

PV Reliability Workshop – Lakewood, CO

February 25 – 27, 2020



Welcome to the 2020 Photovoltaic Reliability Workshop! This year's PVRW continues in the tradition of attendee participation. Attendees (and one guest) should present on the reliability of PV, either giving an oral or poster presentation. The workshop provides a unique opportunity for learning, discussion, and leadership relative to the present issues in PV-module and -system reliability.

Topics of interest during the PVRW include failure modes and degradation rates of fielded systems, module degradation modes (for materials and components), modeling of degradation, extreme weather events, collaborative research, PV standards and accelerated testing, extending system life, power electronics, trackers, and fires.

Chair:

David MILLER

Committee:

Teresa BARNES

Mike BOLEN

Dan BRAKE

Evelyn BUTLER

Chris DELINE

James ELSWORTH

Jack FLICKER

Tassos GOLNAS

Margaret GORDON

Greg KIMBALL

Inna KOZINSKY

Sarah KURTZ

Sumanth LOKANATH

Jenya MEYDBRAY

Matt MULLER

Dana OLSON

Nancy PHILLIPS

Jon PREVITALI

Ingrid REPINS

Laura SCHELHAS

Tim SILVERMAN

Josh STEIN

Scott STEPHENS

Mani G. TAMIZHMANI

Andy WALKER

Kent WHITFIELD

AGENDA – Tuesday, 25 February 2020

7:30 - 8:00	Continental Breakfast
8:00 - 9:50	<p>Session A: PV system failure modes & degradation rates <i>Session Chairs: Todd KARIN (LBL) and GovindaSamy TAMIZHMANI (ASU)</i></p> <p>8:00 – Welcome to the PVRW 2020 – David MILLER (NREL)</p> <p>8:05 – Slido Tutorial – Josh STEIN (Sandia National Laboratories - SNL)</p> <p>8:10 – PV Fleet performance data initiative – Chris DELINE (NREL)</p> <p>8:30 – PV degradation uncertainty – Jeff NEWMILLER (DNV GL)</p> <p>8:50 – Global DC health trends - Findings from 30+ GW of global PV projects – Rob ANDREWS (Heliolytics)</p> <p>9:10 – Connecting accelerated aging to the field to understand the mechanism of backsheet cracking – Kaushik ROY-CHOUDHURY (DuPont)</p> <p>9:30 – Questions/Discussion – led by Session Chairs and Slido Team</p>
9:50 - 10:10	Coffee Break
10:10 - 11:40	<p>Session B: Module degradation modes: Material <i>Session Chairs: Mike KEMPE (NREL) and Ashley MAES (SNL)</i></p> <p>10:10 – DuraMAT: Durable module materials research – Teresa BARNES (NREL)</p> <p>10:30 – Reliability and long-term stability of polyolefin encapsulants – Gernot ORESKI (PCCL)</p> <p>10:50 – Towards validation of advanced accelerated stress testing protocols through failure analysis and advanced characterization – Laura SCHELHAS (SLAC)</p> <p>11:10 – Questions/Discussion – led by Session Chairs and Slido Team</p>
11:40 - 12:40	Lunch (poster viewing/discussion encouraged)
12:40 - 14:10	Poster Session C - posters associated with Sessions A, B, D, E
14:10 - 15:40	<p>Session D: Module degradation modes: Components <i>Session Chairs: Margaret GORDON (SNL) and Archana SINHA (SLAC)</i></p> <p>14:10 – New concepts for reliable low-cost module encapsulation and moisture barrier technologies – Patrick THORNTON and Oliver ZHAO (Stanford)</p> <p>14:30 – 25-year low-cost frontsheet for flexible panel – HoiHong NG (SunPower)</p> <p>14:50 – LeTID testing of PV-Modules – Jork SAAL (TÜV Rheinland)</p> <p>15:10 – Questions/Discussion – led by Session Chairs and Slido Team</p>
15:40 - 16:00	Coffee Break
16:00 - 17:35	<p>Session E: Material and component failure analysis and mechanism modeling <i>Session Chairs: Laura SCHELHAS (SLAC) and Michael OWEN-BELLINI (NREL)</i></p> <p>16:00 – Materials characterization and multi-scale modeling of ECA's – Martin SPRINGER (NREL) and James HARTLEY (SNL)</p> <p>16:20 – Reliability of transparent polymeric backsheets under accelerated aging for bifacial modules – William GAMBOGI (DuPont)</p> <p>16:40 – Degradation of fielded modules characterized by luminescence and thermal imaging – Dana SULAS-KERN (NREL)</p> <p>17:00 – Questions/Discussion – led by Session Chairs and Slido Team</p> <p>17:30 – Today's Poster Awards – Xiaohong GU (NIST) and David MILLER (NREL)</p>
17:35	Adjourn from Workshop (poster viewing/discussion encouraged)
17:35	Adjunct Meeting
	IEC 63209 – Sarah KURTZ – Jefferson Boardroom

POSTER SESSION C: Tuesday, 25 February 2020

Session C posters are associated with Sessions **A, B, D, or E**

3. T. Karin, X. Chen, B. Jones, R. White, A. Jain, "DuraMAT Capability 1: Data Management & Analytics"
4. R. White, A. Jain, T. Karin, K. Munch, N. Wunder, C. Pailing, D. Rager, C. Webber, "DuraMAT Data Hub Year 3--accelerating activities"
5. X. Meng, S. Vishwakarma, M. Bertoni, "Direct Imaging of Stress in Crystalline Silicon Modules: Validation and Testing"
7. M. Bora, S. Pop, R. Schulze, M. Rowell, D. Harwood, "Moisture content imaging in glass-glass and glass-backsheet photovoltaic mini-modules"
9. J. Sorensen, B. DeFresart, "Impact of narrow mount configurations on power degradation"
11. S. Bowden, M. TamizhMani, A. Augusto, J. Karas, F. Li, "Reliability of modules with high-efficiency solar cells using copper-plated contacts"
12. N. Bosco, Vijaykumar Upadhyaya, "Fatigue-Like Behavior of Silver Metallization Gridlines and Proposed Damage Mechanics Model"
12. N. Bosco, R. French, J. Carter, J. Liu, "Employing Fracture Statistics to Track Cell Reliability Through Module Fabrication"
12. N. Bosco, X. He, M. Springer, "Improving Computational Efficiency of Mechanical Finite Element Method Simulations for PV Modules"
13. L. L. Kazmerski, A. S. A.C. Diniz, Suellen C.S. Costa, "Photovoltaic reliability R&D: an assessment of the evolution of soiling research from observaton toward mitigation"
15. J. L. Braid, J. S. Stein, B. G. Pierce, N. A. Parrilla, A. Maroof Karimi, R. H. French, "Quantifying cell fractures in Si PV modules"
17. B. G. Brownell, "The alternative to glass front sheets"
21. D. J. Colvin, E. J. Schneller, K. O. Davis, "Describing interconnect breakage impact on photovoltaic module performance"
24. A. Kumar, A. Pavgi, S. Tatapudi, G. TamizhMani, P. Hacke, M. Owen-Bellini, K. Roy Choudray, J. Walters, "Field reliability of glass/glass modules"
25. F. Dross, R. Janssen, P. Pasmans, K. van-Durme, D. Miller, L. T. Schelhas, B. H. King, A. Maes, J. Sherwin, "Determination of backsheet material properties : a comparison of market-benchmark technologies to novel non-fluoro-based co-extruded backsheet materials and their correlation and impact on PV module degradation rates"
29. A. J. Curran, M. Wang, E. J. Schneller, M. Martin, D. J. Colvin, N. Iqbal, J. Dai, J-N Jaubert, L. S. Bruckman, B. D. Huey, K. O. Davis, J. L. Braid, R. H. French, "Impact of module packaging materials on reliability and power degradation mechanisms of mono- and multi-crystalline, mono- and bi-facial PERC modules"

31. S. Kurtz, G. Kelly, T. Sample, "Extended stress testing to inform decisions and risk assessment of modules"
33. F. Quartiani, F. Turco Liveri, F. Babolin, M. Caddeo, "Neural network SW and automatic detection SW in electroluminescence tester"
35. X. Gu, P-C Pan, S. L. Moffitt, L. N. Perry, D. S. Jacobs, M. D. Kempe, J. Tracy, K. R. Choudhury, "Cracking and microstructural changes of PVDF-based backsheets during aging"
36. A. Sinha, L. Spinella, M. Owen-Bellini, D. B. Sulas-Kern, S. L. Moffitt, S. Johnston, L. T. Schelhas, "Investigation of interfacial degradation in glass/glass PV modules"
37. B. Habersberger, L. Madenjian, P. Hacke, "Elucidating PID mechanisms using polyolefin encapsulants"
41. A. Chavez, B. Rummel, N. Dowdy, J. Chavez, S. M. Han, B. White, N. Heckman, B. Boyce, "Electromechanical characterization of crack-tolerant, carbon-nanotube-reinforced composite gridlines using in situ scanning electron microscope strain test"
43. C. Hansen, T. Gunda, W. Vining, D. Jordan, "Data cleaning for degradation analyses"
45. J. Hartley, A. Maes, S. Roberts, J. Stein, "Multi-scale, multi-physics modeling for PV reliability"
47. B. Hartweg, K. Fisher, Z. Holman, "Failure analysis of electrically-conductive adhesives in shingled solar modules"
48. Joshua S. Stein, Cameron T. Stark, "DuraMAT SPARK: outdoor accelerated testing of photovoltaic modules"
49. S. Johnston, "Outdoor Module Electroluminescence Imaging Without Disconnecting Cables"
51. S. R. Ellis, W. S. Sampath, T. Shimpi, L. Maple, K. L. Barth, "Non-lamination encapsulation technology to improve reliability and reduce costs"
53. M. Owen-Bellini, S. L. Moffitt, A. Sinha, D. C. Miller, A. M. Maes, J. Y. Hartley, T. Karin, C. Thellen, D. R. Jenket, P. Hacke, L. T. Schelhas, "Correlation of advanced accelerated stress testing procedures with field data through advanced characterization and data analytics"
55. J. Irikawa, A. Fukushima, K. Kubo, M. Taguchi, "Effects of shading conditions on photovoltaic module temperature"
57. T. Karin, A. Jain, M. Deceglie, D. Jordan, B. Meyers, L. Schelhas, A. Maes, C. Hansen, B. King, "PV-PRO: Methods for determining photovoltaic degradation from power plant production data"
59. P. Hacke, "Application of Acceleration Science and Validation for Combined-Accelerated Stress Test (CAST) Development"

DuraMAT posters are indicated with red-printed titles

POSTER SESSION C: Tuesday, 25 February 2020 (continued)

Session C posters are associated with Sessions **A, B, D, or E**

61. C. Kearns-McCoy,
"Study of microcrack formation and propagation during module shipment"
62. H. Seigneur, E. Schneller, M. Matam, J. Walters,
"The effect of cell crack initiation, propagation, and opening on PV module I-V parameters paving the way for early crack fault detection and monitoring"
63. M. D. Kempe, D. Holsapple,
"Using meteorological data to evaluate worldwide PV degradation rates"
65. I. Khan, C. Phillips, S. Robbins, R. White, D. C. Miller,
"High-Throughput Optical Mapping for Accelerated Stress Testing of PV Module Materials"
66. M. Woodhouse, B. Smith,
"Highlights of technoeconomic analysis for DuraMAT"
67. B. King, A. Maes, J. Stein,
"DuraMat Field Module Library"
69. A. Kingma, S. Kulkarni, K. Bakker, M. van den Nieuwenhof, D. Roosen, P. Toonssen, M. Theelen,
"Reliability studies of rigid and flexible Cu(In,Ga)Se₂ devices with thermography and luminescence techniques"
70. A. Bowring, G. Liang, A. Shakir,
"Impact of interconnect design on solder joint fatigue for back contact solar cells"
73. N. Kopidakis,
"PV cell and module performance testing at NREL: capabilities and services"
74. K. Roy Choudhury, J. Tracy, R. Khatri, X. Ji, H. Hu,
"Degradation in globally-fielded PV modules from the impact of field stresses"
75. M. Kuehne, C. Stelling,
"Simulation of the cross-linking reaction of encapsulation materials with different model free kinetics approaches"
77. J. Gallon, G. Horner, E. Ignatovich, L. Vasilyev, S. Antonov,
"Contactless electroluminescence of PV modules"
78. K. Lu, T. Rigdon, G. Horner,
"Electroluminescence excitation -- non-contact quantum efficiency for process control"
81. A. M. Maes, J. Y. Hartley, J. S. Stein,
"Instrumented modules for environmental characterization and simulation model validation"
82. S. Li, R. Farshchi, M. Miller, A. Arehart, D. Kuciauskas,
"Reduced metastability in high-efficiency (Ag,Cu)(In,Ga)Se₂"
83. L. Kraus Lovenshimer,
"Case study: production impacts of UAS-identified faults in PV modules in the Southeast"
85. A. Meyer, V. LaSalvia, W. Nemeth, M. Page, D. Young, S. Agarwal, P. Stradins,
"Effect of Tabula Rasa on degradation mechanisms on boron-doped Czochralski silicon"

87. S. L. Moffitt, X. Gu,
"Detecting and understanding sodium movement in PV panel encapsulant polymers"
88. I. Repins, K. Terwilliger, C. Deline,
"Accelerated testing for light and elevated temperature degradation (LeTID) of purchased modules"
91. P. Nivelle, E. V^rsh·zi, J. Poortmans, M. Daenen,
"Multi-scale thermo-mechanical parametrised framework for photovoltaic module stress"
93. G. S. O'Brien, B. Schlinquer, B. Douglas, A. Hauser,
"Long-term outdoor and accelerated indoor weathering performance of KynarÆ PVDF films"
95. A. Pavgi, J. Oh, S. Tatapudi, G. TamizhMani,
"Thermally-conductive backsheets: performance and reliability"
97. C. Libby, M. Deceglie, D. Fregosi, B. Paudyal,
"Effect of cell cracks on module power loss and degradation"
99. S. Wendlandt, L. Podlowski,
"Lab and outdoor LeTID degradation and regeneration of p-type c-Si PERC modules"
101. C. P. Thompson, G. Obikoya, U. Das, S. S. Hegedus,
"Identifying causes of new degradation modes in high-efficiency silicon heterojunction solar cells"
103. R. Ruhle, L. Maple, T. Shimpi, K. Barth,
"Use of hydrophobic coatings for the purpose of improving the anti-soiling properties and longevity of PV modules"
105. K. Sakurai, H. Tomita, D. Schmitz, S. Tokuda, K. Ogawa, H. Shibata, A. Masuda,
"Spectral dependency of effect of illumination during high-voltage stress to CIGS mini-modules"
107. C. Sillerud, D. Zirzow, J. Crimmins,
"Regeneration of B-O defect stabilization following damp heat"
109. R. J. Wieser, S. L. Moffitt, R. Zabalza, X. Gu, C. O'Brien, L. Ji, A. W. Hauser, G. S. O'Brien, R. H. French, M. D. Kempe, J. Tracy, K. Rpy Choudhury, W. J. Gambogi, K. P. Boyce, L. S. Bruckman,
"Design of a statistically-informed field survey protocol for backsheets degradation studies of commercial PV power plants"
111. H. Wilterdink, R. Sinton, W. Dobson, J. Dinger, C. Sainsbury, K. Dapprich,
"SunsVoc analysis for diagnosing module degradation in the field: an overview"
113. T. Tanahashi, S-T Hsu,
"Electrical signatures of cracked PV cells within a PV module"
114. M. Springer, N. Bosco,
"Environmental influence on fracture and delamination of electrically conductive adhesives (ECAs)"
116. L. Schelhas, A. Sinha, J. Qian, S. Moffit, D. Miller, K. Hurst, P. Hacke,
"Module-level solutions for degradation by ionization damage"

DuraMAT posters are indicated with red-printed titles

AGENDA – Wednesday, 26 February 2020

7:30 - 8:00	Continental Breakfast
	<p>Session F: PV and extreme weather events <i>Session Chairs: Nick DeVRIES (Silicon Ranch) and Narendra SHIRADKAR (IIT-Bombay)</i></p> <p>8:00 – Multi-site assessment of extreme weather impacts on PV plant performance and reliability” – Nicole JACKSON (SNL)</p> <p>8:20 – Storms and other events - experiences with cell cracks – Will HOBBS (Southern Company)</p> <p>8:40 – Bankable independent engineering review for extreme weather conditions: structural loads, hydrological and geotechnical hazards – Dan BERGER (DNV GL)</p> <p>9:00 – Hail damage – laboratory and field studies – James RAND (Energy Works LLC)</p> <p>9:20 – Questions/Discussion – led by Session Chairs and Slido Team</p>
8:00 - 9:50	
9:50 - 10:10	Coffee Break
	<p>Session G: PVQAT and other collaborative efforts <i>Session Chairs: Peter HACKE (NREL) and Ingrid REPINS (NREL)</i></p> <p>10:10 – PVQAT: Overview – Tadanori TANAHASHI (AIST)</p> <p>10:30 – Update on the newly formed PVQAT - India – Narendra SHIRADKAR (IIT-Bombay)</p> <p>10:50 – The developments and research of PVQAT TG13 [PV cells] – Qi WANG (Jinko Solar)</p> <p>11:10 – Questions/Discussion – led by Session Chairs and Slido Team</p>
10:10 - 11:40	
11:40 - 12:40	Lunch (poster viewing/discussion encouraged)
12:40 - 14:10	Poster Session H - posters associated with Sessions F, G, I, and J
	<p>Session I: PV system performance and degradation <i>Session Chairs: Evelyn BUTLER (SEIA) and Bruce KING (SNL)</i></p> <p>14:10 – PV reliability of 100,000 systems– Dirk JORDAN (NREL)</p> <p>14:30 – Data analytics to predict onset of failure – Alex AU (NEXTracker)</p> <p>14:50 – Degradation case studies: from the field to the lab – Michael DECEGLIE (NREL)</p> <p>15:10 – Questions/Discussion – led by Session Chairs and Slido Team</p>
14:10 - 15:40	
15:40 - 16:00	Coffee Break
	<p>Session J: PV standards and accelerated testing <i>Session Chairs: Keiichiro SAKURAI (AIST) and John WOHLGEMUTH (Powermark Corp)</i></p> <p>16:00 – IEC standards and PV system certification – George KELLY (Sunset Technology)</p> <p>16:20 – Revised static load requirements for PV modules – Sumanth LOKANATH (First Solar)</p> <p>16:40 – IECRE PV system certification on quality system of manufacturers and service providers – Masaaki YAMAMICHI (RTS)</p> <p>17:00 – Questions/Discussion – led by Session Chairs and Slido Team</p> <p>17:30 – Today’s Poster Awards – Xiaohong GU (NIST) and David MILLER (NREL)</p>
16:00 - 17:35	
17:35	Adjourn from Workshop
	<i>BONUS NETWORKING & POSTER TIME:</i> Attendees are welcome to view posters Wed evening. A cash bar and hors d’ouerves are available near the City Lights Ballroom.
17:35	Adjunct Meetings
	Hail Damage & PV meeting – Sumanth LOKANATH – Lakewood Ballroom IECRE – Masaaki YAMAMICHI – Jefferson Boardroom

POSTER SESSION H: Wednesday, 26 February 2020

Session H posters are associated with Sessions **F, G, I, or J**

1. *B. AÔssa, R. J. Isaifan, V. E. Madhavan, N. H. Al-Jufairi, A. A. Abdallah,*
"Structural and physical properties of the dust particles in Qatar and their influence on the PV panel performance"

6. *K. Anderson, K. Perry,*
"Estimating subhourly inverter clipping loss from satellite-derived irradiance data"

8. *S. Toth, M. Hannigan, M. Vance, M. Deceglie,*
"Predicting photovoltaic soiling from air quality measurements"

10. *D. Fregosi, N. Paudyal, M. Bolen,*
"Benchmarking performance and loss rate of PV plants"

14. *P. Bostock, B. Littmann,*
"A framework for estimating PV energy production and probabilities of exceedance"

16. *N. Brunner,*
"A case study in year-on-year trending of photovoltaic performance ratio"

18. *L. Burnham, C. Stark, S. Dittmann, R. Gottshalg, A. Benlarabi, T. Betts, J-H Choi, B. Figgis, S-Y Oh, T. Reindl, R. Ruther,*
"A global cross-climate platform for high-quality data sharing"

19. *E. Ortega, G. Aranguren, J. Carlos Jimeno,*
"New monitoring method to self-characterize individual modules in large photovoltaic systems"

20. *V. Chawla, T. Tolliver, M. Reusser, H. Larson,*
"Evaluation of system degradation and useful life for solar project finance"

22. *D. Cormode, R. Hamilton, N. Croft,*
"Improving predictive value of capacity tests via parameter adjustment"

23. *J. Chard, M. Dooraghi, C. Hunter, J. Robinson, K. Morley,*
"A comparison of ground-based PV module soiling measurements systems at a semi-arid site in northern Utah"

26. *N. de Vries, D. Sontag, C. Helms, E. Spraggins,*
"Identifying failing inverters using normalized IGBT temperature"

27. *J. Forbess, T. Reed,*
"Daily soiling rates correlated with air quality and other meteorological data in Oakland CA"

28. *J. Elsworth, O. Van Geet,*
"PV storm hardening costs"

30. *M. Gostein,*
"Spectral mismatch in albedo measurements"

32. *A. De Mendoza, Z. Hammond,*
"The effect of polar vortices on fixed-tilt solar PV systems"

34. *L. Ji,*
"UL and IEC standard updates on PV connectors ñ field assembly and incompatibility"

38. *B. Kim, A. Vilanova Cortezon, C. Ki Kim, Y-H Kang, H-G Kim,*
"Non-linear regression model between solar irradiation and PV generation output"

39. *A. Habte, M. Sengupta,*
"Modeling of ultraviolet irradiance from total irradiance: a simplified approach"

40. *C. K Kim, H. Kim, Y-H Kang, B-Y Kim, C-Y Yun,*
"Examination of performance ratios for solar power plants based on satellite-derived solar irradiance in the Korean Peninsula"

42. *B. Marion,*
"Albedo data for bifacial PV systems update"

44. *B. Meyers, L. Schelhas,*
"Solar data tools: automatic solar data processing pipeline"

46. *H. Seigneur, E. Schneller, D. Colvin, R. Janoch, A. Anselmo, A. Gabor,*
"The influence on cracked solar cell degradation from Hurricane Dorian wind-loading events and the influence of RailPad bracing elements"

52. *O. VanGeet,*
"PV high wind user test facility"

54. *M. Owen-Bellini,*
"Combined-Accelerated Stress Testing for Advanced Reliability Assessment of Photovoltaic Modules"

58. *E. Kam-Lum, D. Cosme, M. Sakhujia, J. Chapon, M. Sander, S. Aid,*
"Determination of outdoor soiling rates in desert environments by comparing daily Impv current of soiled and cleaned photovoltaic strings"

60. *P. Hacke,*
"Analysis of Hail Damage in PV Modules with Respect to Mounting Angle and Direction"

68. *C. Schmid, C. Honeker, A. Watts, A. Lloyd, K. Lee, J. Richards, D. McDougall, J. Miller, W. MacDonald,*
"Reliability aspects of adhesive mounting of conventional PV solar modules"

71. *M. Koentopp,*
"Towards an IEC LETID test standard. Procedures, kinetics and separation of B-O degradation from LETID"

76. *M. M. Kivambe, A. A. Abdallah, B. AÔssa, B. Figgis, C. A. Broussillou,*
"Performance comparison of bifacial PV modules due to soiling in desert climates"

84. *J. Wohlgemuth,*
"PV standards activities of IEC"

86. *D. Celvi, R. Tirawat, C. Schreiber, G. Zhu,*
"Development of an accelerated aging test procedure for solar mirrors"

POSTER SESSION H: Wednesday, 26 February 2020 (continued)

Session H posters are associated with Sessions **F, G, I, or J**

- 89.** S. Nalin Venkat, J. Liu, N. S. Bosco, J. Dai, W. J. Gambogi, B. Brownell, Y. Gu, J. Carter, L. S. Bruckman, J-N Jaubert, J. L. Braid, R. H. French,
"Towards 50 year module lifetimes: impact of module architecture and packaging materials"
- 90.** K. Lee, J. Nagyvary, J. Sharp, L. Creasy,
"Testing for risk of hot spots and bypass diode activations in bifacial arrays on single-axis trackers"
- 94.** A. Richter,
"PV mounting: often underestimated for reliability of solar systems"
- 98.** W. Shan,
"Effective efficiency of energy generation by field-deployed PV modules as a long-term performance indicator"
- 102.** A. Barriga, A. Shinn,
"Deciphering degradation: machine learning on real-world performance data"
- 106.** L. J. Simpson, J. M. Newkirk, C. Lanaghan, A. Einhorn, R. Huntamer, A. Bergeson-Keller, L. T. Schelhas, C. Engtrakul, D. Holsapple, J. Morse, B. To, P. F. Ndione, H. R. Moutinho, A. Alnuaimi, J. J. John, B. To,
"IEC 62788-7-3 Standard: PV abrasion development update"
- 108.** C. Wolfrom, S. MacAlpine,
"Empirical method for determining heat transfer coefficients"
- 110.** A. Livera, M. Theristis, E. Koumpli, G. Makrides, J. Sutterlueti, J. S. Stein, G. E. Georghiou,
"Guidelines for ensuring data quality for photovoltaic system performance assessment and monitoring"
- 112.** D. Zirzow, J. Crimmins, J. Richards, C. Sillerud,
"Bankability testing for new generations of PV modules"

AGENDA – Thursday, 27 February 2020

7:30 - 8:00	Continental Breakfast
8:00 - 9:50	<p>Session K: Extending system life <i>Session Chairs: Tristan ERION-LORICO (PVEL) and Jon PREVITALI (Wells Fargo)</i></p> <p>8:00 – Trends in accelerated testing – Henry HIESLMAIR (DNV GL)</p> <p>8:20 – Correlation between financial yield improvements, extending system life, standardization, risk mitigation, and rating – Thomas SAUER (Exxergy)</p> <p>8:40 – Assessing existing solar arrays for storm vulnerabilities; assessing risks by location and retrofit measure – Gerald ROBINSON (LBNL)</p> <p>9:00 – Perspectives on the useful life of module – Henry HIESLMAIR (DNV GL)</p> <p>9:20 – Questions/Discussion – led by Session Chairs and Slido Team</p>
9:50 - 10:10	Coffee Break
10:10 - 11:40	<p>Session L: Inverters and power electronics <i>Session Chairs: Michael BOLEN (EPRI) and Jens MOSCHNER (KU Leuven)</i></p> <p>10:10 – Inverter faults & failures: Common modes & patterns – Thushara GUNDA (SNL)</p> <p>10:25 – Inverter reliability data – Phil STILES (Leidos) <i>(Speaker was sick so no presentation but the slides will be included in the proceedings)</i></p> <p>10:40 – Inverter reliability: An EPC Contractor’s Perspective – Beth COPANAS (RES)</p> <p>10:55 – Inverter AFCI: challenges and real-world performance – Jenya MEYDBRAY (PVEL)</p> <p>11:10 – Questions/Discussion – led by Session Chairs and Slido Team</p>
11:40 - 12:40	Lunch (poster viewing/discussion encouraged)
12:40 - 14:10	Poster Session M - posters associated with Sessions K, L, N, and O
14:10 - 15:40	<p>Session N: Trackers <i>Session Chairs: Sumanth LOKANATH (First Solar) and Matt MULLER (NREL)</i></p> <p>14:10 – Wind standards, plant lifetime, and aeroelasticity of PV trackers – Alex ROEDEL (NEXTTracker)</p> <p>14:30 – Torsional response of single axis tracker with passive load mitigation – Todd ANDERSEN (Array Technologies)</p> <p>14:50 – Aeroelastic modeling and full-scale loads measurements for investigation of wind driven dynamic instabilities in single-axis PV trackers – Scott DANA (NREL)</p> <p>15:10 – Questions/Discussion – led by Session Chairs and Slido Team</p>
15:40 - 16:00	Coffee Break
16:00 - 17:35	<p>Session O: PV Fires and contributing components <i>Session Chairs: Colleen O'BRIEN (UL) and Timothy SILVERMAN (NREL)</i></p> <p>16:00 – The good, the bad and the fugly – Dean SOLON (Shoals Technology)</p> <p>16:20 – Measured DC arc-flash incident energy in PV plants – Bijaya PAUDYAL (EPRI)</p> <p>16:40 – PV fires experiences in Italy: from forensic activities to fire risk assessment of existing and new PV plants – Luca FIORENTINI (TECSA S.p.A.) <i>(Presented by Colleen O'Brien on Luca's behalf due to travel restrictions)</i></p> <p>17:00 – Questions/Discussion – led by Session Chairs and Slido Team</p> <p>17:30 – Today's Poster Awards – David MILLER (NREL)</p>
17:35	Adjourn – REMOVE POSTERS

POSTER SESSION M: Thursday, 27 February 2020

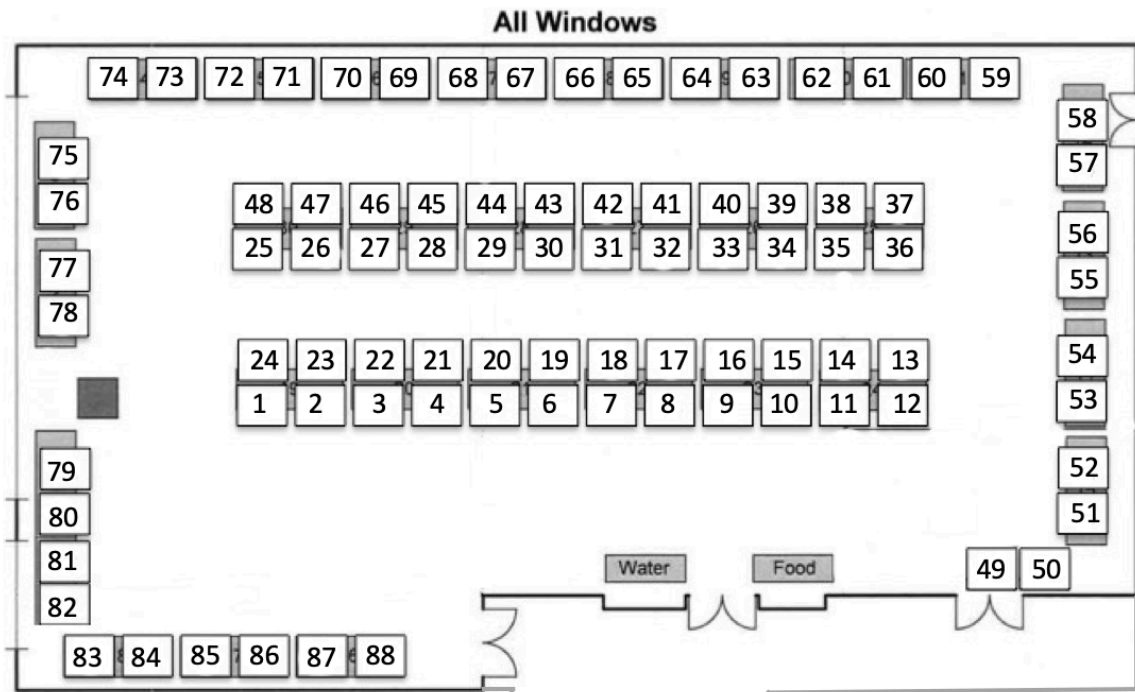
Session M posters are associated with Sessions **K, L, N, or O**

- | | |
|-------------|---|
| 2. | <i>A. M. Gabor, A. Sanghvi, A. Anselmo, R. Janoch, R. Lockhart, A. Elrefaiy,</i>
"Pre-installation EL & I-V solar panel testing in a mobile test lab" |
| 50. | <i>S. Johnston, D. B. Sulas-Kern, D. Jordan,</i>
"Module imaging for hail damage assessment and two-year follow-up" |
| 56. | <i>R. Hill,</i>
"Progress in IEC PV availability and reliability standards" |
| 64. | <i>M. A. Green, Y. Jiang, Z. Zhou, S. Pillai, M. Keevers, J. Bilbao Bernales, J. Guo, N.J. Ekins-Daukes,</i>
"Reduced operating temperature to improve durability and efficiency of solar modules" |
| 72. | <i>M. B. Koentopp, T. G`ttermann, W. Engler,</i>
"A new manufacturing quality control program based on IEC 63209" |
| 79. | <i>A. S. Edun, C. LaFlamme, M. U. Saleh, S. Kingston, E. Benoit, H. Ellis, J. Mismash, M. A. Scarpulla, C. M. Furse, J. B. Harley,</i>

"Spread spectrum time domain reflectometry to detect and locate disconnects in large-scale PV arrays" |
| 80. | <i>C. LaFlamme, A. S. Edun, E. Benoit, M. A. Scarpulla, C. M. Furse, J. B. Harley,</i>
"Quantifying impact of environment on spread spectrum time domain reflectometry signatures of PV arrays and implications for fault detection" |
| 92. | <i>K. G. Bedrich, Y. Wang, J. Chai, Y. Sheng Khoo,</i>
"Quantitative electroluminescence imaging of PV modules: quality enhancement through multi-frame super resolution" |
| 96. | <i>J. D. Moschner, S. Ravyts, J. Driesen,</i>
"Module-level inverters and converters for BIPV ñ performance limitations and reliability aspects" |
| 100. | <i>G. Touloupas,</i>
"Benchmarking PV module quality in the factory: quality risk statistics over GWs of projects in a very dynamic sector" |
| 104. | <i>J. Walzberg, A. Carpenter, G. Heath,</i>
"Closing the loops on solar photovoltaics" |
| 115. | <i>S. Ayala Pelaez, H. Mirlatz, T. Silverman, A. Carpenter, T. Barnes</i>
"De-fluffing circular economy metrics with open-source calculator for PV" |

Please remember to **take your posters with you** at the end of the workshop

Poster Layout: City Lights Ballroom



Poster Layout: Genesee Room

