ESIG Fall Technical Workshop

Charlotte, NC

October 28-30, 2019

ESIG

ENERGY SYSTEMS INTEGRATION GROUP

Meeting Overview – Monday

- **Monday Morning - Pre-Workshop Tutorial**
  - Future Directions for Market Design and System Planning
    - *Co-chairs: Bethany Frew, NREL and Mark Ahlstrom, NextEra*
- **Monday Afternoon – Working Group Meetings**
  - Research and Education WG – Chair, Mark O'Malley, NREL
  - Reliability WG – Chair, Jason MacDowell, GE
  - System Planning WG – Chair, Aaron Bloom, NextEra Analytics
  - Distributed Energy Resources (DER) WG – Chair, Brian Palmintier, NREL
  - System Operations and Market Design WG – Chair, Aidan Tuohy, EPRI
- **Monday evening ESIG Board meeting 6:00 pm**

Meeting Overview – Tuesday AM

- **Welcome and Overview Session**
  - Moderator, Mark Ahlstrom, NextEra Energy Resources, Board President, ESIG
  - Local Welcome and Keynote Comments: IRP Process of the Future, Mark Oliver, Managing Director, Integrated System Operations Planning, Duke Energy
  - Meeting Overview, Charlie Smith, ESIG Executive Director
- **Opening Plenary Session - Considerations for the System of the Future**
  - Chair – Bryan Hannegan, President & CEO, Holy Cross Energy

Meeting Overview –Tuesday PM

- **Session 2A – PPA's and Corporate 100% Renewables Targets – What Comes Next: A Panel Discussion**
  - Chair: Derek Stenclik, Founding Partner, Telos Energy
- **Session 2B – Offshore Wind Development**
  - Chair: Mike Derby, Program Manager, Wind Technology, DOE
- **Session 3A - System Planning for Energy Storage**
  - Chair: Aaron Bloom, Director New Product R&D, NextEra Analytics
- **Session 3B - System Planning for High VRE Penetration**
  - Chair: Ryan Quint, Sr. Manager, Advanced Analytics and Modeling, NERC
- **Early Career Networking Meeting/Reception 5:30 pm**
- **Networking Reception & Poster Session 6:30 pm**

Meeting Overview – Wednesday AM

- **Session 4A - System Operations Considerations for High Penetration Scenarios**
  - Chair: Aidan Tuohy, Principal Project Manager, EPRI
- **Session 4B - Market Design Evolution for High Share of Renewables**
  - Chair: Rob Gramlich, Founder & President, Grid Strategies
- **Closing Plenary Session: Creating the Future - A Panel Discussion**
  - Moderator: Mark Ahlstrom, NextEra; President, ESIG Board
- **Working Group Meeting Summaries & Closing Remarks**
  - Mark O'Malley, NREL/ESIG
- **Adjourn: 12:30 pm**

Renewable Energy is Very Competitive

- Lazard reports on lowest unsubsidized energy costs at end of 2018 for:

Rooftop residential solar	$160/MWh
Simple Cycle GT	$152/MWh
Nuclear	$112/MWh
Community Solar	$73/MWh
Coal	$60/MWh
Combined Cycle GT	$41/MWh
Utility scale solar	$36/MWh
Wind energy	$29/MWh

- Other reports from industry pubs on recent PPA prices:

Utility scale solar	$22-$35/MWh
Wind energy	$11-$25/MWh

Storage Systems Definitely Making Progress

- Lazard reports at end of 2018 on estimated lowest unsubsidized energy costs for a range of storage systems (10 kw to 100 MW):

Peaker Replacement (4 hr @ 100 MW)
- Lithium Ion $204/MWh

Utility Scale PV + Storage (PV @ 40 MW + storage of 20 MW @ 4 hr)
- Lithium Ion $108/MWh

C&I BTM Standalone (2 hr @ 1 MW)
- Lithium Ion $829/MWh

C&I BTM PV + Storage (PV @ 1 MW + storage of .5 MW @ 4 hr)
- Lithium Ion $315/MWh

Residential BTM PV + Storage (PV @ 20 Kw + storage of 10 Kw @ 4 hr)
- Lithium Ion $476/MWh

- Xcel Energy CO June 2018 ERP: **PV plus battery at $30-32/MWh**
- NextEra projects at NV Energy: **PV plus battery at $<30/MWh**

An Industry Maturing - Globally

- Global wind capacity end of 2018: 600 GW
- Global PV capacity end of 2018: 512 GW
- Global VG installations in 2018
  - Wind 54 GW
  - PV 109 GW
- Ballpark estimates for 2019 global VG installations
  - Wind 60 GW
  - PV 120 GW

Recent Industry Trends

- Corporate demand for carbon-free energy is increasing. Bloomberg NEF reported US corporations acquired 8.5 GW of clean energy in 2018, with 2019 poised to set new records
- RE100 corporate membership expands from 158 at end of 2018 to 206 today
- Sierra Club *Ready for 100* campaign reports increasing commitments to 100% renewable goals;
  - 141 cities, 11 counties
- Eight states and DC have legal requirements:
  - HI – 100% clean energy by 2045
  - CA – 100% clean energy by 2045
  - NM – 100% clean energy by 2045
  - WA – 100% clean energy by 2045
  - CO – 100% clean energy by 2050
  - NV – 100% clean energy by 2050
  - ME – 100% clean energy by 2050
  - NY – 100% clean energy by 2040
  - DC – 100% renewable energy target by 2035
- Eight states to watch for 100% clean energy targets by 2050:
  - MN, MI, WI, IL, MA, NJ, PA, NC

Recent Industry Developments

- CAISO explores initiative to develop an approach to extend participation in the day-ahead market to the Western Energy Imbalance Market (EIM) entities in a framework similar to the existing EIM approach for the real-time market. EIM reports total benefits at end of Q2 2019 of $736 million since its inception in November 2014.
- Record coal plant retirements of 16 GW in 2018
- Sunrun clears ISO-NE capacity auction with 20 MW VPP with aggregation of residential PV and storage, first ever
- FPL unveils plans to build what it says will be the largest solar-powered battery plant in the world, 409 MW / 900 MWh Manatee Energy Storage Center, to begin operation in 2021
- Or is it the Vistra Moss Landing battery at 300 MW/1200 MWh?

Some Recent Headlines…

- MidAmerican To Become First 100% Renewable Energy Utility with Wind XII Project
  - *Wind XII will transform our 100% renewable energy vision from a bold dream into a reality.* Adam Wright, MidAmerican President and CEO
- Even in Indiana, New Renewables are Cheaper than Existing Coal Plants
  - NIPSCO found it can save customers more than $4B over 30 years by moving from 65% coal today to eliminating it by 2028 and replacing it with mostly wind, solar and storage.
- Idaho Power targets 100% carbon free energy by 2045, joining the ranks of Xcel
- Duke Energy Aims for 100% Carbon-free Power by 2050

More Recent Headlines…

- Offshore wind picks up …
  - NJ selects Orsted for 1.1 GW offshore plant in country's largest offshore procurement to date (June 2019)
  - NY awards 1.7 GW of offshore wind in single largest renewables procurement in country's history (July 2019)
  - Dominion lays out plan for 2.6 GW of offshore wind in VA, largest offshore wind project so far in the US (Sept 2019)
- Skirmishes Continue Around FERC Order 841 on Integration of Energy Storage into Wholesale Markets
- Statkraft Looks to VPPs as Renewable Energy Demand Surges
  - 12 GW German VPP consists of approximately 1,300 wind plants, 100 solar projects, 12 biomass power plants, and eight hydro stations.

And More Recent Headlines…

- Study: Fossil Fuel Generation has No Business Case in Australia, according to the author of a report by CSIRO and AEMO
- MISO Looks to Reduce Coal Fired Generation from 48% to 29% by 2030, and Expects Solar and Wind to Increase to 30% from 7% Today
- Replacing Most Coal Plants with Renewables Cheaper than Keeping Them Open, Report Finds
  - 74% of existing coal could be replaced with cheaper renewables today. That percentage climbs to 86% by 2025. Assumptions only considered solar and wind potential within 35 miles of coal power plants.

And Even More Recent Headlines…

- Idaho Power claims one of lowest priced solar deals at $22/MWh
- Portugal Lands World Record-Breaking Solar Price of US$16.54/MWh
- LA regulators approve “historically low cost” solar plus storage project (400 MW PV plus 300 MW/1200 MWh battery) at $19.97/MWh for PV energy and $13/MWh for battery energy
- NextEra announces PGE project with 300 MW wind, 50 MW PV, and 30 MW, 4 hr battery
- NextEra Inks Massive Wind/Storage/Solar Deal in Oklahoma with Western Farmers Electric Coop: Cheaper Than a Peaker (250 MW wind, 250 MW PV, 200 MW, 4 hr battery)
- Increasing amounts of solar PV-battery and other hybrids in the interconnection queues nationwide

NextEra Energy Earnings Call – Jan 2019

From an article by Christian Roselund reporting on the NextEra Energy earnings release conference call of January 25, 2019

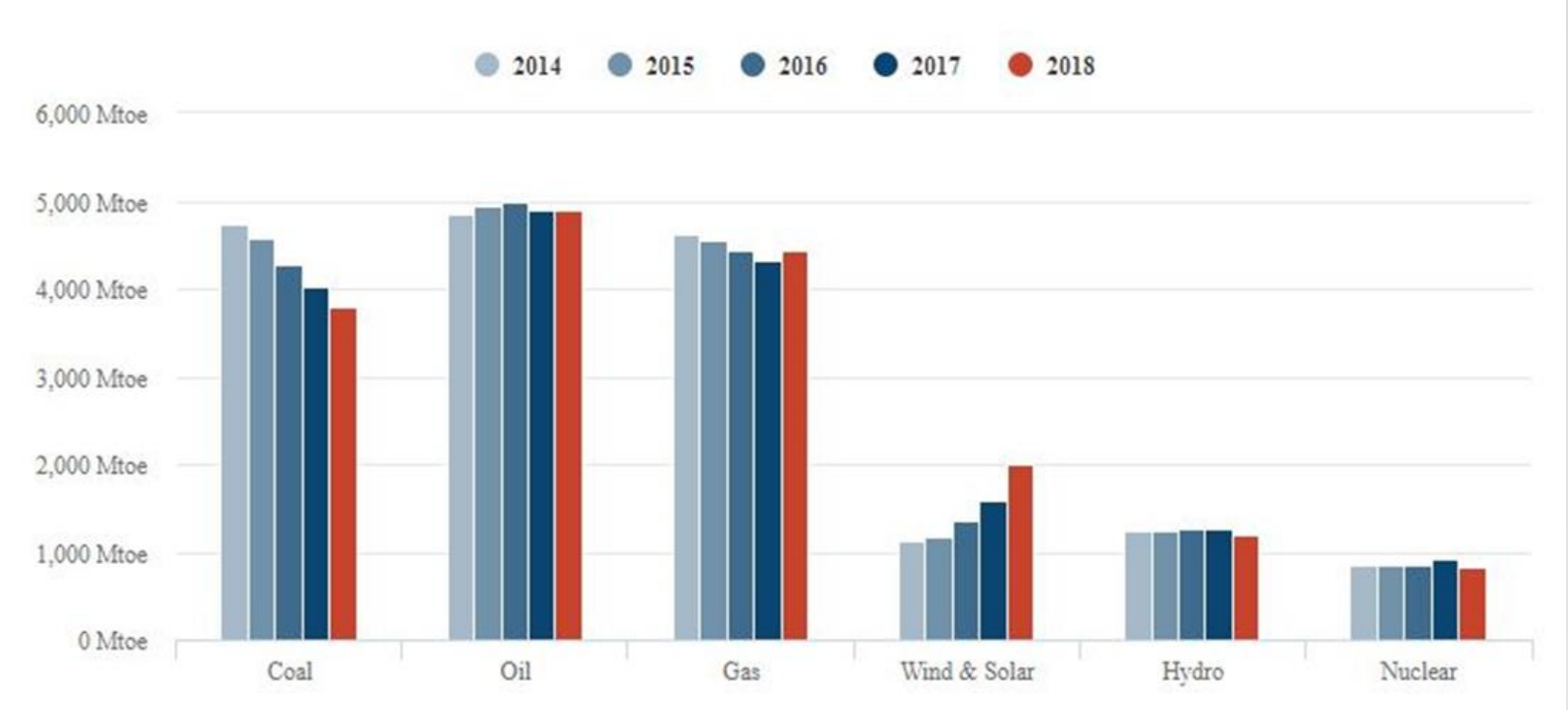
- CEO Jim Robo predicted that solar and wind plus storage will be cheaper than coal, oil or nuclear, that this will be massively disruptive to the conventional fleet, and that it will provide opportunities to developers well through the next decade
- Here are the costs Robo anticipates early in the next decade:
  - Unsubsidized new wind: 2.0-2.5 cents per kilowatt-hour
  - Unsubsidized new solar: 2.5-3.0 cents per kilowatt-hour
  - Storage will add .5-1 cents per kilowatt-hour to cost of solar
- Lowest average cost of CC plant around 4 cents per KWh, and you still have the uncertainty of the fuel cost

Xcel Energy Clean Energy Plan

- In June 2018, Xcel Energy Colorado submitted a plan to retire two coal units 10 years early and replace them with $2.5B of wind, solar and batteries, while reducing cost and emissions and improving reliability
- *"I will tell you, it's not a matter of if we're going to retire our coal fleet in this nation, it's just a matter of when,"* Xcel Energy CEO Ben Fowke said on stage at EEI Annual Convention in San Diego in preview of the plan.
- In December of 2018, Xcel Energy announced a commitment to achieve 100% carbon-free electricity across its 8 state territory by 2050, a first for the industry
  - *Plans to cut carbon emissions 80% below 2005 levels by 2030 will be fairly easy and affordable*
  - *Getting all the way to 100% is the tough part*
- See Alice Jackson editorial in Nov-Dec IEEE PES magazine

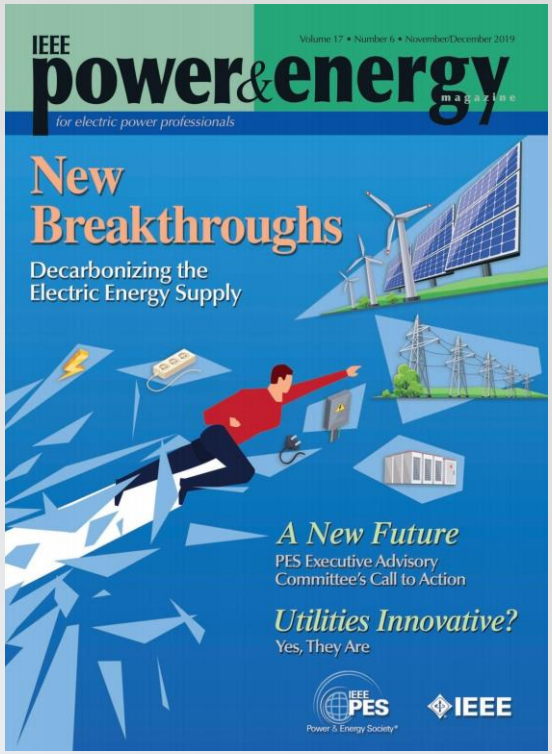
Renewables are the Way of the Future

BP Outlooks for 2035



Onward and Upward

- New IEEE P&E integration issue is out
- A warm welcome to visitors from afar:
  - Australia
  - Japan
  - China
  - Korea
  - Malaysia
  - Denmark
  - Belgium
  - Canada
  - Texas
- Take the time to make some new friends!
- Looking forward to another great meeting!



Upcoming 2020 Meetings

2020 Spring Technical Workshop
March 17-19, 2020
Loews Ventana Canyon Resort
Tucson, AZ

2020 Meteorology & Market Design for Grid Services Workshop
June 9-11, 2020
Curtis Hotel - Downtown Denver
Denver, CO

2020 Fall Technical Workshop
October 26 – 28, 2020
Sheraton Austin at the Capitol
Austin, TX

Thank You!

Charlie Smith

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