H.J.J. Yu
CEA, Gif sur Yvette, France

7DV.2.14 **Challenges for Financing Utility Scale Solar PV Projects Using Bifacial Technologies**
D. Barandalla, X. Puerta & M. Clemente
UL Renewables, Barcelona, Spain

7DV.2.15 **Solar PV on the Distribution Grid: Smart Integrated Solutions of Distributed Generation Based on Solar PV, Energy Storage Devices and Active Demand Management**
H. Bartoszewicz-Burczy
Institute of Power Engineering, Warsaw, Poland

7DV.2.16 **Energy, Cost And CO2 Savings from Replacing Residential Airconditioners by Impressive Photovoltaic Windows**
M. de Wild-Scholten
SmartGreenScans, Groet, Netherlands
F. Sauvage
University of Picardie, Amiens, France
M. Grätzel & S. Zakeeruddin
EPFL, Lausanne, Switzerland
C. Barolo
University of Turin, Italy
A. Di Carlo
University of Rome, Italy
Y. Cao
HGLASS, Lausanne, Switzerland
Y. Lafon & E. Gay
Euroquality, Paris, France

7DV.2.17 **Community Solar as an Innovative Business Model for Building-Integrated Photovoltaics**
A. Stauch & P. Vuichard
University of St.Gallen, Switzerland

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

7DV.2.23 PV Tender Program in Japan: Its Design and Impacts on Cost Reduction
K. Sugibuchi, I. Kaizuka, H. Yamaya, T. Ohigashi & O. Ikki
RTS Corporation, Tokyo, Japan

7DV.2.24 Policy and Statement of Certified PV Module Registration in Taiwan
C.-C. Chou
ITRI, Hsinchu, Taiwan

7DV.2.25 Renewable Energy Financing, Markets and Policies: Issues and Perceptive in West Africa, Special Case of Niger
M.I. Rabiou
CODDAE, Niamey, Niger

7DV.2.26 Energy for Sustainable Development in Niger: Successes, Challenges and Possible Way Forward
I. Ali Soumana
ANETIC, Niger, Niger

7DV.2.27 Solar Energy and Sustainable Development in Morocco
M. Boussetta & R. El Bachtiri
USMBA, Fez, Morocco
Y. Chaibi
ENSAM, Meknes, Morocco

7DV.2.28 Neighbourhood Influence and Social Acceptance of PV Systems in Rural Developing Communities
N. Opiyo
Ulster University, Londonderry, United Kingdom

7DV.2.29 How Mobile Money Platforms and Other Innovative Technologies Have Stimulated Energy Revolution in Rural Sub-Saharan Africa
N. Opiyo
Ulster University, Londonderry, United Kingdom

7DV.2.31 Binomial Rate for Low Voltage Consumers in Brazil: Conditions for Successful Implementation
R. Teixeira, R. Flora Calili & D. Louzada
PUC-Rio, Rio de Janeiro, Brazil

7DV.2.33 SocialRES Project - Fostering Socially Innovative and Inclusive Strategies for Empowering Citizens in the Renewable Energy Market of the Future
S. Caneva & P. Alonso
WIP Renewable Energies, Munich, Germany
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N. Brito-Jorge
GoParity, Lisbon, Portugal
K. Harder
Abundance, London, United Kingdom
V. Segon
REGEA, Zagreb, Croatia
F. Ciausiu
Tractebel, Bucharest, Romania

7DV.2.34 Newcoming Citizen Photovoltaic Projects in Ile-de-France
C. Blondel, T. Le Roux, N. Harada, B. Blanc, A. Le Huérou, F.-M. Blondel, G. Hervé & G. Macchi
Sud Paris Soleil, Cachan, France
D. Lincot
IPVF, Palaiseau, France

7DV.2.35 Multi-Criteria Decision Analysis for Renewable Energy Applications
A. Boumaiza, A. Sanfilippo & N. Mohandes
QEERI, Doha, Qatar

7DV.2.36 BIPVBOOST Project – Bringing Down Costs of Building-Integrated Photovoltaic (BIPV) Solutions and Processes Along the Value Chain, Enabling Widespread Implementation in Near Zero Energy Buildings (nZEBs) Implementation

M. Machado & R. Alonso
Tecnalia, San Sebastián, Spain
F. Frontini & P. Bonomo
SUPSI, Canobbio, Switzerland
I. Weiss & P. Alonso
WIP Renewable Energies, Munich, Germany
E. Rico
Onyx Solar Energy, Avila, Spain
P. Alamy
ENERBIM, SEILH, France
A. Apraiz
Mondragon Assembly, Aretxabaleta, Spain
S. Pierret
Optimal Computing, Mons, Belgium
P. Macé
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S. Boddaert
CSTB, Sophia-Antipolis, France
J. Adami
Eurac Research, Bolzano, Italy
J. Payet
Cycleco, Ambérieu-en-Bugey, France
R. Baetens
3E, Brussels, Belgium
P. Stassen
Tulipps, Waalwijk, The Netherlands
U. Rühle
Flisom, Dubendorf, Switzerland
K. Viriden
Viriden + Partner, Zurich, Switzerland
M. Martínez
ISFOC, Puertollano, Spain
C. Pirotta
PIZ, Cosio Valtellino, Italy
M. Polo
COMSA, Munich, Germany
A. Haller
Ernst Schweizer, Hedingen, Switzerland

7DV.2.38 EU-Comparison of the Economic Viability of Prosumer PV Systems

V. Fluri, K. Niedermeier, H. Steffens, B. Wille-Haussmann, C. Kost, T. Schlegl & S. Shammugam
Fraunhofer ISE, Freiburg, Germany

7DV.2.39 MOST Project – Advanced Master's Education Based on Smart Grid Technology

S. Arancón, S. Caneva & M. Kovarova
WIP Renewable Energies, Munich, Germany
F. Pilo & S. Mocci
University of Cagliari, Italy
V. Efthymiou, A. Stavrou, G.E. Georghiou & C. Panayi
University of Cyprus, Nicosia, Cyprus
G.C. Christoforidis & I. Panapakidis
Western Macedonia University of Applied Sciences, Kozani, Greece
G. Heilscher & S. Hofbauer
Ulm University of Applied Sciences, Germany
A. Michiorri
MINES ParisTech, France
E. Loucaidou
Deloitte, Lemassol, Cyprus

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 have the opportunity to perform a 5 minutes presentation to the poster area audience during the closing visual session on Thursday from 17:00 to 18:30. Winning posters will be moved to the "Winners Wall" in the poster area and presentations will take place there.

The Poster Awards ceremony, when awards will be delivered, is scheduled for Friday morning on the occasion of the Conference Closing.

For more information on the Poster Area please refer to the Poster Guide or visit *www.photovoltaic-conference.com*

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PARALLEL EVENTS

For more information please refer to
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PARALLEL EVENTS

The EU PVSEC Parallel Events are open to all registered Conference Participants of the EU PVSEC 2019.

For detailed information and programme please visit *www.photovoltaic-conference.com/programme/parallel-events*.

Monday, 09 September 2019

14:30 - 17:00
French National Day - Highlighting French PV Innovation

13:30 - 17:30
Trends in PV Development – Self-Consumption and Innovative Distributed Applications

Tuesday, 10 September 2019

08:30 - 12:30
Eco-Design, Eco Labeling, Green Public Procurement – Sustainability Leadership for the Terawatt Age

08:30 - 12:30
Research meets Business – Solar Industry Forum

13:30 - 17:00
Photovoltaics | Forms | Landscapes - Energy as a Landscape Infrastructure

13:30 - 18:30
Research meets Business – Solar Industry Forum

17:45 - 20:30
New Solutions of Energy

Wednesday, 11 September 2019

08:30 - 12:30
Innovations in Photovoltaic Materials

08:30 - 12:30
Research meets Business – Solar Mobility Forum

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Probabilistic PV Production Forecasts: Technics and Use-Cases

16:00 - 18:30
The EU Support Instruments – Unlocking Developing Markets

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08:30 - 12:30
BIPV – Moving into the Next Phase

10:10 - 12:10
Standardization of the Protocols for Emerging PV Technologies

15:15 - 18:30
Advanced PV Energy Rating for Emerging Technologies

More information on the following pages.

French National Day - Highlighting French PV Innovation

Overview of the French PV Innovation: Roadmap, Market and Policies, and Technical Achievements

Day:	**Monday, 09 September 2019**
Time:	**14:30 - 17:00**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 2 *Callelongue Gradin*, first floor**
Access:	**Registration free of charge but mandatory via *https://registration.n200.com/survey/3pdbs8hks87to***

This workshop will present the main research, development and innovation activities in France. It will start with a brief overview of the current market situation, the main policy issues and the ambitious goal around 40 GW stated for 2028. Then, it will address all the aspects of the innovation process, from basic and applied research carried out within the main research institutes (IPVF and INES), to the last innovative results obtained by the main stakeholders, upstream of the value chain with the equipment and module manufacturers, and downstream with developers, SMEs and start-ups.

Trends in PV Development – Self-Consumption and Innovative Distributed Applications

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 1 in cooperation with IRENA

Day: **Monday, 09 September 2019**
Time: **13:30 - 17:30**
Site: **EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room: **Auditorium 5 *Morgiou*, first floor**
Access: **Open to all Conference participants (on days registered)**

While distributed PV represented one third of global PV installations in 2018, it is poised to develop fast in the coming years under new policies and adequate regulatory frameworks. Self-consumption policies are evolving towards more complex and decentralized regulations allowing collective and virtual self-consumption, while innovative business models allow to rethink electricity production and consumption.

This event will first discuss the development of the PV market, and the impact of policies on the speed at which PV could develop. Will policies continue to shape the market and especially long-term targets? How are self-consumption policies developing and what does that mean for the energy transition? Are electricity markets adapted?

As an official event of the EU PVSEC 2019, this PVPS Programme Workshop is jointly organised by IEA - International Energy Agency and the EU PVSEC. Partners: SET-Plan Action 4, Self-Consumption Initiative, PVProsumer4Grid Horizon2020 Project.

Programme Outline

13:30 **Welcome Speech & the Role of the IEA PVPS Program**

13:35 **Session 1 – Current Trends in innovative PV Policies for Self-Consumption**

Self-consumption policies have evolved rapidly and encompass now the ability to develop PV for self-consumption in multi-stories buildings, as well as virtual compensation between different sites. The following subjects will be discussed.

- Summary of PV self-consumption policies and innovations
- PVP4GRID project summary: collective self-consumption results
- Self-Consumption Initiative: Use cases
- Policy innovation for self-consumption policies: Country cases

15:00 **Coffee Break**

15:30 **Session 2 – Innovative Distributed Applications for PV, Smart Buildings and Electric Mobility**

What could drive PV development in the coming years? From innovative applications in buildings to the integration in the transport sector, this session will explore innovation and forward-looking ideas, including innovative business models for self-consumption.

- Electricity markets and RES profitability
- Hydrogen as a vector to support PV development
- A new dawn for Solar Heating and Cooling using PV electricity
- Innovative cross-cutting applications for electric mobility and PV

17:30 **Closing Speech**
Stefan Nowak, IEA-PVPS Chairman, Net Energy

Contact for further information: Gaëtan Masson, Task 1 Operating Agent g.masson@iea-pvps.org

Eco-Design, Eco Labeling, Green Public Procurement – Sustainability Leadership for the Terawatt Age

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 12

Day:	**Tuesday, 10 September 2019**
Time:	**08:30 - 12:30**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 5 *Morgiou*, first floor**
Access:	**Open to all Conference participants (on days registered)**

The preparatory study of the European Commission on Eco-Design, Eco-Labeling, Green Public Procurement and Energy Labeling for PV modules, inverters and PV systems will be concluded in June/July 2019 with policy recommendations for sustainable product policies for these components.

At the same time, the International Sustainability Leadership Standard for PV Modules and Inverters (NSF457) will be finalized and form the basis for an EPEAT listing of these components and an international eco-label as well as Green Public Procurement rules for PV modules and inverters, potentially applicable in 33+ countries globally.

The parallel event should provide an overview on these policy developments and give perspectives from the industry, procurement and customer side on proposed policy measures as well as lining out the potential effects these would have on product developments and industrial policy in the European Union.

What will be the effect of potential policy measures in the EU and how can those be streamlined with the international sustainability leadership standard and discussions around the taxonomy for sustainable finance?

Research meets Business – Solar Industry Forum

jointly with ETIP-PV, Becquerel Institute along with the support of SOLARUNITED

Day: **Tuesday, 10 September 2019**
Time: **08:30 - 12:30**
Site: **EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room: **Auditorium 6 *Sormiou*, first floor**
Access: **Open to all Conference participants (on days registered)**

- Dedicated to Global Manufacturing Challenges

Programme Outline

08:30 – 10:00

SESSION 1 – GLOBAL MANUFACTURING CHALLENGES: The state of the PV industry – an ongoing challenged Industry

This session presents the latest developments and challenges of the PV industry in Europe and on the international stage focusing on the declining market prices and the pertinence of the learning curve.

10:00 – 10:20 **Coffee Break**

10:20 – 11:20

SESSION 2 – GLOBAL MANUFACTURING CHALLENGES: Industry 4.0 concepts – how to improve manufacturing? The role of equipment manufacturers in the entire manufacturing value chain.

This session discusses options for improving manufacturing through automatisation and digitalisation of processes: the role of equipment manufacturers and innovations to lower production costs in the coming years.

11:20 – 12:15

SESSION 3 – GLOBAL MANUFACTURING CHALLENGES: Bringing back the industry – the policy debate. From ecodesign to technology tenders, a few paths for PV industry development.

PARALLEL EVENTS

PHOTOVOLTAICS | FORMS | LANDSCAPES
Energy as a Landscape Infrastructure

jointly with ENEA, Becquerel Institute, ETA-Florence and WIP Renewable Energies

Day:	**Tuesday, 10 September 2019**
Time:	**13:30 – 17:00**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 5 *Morgiou*, first floor**
Access:	**Open to all Conference participants (on days registered)**

This is a special event, at its 8th edition, in conjunction with the 36th EU PVSEC, organised by ENEA, Becquerel Institute, ETA-Florence and WIP Renewable Energies. The event highlights how architects, designers, developers, and researchers take up the challenge of letting photovoltaic systems interact with landscapes and buildings. “Energy as a landscape infrastructure” is the challenge for this year’s edition, in Marseille. Architects, developers and researchers wishing to present already completed or ongoing projects, as well as innovative research results and ideas should apply by filling the submission form. A committee of distinguished experts will select the works to be delivered as oral/ visual presentations.

Please, do not hesitate to contact us at info@pv-landscapes.com should you have any queries.

With kind regards and looking forward to an exciting event.

ENEA

BECQUEREL INSTITUTE

etaflorence renewableenergies

WIP RENEWABLE ENERGIES

with the support of

JOINT RESEARCH CENTRE

Research meets Business – Solar Industry Forum

jointly with ETIP-PV, Becquerel Institute along with the support of SOLARUNITED

Day: **Tuesday, 10 September 2019**
Time: **13:30 - 18:30**
Site: **EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room: **Auditorium 6 *Sormiou*, first floor**
Access: **Open to all Conference participants (on days registered)**

- Dedicated to Increasing the Competitiveness

Programme Outline

13:30 - 15:00

SESSION 4 – INCREASING COMPETITIVENESS: innovation and future of cells & modules

Will n-type finally find its way to mass manufacturing, can we expect HJT to surpass n-PERT? What's next for IBC innovations? With p-type PERC dominating the market? How innovations can increase efficiency and lower the costs? Will tandem cells finally meet expectations?

15:15 - 16:00

SESSION 5 – INCREASING COMPETITIVENESS: Quality and efficiency in manufacturing 4.0

16:00 - 16:45

SESSION 6 — CIRCULAR ECONOMY AND SMART ENGINEERING: pushing the industry forward

17:00 - 18:15

SESSION 7 INCREASING COMPETITIVENESS: thin films

Thin films are not dead and production capacities are increasing, allowing some technologies to thrive thanks to low production costs. What about perovskites in manufacturing and OPV?

New Solutions of Energy

CEA-Liten

Day: **Tuesday, 10 September 2019**
Time: **17:45 – 20:30**
Site: **EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room: **Auditorium 5 *Morgiou*, first floor**
Access: **Registration free of charge but mandatory via https://ypl.me/bYt**

This event will be an opportunity to unveil the Liten's strategy, its latest research, and to celebrate the Institute's 15th anniversary. Presentations will be followed by a networking cocktail reception.

Programme Outline

17:45 - 18:00
Welcome

18:00 - 18:15
Liten, Innovation for Energy Transition
Florence LAMBERT, CEO CEA Liten

18:15 - 18:30
Keynote ext
TBD

18:30 - 18:40
PV In Europe - The New Era with SHJ Technology
Anis JOUINI, Head of Solar Technology division at CEA Liten

18:40 - 18:50
Smart Grid for the Integration of Renewable Generation
Franck BOURRY, Head of Intelligent Electrical System Laboratory, Solar Technology division at CEA Liten

18:50 - 19:00
Energy Storage & Sector Coupling
Simon PERRAUD, Deputy Director, Research Funding Programs at CEA Liten

19:00 - 19:10
Circular Economy for Energy Transition
Chrystel DEGUET, Head of New Materials division at CEA Liten

19:10 -19:15
Closing

19:15 - 20:30
Cocktail & Networking

Innovations in Photovoltaic Materials

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 13

Day:	**Wednesday, 11 September 2019**
Time:	**08:30 - 12:30**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 5 *Morgiou*, first floor**
Access:	**Open to all Conference participants (on days registered)**

As a parallel event of the EU PVSEC 2019, the Workshop “Innovations in Photovoltaic Materials” organized by the International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS) Task 13, will present ideas, concepts, and results from a global set of researchers aiming to both reduce cost and improve the performance and reliability of PV modules and systems by using new materials.

Programme Outline

Moderation: Ulrike Jahn, TÜV Rheinland, Germany

08:30 - 08:40
Short Introduction of IEA PVPS of Task 13
Ulrike Jahn, Task 13 Operating Agent

08:40 - 09:00
Functional Requirements of PV Materials
Joshua S. Stein, Sandia National Laboratories, NM, USA

09:00 - 09:20
Light-Weight PV Modules – Approaches and Reliability Aspects
Hartmut Nussbaumer, ZHAW, CHE

09:20 - 09:40
Encapsulant Innovations for Replacement of EVA
Gernot Oreski, Polymer Competence Center Leoben, AUT

09:40 - 10:00
Feedbacks and Discussion

10:00 - 10:30
Coffee and Networking Break

Moderation: Joshua S. Stein, Sandia National Laboratories, NM, USA

10:30 - 10:50
How to Extend PV Modules Service Life beyond 25 Years using Adapted Coextruded PP Backsheets and Encapsulants
Francois Rummens, Renolit, Belgium

10:50 - 11:10
Low-Cost Advanced Metallization to Reduce Cell-Crack-Induced Degradation for Increased Module Reliability
Sang Han, Osazda Energy, Albuquerque, NM USA

11:10 - 11:30
Reliability Aspects of New Cell Interconnection Technologies
Andreas Halm, ISC Konstanz, DEU

11:30 - 12:15
Panel discussion
Task 13 speakers and invited experts (tbc):
Michael Woodhouse, NREL, USA

12:15 - 12:30
Wrap-up & Closing session
Gernot Oreski, Polymer Competence Center Leoben, AUT

12:30
End of Workshop

Research meets Business – Solar Mobility Forum

jointly with ETIP-PV, Becquerel Institute along with the support of SOLARUNITED

Day: **Wednesday, 11 September 2019**
Time: **08:30 - 12:30**
Site: **EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room: **Auditorium 6 *Sormiou*, first floor**
Access: **Open to all Conference participants (on days registered)**

Dedicated to

- E-Mobility through Solar Energy
- PV for transports
- Solar fuels for transports

Programme Outline

08:30 – 10:00

SESSION 1 – E-mobility through solar energy: a step towards the energy revolution

The energy revolution cannot exist without solar and electric mobility. How do they complement each other, what could be the connection between two sectors so different? From integrated actors acting in both fields to newcomers, the debate is open whether PV will drive the EV development or the other way around. Time for vehicles-to-grid!

10:00 – 10:20 **Coffee Break**

10:20 – 11:20

SESSION 2 – PV for transports

Using PV in transport vehicles implies new constraints and new opportunities. How can we integrate PV and how far PV-driven cars could go? Are we ready for PV-powered vehicles? Is this the beginning of a new era for PV and EV development?

11:20 – 12:15

SESSION 3 – Solar fuels for transports

With PV electricity costs reaching record-low levels in several places in the world, the production of solar fuels from PV – hydrogen, renewable gas and ammonia – becomes a tangible reality which could change the face of the energy world. With hydrogen as an alternative to battery EVs, the road may be bright for solar powering the future of transports.

Probabilistic PV Production Forecasts: Technics and Use-Cases

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 16

Day:	**Wednesday, 11 September 2019**
Time:	**13:30 - 15:00**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 5 *Morgiou*, first floor**
Access:	**Open to all registered participants of the EU PVSEC 2019**

The workshop will give an introduction into probabilistic forecasts for solar energy, shows some examples of existing forecasts and how to implement them.

The EU Support Instruments – Unlocking Developing Markets

jointly with SolarPower Europe and GET.invest

Day:	**Wednesday, 11 September 2019**
Time:	**16:00 - 18:30**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 5 *Morgiou*, first floor**
Access:	**Open to all registered participants of the EU PVSEC 2019**

GET.invest, in partnership with SolarPower Europe, is organising a workshop at the EU PVSEC 2019 conference in Marseille. The event will inform participants about the financing and technical assistance instruments available through the EU External Investment Plan (EIP) to investors and entrepreneurs active in the clean energy markets of Africa and the EU Neighbourhood region. It will feature presentations, panel discussions and a Q&A session about the various pillars of the EIP, including the European Fund for Sustainable Development, various existing investment facilities and guarantee schemes, such as ElectriFI and Africa GreenCo, as well as technical assistance instruments such as GET.invest.

The EU's ambitious EIP encourages investment in partner countries in Africa and the EU Neighbourhood region. Its objective is to leverage €44billion worth of investments with an input of €4.5billion in the form of grants and guarantees.

After the event, the speakers and participants are invited to get to know each other at a networking reception.

Programme Outline

16:00 - 16:15
Welcome
DG DEVCO, European Commission
SolarPower Europe

16:15 - 16:30
Overview of the EU External Investment Plan's guarantees for sustainable energy investments
Representative of DG DEVCO, European Commission

16:30 - 16:15
Presentation of GET.invest
Representative of GET.invest

16:45 - 17:00
Presentation of ElectriFI
Representative of ElectriFI

17:00 - 17:15
Presentation of the European Guarantee for Renewable Energy (EGRE)
Representative of DG DEVCO, European Commission

17:15 - 17:30
Presentation of the solar industry on industry initiatives and the needs of the industry
Representative of SolarPower Europe

17:30 - 18:15
Moderated panel discussion with various stakeholders

- DG DEVCO, European Commission
- GET.invest
- SolarPower Europe
- Representatives from partner countries in the African, Caribbean,
- Pacific region
- Moderator (SolarPower Europe Secretariat)

18:15 - 18:25
Q&A with the audience

18:25 - 18:30
Conclusions
Moderator

18:30 - 19:15
Networking reception

BIPV – Moving into the Next Phase

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 15, ETIP PV, WIP Renewable Energies, Zuyd University and Helmholtz-Zentrum Berlin

Day:	**Thursday, 12 September 2019**
Time:	**08:30 - 12:30**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 6 *Sormiou*, first floor**
Access:	**Open to all Conference participants (on days registered)**

In 2015, the IEA PVPS Task 15 collaboration started, focusing on the creation of an enabling framework for the acceleration of BIPV. Together with a number of other international research activities this has contributed to the international uptake of BIPV. In 2019, the first phase of IEA PVPS Task 15 will come to an end and a second phase is in development.

In 2014, ETIP PV started with a working group on BIPV, which was extended in 2018 to include all forms of integrated PV. With its activities, the Working Group IPV pushes the agreed target of the EU´s SET-Plan - Declaration on Strategic Targets in the context of an Initiative for Global Leadership in Photovoltaics (PV). This includes enabling mass realisation of “(near) Zero Energy Buildings” by Building-Integrated PV (BIPV) through the establishment of structural collaborative innovation efforts between the PV sector and key sectors from the building industry.

This session showcases some results of the international collaboration in the field of BIPV that was initiated by ETIP PV and IEA PVPS Task15. It will also discuss how national and international collaborations can help BIPV to move into its next phase of development.

Programme Outline

SESSION I: Results of five years of international collaboration
Chair: Zeger Vroon, Zuyd UAS, IEA PVPS Task 15

8:30
Opening Session I
Zeger Vroon, Zuyd UAS

8:40
BIPV case studies from an architectural perspective
Tjerk Reijenga, BEAR

9:00
Research and Development of BIPV in an international context
Simon Boddaert, CSTB, France

9:20
Regulatory aspects of BIPV
Francesco Frontini SUPSi/ Nuria Martin Ciemat

9:40
Solar Skins, an opportunity for greener cities (joint study by ETIP PV/SolarPower Europe)
Aurelie Beauvais, SolarPower Europe

SESSION II: Entering the next phase of BIPV
Chair: Rutger Schlatmann, PVcomB, Helmholtz Zentrum Berlin, WG Leader of Integrated PV of ETIP PV

10:15
Opening Session II
Rutger Schlatmann, PVcomB, WG Leader of Integrated PV of ETIP PV

10:25
Using the potential of Photovolaics in Cities
Francisco Goncalves, energycities (tbc)

10:45
The BIPV business model canvas
Jessica Benson, RISE, Sweden

11:05
National consultancy office for Building Integrated Photovoltaics - independent advice on a local level
Björn Rau, Helmholtz Zentrum Berlin (tbc)

11:25
BIPV success stories! – Results of R&D collaboration on European level
Eduardo Roman, Tecnalia

11:45
IEA PVPS Task 15 phase 2 – the next step in international collaboration
Johannes Eisenlohr, Fraunhofer ISE, Germany

12:05
Moderated Discussion
by Rutger Schlatmann

Standardization of the Protocols for Emerging PV Technologies

Worldwide actions from material research community, companies and reference testing labs to the new measurement guidelines deployment

jointly with the EC Joint Research Centre

Day: **Thursday, 12 September 2019**
Time: **10:10 - 12:10**
Site: **EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room: **Auditorium 5 *Morgiou*, first floor**
Access: **Open to all Conference participants (on days registered)**

Parallel event during the 36th EU PVSEC possibly on Thursday 12th initiated by EC Joint Research Centre. The purpose of this event will be to introduce the most relevant works done in the development of measurement guidelines for a reliable characterization of emerging PV technologies, with a strong focus on how material research labs, testing labs and industrial project partners can benefit from a common approach. The workshop will highlight how existing IEC standards can be applied to innovative PV devices and what are the most critical issues not covered by the current version.

Programme Outline

10:10
Chair welcome
Speaker: TBD

10:15
New IEC TR 63228: Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials
Speaker: Giorgio Bardizza (EC - JRC), Chris Fell (CSIRO), Toshiro Matsuyama

10:30
Materials research lab perspective: methods used in materials research labs
Speaker: Antonio Abate (Helmholtz-Zentrum Berlin)

10:45
Industrial perspective 1: protocols used in companies, critical issues observed and proposed solutions
Speaker: David Bushnell (OxfordPV)

11:00
Industrial perspective 2: protocols used in companies, critical issues observed and proposed solutions
Speaker: TBD

11:15
Reference testing lab perspective: protocols used in reference testing labs
Speakers: Yoshihiro Hishikawa and Masahiro Yoshita (AIST)

11:30
Panel discussion
Moderator: TBD

12:05
Concluding remarks
Speaker: TBD

12:10
End of event

Advanced PV Energy Rating for Emerging Technologies

jointly with LNE in the framework of the PV-ENERATE project supported by the EURAMET EMPIR program

Day:	**Thursday, 12 September 2019**
Time:	**15:15 - 18:30**
Site:	**EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France**
Room:	**Auditorium 5 *Morgiou*, first floor**
Access:	**Open to all Conference participants (on days registered)**

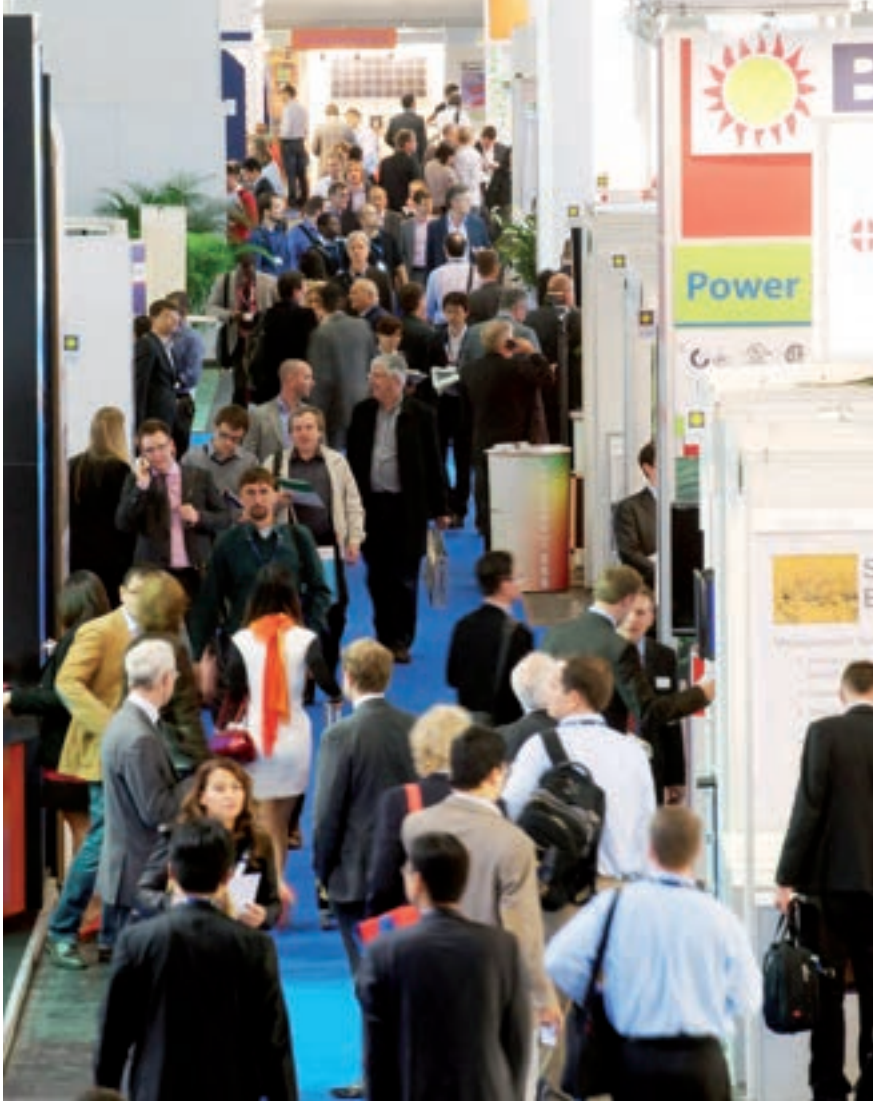
The IEC 61853 standard series provides a framework for the energy rating of traditionally mounted classical PV modules. Today stakeholders have identified a need to extend the energy rating to emerging technologies (bifacial) or applications (BIPV). This implies the implementation of the metrological infrastructure and techniques to improve the measurement equipment and methodologies, to enable precise measurements of the parameters required.

This workshop is a parallel event of the EU PVSEC conference and is organized in the framework of the PV-ENERATE project supported by the EURAMET EMPIR program.

Participants to the event are invited to present their work on the following subjects (this list is not exhaustive):

- Improvement in the energy rating evaluation
- Development of traceable measurement methods
- Definition of testing conditions for the measurement of power and short-circuit current
- Evaluation of the measurement uncertainty including the spectral mismatch correction taking into account the correlation of the spectral data

NOTES



EXHIBITION

For more information please visit
www.photovoltaic-conference.com/programme/exhibition

List of Exhibitors · alphabetical

Abet Technologies, Inc. F2

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web: www.abet-technologies.com

Abet Technologies manufacturers a broad range of standard and custom PV-IV and IPCE and IQE measurement systems for solar cells up 300 x 300 mm, ASTM and IEC compliant steady state solar simulators, test stations from simple manual load to temperature stabilized vacuum chuck models, standards compliant software, calibrated reference cells, and a range of electronic loads for low and high current cells.

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Atotech is a global leader in surface-finishing solutions. Through our comprehensive systems-and-solutions approach, we deliver chemistry, equipment and service to support diverse markets such as consumer electronics, global automotive industries, photovoltaic and many other end-markets. Atotech is a team of 3,800 experts in over 40 countries generating annual revenue of $1.2 billion. We are headquartered in Berlin, Germany, and have manufacturing operations across Europe, the Americas and Asia.

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Bentham are UK-based, market leaders in the design and manufacture of high-performance monochromator-based light measurement solutions, spanning applications in the optical characterisation of sources, detectors, materials and in-vivo diagnostics.

We will showcase our PVE300 EQE tool, utilised by research and industry worldwide in the measurement of spectral response, reflectance and transmission of all types of PV devices and architectures.

CNRS - Centre National de la Recherche Scientifique F6

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The French National Centre for Scientific Research (CNRS) is among the world's leading research institutions. More than 30000 researchers and engineers are generating new knowledges and technologies in all disciplines of science, ranging from mathematics to engineering. CNRS is strongly involved in the field of Energy, with an emphasis on Renewable energies. About 700 researchers are dealing daily with solar energy. Several of the research activities are conducted in collaboration with industry.

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CSEM is a private, non-profit Swiss research and technology organization focused on generating value for a sustainable world. It is host of the Swiss CSEM PV-center.

The PV-center is an industry driven, application-oriented program created to foster innovation and accelerate the pace of technology transfer in the field of pv. Our mission is to bring new high-tech solutions for solar components and systems to technological maturity, and to serve the Swiss and global renewable energy industry.

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ECM Greentech proposes innovative technologies and turnkey solutions for the PV industry. ECM Greentech is specialized in the design, manufacturing and commercialization of industrial furnaces for crystal growth, solar cells manufacturing and the engineering of factories producing solar and energy storage systems.

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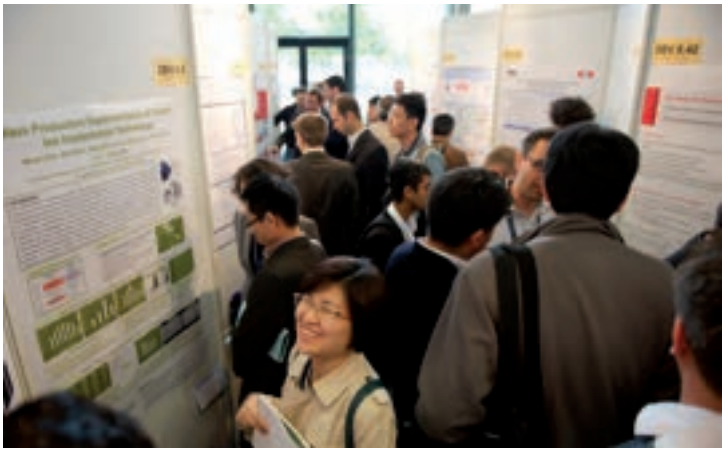
Engineered Materials Systems, Inc., a subsidiary of Nagase Co., Ltd. is a technology focused company specializing in manufacturing electronic materials for the Photovoltaic, Semiconductor, and Microelectronic Assembly markets. The EMS photovoltaics business is focused on formulating Electrically Conductive Adhesives for the interconnection of solar modules.



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With 25 years of experience, ETA Florence is also European leader in knowledge management and established an interdisciplinary international team with diverse professional backgrounds from scientific research, strategic consultancy, communications, graphics, event organisation. These specialists ensure that the knowledge resulting is used effectively for the innovation cycle. ETA Florence collaborates with more than hundred institutions in over 30 countries to design projects with beneficial effects, using the team's collective expertise, to facilitate knowledge transfer and provide dissemination plans that are specifically tailored to European Commission co-funded project. We have been partner in more than 300 EC-funded projects.

Our Expertise: Market Analysis, Knowledge Management and Transfer, Stakeholder Engagement, Education and Training, Events, Workshops, Webinar, Social Media, Dissemination Material, Publications, Communication, Dissemination and Strategies, Project Management and IPR issues related to the Management of the Consortium.

EUREC D3

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EUREC is the voice of renewable energy research in Europe, representing European Research Centres active in renewable energy. Our members are prominent research and development (R&D) groups spread across Europe, operating in all renewable energy technologies. Our members also conduct research into supporting technologies such as energy efficiency, storage, distribution and integration, and undertake studies to evaluate the social and economic aspects surrounding renewable energy.

European Commission JRC B4

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e-mail: jrc-esti-services@ec.europa.eu
web: https://ec.europa.eu/jrc/en/research-facility/european-solar-test-installation

The Joint Research Centre (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. As part of its activities the JRC operates the European Solar Test Installation (ESTI) for assessing PV device performance at its site in Ispra, Italy. It's online tool PV-GIS provides free data on solar energy resource and potential PV electricity output for Europe and beyond.

exateq GmbH A5

Alois-Senefelder-Str. 6
92318 Neumarkt
Germany

phone: +49-9181 4636 422
e-mail: info@exateq.de
web: www.exateq.de

More than 20 years in designing and manufacturing of batch wet processing equipment relaunched 2015 as exateq GmbH. 4 platforms of batch wet benches developed since then, manual for labs, fully automatic pilot/lab systems, mass production of 12,000 w/h, proven in the field for several years. Equipment competency up to IBC cells. Production equipment operating in various Asia. History in carriers and automation. Genuine German engineering trained by Asian market requirements.

FME (Dutch PV Sector) F7

P.O. Box 190
2700 AD Zoetermeer / Zuid-Holland
The Netherlands

phone: +31-79 353 13 90
e-mail: info@cleantechholland.com
web: www.fme.nl

Cleantech Holland wishes to make a valuable contribution towards the achievement of the national, European and international climate objectives. It will do so by promoting the products and services of Dutch clean technology companies on the international markets. Cleantech Holland is an export organization and platform for Dutch clean tech businesses, universities, governments, and nonprofit organizations.

Our aim is to promote the use of Dutch products, services, systems and innovations in the following fields; 1.Renewable Energy, 2.Energy Infrastructure, 3.Energy Efficiency, 4.Energy Storage

The world is our market and we actively promote our solutions worldwide. We are committed to advancing sustainable solutions for benefit of the economy and the environment.

Fraunhofer Institute for Solar Energy Systems ISE F5

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79110 Freiburg
Germany

phone: +49-761 4588 0
e-mail: info@ise.fraunhofer.de
web: www.ise.fraunhofer.de

With a staff of 1200 the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, Germany, is the largest solar energy research institute in Europe. Fraunhofer ISE is committed to promoting sustainable, economic, safe and socially just energy supply systems based on renewable energies. Its research provides the technological foundations for supplying energy efficiently and on an environmentally sound basis in industrialized, threshold and developing countries throughout the world.

Welcome Reception

Monday 09 September 2019
18:30 - 20:00
Exhibition Area
First Floor

G2V Optics Inc. E4

6801 104 St NW
Edmonton, AB T6H 2L5
Canada

phone: +1-877 428 0428
e-mail: info@g2voptics.com
web: www.g2voptics.com

G2V Optics was founded to apply innovative technology and data-driven, collaborative design toward solutions for this generation's global issues. Starting with the highest precision spectral replication ever produced, G2V now provides a suite of advanced lighting. Our continuous, software-controlled, adjustable-spectra LED solar simulators enable researchers to unlock the potential of tomorrow's solar-powered devices. When spectral precision matters for your research, let G2V Engineer the Sun™.

GenSun A6

1025, rue Henri Bequerel -
No. 11 Parc Club du Millénaire
34000 Montpellier
France

phone: +33-4 67 58 76 01
e-mail: info@gensun.fr
web: www.gensun.fr

GenSun is a French EPC created in 2007 which helps Independent Power Producer in the design, construction, operation and maintenance of medium and large-scale solar power plants (free fields, rooftops and carports) in France and abroad.

GGEIC - Global Green Energy Industry Council G4

Rond Point Schuman 6 c/o EUBIA,
1040 Brussels
Belgium

e-mail: sinuo.sun@etaflorence.it

Global Green Energy Industry Council (GGEIC) is a global platform launched at COP24, aiming to serve as an information sharing and networking hub of green energy, with a mission to promote and advance the role of green energy industries in the world. GGEIC is initated and co-founded by Asian Photovoltaic Industry Association (APVIA), European Biomass Industry Association (EUBIA) and New Energy Industry Association Asia Pacific (NEIAAP) and supported by other international associations.

GIORDANO Industries C4

529, avenue de la Fleuride, Z.I. des Paluds
13685 Aubagne
France

phone: +33-442 845 800
e-mail: jean-francois.petit@giordano.fr
web: www.giordano.fr

French manufacturer since 1971 of renewable energy systems including SOLAR PUMP: brine to water heat pumps using unglazed solar thermal collector as energy source for hot sanitary water, space heating & cooling, swimming pool heating for domestic and collective new or existing projects.

It covers 100 % of needs (+ distribution losses) without back up. Divides energy bill by 3 or +, 0 db on roof, 0 CO2, 0 over heating risks. Standards PV panels can be added to hybrid collectors: COP +28%!

h.a.l.m. elektronik B1

Friesstr. 20
60338 Frankfurt am Main
Germany

phone: +49-69 94 33 53-0
e-mail: info@halm.de
web: www.halm.de

h.a.l.m. elektronik GmbH develops and delivers high-end measuring systems for photovoltaic technologies world-wide. Founded in Germany in 1984, h.a.l.m. has focused its experience and passion for the last 14 years to the measurement of electrical characteristics of photovoltaic cells and modules by providing state of the art equipment. h.a.l.m.'s position as market and technological leader shows its commitment to the Photovoltaic industry.

H2020 Projects for the Future of PV in EU F1

Wilhelm-Johnen-Str.
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phone: +49 2461 61-1604
e-mail: k.ding@fz-juelich.de
web: http://nextbase-project.eu

Co-funded by the Horizon 2020 Framework Programme of the European Union

NEXTBASE
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NextBase - Next-generation interdigitated back-contacted silicon heterojunction solar cells and modules by design and process innovations

DISC - Double side contacted cells with innovative carrier-selective contacts

AMPERE - Automated photovoltaic cell and Module industrial Production to regain and secure European Renewable Energy Market

IEA PVPS (International Energy Agency Photovoltaic Power Systems Programme) D3

c/o NET Ltd.
Waldweg 8
CH-1717 St. Ursen
Switzerland

phone: +41-26 494 00 30
e-mail: mary.brunisholz@netenergy.ch
web: www.iea-pvps.org

INTERNATIONAL ENERGY AGENCY PHOTOVOLTAIC POWER SYSTEMS PROGRAMME (IEA PVPS)

- Global cooperation towards sustainable development.
- 32 members: 27 countries, EC, SolarPower Europe, Copper Alliance, SEPA & SEIA.
- Activities are carried out collaboratively on a country basis along a number of technical and non-technical subjects related to photovoltaics.
- Currently, 8 projects (Tasks) are active.

INES-CEA Liten F4, G2

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web: www.ines-solaire.org / www.liten.cea.fr

CEA-Liten and its Department of Solar Energy INES represent a major European research institute and a driving force behind the development of the sustainable energy technologies of the future. The institute is spearheading the efforts of all those working in Europe to limit dependency on fossil fuels and reduce greenhouse gas emissions in key areas: solar energy, hydrogen, energy storage and energy efficiency for buildings, industry, energy networks and transport.

InnoLas Solutions GmbH E1

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e-mail: info@innolas-solutions.com
web: www.innolas-solutions.de

InnoLas Solutions is part of the photonic systems group and designs and produces highly reliable laser systems for micro material processing for the use in the photovoltaic, electronics, semiconductor and precision engineering industries.

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Institut Photovoltaïque d'Ile de France F4, G2

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e-mail: contact@ipvf.fr
web: www.ipvf.fr

The Institut Photovoltaïque d'Ile-de-France (IPVF) is a global collaborative research platform, specialized in solar PV technologies. IPVF brings together internationally recognized industrial leaders (EDF, Total, Air liquide), academic research teams (CNRS, Ecole polytechnique), equipment manufacturers (Horiba, Riber) and aims at becoming a world leading center for research, innovation & training in the solar PV arena.

Ion Beam Services F4, G2

Z.I. Peynier-Rousset
Rue Gaston Imbert prolongée
13790 Peynier
France

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e-mail: ibsco@ion-beam-services.fr
web: www.ion-beam-services.com

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IBS has developed a unique and powerful Plasma Immersion Ion Implanter (PIII), PULSION®. Used in INES, PULSION Solar is a low cost, high throughput tool for applications such as Phoshphorus, Boron implant for P-type AI-BSF & PERC cells, N-PERT and Bifacial cells with a simplified process and implantation of the Poly-Si layer in TOPCON or IBPC structures.

Ivy Battery Tech Ltd E10

Caicheng Industrial Park Xingye Bvld
Shangrao, Jiangxi
China

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e-mail: millson@ivybattery.com
web: www.ivybattery.com

For more than 30 years, IBS has assembled the expertise, tools and skills required to meet the diverse ion implantation needs of global clients.

IvyBattery was funded by wealthy knowledge in battery, energy storage and smart control. We have developed a fully integrated energy storage solution for optimizing energy utilization and maximizing energy savings. Our solution range includes long duration batteries, efficiency hybrid systems and cloud data applications.

Jonas & Redmann Group GmbH E1

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The basis for the profitable production of crystalline silicon solar technology is the stringent control of production costs while simultaneously achieving and maintaining a high level of efficiency. This is only feasible with innovative engineering. Since the year 2000, we have been accompanying our customers from the photovoltaic industry and providing them with highly innovative automation, metallization and laser process technology.

Newport Spectra-Physics E7

Guerickeweg 7
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MKS Instruments, Inc. is a global leader in vacuum and control solutions and a provider of technologies that enable advanced processes and improve productivity. With the acquisition of Newport Corporation, MKS added leading capabilities in sophisticated light and motion solutions for highly demanding applications to its portfolio. The Light & Motion Division of MKS features Newport, Spectra-Physics and Ophir – three of the most respected brands in the photonics industry.

PHOTOWATT F4, G2

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The DERBI competitivity cluster, dedicated to energy transition, carries out its activities in the southern French Occitanie / Pyrénées Méditerranée region. Its missions: > To develop innovation, research, training, the transfer of technologies, development, and the creation of businesses at regional, national, and international level.Today, the DERBI competitiveness cluster counts 170 members: companies, research centers, laboratories, universities, professional associations, ...

pv magazine group C2

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Since the publication of its first magazine in 2008, pv magazine has evolved into the top international publication for solar decision makers and is now leading the global solar media market.

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web: www.semilab.hu

Semilab is leading supplier of metrology equipment for solar industry. We design, produce and sell metrology equipment for the characterization of semiconductor and photovoltaic materials, for monitoring the manufacturing process of semiconductor devices, flat panel displays and solar cells, and also for R&D purposes in these areas.

SINGULUS TECHNOLOGIES D2

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USA

phone: +1-303 945 2113
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Sinton Instruments provides state-of-the-art test and measurement instruments for use in Silicon PV manufacturing and R&D for each stage of the solar cell production process from bricks and ingots through module test. We have revolutionized industrial cell and module testing by incorporating patented methodology and analysis techniques to provide unprecedented accuracy and process-control information.

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Slovakia

phone: +421-2 4319 1708
e-mail: contact@solargis.com
web: www.solargis.com

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SolarSwissConnect E6

c/o FSRM
Ruelle Du Peyrou 4
Case postale 2353
2001 Neuchatel
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phone: +41-32 720 09 00
e-mail: info@solarswissconnect.ch
web: www.solarswissconnect.ch

SolarSwissConnect is the Switzerland association of equipment manufacturers, products manufacturers and scientific & testing institutes of photovoltaic field.

SOLARUNITED E1

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phone: +49-618 198 280 42
e-mail: ekus@ipvea.com
web: www.solar-united.org

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Tenerrdis is based in Grenoble, in the Auvergne-Rhône-Alpes region. It has been awarded by a Gold Cluster Management Excellence certification.

University of Ljubljana, LPVO C5

Trzaska cesta 25
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Slovenia

phone: +386 1 4768 470
e-mail: Marko.Topic@fe.uni-lj.si
web: http://slo-pv.fe.uni-lj.si/

The University of Ljubljana is the largest and the oldest in Slovenia. The Laboratory of Photovoltaics and Optoelectronics (LPVO) within its Faculty of Electrical Engineering is central R&D&I group for photovoltaics in Slovenia. In the fields of photovoltaics, optoelectronics and electronics we offer:

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VON ARDENNE GmbH E5

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WCRE - World Council for Renewable Energy G3

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WIP is a renewable energy consultancy with a long history of managing research and innovation projects and organizing leading conferences and events in the sector.

The current energy infrastructure worldwide must be transformed with the objective to reduce fossil energy related conflicts, mitigate climate change, and avoid other negative impacts of nuclear and fossil energy systems.

Our mission is to contribute to this goal by facilitating research, innovation and market integration of renewable energy systems through collaborative efforts across all sectors of society.

WIP Renewable Energies has over 37 years of experience in leading international collaborative projects aiming to bring innovative renewable energy technologies and services closer to the market.

WIP Renewable Energies has over 30 years of experience in event organization. This includes the conception, pre-financing, preparation, organisation and management of high level and large-scale international scientific conferences, workshops, seminars in the field of Renewable Energies.

Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW) A1

Meitnerstr. 1
70563 Stuttgart
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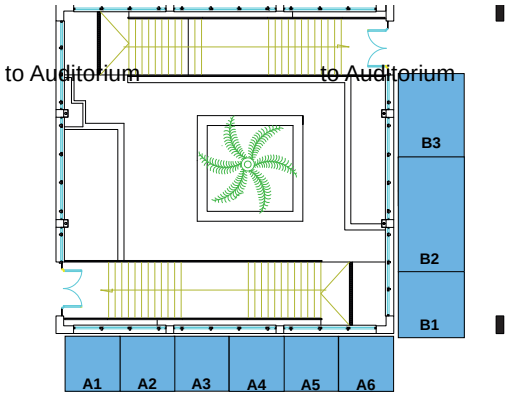
e-mail: info@zsw-bw.de
web: www.zsw-bw.de

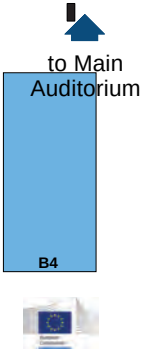
The ZSW is one of the leading institutes for applied research in the field of photovoltaics, renewable fuels, battery technology, fuel cells and energy systems analysis with 260 employees at its locations in Stuttgart and Ulm, a solar testing facility at Widderstall, Germany, and a wind power field test site in complex mountainous terrain near Geislingen/Steige.

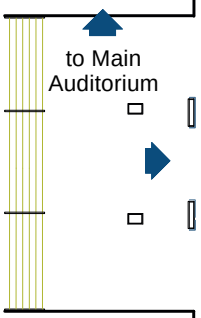
Exhibition Layout with Exhibitors by stand number

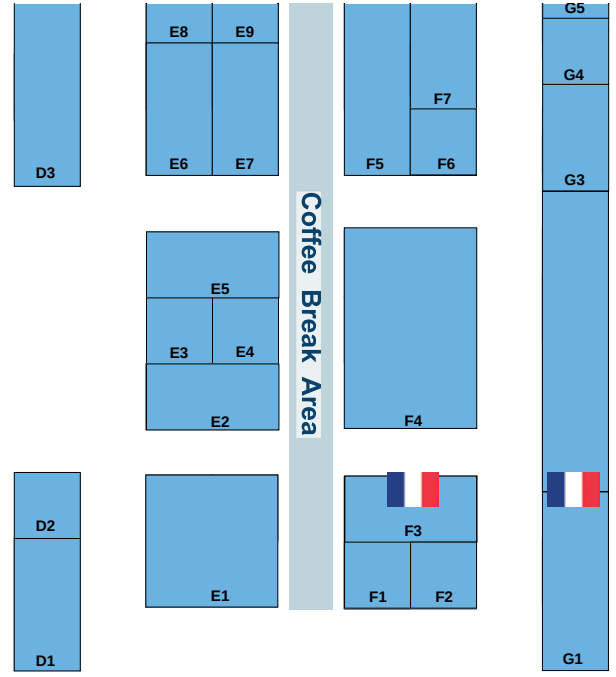
Exhibition Area

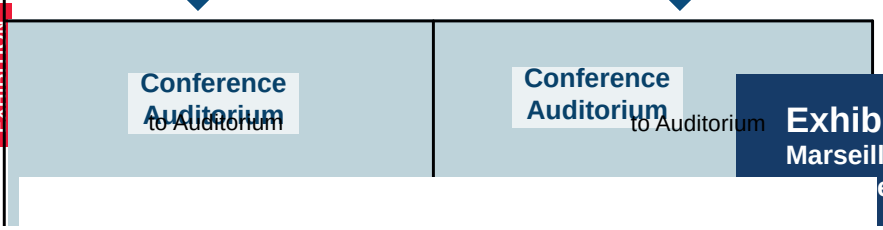
Reception Hall & Les Goudes Room









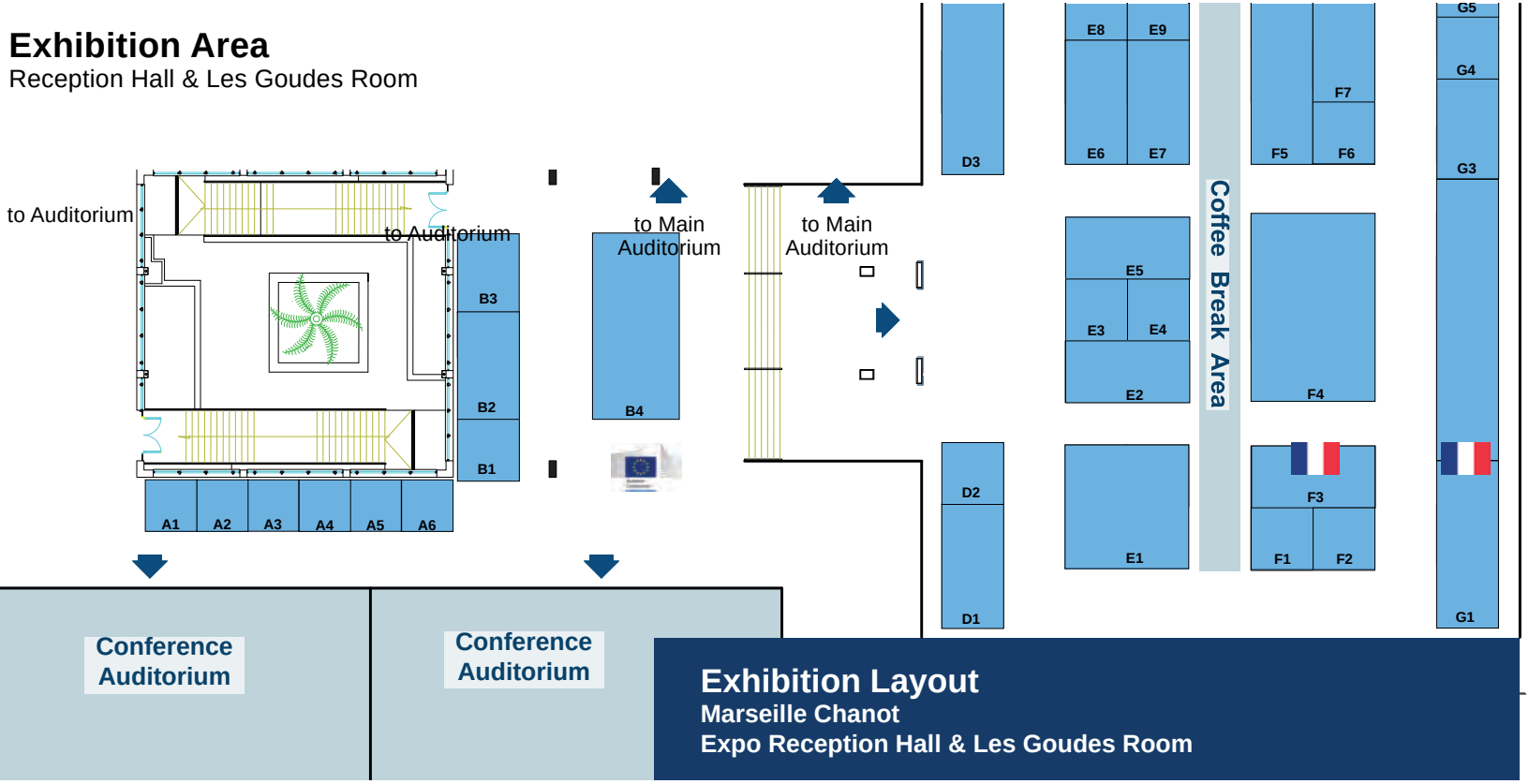


Exhibition Layout
Marseille Chanot
eception Hall & Les Goudes Room

List of Exhibitors, alphabetical

Exhibition Area

Reception Hall & Les Goudes Room



Exhibition Layout

Marseille Chanot

Expo Reception Hall & Les Goudes Room

List of Exhibitors, alphabetical

A1 ZSW Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg

A2 Engineered Materials Systems, Inc.

A5 exateq GmbH

A6 GenSun

B1 h.a.l.m. elektronik

B3 Bentham Instruments Ltd.

B4 European Commission JRC

C1 Solargis s.r.o.

C2 pv magazine group GmbH & Co.KG

C3 Tempress Systems BV

C4 GIORDANO Industries

C5 University of Ljubljana, Faculty of Electrical Engineering

D2 SINGULUS TECHNOLOGIES

D3 EUREC

D3 IEA PVPS International Energy Agency Photovoltaic Power Systems Programme

D3 WIP Renewable Energies

E1 InnoLas Solutions GmbH

E1 Jonas & Redmann Group GmbH

E1 SOLARUNITED

E10 Ivy Battery Tech Ltd

E11 Semilab Co. Ltd.

E2 RENA Technologies GmbH

E3 Atotech Deutschland GmbH

E4 G2V Optics Inc.

E5 VON ARDENNE GmbH

E6 CSEM SA

E6 SolarSwissConnect

E7 Newport Spectra-Physics

E8 Wiley

E9 SOLARC Innovative Solarprodukte GmbH

F1 H2020 Projects (NextBase, DISC, AMPERE)

F2 Abet Technologies, Inc.

F3 Sinton Instruments

F4, G2 ECM Greentech

F4, G2 INES - CEA LITEN

F4, G2 Institut Photovoltaïque d'Ile de France

F4, G2 Ion Beam Services

F4, G2 PHOTOWATT

F4, G2 Pôle de Compétitivité DERBI

F4, G2 SOLEAN

F4, G2 Tenerrdis

F5 Fraunhofer Institute for Solar Energy Systems ISE

F6 CNRS - Centre National de la Recherche Scientifique

F7 FME (Dutch PV Sector)

G3 ETA - Florence Renewable Energies

G3 WCRE - World Council for Renewable Energy

G4 GGEIC - Global Green Energy Industry Council

NOTES

GENERAL INFORMATION

For more information please refer to
www.photovoltaic-conference.com/participation

VENUE OF EU PVSEC 2019

Marseille Chanot Convention and Exhibition Centre
114 Rond-Point du Prado
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EU PVSEC Conference

Upon arrival at Marseille Chanot Convention and Exhibition Centre, Conference participants should proceed to the Conference Registration Desk at the Registration Area, 1st floor to check in and pick up their badge.

Opening hours of the Conference Registration Desk:

Sun	08 Sept 2019	16:00 – 18:00
Mon	09 Sept 2019	07:30 – 19:00
Tue – Thu	10 - 12 Sept 2019	08:00 – 19:00
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Tue – Wed	10 - 11 Sept 2019	09:00 – 18:00
Thu	12 Sept 2019	09:00 – 16:00

EU PVSEC Parallel Events

All EU PVSEC 2019 Parallel Events are open to Conference Delegates on day/s registered.

For further information about the EU PVSEC Parallel Events see page 240.

Find here a general overview of the EU PVSEC 2019 ticketing categories and registration benefits:

EU PVSEC 2019 Registration Benefits

Registration Category	Conference	Exhibition	Parallel Events	Information Material	Proceedings	EU PVSEC Dinner	Networking Lunch	Welcome Reception
Full Conference Week	✓	✓	✓	✓	✓			✓
One Day Admission *	✓*	✓	✓*	✓	✓			✓
Two Days Admission *	✓*	✓	✓*	✓	✓			✓
Students	✓	✓	✓	✓	✓			✓
Networking Lunch (from Mon - Thu)							✓	
EU PVSEC Dinner (Wednesday)						✓		
Exhibition Visitors		✓						

* on registered day/s only

CONFERENCE PROCEEDINGS

The EU PVSEC 2019 Proceedings contain all scientific papers presented at the EU PVSEC 2019 and submitted for publication.

They constitute a comprehensive source of state-of-the-art information and vital point of reference for researchers, technologists, decision-makers, entrepreneurs and all involved in the global PV sector.

The EU PVSEC 2019 Proceedings include full presented papers, slides presentations and poster presentations (if available).

A digital identifier (DOI code) has been assigned to each paper to ensure unequivocal and permanent identification and citation capability of the online publication. This identification system is administered by the German National Library of Science and Technology.

Conference participants will have immediate and free access to the EU PVSEC 2019 Proceedings right after publication. All EU PVSEC Proceedings are published under a full free access policy and are searchable online (and citable online). This underlines our commitment to prioritising quick and open access to high quality scientific results and allows the entire PV community to easily access this comprehensive database for PV research and technology, renowned for the high standard of its scientific contributions.

The EU PVSEC Proceedings are available on *www.eupvsec-proceedings.com*.

Authors are requested to submit their manuscript for publication in the Conference Proceedings (see page 334).

COOPERATION WITH 'PROGRESS IN PHOTOVOLTAICS'

In 2019, *Progress in Photovoltaics* once again proudly partners with the EU PVSEC. Through the partnership, selected research papers from the event will be peer reviewed and published on the website and in a digital special issue in *Progress in Photovoltaics*, the high impact, international journal for the latest research in photovoltaic technology in adition to the EU PVSEC 2019 Conference Proceedings.

PRIZES & AWARDS

European Becquerel Prize for Outstanding Merits in Photovoltaics

The European Becquerel Prize for Outstanding Merits in Photovoltaics will be awarded during the Conference. This prize was established by the European Commission in 1989 to mark the 150th anniversary of Alexandre-Edmond Becquerel's discovery of the photovoltaic effect in 1839, which laid the foundation of both, photovoltaics and photography. The Becquerel Prize will be awarded on Monday, 09 September 2019 during the Opening Ceremony in Auditorium 1.

The Becquerel Prize 2019 is awarded to

Dr. Pierre Verlinden

Consultant, Non-Executive Director to PV companies, Visiting Professor at Sun Yat-sen University (Guangzhou).

He receives the award in honour of his scientific and technological merits in the development of high-efficiency photovoltaics. The decision of the Becquerel Committee is based on the outstanding work of Dr. Verlinden on the design of high-efficiency solar cells, modules and systems including back contact and rear side passivated silicon solar cells.

Throughout his career, Dr. Verlinden has pioneered the development of advanced solar cell structures, not limiting his work to just scientific progress but focusing on feasible implementation for industrial mass production. This combination of deep scientific understanding and his contributions to the global PV industry makes his work unique for the progress of photovoltaics over the last 40 years. He has been very active in the global photovoltaic scientific community, serving on numerous scientific boards. Committed to education and teaching for decades, Dr. Verlinden has passed on his great passion and deep knowledge of photovoltaics to generations of young scientists as well as manufacturing engineers.

Award Ceremony
The prize will be awarded at the Opening of this years' European Photovoltaic Solar Energy Conference and Exhibition, on Monday morning, 09 September 2019.

Awards for Outstanding Visual Presentations

This award is one of the highlights of the Closing Session: The most outstanding Visual Presentations of each session will be awarded.

A jury of experts judges the quality of the contents reported and the quality of the presentation.

New this year!: Aiming to increase the visibility of poster awards winners and as a recognition to the quality of their presentation, the winners will have the opportunity to perform a 5 minutes presentation to the poster area audience during the closing visual session on Thursday 12 September from 17:00 to 18:30. Winning posters will be moved to the "winners wall" in the poster area and it is there where the presentations will take place.

Same as in previous years, the awards will be delivered as part of the Conference Closing on Friday, 13 September 2019. The winners will be invited on stage and the winning posters will be projected in the Auditorium.

EU PVSEC 2019 Student Awards

Following the success of previous years, to encourage high-quality work among young researchers and to engage themselves in the scientific examination of the multifaceted issues and questions in the photovoltaic sector, the EU PVSEC Student Awards will be delivered in recognition of the most remarkable and outstanding research work in the field of PV on the occasion of the EU PVSEC 2019. The award is meant to honour students with extraordinary achievements in their scientific activities.

Among the applications received, the EU PVSEC Scientific Committee, made up of more than 230 leading research and industry experts, selected 14 international students who submitted abstracts to one of the seven topics of EU PVSEC's conference programme. Finalists presentations will be evaluated by the Student Awards Committee during the week and the 6 EU PVSEC Student Award Winners will be presented during the Closing Session on Friday, 13 September 2019.

Take the chance to attend the presentation of their outstanding work in the following sessions:

GENERAL INFORMATION

Monday, 09 September 2019

Dennis Bredemeier
ISFH, Emmerthal, Germany
2AO.4.4 Impact of Silicon Nitride Film Properties on Hydrogen In-Diffusion into Crystalline Silicon

Andres Calcabrini
Delft University of Technology, The Netherlands
1AO.2.1 The Ultimate Potential of Reconfigurable Modules for Increasing the Energy Yield of Partially Shaded Urban Photovoltaics Systems

Nasim Rezaei
Delft University of Technology, The Netherlands
3AO.8.2 Submicron CIGS Solar Cells: Feasibly towards the Absorption Limit

Tuesday, 10 September 2019

Achala Satharasinghe
Nottingham Trent University, United Kingdom
1BO.9.2 Wearable and Washable Photovoltaic Fabrics

Aline Kirsten Vidal de Oliveira
UFSC, Florianópolis, Brazil
5BO.6.4 Automatic Fault Detection of Photovoltaic Array by Convolutional Neural Networks during Aerial Infrared Thermography

Klemens Ilse
Fraunhofer CSP, Halle (Saale), Germany
4BO.11.5 Physics of Soiling and Dust Adhesion - Lessons Learnt from Laboratory Soiling Tests

Wednesday, 11 September 2019

Adrien Bercegol
IPVF, Palaiseau, France
3CO.5.2 Multidimensional Luminescence Imaging of Electron/Hole Transport in Triple Cation Perovskite

Elise Bruhat
CEA, Le Bourget du Lac, France
2CO.9.1 Fired Hydrogenated AZO Layers: A New Passivation Approach for High Temperature Passivated Contact Solar Cells

Laurie-Lou Senaud
CSEM, Neuchâtel, Switzerland
2CO.10.2 Bottom-Up vs Top-Down Approaches for Identifying and Mitigating the Transport Losses in High-Efficiency Silicon Heterojunction Solar Cells

INFORMATION

Cyril Leon
GeePs, Gif sur Yvette, France
3CO.8.3 Capacitance-Voltage Characterization Technique Adapted to Tandem Solar Cell

Dominik Amstad
University of Applied Sciences, Rapperswil, Switzerland
5CV.4.6 Fault Inspection of CIGS PV Plant Using Aerial Infrared Thermography

Thursday, 12 September 2019

Kathlen Schneider
UFSC, Florianópolis, Brazil
7DO.7.1 Shared Solar Cooperatives in Brazil: Context, Overcoming Barriers and Lessons to Be Drawn from Previous European Countries Experiences

Sara Mirbagheri Golroodbari
Utrecht University, The Netherlands
5DO.6.3 Simulation of Performance Differences between Off-Shore and Land-Based Photovoltaic Systems

Moonyong Kim
UNSW Australia, Sydney, Australia
2DO.6.1 Generalised LeTID Modelling Using Temperature and Injection-Level Dependencies

Above programme may be subject to adaptation.

NETWORKING

Coffee Breaks (for Conference Delegates)

Coffee Breaks are included in the Conference fee. They will be served during the Conference breaks in the Exhibition Area, 1st floor.

Catering / Restaurants

A special dedicated Networking Lunch could be booked prior to the event. Tickets are not available on-site. The Networking Lunch will be served in a dedicated networking area in exclusive ambiance, directly in the Marseille Chanot Convention and Exhibition Centre. For those who did not include Networking Lunch tickets in their registration, there is a wide range of cafés and restaurants around Marseille Chanot Convention and Exhibition Centre.

Welcome Reception

On Monday, 09 September, there will be a Welcome Reception for all Conference participants and Exhibitors, from 18:30 in the Exhibition Area, 1st floor. Come and meet your colleagues of the PV community and celebrate the EU PVSEC 2019 as a major networking platform for the global PV Solar sector.

EU PVSEC Dinner

TThe EU PVSEC 2019 Conference Dinner takes place on Wednesday evening, 11 September 2019.

The EU PVSEC Dinner will be a most captivating social event of the EU PVSEC week:

- Meet professionals from the PV world
- Enjoy excellent Cuisine
- Relax and network in pleasant ambiance
- Wednesday, 11 September 2019 from 19:30 – 23:00
- Free Bus Shuttle starting at 18:45 at the Marseille Chanot Convention and Exhibition Centre and going back at 22:00.

Networking Lunch

A networking lunch will be available for interested delegates from Monday to Thursday, 09 – 12 September in a dedicated networking area in exclusive ambiance, directly in the Marseille Chanot Convention and Exhibition Centre, Room Endoume 3, 1st floor.

This avoids queueing up in lunch periods and provides a networking environment. The networking lunch will be served in buffet style, and is convenient for both meat lovers and vegetarians. Tickets can be bought online prior to the event, may become subject to availability and need to be paid in advance. Tickets will not be sold on-site. Access to the networking lunch will be granted upon presentation of a lunch voucher which you will receive at the registration desk on-site along with your registration documents. Lost tickets will not be replaced.

SERVICES

EU PVSEC Programme Online / App

We recommend using the EU PVSEC Programme Online Tool / App in order to most successfully schedule your EU PVSEC week.

The EU PVSEC Programme Online provides a quick and detailed general synopsis of all events, sessions and presentations, speaker´s CV and photos of the EU PVSEC 2019. It provides targeted search e.g. by speakers, organisations, topics, product categories, keywords, time and location.

Create your personal, clearly laid out agenda. See at a glance where and when your chosen presentations / sessions take place and get detailed information about the respective topics. You may save and modify your agenda at any time.

Please use the online version at *www.eupvsec-planner.com*, or the mobile version at *mobile.eupvsec-planner.com*.

The mobile version is web-based and can be used by all kinds of smartphones. All you need is your smartphone's browser and internet connection.

More information about the EU PVSEC App can be found at *www.photovoltaic-conference.com*.

INSTRUCTIONS FOR AUTHORS AND PRESENTERS

Plenary / Oral Presentations

Speakers of Plenary and Oral presentations hand in their presentation/s at the **Presenters' Desk (Room Escalette, 1st floor) at least 2 hours prior to the start of their presentation**. A technician will control the correct functionality and transfer the presentation to the respective auditorium. Further details regarding Plenary/Oral Presentations can be found in the Notes for Authors available on the EU PVSEC website.

Opening hours of Presenters' Desk (Room Escalette, 1st floor):

Sun	08 Sept 2019	16:00 – 18:00
Mon	09 Sept 2019	07:30 – 19:00
Tue – Thu	10 - 12 Sept 2019	08:00 – 19:00
Fri	13 Sept 2019	08:00 – 12:00

Speakers and Chairpersons of Plenary and Oral sessions meet **15 minutes prior to the start of their session** in the respective auditorium in order to be briefed and to become acquainted with audio-visual aids.

Visual Presentations

Authors of all Visual Presentations are requested to bring their posters with them and to set them up on the allotted boards during registration hours on Sunday (08 September), or the latest by Monday morning (09 September) and to take them down on Thursday (12 September) after the last Session at 18:30. All Visual presentations should be presented through the full 4 days from Monday to Thursday in the Poster Area. Authors of posters are requested to be in situ at their posters at the session time indicated in the Programme Brochure, in order to present their paper to the audience and to create a Q&A session. Please find all detailed guidelines in the Notes for Authors of Visual Presentations.

Submission of papers for publication in the EU PVSEC Conference Proceedings

In order to be published in the EU PVSEC 2019 Proceedings, corresponding authors of each presentation have to submit the original paper online between 02 - 12 September 2019 in his/her user area.

Only corresponding authors of each submission may upload final manuscripts. This means that the corresponding author is the only author from each paper that is able to complete the submission (as is the case for abstract submission). If the manuscript is not made available during this period, your paper cannot be published in the Conference Proceedings.

The document must be submitted in both Microsoft Word and Adobe Acrobat PDF formats.

To upload the paper, corresponding authors have just to follow the step-by-step procedures provided in the user area and complete the mandatory electronic Copyright Transfer Agreement as one of the steps of the online submission. The Copyright Transfer Agreement is compulsory and can only be carried out electronically. During the submission of your paper, you will be taken automatically to the EU PVSEC electronic copyright form. Your paper submission will not be complete and therefore cannot be published without the electronic copyright submission.

The Instructions for Preparation of Papers are available for download on the EU PVSEC website.

You can find computers and technical support for the online submission of final manuscripts on site.

Opening hours of the "Authors' Area" (Room Escalette, 1st floor) are:

Sun	08 Sept 2019	16:00 – 18:00
Mon	09 Sept 2019	07:30 – 19:00
Tue - Thu	10 – 12 Sept 2019	08:00 – 19:00

INFORMATION

INSURANCE

The organiser cannot be held responsible for injury to Conference attendees or for damage to or loss of their personal belongings, regardless of cause.

Attendees are advised to make their own insurance arrangements.

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ACKNOWLEDGEMENTS

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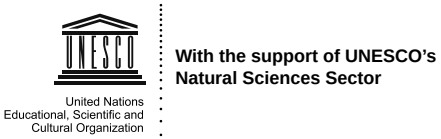

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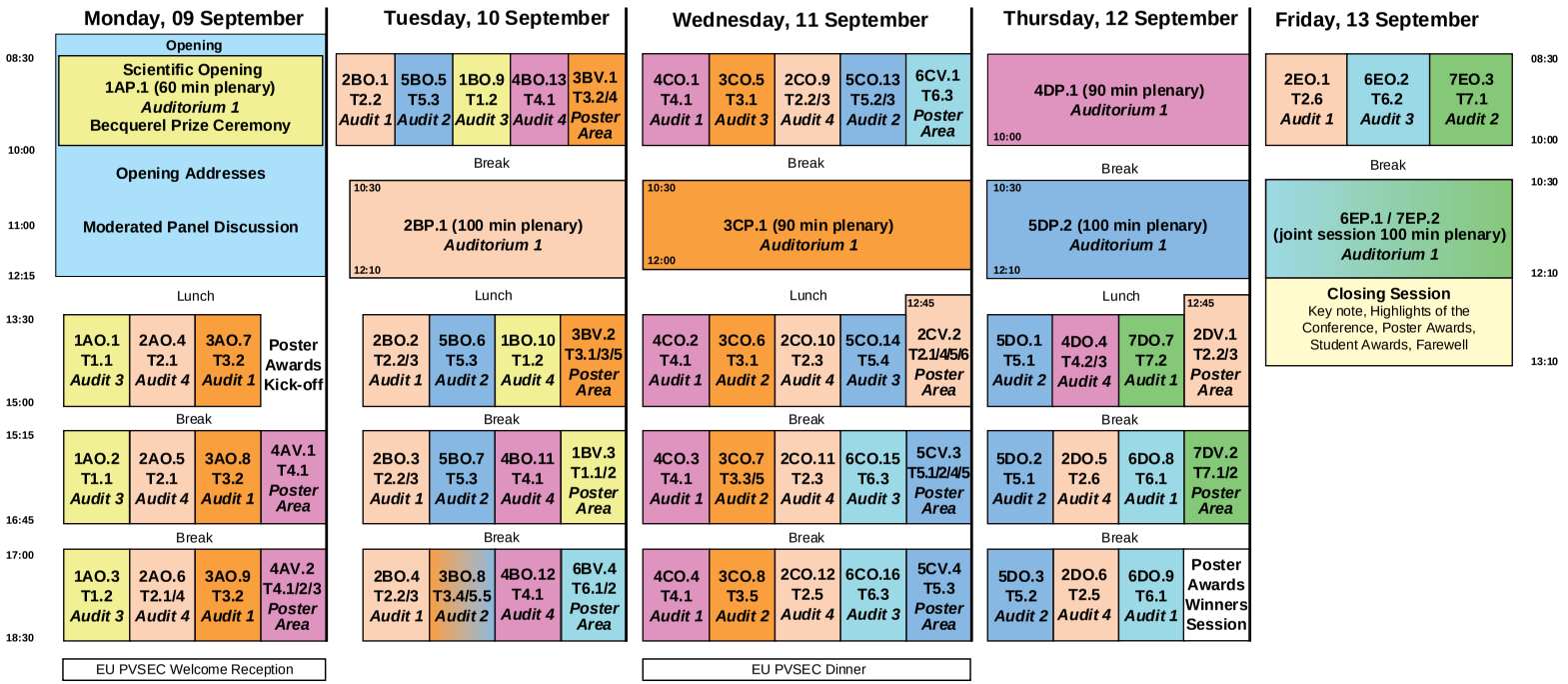
Conference Programme Outline



Topics / Subtopics

1 New Materials and Concepts for Photovoltaic Devices
- T1.1 Fundamental Studies
- T1.2 New Materials and Concepts for Cells and Modules

2 Silicon Materials and Cells
- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices
- T3.1 Perovskites Based Photovoltaics
- T3.2 CI(G)S, CdTe and Related Thin Film Solar Cells
- T3.3 Organic and Dye-Sensitised Devices
- T3.4 III-V and Related Compound Semiconductor Based Devices
- T3.5 Tandems

4 Photovoltaic Modules and BoS Components
- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

5 PV Systems and Storage – Modelling, Design, Operation and Performance
- T5.1 Solar Resource and Forecasting
- T5.2 Design and Installation of PV Systems
- T5.3 Operation, Performance and Maintenance of PV Systems
- T5.4 Storage
- T5.5 Concentrators and PV for Space Applications

6 PV Applications and Integration
- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

7 Finance, Markets and Policies
- T7.1 Costs, Economics, Finance and Markets
- T7.2 Policies and Scenarios for Renewables, Societal and Global Challenges

Session Code

1 A P 1

Day Codes
- A Monday, 09 Sept 2019
- B Tuesday, 10 Sept 2019
- C Wednesday, 11 Sept 2019
- D Thursday, 12 Sept 2019
- E Friday, 13 Sept 2019

Session Type
- P Plenary Session
- O Oral Session
- V Visual Session

Session Number

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