

UTILITY-SCALE SOLAR POWER PLANT DESIGN FUNDAMENTALS

February 22 – 23, 2017
The Inn at Opryland
Nashville, TN

POST-COURSE WORKSHOP

O&M Best Practices

FRIDAY, FEBRUARY 24, 2017



EUCI is authorized by IACET to offer 1.2 CEUs for the course and 0.6 CEUs for the workshop

OVERVIEW

Utility-scale solar is now in the midst of “boom” times, just as residential solar has enjoyed for the past few years. Industry experts confirm that trend will hold and perhaps even accelerate into the predictable future. Moreover, the average size of utility-scale plants — starting at, say, 5 MW and going to 500 MW — is enlarging also. Thus, the pool is expanding of utilities, developers and investors who must understand how these power plants are planned, operate and interconnect with the existing electric grid.

This course is designed to familiarize attendees with the key elements of solar power plant design and development, including a detailed understanding of system criteria, component function and selection, power flow through the plant, and interconnection requirements with the distribution utility and the power grid. Instructors will guide participants specifically through the selection of PV module and mounting/racking systems, as well as other balance of system (BOS) components. A broad examination of site preparation and development costs will also be addressed. Energy prediction, assessment and modeling elements, as well as technology and EPC evaluation approaches, and RFP process best practices will be examined.

At the conclusion of the program, attendees should have a sound understanding of the important elements that serve as the foundation of utility-scale PV plant development and design.

LEARNING OUTCOMES

Attendees at this course will:

- Discuss the fundamentals of solar utility-scale generation and its distinctive requirements on transmission and distribution systems
- Review fundamental design and system integration requirements of utility-scale and large-scale commercial solar projects
- Define the components of a solar power plant and identify their respective functions
- Discuss the function of the inverter between the DC and AC sides of the plant and its role in regulating power to the interconnection
- Examine grid interconnection requirements
- Assess energy prediction tools, methodologies and applications
- Discuss equipment and component selection criteria and processes
- Evaluate control systems and software needed to balance variable power output to grid interconnection



“Awesome course! I will use the information I learned today going forward throughout my career.”

Business Developer, Engie Canada



“This course is a great way to introduce yourself to the ways the utility industry are incorporating solar power into their service territories and how the plants are designed on large scales.”

Sub-station Engineer, Sargent and Lundy

AGENDA

Wednesday, February 22, 2017

8:00 – 8:00 am Registration and Continental Breakfast

8:30 – 10:00 am The Solar Building Blocks

- Overview of Technologies
 - PV panels and racking
 - DC electrical
 - Inverters/transformers
 - AC collectors
 - Power plant control (SCADA) and grid integration
- Designing the DC System
 - Photovoltaics 101
 - Sizing panels and configuration for site
 - DC system protection
 - Cabling to inverter
- Designing the AC System
 - Collector system overview
 - Power flow analysis and conductor sizing
 - Collector layout and installation
 - System grounding
 - Substation

10:00 – 10:15 am Morning Break

10:15 am – 12:00 pm The Solar Building Blocks (continued)

- Inverter Types and Topologies
 - “Power block” and the inverter’s role
 - Inverter types, equipment and modules
 - DC connections
 - Inverter grid monitoring and controls
 - Maximizing output – Best practices
 - The role and future of “smart” inverters with advanced (and currently restricted) functionalities
- Interconnecting PV to the Grid
 - Interconnection agreements and studies
 - Connection locations and impact on costs
 - Grid codes
 - Disturbance ride-through
 - Post-fault recovery
 - Solar plant modeling in power system analyses
 - Cloud transients, ramp rates, and control software

12:00 – 1:00 pm Group Luncheon



“Having a basic understanding of solar and having an electrical power industry background, this course delivered the right amount of detail and really took my knowledge to the next level.”

Solar Power Operations & Maintenance Engineer, Southern Company

AGENDA

- 1:00 – 3:00 pm** **Site, Engineering and Other Balance of System Aspects**
- Terrain
 - Proximity to distribution/transmission system(s)
 - Permitting issues and timeline
 - Mounting/racking design and assembly
 - Access to modules
 - Construction staging
 - Geotechnical considerations
- 3:00 – 3:30 pm** **Networking Break**
- 3:30 – 5:00 pm** **Energy Prediction – Definition and Tools**
- Solar power assessment
 - Energy estimation
 - Insolation forecast
 - Module and mounting aspects
 - Soiling and snow loss
 - Ambient ecosystem, environmental and atmospheric conditions
 - Predictive modeling and development analysis
 - Energy assessment and other advanced topics
 - Data sourcing and collection reflecting 24/7 operation
 - Environmental, weather and other ambient conditions
 - Modeling assumptions
 - Power factor, inverters and energy model
 - Uncertainty
 - Bankability

THURSDAY, FEBRUARY 23, 2017

- 8:00 – 8:30 am** **Continental Breakfast**
- 8:30 – 10:00 am** **Quality and Reliability**
- Industry metrics
 - Module and power plant
 - Components
 - Testing
 - Supplier vetting
 - O&M
 - Project “life expectancy”

- 10:00 – 10:15 am** **Morning Break**
- 10:15 – 11:45 am** **Technology Selection – Quality, Equipment Warranties, and Performance Guarantees**
- Performance metrics
 - Performance tests
 - Performance guarantees
 - Types of metrics and adjustments
 - Capacity tests
 - RFP and PPA specifications

- 11:45 am – 1:00 pm** **Group Luncheon**



“Provided an excellent amount of information and tools to evaluate and plan PV resources.”

Senior Systems Analyst, Entergy

THURSDAY, FEBRUARY 23, 2017 (CONTINUED)

1:00 – 2:45 pm

Mobility of the Production Curve

- Technology advances
- Contributions to grid reliability
- More sophisticated tracker systems
- Outlook for storage implementation
- Resource planning best practices
- Resource planning and RFP processes
- Accurately assessing solar resources in the enterprise long-range plan
- Data and modeling assumption improvement options
- RFIs vs RFPs
- RFP designs and specifications to ensure “apples-to-apples” evaluations
- Avoiding common specifications errors and non-mission-responsive bids

2:45 – 3:00 pm

Afternoon Break

3:00 – 4:30 pm

Cost Estimating

- Costs associated with the power system
- Modules
- Inverters
- Electronics
- Balance of System costs
- Other components
- “Soft” costs
- Acquisition and siting elements
- Permitting, processing and back office development costs
- Assigning O&M costs
- Project financing costs

4:30 pm

Course Adjourns



“This course expanded greatly on the basic knowledge I already had for the design process of solar fields.”

Assistant Project Manager, McCarthy Building Co



“My second EUCl event that I experienced deep technical training and in-depth content.”

CEO, True South Renewables Inc

POST-COURSE WORKSHOP

O&M Best Practices

FEBRUARY 24, 2017

OVERVIEW

As solar installations multiply and merge into the generation mainstream, greater attention is turning to solar operations and maintenance. In just a few short years, the technology has matured so rapidly that a solid body of best practices is emerging from the lessons learned.

This workshop offers a comprehensive and in-depth treatment of operational processes and maintenance practices that all solar owners and asset stakeholders will find essential. It will address the distinctions of scope, scale and responsibilities associated with utility-scale solar installations. It will delve into the key system components and their critical requirements. Controls management, forecasting, performance engineering and analyses, training and risk assurance metrics are examined in detail. Maintenance measures will be spelled out by function. And risk exposures, with their commensurate remedies, will be set forth.

LEARNING OUTCOMES

- Attendees will cover materials and engage in discussions that will allow them to:
- Define the O&M roles and functions with regard to various types of owners and stakeholders
- Review the scope, scale and responsibilities of O&M for the different types of solar installations
- Examine the O&M requirements for 6 primary system components
- Discuss operations best practices associated with...
 - o Controls
 - o Alarms
 - o Forecasting
 - o Performance engineering and analysis
 - o Compliance and training
- Assess grid interface and off-taker requirements
- Evaluate and apply best practices associated with 8 critical maintenance metrics
- Employ the proper risk measures to manage access, outage, natural resource, real estate and other exposures

AGENDA

FRIDAY, FEBRUARY 24, 2017

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|-----------------------|--|
| 8:00 – 8:30 am | Registration and Continental Breakfast |
| 8:30 – 8:45 am | Overview and Introductions |
| 8:45 – 9:30 am | Survey of O & M Practices and Prices <ul style="list-style-type: none">• Basis for increasing focus on O&M• Scope, applicable scale and responsibilities of power plant contract parties• O&M performance levels and strategies• Budgeting process and contractual structures• Contract provisos• PV budget for O&M components and costs |

FRIDAY, FEBRUARY 24, 2017 (CONTINUED)

- 9:30 – 10:15 am** **Primary Components Requiring O&M**
- Modules
 - Inverters
 - Mounting and tracking systems
 - System electrical and electronics
 - Siting/landscaping
 - Sub-station and switchyard
- 10:15 – 10:30 am** **Morning Break**
- 10:30 am – 12:15 pm** **Operations (O&M)**
- Physical processes
 - o Controls
 - o Alarms
 - o System enhancement
 - o Testing methods (curve tracing, thermal imaging of connectors/transformers, etc.)
 - Optimization practices
 - o Forecasting
 - o Performance engineering and analysis
 - Continuous performance measures
 - o Compliance
 - o Training
- 12:15 – 1:30 pm** **Group Luncheon**
- 1:30 – 3:15 pm** **Maintenance (O&M)**
- Metrics and practices
 - o Preventative
 - o Corrective/reactive
 - o Condition-based
 - Monitoring systems
 - o Cleaning and vegetation management
 - o Supply chain management
 - o Sub-station
 - o Spares and tools
 - o Useful life and life expectancy
- 3:15 – 4:15 pm** **Risk Management and Liability Aspects**
- Exposures and limitation measures
 - Access / security
 - Natural resource(s), constraints
 - Real estate (e.g., leasehold) considerations and constraints
 - Insurance
 - Asset management/investor reporting
- 4:15 pm** **Workshop Adjourns**

INSTRUCTORS

Matt Brinkman

Solar Business Unit Manager, Burns & McDonnell

Matthew Brinkman is the Solar Business Unit Manager at Burns & McDonnell. In that capacity, he is responsible for business development, resource allocation, and business planning related to utility-scale solar projects. He manages a multi-disciplinary group of 70-plus engineers and directs a \$20 million annual budget for utility capital projects. His team specializes in capital and operations & maintenance projects at existing power plants, and utility-scale solar plants. Mr. Brinkman's team has worked on some of the largest and most lauded solar projects in the nation, including serving as the Owner's Engineer on the largest solar thermal plant in the world (392 MW Ivanpah) and the largest solar PV project in the United States (580 MW Solar Star). Mr. Brinkman was appointed by Governor Janet Brewer to serve on the Arizona governor's Solar Advisory Task Force.

Donald Chung

Senior Project Leader, National Renewable Energy Laboratory (NREL)

Donald Chung is a senior project leader at the National Renewable Energy Laboratory, with 18 years' experience leading business development, marketing, operations, and engineering functions. His expertise is specific to the solar PV industry and markets. At NREL, he has focused on multiple analysis topic areas, including solar PV manufacturing and installed project cost analysis, as well as lithium-ion cell manufacturing cost analysis. Prior to affiliating NREL, he worked in product management, project development, engineering and construction, and management consulting positions, where cost estimation and value proposition analysis and development were critical elements of his roles. Mr. Chung has an MBA in Finance from the University of Michigan, an MSc in Environmental Engineering from the University of California-Berkeley, and a BSc in Civil Engineering from Duke University.

Frankie Greco

Engineering Supervisor – Interconnection Engineering & Power Quality, Arizona Public Service (invited)

Frankie Greco is an Engineering Supervisor in the Interconnection Engineering & Power Quality group of Arizona Public Service. The group supports APS's Renewable Energy Program team, which processes the applications for both commercial and residential customers with particular emphasis on power quality-related issues at both the customer and system levels. Team responsibilities also include maintaining and updating the APS Interconnection Requirements as necessary in order to address new technology, safety concerns, and ACC (commission) mandates, as well as providing training to the solar industry regarding updates to APS Requirements as well as various NEC Code requirements. Mr. Greco also provides solar awareness and solar safety training to APS first responders and firemen/emergency response personnel, in addition to company training for new project managers and designers with reference to distribution transformer and service sizing. Before assuming his current position, he worked for a small utility consulting firm learning electrical distribution design, then joined APS in 2004 doing customer construction designing new power feeds for homes and businesses. Mr. Greco has also held positions in distribution design, customer project management and as a division engineer before joining APS T&D Engineering, where he has held various positions in Interconnection, Operations and Planning. During his time as an Interconnection Engineer, he has personally interconnected over 160 MW of large scale solar.

Zach Kreifels

PV Plant Performance Engineer, First Solar

Zach Kreifels is a PV Plant Performance engineer in First Solar's Operation and Maintenance team. He joined First Solar in 2014 and monitors performance for 12 plants totaling over 650 MW of capacity. His experience at First Solar involves conducting plant performance analysis and reporting for plants from 5 MW up to 300 MW. Mr. Kreifels has also been involved in developing new reporting metrics, cost reduction studies, and executing plant energy guarantee tests. He received his Bachelors of Science in Mechanical Engineering from Iowa State University.

Eran Mahrer

Senior Director Utilities, First Solar

Eran Mahrer serves as the Sr. Director of Utilities for First Solar in North America. He joined First Solar in 2014 and leads the company's engagement with utilities on solar planning and programming. In this role, Mr. Mahrer establishes and maintains relationships with utilities, engages in strategic planning, integrated resource planning and program design initiatives. With more than eight gigawatts (GW) of modules installed world-wide and as operators of 30 utility-scale power plants with a plant availability of over 99 percent, First Solar is considered the industry's leading partner to utilities in the transition to diversified carbon free generation fleet. Prior to joining First Solar, Mr. Mahrer served as the Executive VP of Strategy and Programs for the Solar Electric Power Association (SEPA). He joined SEPA in 2012 and led the organization's efforts in driving utility and solar industry strategies and practices in support of solar energy. He also led the organization's efforts in educational programming, overseeing SEPA's research agenda and working closely with utility leadership, regulators, developers, as well as other key stakeholders to position solar as part of the utility's core resource strategy. Under his leadership, SEPA advanced critical research in utility planning, strategy development and program design. Prior to joining SEPA, Mr. Mahrer served as Arizona Public Service Company's (APS's) Director of Renewable Energy and Resource Portfolio Planning. In his 11 years with APS, he led the company's renewable energy strategy, renewable and customer program resource planning. He was the company's regulatory interface on many renewable matters, and implemented all its renewable programs. He received his MBA from the W.P. Carey School of Business at Arizona State University, a Masters of Science from Washington State University, and his Bachelors of Science from the University of California, San Diego.

Austin Quig-Hartman

Senior Technical Manager, First Solar

Austin Quig-Hartman has over 12 years of experience in the solar industry. As Senior Technical Manager at First Solar, Mr. Quig-Hartman oversees technical aspects of First Solar's US business development organization from origination through contract execution. Prior to joining First Solar in 2014, he managed the design team at SunPower. Mr. Quig-Hartman holds a Bachelor of Science in Mechanical Engineering from California Polytechnic University, San Luis Obispo.

Robert Wanless

Vice President – National Accounts, M + W Group

Robert Wanless is Vice-President of National Accounts at M + W Energy, which is a company of the M + W Group. He has been associated with the organization for three-and-a-half years. He previously worked for SOLON Corp, a producer of solar power modules and solar systems for rooftop, roof integrated and greenfield installations specializing in the turnkey development, construction, and maintenance of commercial and utility-scale solar systems. Prior to that, Mr. Wanless worked as a senior analyst at Arizona Public Service (APS), as a northeast energy trader for Pacific Gas & Electric, and at the Ontario Power Generation. He also served as a board member on the Arizona Governor's Solar Energy Advisory Task Force for 3 years.



"This course was a helpful tool to fill in some of the blanks in my knowledge of solar power plant design."

Estimator, McCarthy Building Co

REQUIREMENTS FOR SUCCESSFUL COMPLETION OF PROGRAM

Participants must sign in/out each day and be in attendance for the entirety of the course to be eligible for continuing education credit.

INSTRUCTIONAL METHODS

Case Studies, Power Point presentations and Classroom exercise will be used for this event.

PROCEEDINGS

The proceedings of the course will be published, and one copy will be distributed to each registrant at the course.

EVENT LOCATION

A room block has been reserved at the The Inn at Opryland, 2401 Music Valley Drive, Nashville, TN 37214, for the nights of February 21-23, 2017. Room rates are US \$167 plus applicable tax. Call **1-615-889-0800** for reservations and mention the EUCI event to get the group rate. The cutoff date to receive the group rate is January 24, 2017 but as there are a limited number of rooms available at this rate, the room block may close sooner. ***Please make your reservations early.***

IACET CREDITS



EUCI has been accredited as an Authorized Provider by the International Association for Continuing Education and Training (IACET). In obtaining this accreditation, EUCI has demonstrated that it complies with the ANSI/IACET Standard which is recognized internationally as a standard of good practice. As a result of their Authorized Provider status, EUCI is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.

EUCI is authorized by IACET to offer 1.2 CEUs for the course and 0.6 CEUs for the workshop.

REGISTER 3, SEND THE 4TH FREE

Any organization wishing to send multiple attendees to these courses may send 1 FREE for every 3 delegates registered. Please note that all registrations must be made at the same time to qualify.

REGISTRATION
to register [CLICK HERE](#) or

Call: 201 871 0474
fax: 253 663 7224
email: register@pmaconference.com
web: <http://pmaconference.com/>
Mail: POB 2303 Falls Church Va 22042

Please make checks payable to: "PMA"

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PLEASE REGISTER

- UTILITY-SCALE SOLAR POWER PLANT DESIGN FUNDAMENTALS COURSE AND WORKSHOP:**
 FEBRUARY 22 – 24, 2017: US \$2295,
 EARLY BIRD on or before FEBRUARY 3, 2017: US \$2095

- UTILITY-SCALE SOLAR POWER PLANT DESIGN FUNDAMENTALS COURSE ONLY:**
 FEBRUARY 22 – 23, 2017: US \$1495,
 EARLY BIRD on or before FEBRUARY 3, 2017: US \$1295

- POST-COURSE WORKSHOP ONLY:**
 FRIDAY, FEBRUARY 24, 2017: US \$995,
 EARLY BIRD on or before FEBRUARY 3, 2017: US \$895

How did you hear about this event? (direct e-mail, colleague, speaker(s), etc.)

Print Name

Job Title

Company

What name do you prefer on your name badge?

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State/Province

Zip/Postal Code

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List any dietary or accessibility needs here

CREDIT CARD INFORMATION

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Account Number

Billing Address

Billing City

Billing State

Billing Zip Code/Postal Code

Exp. Date

Security Code (last 3 digits on the back of Visa and MC or 4 digits on front of AmEx)

OR Enclosed is a check for \$ _____ to cover _____ registrations.

Substitutions & Cancellations

Your registration may be transferred to a member of your organization up to 24 hours in advance of the event. Cancellations must be received on or before January 20, 2017 in order to be refunded and will be subject to a US \$195.00 processing fee per registrant. No refunds will be made after this date. Cancellations received after this date will create a credit of the tuition (less processing fee) good toward any other EUCL event. This credit will be good for six months from the cancellation date. In the event of non-attendance, all registration fees will be forfeited. In case of course cancellation, EUCL's liability is limited to refund of the event registration fee only. For more information regarding administrative policies, such as complaints and refunds, please contact our offices at (201) 871-0474.