2017 NREL/SNL/BNL PV Reliability Workshops

PV Module Reliability Workshop

Tuesday, Feb. 28th: Module failure mechanisms – observations and testing
Includes: Observations of new failures, cell cracking, light-induced degradation

Wednesday, March 1: PVQAT updates and testing strategies
Morning: Updates from PVQAT Task Groups and technical discussions
Afternoon: What test data do investors want to see to gain confidence?

PV System Reliability Workshop

Wednesday, March 1: Testing strategies
Afternoon: What test results do investors want to see to gain confidence?

Thursday, March 2: Soiling, reliability of power electronics, requirements for firemen safety

Sign-up options:

PV Module Reliability Workshop: $200 ($250 after Feb. 1)
Co-organized by NREL and Brookhaven National Laboratory
Tuesday, Feb. 28th and Wednesday, March 1st, will include:

- PV module failure mechanisms such as new problems, cell cracking, and light-induced degradation,
- Reports from PVQAT Task Groups with discussion of implications on weathering, testing for high-temperature operation and other testing
- *What test data do investors want to see? (Qualification, durability protocol, quality management, service life prediction?)

PV System Reliability Workshop: $150 ($200 after Feb. 1)
Co-organized by NREL and Sandia National Laboratories
Wednesday afternoon, March 1st and Thursday, March 2nd, will include:

- *What test data do investors want to see? (Qualification, durability protocol, quality management, service life prediction?)
- Soiling, reliability of power electronics, enhancing firefighting safety

Both workshops: $250 ($350 after Feb. 1)
*Starred session is shared by both workshops.

DRAFT AGENDA – Not all speakers have been confirmed.

PV Module Reliability Workshop

Tuesday, Feb. 28th: Module failure mechanisms – observations and testing

Includes: Observations of new failures, cell cracking, light-induced degradation

7:30 Continental breakfast

Tuesday Session 1 – Welcome and New failures and failure statistics

8:00 "Welcome" – Sarah Kurtz and Charlie Gay

8:15 "Statistics on observed failures and how they are changing" – Dirk Jordan, NREL

8:45 "Observations of new problems with PV modules" – Eric Daniels, Suncycle USA

9:15 "Electrochemical mechanisms of leakage-current-induced delamination and corrosion" – Yu-Chen Shen

9:45 Break and poster viewing

- Teresa Barnes (NREL) "DuraMat Overview"

10:30 "Durability evaluation of field aged PV modules from diverse climates: Causes of series resistance increase" – Mani Govindasamy, ASU

11:00 Discussion: *What other new failure mechanisms are being observed? How does the observation of new failures affect our research agendas and test plans?*

11:45 Lunch

12:45 Poster viewing

Posters:

- A.S. Budiman (SUTD), S.K. Tippabhottla, I. Radchenko, and N. Tamura, "Probing stress evolution and fracture mechanisms using synchrotron x-ray micro-diffraction – Enabling thin silicon solar cell technologies for next-generation solar PV systems"
- W. Luo (SERIS), J. Chai, Y. S. Khoo, Y. Wang, "Potential-induced degradation of n-type bifacial modules"

Tuesday Session 2 - Cracked Cells

Session Chairs: Alessandra Colli, Andreas Meisel, Eric Daniels

13:40 "Ultra-violet fluorescence method to detect cell cracks and safety issues of cell cracks" – Marc Koentges, ISFH

14:00 "Field observations of cracked cells" – Jim Rand, Core Energy Works

14:15 "Look while you load: Electroluminescence and IV testing of solar panels under mechanical load" Andrew Gabor, BrightSpot Automation

14:30 "Metrology for cracks in modules" – Klaus Attenkofer – NSLSII, BNL

14:45 Discussion: Moderators: Alessandra Colli, Andreas Meisel, Eric Daniels; Participants: Marc Koentges, Jim Rand, Andrew Gabor, Klaus Attenkofer *"What does it mean to have cracks? (What do we need to do? Can we live with the power loss and the safety risk? Are there thresholds to respect for electric or temperature variables of the module?) "What can we do to reduce problems with cracked cells?" "Should we be*

developing a new standard to better understand the effects of cracks combined with mechanical strain?"

15:00 Break

Tuesday Session 3 - LID
Session chairs: Scott Stephens, Andreas Meisel and/or Kaitlyn VanSant
15:30 "Effects of nameplate assignment – how important is it in determining energy delivered relative to the effects of variable operating conditions?" Markus Schweiger.
15:50 "Permanent deactivation of LID in PERC cells" Max Koentopp, Q-cells
16:10 "Field performance after H-Passivation of LID" Henry Hieslmair, SunEdison
16:30 Discussion: *Is LID in PERC a problem? Will regeneration be stable? What are the differences between mono and multi? How do these problems compare with effects in thin-film and other silicon cells?*

17:00 Adjourn for more poster viewing and informal evening meetings

Wednesday, March 1: PVQAT updates and testing strategies
Morning: Updates from PVQAT Task Groups and technical discussions
Afternoon: What test data do investors want to see to gain confidence?

7:30 Continental breakfast

Wednesday Session 1 – PVQAT Updates and Technical Discussions
8:00 PVQAT TG1: "Status and implementation of IEC 62941" Masaaki Yamamichi, AIST
8:15 Discussion: *What more do we need to do to be able to have confidence in consistency of manufacturing?*
8:20 PVQAT TG2: "Proposal for thermal cycling for hot climates" Nick Bosco, NREL
8:40 Discussion: *What concerns are there about the proposed thermal cycling test protocol? Would it be accepted as a standard approach for an extended durability test protocol?*
8:50 PVQAT TG3: "Proposed PID pass-fail requirement for amendment to IEC 61215, other TG3 status and combined stress testing" Peter Hacke, NREL
9:10 Discussion: *Is the proposed requirement the right one? Is something different needed for thin-film modules? For which situations do we expect to use combinatorial testing?*
9:20 PVQAT TG4: "Climate and mounting specific accelerated test development" Vivek Gade and Narendra Shiradkar
9:30 Discussion: *Is this the right direction? What temperatures and currents are needed?*

9:40 Break and poster viewing
Posters

- Mark Alessandro (Avery Dennison), Emre Unsal, Doug Vermillion (EYE/Iwasaki), "Comparison of weathering test chamber light source spectra, and summary update on developing metal halide light source testing standards"
- Sarah Kurtz (NREL), Govind Ramu, Robert Cornell, Masaaki Yamamichi, George Kelly, John Wohlgemuth "Bringing PV system quality standards to the next level"
- Ronald A. Sinton (Sinton Instruments), Harrison Wilterdink, Wes Dobson, "Module tester spectral classification: Focus on industrial silicon modules"
- Vincent Weeda (Fortum), "Demonstrating the need for Fortum's QA program"

10:20 PVQAT TG5: "Introduction and status of weathering standards development" David Miller, NREL; "Current challenges" Nancy Phillips, DuPont and Xiaohong Gu, NIST; "Future of weathering tests" Sean Fowler, Q-lab
10:50 Discussion: *What should be the pass/fail criteria for weathering tests? Where should those criteria be applied? What method or test sequences are not addressed in the PV standards that need to be considered?*
11:05 Task Group 10: "Update on issues related to connectors" Sumanth Lokanath, First Solar
11:20 PVQAT climate specific: "Proposal for testing for high-temperature operation" John Wohlgemuth, PowerMark; Ingrid Repins, NREL
11:40 Discussion: Is this the right approach?
11:50 Sayuri Workshop report – Tadanori Tanahashi
12:00 SOPHIA Workshop report – Michael Koehl

Joint Session: PV Module Reliability Workshop and PV System Reliability Workshop

12:10 Lunch and poster viewing

Posters:

- Kyung Soo Kim (Korea Institute of Energy Research) "High sun irradiance testing for understanding material life time expectation of PV modules"

14:20 Welcome to System Workshop (Olga Lavrova and Geoffrey Kinsey)
Wednesday Afternoon Session A – Bankability – What does an investor want?
14:30 "What does an independent engineer look for in a PV Plant and what enhanced-reliability data would motivate paying more?" – Ray Hudson, DNV
15:00 "Scientific basis for using a durability protocol to gain confidence in long-term performance of modules" – John Previtali, Wells Fargo
15:20 "Enabling synergies between reliability research, independent verification, and the investment community for enhanced PV bankability" – Mukul Agrawal, SunPower
15:40 Panel Discussion: Moderators: Yu-Chen Shen, Sarah Kurtz; Panelists: Ray Hudson, John Previtali, Mukul Agrawal, Edward Hsi, Scott Stephens

What information does someone need to have confidence in a PV system? Is IEC 61215 enough for the PV module? Is there benefit to developing a standard Durability Test Protocol? What additional demonstration is needed at both the component and the system level?
16:10 Break

Wednesday Afternoon Session B – Bankability – Are the standards in development addressing the investors' questions?
16:30 "Proposal of a quality assurance test protocol to unify reliability testing" Muktha Tumkur, CSA
16:50 "IECRE approach to providing confidence at the system level" George Kelly, IECRE
17:10 Panel Discussion: Moderators: Sarah Kurtz, Yu-Chen Shen; Panelists: Ray Hudson, John Previtali, Sumanth Lokanath, Jim Crimmins
Is this proposed standard Quality Assurance/Reliability Test Protocol what we want? Does it include adequate statistics? Is the IECRE effort headed in the right direction including all pieces, quality, performance, oversight, consistent application?

17:30 Adjourn for more poster viewing and informal evening meetings

PV System Reliability Workshop
Thursday, March 2: Soiling, reliability of power electronics, enhancing firefighting safety

7:30 Continental breakfast

Thursday Morning Session I – System Reliability

8:00 "PV system impacts on the utility system"– Gary Freeman, Duke Energy
8:20 "Improved performance modeling that reflects component reliability metrics" – Geoffrey Klise, Sandia National Laboratories
8:40 "O&M Cost modeling and cost reduction" – Andy Walker, NREL
9:00 "Arc fault detection and mitigation for 1500 V PV systems" – Olga Lavrova, Sandia National Laboratories
9:20 Discussion *What are the most significant issues for PV plants today? Are there new research directions we should be heading?*

9:30 Break and poster viewing

Thursday Morning Session II –Soiling
10:15 "A commercial system perspective on mitigating PV soiling losses" – Mat Taylor, Cyrano PV
10:30 "Progress towards mapping out PV soiling losses in the US?" – Matthew Muller, NREL

10:45 “Overview of Sandia’s Soiling Program: Experimental Methods and Framework for a Quantitative Soiling Model” – Bruce King, Sandia National Laboratories
11:00 “Mechanisms driving the adhesion of soil to PV glass” – Lin Simpson, NREL
11:15 Discussion: *What progress is needed to help understand and/or reduce losses from soiling? What soiling standards are needed?*

11:45 Lunch and poster viewing

Thursday Afternoon Session I – Power Electronics

13:15 “Reliability Testing Power Electronics” – TBD
13:30 “Electromagnetic Interference (EMI) & its Role in Inverter Reliability” – Regan Arndt, Empower Micro Systems
13:45 “IEC 62093: proposed approach to testing inverters” – Paul Parker, SunPower and Paul Sochor, TUV
14:15 Discussion: *What are critical failures being observed in power electronics and how can we decrease the number of these? Are the planned qualification (IEC 62093), safety (IEC 62109), and quality management (NWIP) standards appropriate and adequate? Do we need to be doing more on EMC functional safety and reliability?*

15:00 Break

Thursday Afternoon Session II – Rapid shutdown and enhancing firefighting safety
15:30 “NEC 2017 Requirements Related to Rapid shutdown and firefighters’ safety” – Matt Paiss, (IAFF Rep to NEC)
16:00 “Current UL proposal for meeting NEC 2017 third option and future steps for 2019” – Tim Zgonena (UL)
16:30 Panel discussion: Moderator: Greg Ball, Chris Deline; Participants Tim Zgonena, Olga Lavrova, Matt Paiss, Jason Fisher (Solar City) *What are the technical challenges of rapid shutdown (and module electronics, in general)? What are the technical expectations for what “rapid shutdown” will mean? Do we agree on the safety limits of the voltage, power, and approach boundary? Are options for addressing the new standards available?*

17:00 Adjourn

Special thanks to those who have participated on the Program Committee:

Olga Lavrova, Sandia National Laboratories
Alessandra Colli, Brookhaven National Laboratory
Geoffrey Kinsey, DOE
Regan Arndt, Empower Micro Systems
Markus Beck, SivaPower
Dan Brake, NextEra Energy

Vivek Gade, Jabil
William Gambogi, DuPont
Anastasios Golnas, DOE
Dirk Jordan, NREL
Michael Koehl, Fraunhofer ISE
Sumanth Lokanath, First Solar
Andreas Meisel, SolarCity
Ingrid Repins, NREL
Yu-Chen Shen, SunPower
Bill Shisler, NRG Energy
Mani Tamizhmani, ASU
Tadanori Tanahashi, AIST
Sarah Kurtz, NREL