



ESIG Fall Technical Workshop

Austin, TX
September 29, 2020



Meeting Overview – September to November

- Welcome and Overview Session
- Opening Plenary Session – 100% Clean Energy
- Challenges with Weak Grids and Low Inertia Systems
- Hydrogen Production and Flexibility Requirements
- Corporate Procurement of 24/7 Clean Energy
- Fuels for the Future

Meeting Overview – cont.

- Inter-Regional Transmission – Are We There Yet?
- DER Evolution and System Impacts
- System Planning Considerations for High VRE Penetration
- Offshore Wind Developments
- Advances in System Operation and Market Design for High VRE Penetration
- Generation and Storage Technology – Status and Prospects

Renewable Energy is Very Competitive

- Lazard reports on lowest unsubsidized energy costs at end of 2019 for:

Rooftop residential solar	\$151/MWh
Simple Cycle GT	\$150/MWh
Nuclear	\$118/MWh
Coal	\$66/MWh
Community Solar	\$64/MWh
Combined Cycle GT	\$44/MWh
Utility scale solar	\$32/MWh
Wind energy	\$28/MWh

- Other reports from industry pubs on recent PPA prices:

Utility scale solar	\$15-\$22/MWh
Wind energy	\$11-\$25/MWh

Storage Systems Definitely Making Progress

- Lazard reports at end of 2019 on estimated lowest unsubsidized energy costs for a range of storage systems (6 kw to 100 MW):

Peaker Replacement (100 MW @ 4 hr)

- Lithium Ion \$165/MWh

Utility Scale PV + Storage (PV @ 100 MW + storage of 50 MW @ 4 hr)

- Lithium Ion \$102/MWh

C&I BTM Standalone (1 MW @ 2 hr)

- Lithium Ion \$485/MWh

C&I BTM PV + Storage (PV @ 1 MW + storage of .5 MW @ 4 hr)

- Lithium Ion \$223/MWh

Residential BTM PV + Storage (PV @ 10 kw + storage of 6 kw @ 4 hr)

- Lithium Ion \$457/MWh

- Other reports from industry pubs on recent PPA prices:

NV Energy PV plus battery: \$22-26/MWh

El Paso Electric PV plus battery \$21/MWh

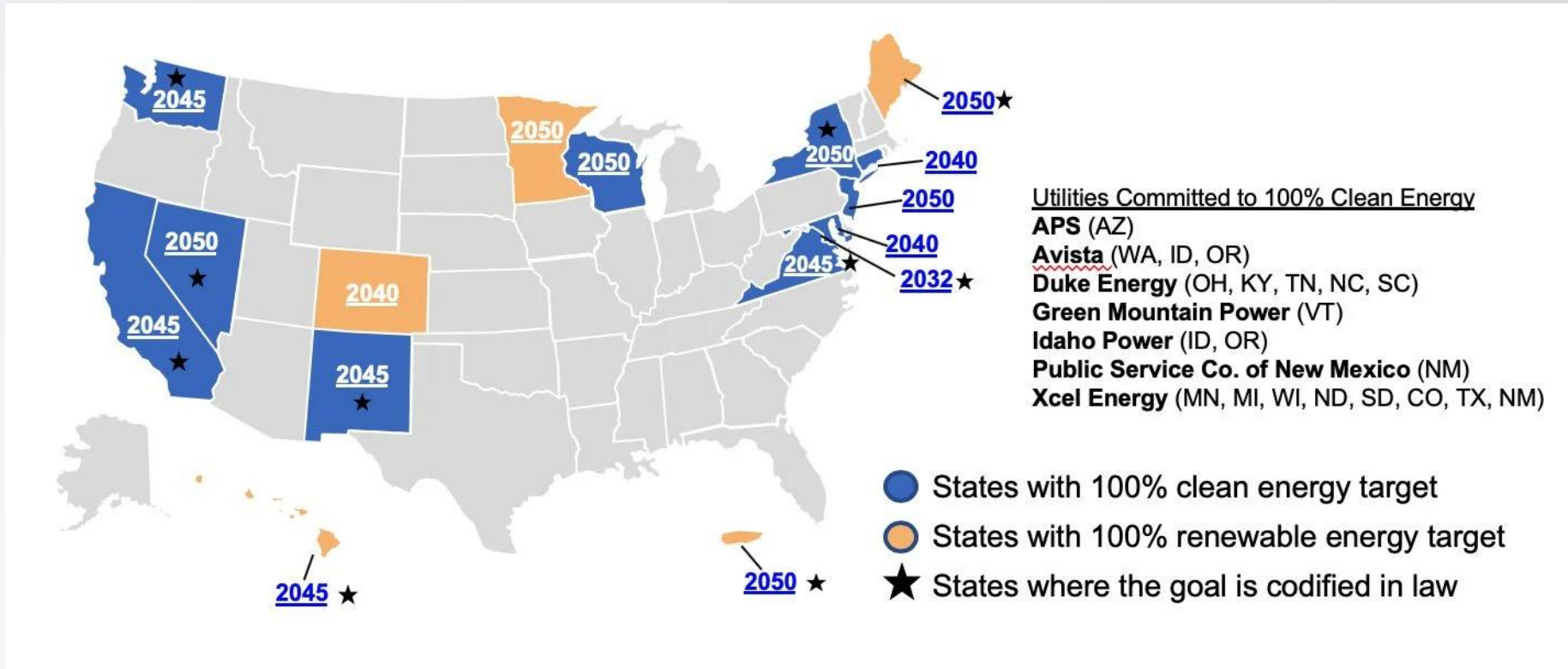
An Industry Maturing - Global

- Global wind capacity end of 2019: 650 GW
- Global PV capacity end of 2019: 580 GW
- Global VG installations in 2019
 - Wind 60 GW
 - PV 115 GW
- Ballpark estimates for 2020 global VG installations
 - Wind 55 GW
 - PV 110 GW

Recent Industry Trends

- Corporate demand for carbon-free energy is increasing. Bloomberg NEF reported US corporations acquired 13.6 GW of clean energy in 2019, with a global total of 19.5 GW procured
- RE100 US corporate membership expands from 158 at end of 2018 to 221 at end of 2019
- Sierra Club *Ready for 100* campaign reports increasing commitments to 100% renewable goals with 160 cities, 11 counties
- Of 370 GW of PV in interconnection queues at end of 2019, 100 GW was PV-battery hybrid

100% Clean Energy



Source: GTM Daily, 9 Sept 2020

Other Clean Energy Commitments by 2050

States – Michigan added last week

Utilities -

- DTE Energy
- Arizona Public Service
- Dominion Power
- Southern Company
- PSE&G
- NRG
- Consumers Energy
- Entergy
- And Ameren today!

Recent Industry Developments

- EIM reports total benefits of \$1 billion on July 3, 2020 since its inception in November 2014.
- CAISO explores initiative for Extended Day Ahead Market (EDAM) layered on top of EIM, with estimated production cost savings in the range of \$119 – \$227 million per year
- New report claims a US southeast regional electricity market could lead to cumulative savings of \$384 billion by 2040. Southern Co and Duke confirm market formation discussions
- Landmark FERC Order 2222 builds on Order 841 to require participation of DER aggregations in competitive wholesale electricity markets

Coal in the Headlines

- 33 GW coal retires in Obama's second term
- 37 GW retired during 3 ½ years under Trump
- EIA predicts renewable electricity production will surpass coal in 2020 and continue the trend thereafter
- Utilities increasingly on board with decarbonization

Natural Gas in the Headlines

- 2019 – US Energy Information Administration (EIA) Annual Energy Outlook put natural gas at 39% of the power mix in 2050 under its base case scenario, with renewables at 31%
- 2020 – US EIA Annual Energy Outlook has natural gas projected to provide 36% of electric energy in 2050, with renewables at 38%

Hydrogen in the Headlines

- Air Products, world's leading hydrogen producer, unveils plans to build world's largest green hydrogen plant in Saudi Arabia powered by 4 GW of wind and solar power
- EU unveils hydrogen strategy targeting 6 GW of electrolyzers by 2024, and 40 GW by 2030
- Australia announces exploration of green hydrogen site by Lightsource BP powered by 1.5 GW of wind and solar power
- Shell consortium wins 759 MW Dutch offshore wind bid, including solar, storage and green hydrogen

Storage in the Headlines

- Vistra receives approval to expand CA Moss Landing battery to 1500 MW, 6000 MWh
- Neoen filed plans for a \$3bn wind and solar plant with a 900 MW/1800 MWh battery at the Goyder South project in South Australia, with 1200 MW of wind and 600 MW of PV
- Australian AGL generation company announces first 150 MW of 500 MW battery at 1,680 MW Liddell coal station in New South Wales, set to close in 2023
- Hornsdale watch out!

Some Recent Headlines

- Mercedes parent Daimler signs 100% renewable PPA with Statkraft for 24/7 real time requirements for German operations - Statkraft hydro is key.
- Google announces pledge that by 2030 it will run its entire business on carbon-free energy 24/7.
 - Reached 100 percent renewable energy goal in 2017
 - Got 61 percent of 2019 global hourly electricity needs from wind, solar and other carbon-free sources
- Offshore wind set to take off on the US East Coast, with 25 GW announced by states

NextEra CEO at IEEFA Conference, October 2019

- Energy industry in the grip of a massive change, with the cost of energy from unsubsidized renewables and storage beating existing coal, nuclear and gas
- Renewables will likely replace coal generation in the US within a decade
- Robo notes EIA estimate of 35% electricity from renewables by 2030, says it could be as high as 50%, and could be 70-75% by 2050, and bring down rates across the country at the same time
- And he notes you can deliver reliable power as well

NextEra Energy Earnings Call – Jan 2020

From an article by Mark Watson reporting on the NextEra Energy earnings release conference call of January 24, 2020

- CEO Jim Robo predicted that solar and wind plus storage will be cheaper than the operating costs of most existing coal, nuclear, oil and gas units, which will be massively disruptive to the conventional fleet
- Here are the costs Robo anticipates early in the next decade:
 - Unsubsidized new near-firm wind: \$20-30 per megawatt-hour
 - Unsubsidized new near-firm solar: \$30-40 per megawatt-hour
- Lowest average cost of CC plant around \$40 per MWh, 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

BP Energy Outlook 2020 (Sept 2020)

- Says peak oil production may have been reached in 2019
(Dallas Fed Reserve Board survey says 66% of Dallas oil businesses are saying the same thing)
- **Key Takeaway #11:** The world is on an unsustainable path. A rapid and sustained fall in carbon emissions is likely to require a series of policy measures, led by a significant increase in carbon prices. These policies may need to be reinforced by shifts in societal behaviours and preferences. Delaying these policy measures and societal shifts may lead to significant economic costs and disruption
- Stock price nose-dived 1 week after announcement of shift from oil and gas company to integrated energy company

Summary of Big Energy Trends in the News

- Renewable energy is the fastest growing source of energy over the next 30 years
- Demand for oil falls over the next 30 years, driven by the increasing electrification of road transportation.
- The outlook for natural gas is more resilient, supporting fast growing developing economies as they decarbonize
- The importance of electricity in final energy consumption increases materially over the next 30 years (by 2x)
- The use of hydrogen increases as the energy system progressively decarbonizes

Blackrock, Morgan Stanley in the Headlines

- “The evidence on climate risk is compelling investors to reassess core assumptions about modern finance” because they see that “climate risk is investment risk,” CEO Larry Fink of Blackrock, the world’s biggest asset manager, wrote in January, 2020.
- “Carbon-heavy utilities” can “accelerate their earnings growth” by “shutting down expensive coal plants and investing in cheap renewables,” S&P Global reported Dec. 20, 2019, on findings from a Morgan Stanley Dec 10 research report

PG&E First Climate Change Related Bankruptcy

- Wall Street Journal Headline: January 18, 2019
- *PG&E: The First Climate-Change Bankruptcy, Probably Not the Last*
- *The fast fall of PG&E after California's wildfires is a jolt for companies considering the uncertain risks of a warming planet*

MIT Technology Review, May/June 2019

– Welcome to Climate Change

- **Catastrophic global climate change is not an event at all, and we're not waiting for it.**
- ***We're living it right now.***
- The three phases of climate change:
 - Mitigation
 - Adaptation
 - Suffering
- We must go on. We have no other choice.



Help is on the Way!



Energy Systems Integration Group

Charting the Future of Energy Systems Integration and Operations



Upcoming 2021 Meetings

2021 Spring Technical Workshop

March 2021

Loews Ventana Canyon Resort
Tucson, AZ

2021 Meteorology & Market Design for Grid Services Workshop

June 2021

Curtis Hotel - Downtown Denver
Denver, CO

2021 Fall Technical Workshop

October 2021

Sheraton Austin at the Capitol
Austin, TX



Energy Systems Integration Group

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Energy Systems Integration Group is a non-profit educational association that provides workshops, resources and education on the evolving electricity and energy systems.

ESIG supports engineers, researchers, technologists, policymakers and the public with the transformation of energy systems in a way that is economic, reliable, sustainable, thoughtful and collaborative.



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