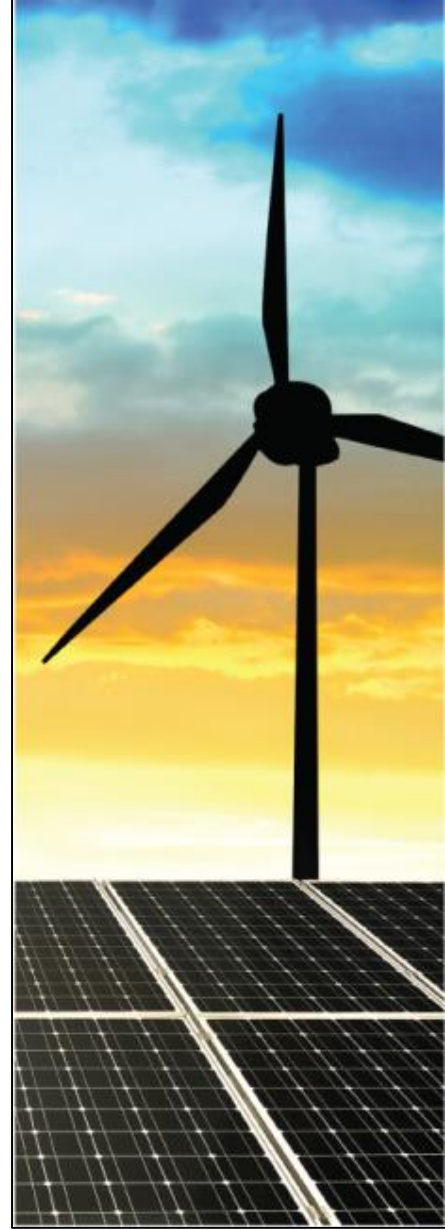


2017 Fall Technical Workshop

Nashville, Tennessee
October 10-12, 2017



Utility Variable-Generation Integration Group

Charting the Future of Wind and Solar Power Integration and Operations



- **Pre-Workshop Tutorial on Tuesday Morning**
 - *Essential Reliability Services – Resources, Requirements and Next Steps – Chair, Mark Ahlstrom, VP, Nextera Energy Resources*
- **Tuesday Afternoon – Working Group Meetings**
 - Reliability WG – Chair, Nick Miller, GE
 - *Recent Fault Ride Through Experience and What it All Means*
 - System Planning WG – Chair, Aaron Bloom, NREL
 - *System Planning Challenges with Reaching 100% Wind and Solar Generation*
 - Distributed Energy Resources (DER) WG – Chair, Debbie Lew, GE
 - *Visibility and Control of DER in Real-Time Operations*
 - System Operation and Market Design WG – Chair, Aidan Tuohy, EPRI
 - *Operating Reserve Practices with Increased VG Penetration*
- **UVIG Board of Directors Meeting**

- **Wednesday Sessions**

- Welcome and Opening Remarks
- Session 1: New Insights into PV and Distribution System Design
Moderator: Abe Ellis, Sandia
- Session 2: Wind and Solar System Studies
Moderator: Mark O'Malley, UCD
- Session 3: Interconnection of Wind and Solar Systems
Moderator: Steve Saylor, Vestas
- Session 4: Advances in Market Design and System Operation
Moderator: Bruce Rew, SPP
- Networking Reception

- **Thursday Sessions**

- Session 5: Recent Industry Developments and Updates

- Moderator: Carrie Dixon, Xcel Energy

- Session 6: Operating Impacts of Higher VG Penetrations –
A Panel Discussion

- Moderator: Bob Zavadil, Enernex

Recent Industry Developments

- EIM reports total benefits at end of Q1 2017 of \$173.72 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
- 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.
- On October 4, PV Magazine announced that a consortium formed by UAE-based Masdar and French company EDF has offered to build a 300 MW PV plant in Saudi Arabia at a LCOE of 0.06697 SAR (\$0.0178) per kWh. In addition, seven of the eight bids were under \$0.03 per kWh. The tender's bidders will be announced by the end of January 2018.
- AEP seeks approval for \$4.5 billion wind plant in OK. Project will capture \$2.7 billion of PTC and save consumers \$7 billion over 25 years.
- Everyone is getting in on the market design act – DOE issued a NOPR on payments to coal and nuclear plants for providing reliability and resiliency!

Recent Industry Trends

- Wind and Solar PV system prices continue to fall
- More utilities moving in the direction of purchasing and rate-basing renewable power plants
- Corporate America's (Apple, Google, Microsoft, Amazon, GM, Walmart, ...) demand for carbon-free energy is increasing, along with 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
- Low energy market prices continue to drive electricity market redesign efforts in US and Europe amid concerns over capacity adequacy, capacity flexibility, and essential reliability services
- The seven top U.S. grid operators told a [House Energy and Commerce subcommittee hearing](#) on "Powering America" on July 26 that the growing reliance by U.S. energy markets on low-cost wind and other clean power sources is a key part of the solution, not a problem, for ensuring the reliability, resilience and security of America's electric grid

- 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

- Lazard reports at end of 2016 on lowest unsubsidized energy costs for large (100 MW - .5 MW) storage systems:

Transmission System (8 hr)

- Pumped Hydro \$152/MWh
- Lithium Ion to Zn flow \$267-434/MWh

Peaker Replacement (4 hr)

- Lithium Ion \$159/MWh

Frequency Regulation (.5 hr)

- Lithium Ion to Zn flow \$267-434/MWh

Distribution Substation (4 hr)

- Lithium Ion to Zn flow \$345-524/MWh

Distribution Feeder (3 hr)

- Lithium Ion to Zn flow \$532-779/MWh

...but beginning to show promise in some applications

- Lazard reports at end of 2016 on lowest unsubsidized energy costs for smaller (2 MW – 5 kw) storage systems:

Microgrid (1 hr)

- Lithium Ion \$372/MWh

Island (8 hr)

- Lithium Ion to Zn flow \$608 - 845/MWh

Commercial & Industrial BTM (4 hr)

- Lithium Ion to Zn flow \$530-741/MWh

Commercial Appliance BTM (2 hr)

- Lithium Ion to Zn flow \$642-1,208/MWh

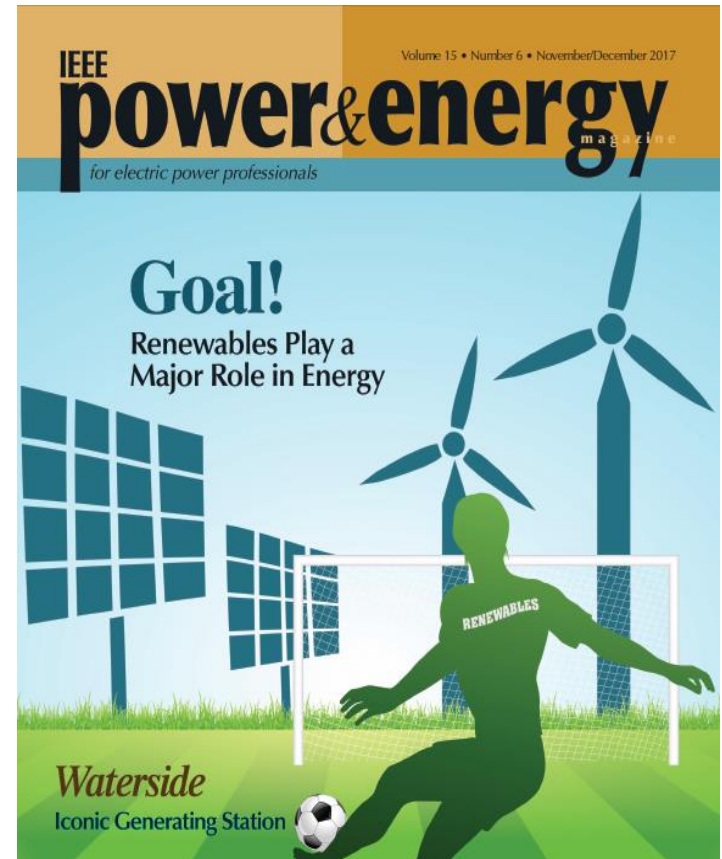
Residential BTM (2 hr)

- Lithium Ion to Zn flow \$890-1,241/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 12 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 visitors from afar:
 - China
 - Japan
 - Canada
 - Texas
- Take the time to make some new friends!
- Looking forward to another great meeting!



2018 Spring Technical Workshop

March 13, 2018 - March 15, 2018
Tucson, Arizona

2018 Forecasting Workshop

June 19, 2018 - June 21, 2018
Saint Paul, Minnesota

2018 Fall Technical Workshop

October 1, 2018 - October 3, 2018
Denver, Colorado

THANK YOU

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Connect with @UVIG



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