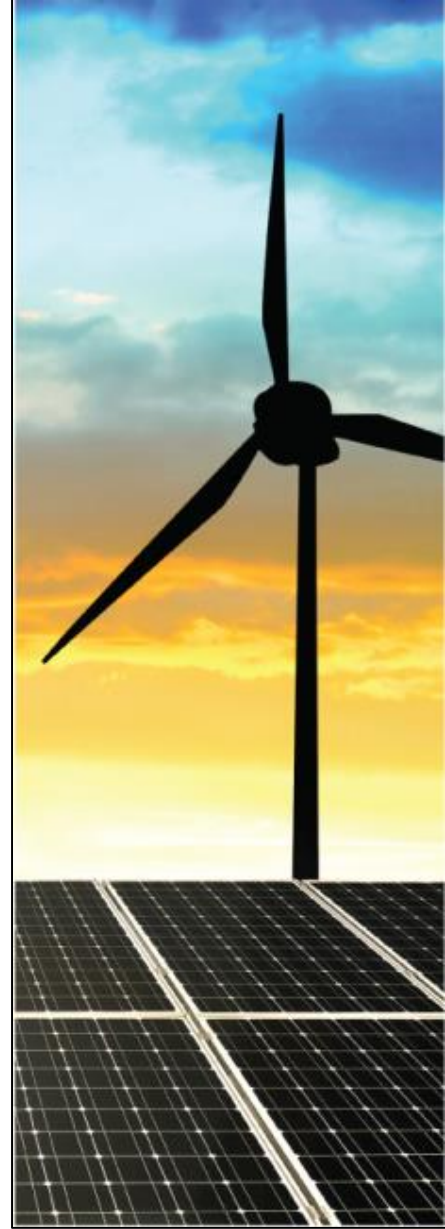


2017 Forecasting Workshop and Tutorial Overview

Charlie Smith
Executive Director

Atlanta, Georgia
June 20-22, 2017



Utility Variable-Generation Integration Group

Charting the Future of Wind and Solar Power Integration and Operations



Meeting Purpose

- Explore the link between meteorology and power system planning and operation
- Explore the value and evolving role of forecasting in day ahead, hour ahead and real-time market operations
- Explore the use of uncertainty forecasts in power system operations
- Explore the value of multiple forecasts and the role of distributed PV forecasting in emerging business models
- Develop a better understanding of VG forecasting developments on the horizon
- Continue an ongoing dialog among the VG forecasting research, development, applications and user communities

- **Pre-Workshop Tutorial on Tuesday Morning**
 - *Integration of Uncertainty Forecasts into Power System Operations*
- **Tuesday Afternoon**
 - Opening Session:
 - *Featured speaker, Mark Lauby, Sr. VP, NERC*
 - Session 1: Meteorology, Climate and the Electric Sector
 - *Intersection of climate, weather and the electric system*
 - *Chair, Justin Sharp, Sharply Focused*
 - Session 2: Where Is the Value in Improved Forecasts
 - *Reliability, economic and market drivers*
 - *Chair, Melinda Marquis, NOAA*
 - Reception

- **Wednesday Sessions**

- Session 3: Global VG Forecasting, Market Implementation and Operation, and R&D Experience with a Focus on Uncertainty
 - Chair, Bob Zavadil, Enernex
- Session 4: Forecasting Benchmarking, Trials and Evaluations
 - Chair, Aidan Tuohy, EPRI
- Session 5: Distributed PV Forecasting and Market Integration: Where are We Going?
 - Chair, Tassos Golnas, DOE
- Session 6: What's New Under the Sun?
 - Chair, Mike Knowland, ISO New England

- **Thursday Sessions**

- Session 7: Renewable Energy, Energy Trading, Market Evolution and the Role of Forecasting
 - Chair, Rob Gramlich, Consultant, Grid Strategies LLC
- Session 8: Changing Markets – Reliability, Economics and Forecasting in a Wind, Solar and Storage Future
 - Chair, Mark Ahlstrom, NextEra Energy Resources, WindLogics
- Closing Session: Open Mike
 - Chair, Charlie Smith, UVIG

Recent Industry Developments

- EIM reports total benefits of \$142.62 million since its inception in November 2014. EIM includes CAISO, Pacificorp, NV Energy, APS and PSE; PGE to join in 2017 and Idaho Power in 2018
- New Moody's Investor Services report says "Wind power economics are driving coal generation up the dispatch curve and into early retirement".
- FERC releases NOPR on aggregation of storage and DER
- Kauai coop announced plans with AES for a 28 MW PV plant with 20 MW, 5 hr battery at 11 cents/kwh in January
- NextEra signs PPA with Tucson Electric Power for solar-plus-storage project in May at sub-4.5 cents/kwh. Project is for 100 megawatts of solar PV with a 30-megawatt, 4 hr storage system.

Recent Industry Trends

- Solar PV system prices continue to fall and experience rapid growth
 - Increased discussion of DG and net metering on utility business model
- Wind plant prices also on a downward trajectory
- Corporate America demand for clean, carbon-free energy; fifty percent of the Fortune 500 have public sustainability goals; pushback against Trump's plans to remove US from Paris climate agreement and roll back CPP
- EEI annual meeting: Gerry Anderson, CEO of DTE Energy and chief environmental officer for EEI, says DTE discovered it could affordably cut carbon 80% from 2005 levels by 2050, during the CPP planning process
- Carbon constrained future, coal plant retirements, nuclear plant operating costs, and rapid growth of renewables continue to drive concern for capacity adequacy and flexibility
- Low energy market prices continue to drive electricity market redesign efforts in US and Europe
- Continuing uncertainty around energy and climate science, R&D and policy in new administration

- Lazard reports on lowest unsubsidized energy costs at end of 2016 for:

Simple Cycle GT	\$165/MWh
Rooftop residential solar	\$138/MWh
Nuclear	\$97/MWh
Coal	\$60/MWh
Combined Cycle GT	\$48/MWh
Utility scale solar	\$46/MWh
Wind energy	\$32/MWh

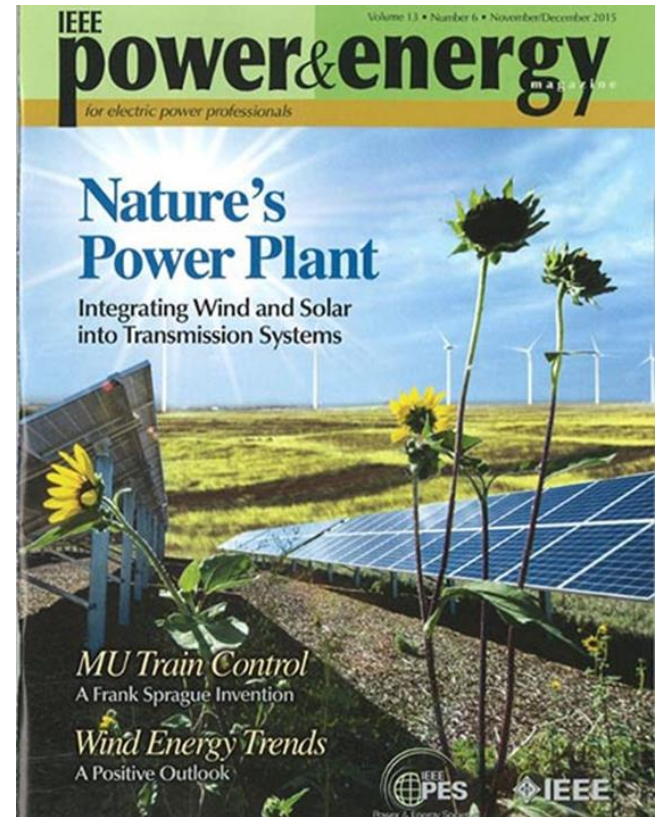
- Other reports from industry pubs on recent PPA prices:

Utility scale solar	\$34-\$45/MWh
Wind energy	\$14-\$30/MWh

- US wind capacity end of 2016 ~ 80 GW
- US solar PV capacity end of 2016 ~ 42 GW
- US VG installations in 2016
 - Wind 8 GW
 - PV 15 GW
- Ballpark estimates for 2017 US VG installations
 - Wind 9 GW
 - PV 16 GW

- Global wind capacity end of 2016: 487 GW
- Global PV capacity end of 2016: 335 GW
- Global VG installations in 2016
 - Wind 54 GW
 - PV 77 GW
- Ballpark estimates for 2017 global VG installations
 - Wind 65 GW
 - PV 79 GW

- A warm welcome to friends and colleagues from afar:
 - Japan
 - Colombia
 - Mexico
 - Germany
 - Denmark
 - France
 - Canada
 - Texas
- Take the time to make some new friends!
- Looking forward to another great meeting!



THANK YOU

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Connect with @UVIG



uvig.org