2025 PV Performance Modeling Collaborative Workshop (V3)

Mon, May 12 5:30-7:30 PM Happy Hour

Site:	**Hotel Albuquerque, 800 Rio Grande Blvd NW, Albuquerque, New Mexico USA**			
Day 1		**Tuesday, May 13, 2025**		
8:00	1:00	Breakfast and Registration		
9:00	0:10	Welcome from Sandia National Laboratories	Rob Leland	Sandia National Laboratories
9:10	0:10	Welcome from Groundwork Renewables	Ann Will	Groundwork Renewables
9:20	0:10	PVPMC Updates	Joshua Stein	Sandia National Laboratories
Session 1		**Hybrid Systems and Grid Inegration -** This session explores how PV systems can provide benefits to the grid by combining PV with other generation resources or providing ancillary services.	**Chair: Juergen Sutterlueti**	Gantner Instruments
9:30	0:15	PV Modeling for Grid Studies: How it's different	Janine Keith	National Renewable Energy Laboratory
9:45	0:15	Reevaluating PV and Wind Power Variability Across Temporal Domains: Implications for Grid Integration	Marc Perez	Clean Power Research
10:00	0:15	Dynamically Curtailing PV Plants to Provide Ancillary Services	Mohit Aggarwal	BrightNight
10:15	0:15	Technoeconomic Modeling of Solar Energy Generation and Storage Grid Penetration	Jennifer Braid	Sandia National Laboratories
10:30	0:15	Q&A		
10:45	**0:45**	**Networking Break**		
Session 2		**PV Tracking on 3D Terrain -** More and more tracked PV systems are being installed on complex terrain. Existing models are being updated to account for terrain-specifc factors.	**Chair: Kevin Anderson**	Sandia National Laboratories
11:30	0:15	Evaluating Software for Terrain-Integrated Modelling of Single-Axis Trackers	John Moseley	Array Technologies
11:45	0:15	Maximizing Energy Gains in PV Tracking Systems: A Comparative Study of Advanced Backtracking Methods on Undulating Terrain	Amir Asgharzadeh Shishavan	NexTracker
12:00	0:15	Validation of terrain losses and energy yield optimization through backtracking tuning – Case study	Kerstin Lukrafka	Wood PLC
12:15	0:15	Q&A		
12:30	**1:00**	**Lunch**		
Session 3		**Posters**		
13:30	0:45	**Poster Session 1 - PV Performance Posters**		
Session 4		**Power Plant Underperformance -** Actual performance of PV systems can be lower than expected due to a wide variety of causes. This session will explore some of these reasons.	**Chair: Jim Crimmins**	GroundWork Renewables
14:15	0:15	Diagnosis of under-performing power plants using new SolarGEMINI	Clara Fernandez	DNV
14:30	0:15	Soiling losses: from modelling to PV systems simulation	Tomas Cebecauer	Solargis
14:45	0:15	Analyzing Real-World Performance Losses in PV Production Models	Marianne Rodgers	Wind Energy Institute of Canada
15:00	0:15	Q&A		
15:15	**0:45**	**Networking Break**		
Session 5		**Model Validation for Bankability -** How do you know the model you are using is valid? How should you compare different models? This session will dive deeply into the nuances of model validation for solar PV.	**Chair: Janine Keith**	National Renewable Energy Laboratory
16:00	0:10	Introduction to the session	Janine Keith	National Renewable Energy Laboratory
16:10	0:15	Commercial Photovoltaic Modeling Software Review and Comparison	Lelia Deville	Sandia National Laboratories, University of Louisiana at Lafayette
16:25	0:15	Validation study of PVcase Yield on Utility-Scale PV Plant	A. Calcabrini	PVcase
16:40	0:15	When random errors are actually systematic errors	Jeff Newmiller	DNV
16:40	0:20	Moderated Discussion		
17:00	**2:00**	Happy Hour		
19:00		End of Day 1		

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Day 2		Wednesday May 14, 2025		
	6:15 AM	Fun Run - Meet at Entrance to Hotel		
8:00	1:00	Breakfast		
9:00	0:10	Introduction to the PV O&M and Analytics Collaborative (PVMAC)	Marios Theristis	Sandia National Laboratories
Session 6		**Reconciling Proforma and Expected Yield -** We will explore challenges in calculating expected energy, where methods vary widely due to limited proforma model availability and reliance on empirical approaches. We will discuss the impact of this variability and whether standardization could improve transparency and consistency.	**Chair: Marios Theristis**	Sandia National Laboratories
9:10	0:10	Harmonizing Calculations of Expected Yield	Joshua Stein	Sandia National Laboratories
9:20	0:10	Uncertainty in availability due to the choice of expected energy models	Ishtiza Azad	Southern Company
9:30	0:10	Differences between pre and post-construction performance modeling	Kurt Rhee	Proximal Energy
9:40	0:10	Expected vs. Measured: Yield assessment for utility scale PV assets in operation	Juergen Sutterlueti	Gantner Instruments
9:50	0:20	Moderated Discussion		
10:10	**0:45**	**Networking Break**		
Session 7		**Challenges for Estimating KPIs -** While KPI definitions exist in industry standards, they are subject to interpretation, especially when working with imperfect datasets. We will discuss sources of uncertainty, their impact on decision-making, and potential approaches to reduce risks.	**Chair: Rob van Haaren**	Proximal Energy
10:55	0:05	Intro to the Session	Rob van Haaren	Proximal Energy
11:00	0:15	Standardizing Availability Calculations for PV inverters	Abhishek Parikh	EDF Renewables
11:15	0:15	Assessing Tracker Availability in Utility-Scale Solar Power Plants	Giuliano Luchetta Martins	Statkraft
11:30	0:15	O&M KPIs: uncertainty due to data loss and operational issues	Kevin Anderson	Sandia National Laboratories
11:45	0:20	Moderated Discussion		
12:05	**1:00**	**Lunch Break**		
Session 8		**Posters**		
13:05	0:45	**Poster Session 2 - PV Operations Posters**		
Session 9		**Solar Capacity Testing: Insights and Trends -** This session will explore the latest trends and insights in solar capacity testing, with a focus on key industry topics, including ASTM standards and IEC 61724-2 capacity testing. Our diverse panel—featuring experts from development, EPC, and consulting—will provide perspectives on current methodologies, challenges, and best practices.	**Chair: Jon Kalantar**	DNV
13:50	0:10	Current Capacity Testing Methods and Uncertainties	Jessica Forbess	Sunshine Analytics
14:00	0:10	Irradiance Measurements in Capacity Testing	Justin Robinson	GroundWork Renewables
14:10	0:10	Major Observed Issues in Capacity Tests by EPCs	Jaya Mallineni	SOLV Energy
14:20	0:10	Capacity Testing Insights from a Developer's Perspective	Andrew Nurse	Invenergy
14:30	0:20	Moderated Discussion		
14:50	**0:45**	**Networking Break**		
Session 10		**From Data to Insights: AI/ML for Predictive Fault and Underperformance Detection -** Discover how AI/ML Models are revolutionizing solar power plants by enabling predictive diagnostics and early detection of underperformance. This session will delve into real-world use cases, showcasing how data-driven models enhance the reliability and efficiency of photovoltaic systems. We aim to inspire the performance community to use this as a starting point to delve deeper into AI/ML-based analytics for solar power plants operations and maintenace.	**Chair: Jaya Mallineni**	**SOLV Energy**
15:35	0:15	The Inverter Classifier: A Boosting Model for Detecting Inverter Underperformance	Sandra Villamar	Power Factors
15:50	0:15	Boosting Physics-Based Models with AI/ML: Case Studies on Data Quality and Data Availability Challenges	Xuanji Yu	Univers
16:05	0:15	Beware of the Black Box	Julien Deckx	3E
16:20	0:15	Leveraging AI/ML for proactive and early identification/classification of photovoltaic (PV) system faults and underperformance	Neeraj Desila	SmartHelio
16:35	0:20	Moderated Discussion		
16:55	0:05	***Poster Award Ceremony***		
17:00		**End of Day 2**		

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Day 3		Thursday May 15, 2025		
8:00	1:00	Breakfast		
Session 11		**Solar Resource -** Irradiance is the fuel that drives solar energy systems. Join this session to learn about the latest updates in data availability, methodology, uncertainty, and modeling.	**Chair: Adam Jensen**	DTU
9:00	0:15	Improving the National Solar Radiation Data Base using PSM v4	Manajit Sengupta	National Renewable Energy Laboratory
9:15	0:15	How complex are satellite-based irradiation data?	Malcorps Philippe	3E
9:30	0:15	The influence of cloud cover on the reliability of satellite-based solar resource data	Yu Xie	National Renewable Energy Laboratory
9:45	0:15	Assessment of the transportability of the coefficients of a new solar radiation decomposition model	Brighton Mabasa	University of Johannesburg
10:00	0:15	Q&A		
10:15	**0:45**	**Networking Break**		
Session 12		**Software Updates -** PV modeling software is always evolving and improving. This session will review the latest developments in the most advanced PV design and performance tools.	**Chair: Clifford Hansen**	Sandia National Laboratories
11:00	0:10	Tools Update Session: SolarFarmer development highlights, insights and near-term plans	Tony Mercer	DNV
11:10	0:10	Updates and future developments in PVsyst	Michele Oliosi	PVsyst SA
11:20	0:10	Unified and validated ray-tracing framework applied from PV cell to PV plant	Arthur Poquet	Total Energy
11:30	0:10	Validation and results of the 3D energy yield calculation model for the RatedPower software	Félix Ignacio Pérez Cicala	RatedPower
11:40	0:10	PlantPredict Model Updates and Roadmap	Jason Spokes	Terabase
11:50	0:15	Q&A		
12:05	0:10	Closing Remarks	Joshua Stein	Sandia National Laboratories
12:15	**1:00**	**Lunch**		

Afternoon parallel sessions continue on next page

Day 3, Continued		Thursday May 15, 2025		
		Parallel Sessions A	**Parallel Sessions B**	**Parallel Session C**
13:15	0:45	**PV Modeling Academy – Developing Curriculum for PV Performance Modeling (Clifford Hansen, Sandia) -** This session aims to gather feedback from industry on modeling expertise and topic areas that they wish new hires had encountered in school. We will solicit User Stories to collect this information and hope to use this information to build PV modeling curriculum.		**Industry Modeling Software Office Hours** **JMP** **PlantPredict** **PowerUQ** **pvcaptest** **Pvcase** **pvlib-python** **PVsyst SA** **RatedPower** **SolarFarmer** **Solargis Evaluate**
14:00	**0:05**	**Transition break**		
14:05	0:45	**Updates on Revision to IEC 61724 (Michael Gostein, Atonometrics) -** This working group session will provide an overview of the ongoing revisions to the IEC 61724 standard series for PV system performance monitoring, including IEC 61724-1 (instrumentation), IEC 61724-2 (short-term capacity testing), and IEC 61724-3 (long-term energy performance testing). Participants will have the opportunity to offer feedback, share experiences, and learn how to contribute to the revision process.	**How to Model Batteries (with PV, stand-alone, or hybrids) in SAM and PySAM (Brian Mirletz, NREL) -** This tutorial will be a deep dive into considerations for battery modeling and demonstrating how to model them in SAM, including battery chemistry, thermal modeling, degradation/lifetime, dispatch, interconnection limits and curtailment, and their associated impacts on project profits and battery lifetime. By the end of the tutorial attendees will know how to size and model both behind-the-meter and front-of-meter battery systems, including financial analysis and pairing with other PV models (including pvlib) via PySAM.	
14:50	**0:30**	**Networking Break**		
15:20	0:45	**PlantPredict API / SDK Introduction and Demonstration (Jason Spokes, Terabase) -** Terabase will introduce attendees to the PlantPredict API (Application Programming Interface) and associated Python SDK (Software Development Kit). Basic API set up and interactions will be demonstrated, and industry use cases will be discussed.	**PVRADAR Python Package: Extension to pvlib for faster and easier modelling (Thore Müller, PVRADAR) -** The PVRADAR Python package enhances pvlib by automating data retrieval, model execution, and parameter optimization, enabling faster and more accurate PV performance modeling. This session will demonstrate its capabilities at the example of soiling modeling, including model creation, parameter fitting to field measurements, and benchmarking against pvlib's existing models.	
16:05	**0:05**	**Transition break**		
16:05	0:45	**"Modeling Streamed Sensor Data: How to Handle Curved Data (Clark Ledbetter, JMP) -** In this presentation we will show how to explore and predict the entire curved response (Irradiance vs wavelength, I-V curves, Temp vs Time. Etc.) given various input factors (other system or environmental inputs)."	**Optimizing Lifecycle Decisions with PV ICE (Heather Mirletx & Silvana Ovaitt, NREL) -** Should you repower or extend the life of your PV system? Are high-efficiency modules, durable modules, or recyclable modules the best option for your site and goals? Evaluating the trade-offs in design and lifecycle strategies can be complex. The PV in Circular Economy (PV ICE) tool is an open-source model designed to help developers, modelers, and decision-makers assess material flows, energy return on investment (EROI), and financial viability of PV systems. Now integrated with the System Advisor Model (SAM), PV ICE enables site-specific comparisons of lifecycle strategies—such as repowering benefits, module selection for reliability and recyclability, among others. This interactive tutorial will provide hands-on experience with PV ICE using Google Collab, exploring scenario-based analyses on these topics.	
16:50		**End of Workshop**		

Day 4		Friday May 16, 2025
9:00	2:00	**Groundwork PV Test Lab Tour** - Tour of the GroundWork PV Test Lab featuring a wide array of indoor PV test equipment and a walkthrough of the outdoor test yard. **Address:** 5600A University Blvd. SE 87106 (Free Parking, Self-Organized Car Pooling, Uber)
11:00		**End of Lab Tour**

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Poster Session 1 - 13:00 -13:45 on Day 1 (May 13)

Number	Session	Title	Name	Institution
1	1	Performance Modeling Challenges with Terrain-following Single-Axis Trackers	Stephen John	Black & Veatch
2	1	Comparison of simplified scaled single inverter block modeling to detailed full-scale plant modeling for utility-scale solar plant optimization	Saurav Kadel	Black & Veatch
3	1	Accurate performance modeling of bifacial PV technologies under different operating conditions	Khadija El Ainaoui	Chouaib Doukkali University
4	1	Remote Assessment of Parking Areas for PV Canopies with Deep Image Segmentation and Minimum Bounding Rectangle Polygonization	Thomas Haley	Clean Power Research
5	1	Correlating Defects in EL Images to PV Module Power Loss Using DeepLabV3 for Semantic Segmentation	Kittessa Roro	Council for Scientific and Industrial Reserch (CSIR)
6	1	Detection of Solar Irradiance Measurement Failures Using Statistical Modeling	Lucas Silva	Delfos
7	1	More than a Year: Beyond the "Typical" for Reliable PV Performance Estimates	Javier Lopez-Lorente	DNV
8	1	Solar Position Algorithms	Adam R. Jensen	DTU
9	1	Sub-hourly solar performance modeling and comparison to field measurements	Christopher E. Valdivia	Enurgen Inc.
10	1	AI/ML Feature Selection and Modeling of Spectral Correction Factors from FARMS-NIT	Bryan Skarbek	First Solar
11	1	AI to predict solar spectra from basic meteorological parameters	Sevillano-Bendezú Miguel Ángel	Instituto de Micro y Nanotecnología (IMN-CNM, CSIC)
12	1	Mitigating Model Bias in Conjunction with Variability-Driven Financial Risks in Solar PV Projects	Mark Campanelli	Intelligent Measurement Systems LLC
13	1	Accounting for Snow Stow in Energy Modeling	Reilly Smith	Invenergy
14	1	Three Methods to Improve Inverter Performance Under Shading Conditions in Large-Scale Complex Terrain PV Systems	Yan Gang	LONGi Green Energy Technology Co., Ltd
15	1	Simulation of Power Generation for Mountainous Photovoltaic Power Plants	Ye Feng and Gang Yan	LONGi Green Energy Technology Co., Ltd.
16	1	Quantifying and examining subhourly correction methodologies	Abby Hentges	Luminate LLC
17	1	Soiling inputs for the Kimber dust soiling model derived from soiling measurements	Nate Croft	Luminate LLC
18	1	A methodology to capture technology and market- specific shading behavior in common industry performance modeling tools	Kiran Balasubramanian	Maxeon Solar Technologies
19	1	Development of The National Climate Database (NCDB) Version 1	Jaemo Yang	NREL
20	1	Comparing PAR Calculation Methods for Tracker and Vertical Agrivoltaic Arrays	Chong-Seok Choi	NREL
21	1	Impact of data temporal resolution on multijunction energy yield modeling	Rajiv Daxini	NREL
22	1	Solar Energy Non-Standard Probability Distributions Estimated via Monte Carlo Simulations	Haley Darling	OWC
23	1	Dynamic Models for PV Module Temperature and Practical Methods for Parameter Extraction	Anton Driesse	PV Performance Labs
24	1	Stable, Standardized PV Reference Cells	Anton Driesse	PV Performance Labs
25	1	PVRADAR Python Package: Extension to pvlib for faster and easier modelling	Thore Müller	PVRadar
26	1	Integrating SPICE and pvlib for Advanced Modeling of PV String Power Losses	Norman Jost	Sandia National Laboratories
27	1	Comparative analysis of First Solar's new 'Spectral 3.0' model	Kevin Anderson	Sandia National Laboratories
28	1	Selecting horizon sample locations for utility-scale solar projects	Michael Locher	Silicon Ranch
29	1	Importance of meteorological parameters and their quality control on solar resource and PV yield assessment	Katarina Blstak Catlosova	Solargis
30	1	Snow losses: from modelling to PV systems simulation	Branislav Schnierer	Solargis
31	1	Subhourly Clipping Model Comparisons	Kenneth Sauer	UL Solutions
32	1	How solar panels help crops: an open-source tool for end-to-end modeling	Josh Marrs	University of New Mexico

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Poster Session 2 - 13:05-13:50 on Day 2 (May 14)

Number	Session	Title	Name	Institution
33	2	Mitigation of curtailment through BESS in Chile	Felipe Salinas	3E
34	2	Severe Weather Risk Assessment - Preliminary Guidance for Proactive Procurement Strategies	Dominic Cartina	Apex Clean Energy
35	2	Maintenance-Free Measurement of Power Losses from Soiling	Michael Gostein	Atonometrics
36	2	Analysis of hybrid PV+BESS energy dispatch profiles with various Solar PV orientations	Shail Bajpai	Black & Veatch
37	2	PV project performance testing from an EPC perspective	Jay Miller	Black & Veatch
38	2	Probabilistic Ramp Rate Forecasts of Aggregate Power of PV Fleets	Thomas Haley	Clean Power Research
39	2	A review of impacts of uncertainty in PV system capacity tests	Jeff Newmiller	DNV
40	2	Empirical Performance Loss Rates in Distributed Solar PV Installations	Dale Tutaj	DNV
41	2	A Comparison of PV Capacity Test Standards	Thomas Dodamead	EDF Renewables
42	2	Physics and machine learning: two digital twins for production modelling; two views of plant performance	Malcolm Heath	GreenPowerMonitor
43	2	Energy Performance Index (EPI) application for solar farms under energy curtailment and frequent reactive power injection into the grid	Rafael Avila	ICREA
44	2	Temporal Graph Neural Networks for Early Anomaly Detection and Performance Prediction via PV System Monitoring Data	Srijani Mukherjee	L'Institut national de l'énergie solaire (INES), France
45	2	Quantifying Power Losses from Inverter Voltage Floor Limitations	Sha Li	Leeward Renewable Energy LLC
46	2	Calculation of Expanded Uncertainty for a Capacity Test	David Auslender	McCarthy Building Companies, Inc.
47	2	The Fourth Edition of the Best Practices Handbook for Solar Resource Data for Solar Energy Application	Manajit Sengupta	NREL
48	2	Recent Update of International Standards on Radiometry	Aron Habte	NREL
49	2	Scaling the PV Fleet Performance Data Initiative	Martin Springer	NREL
50	2	Automated Detection of SCADA Tag Mismatches in Utility-Scale PV Systems Using Time-Series Cross-Correlation	Rob van Haaren	Proximal Energy
51	2	Three Approaches to Deriving the Expected Capacity of PV Power Plants	Beth Copanas	Qcells USA
52	2	AI and Big Data Enabled Predictive Maintenance Tool for Solar Farms	Yashwant Sinha	Rowan University
53	2	Effect of Intra-row Placement of Pyranometers on Capacity Tests for Non-Backtracking Systems	Chris Hart	SB Energy
54	2	PI Data-Driven Predictive Analytics for BESS Performance Monitoring	Drumil Joshi	Southern Power Company
55	2	Automated Fault Detection & Performance Monitoring for PV Systems Using Dash	Jason Chestnutt	Southern Power Company
56	2	Plant performance analysis with satellite resource data and public power data	Will Hobbs	Southern Power Company
57	2	Remote sensing for floating PV site prospection: automatic water body detection and layout generation	Emanuela Matrullo	TotalEnergies
58	2	Modeling soiling of photovoltaic systems with atmospheric reanalysis: Supporting Site Selection and Cleaning Strategy Optimization	Guillaume Masson	TotalEnergies
59	2	Intra-day Solar and Power Forecast for Optimization of Market Participation	Nelson Salazar-Peña	Universidad de los Andes
60	2	Improved PV Cleaning Schedule Optimization with a Markov Decision Chain Approach	Carl Becker	University of Heidelberg
61	2	How Remote sensing helps solar power plants mitigate wind hazards	Parmentier Remy	VAISALA
62	2	Advanced Hail Risk Modeling, Maps & Fighting-Jays Adjacent Hail Stow Case Study	Jon Previtali	VDE Americas
63	2	Inverter availability analysis of operational solar project portfolio	Albert Chang	VDE Americas / Carnegie Mellon University
64	2	How to Assess Energy Yield and Degradation with Operational Power Curves	Innes MacMillan	Wood PLC
65	2	Challenges in Capacity Testing: A Case Study	David Smith	Wood PLC