Highly Distributed Energy Future Session

ESIG Towards 100% Renewables Pathways Workshop

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Ground Rules

- Chatham House Rules - participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.
- **Speak for yourself, not your company**

Scope of this session

- There is overlap with the *Volts and Amps* session on Grid-forming converters – *Volts and Amps* will take the lead on that topic
- There is overlap with *Flexibility and Operations* and *Adequacy* because distributed loads will contribute to some of the flexibility/peak that those tasks need
- This is not about transactive energy and price signals to induce consumer behavior – that's in *Markets*
- This is not about incremental DER penetration challenges. Those are important but not the topic for a futuristic visionary workshop like this.
- **This is about massive amounts of DER and what are challenges and potential approaches to enabling that?**

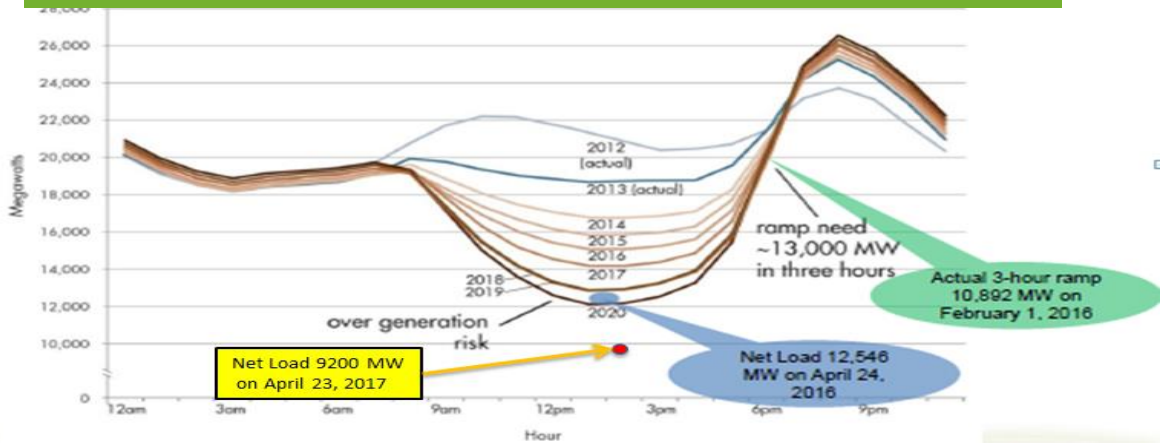
Agenda for 7 ¾ hours of this session:

- Introductions – 5 minutes
- Setup of issues – 10 minutes
- Autonomous Energy Grid Concept presentation by Ben Kroposki, NREL – 30 minutes
- Envisioning the Future – 2 hours
- How do you get there from here? – 2 hours
- What do we need? What are the gaps? – 2 hours
- Wrap-up – 1 hour

Introductions

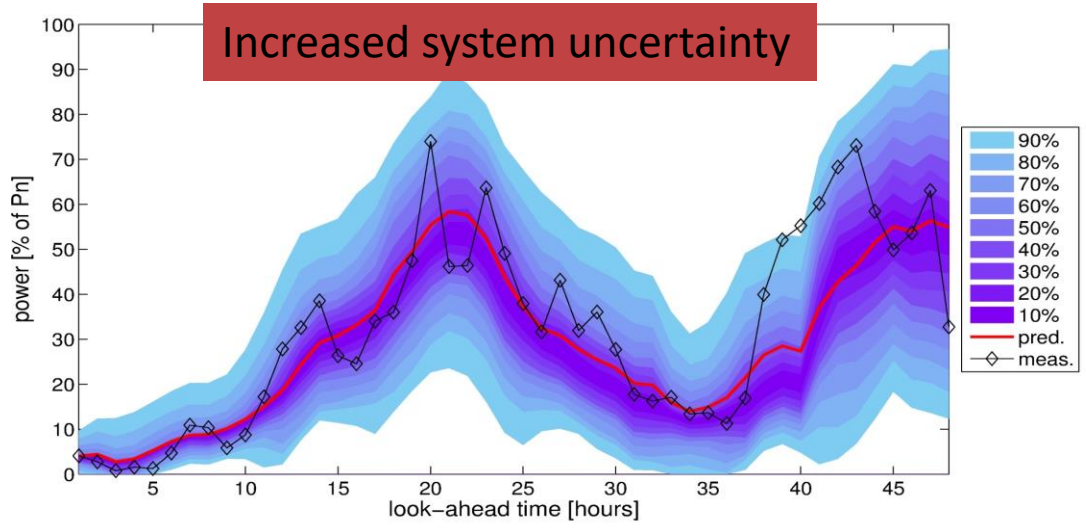
What are the challenges

Increased variability of supply side and uncertainty

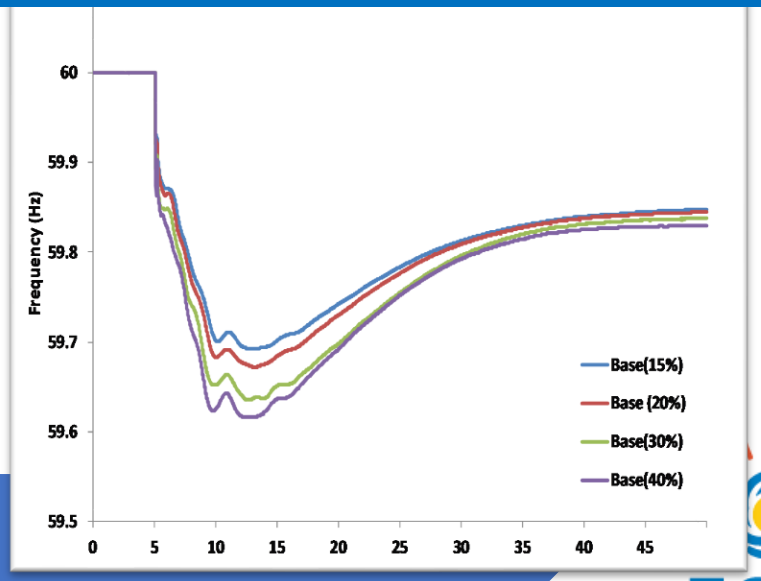


Transition to decentralized system

Increased system uncertainty



High penetration of inverter based resources



ESIG

Issues/challenges to tackle

- Scaling up control and communication to many nodes
- Control and communication on distribution system
- IBR issues: Protection, low inertia, weak grids
- Cybersecurity
- Interoperability with existing paradigm
- T&D operations

Autonomous Energy Grid Concept

Ben Kroposki, NREL

Envisioning the Future

- What would it look like if we designed a 100% renewables grid with very high penetrations of DER?
- Imagine a future with millions/billions of generation and load nodes. What capabilities do we need from each node?
- How do we monitor and assess security for a system that has millions/billions of nodes?
- What does the system architecture look like? How do we operate this autonomous system?
- Is some centralized control needed? What role would it play?
- What can we learn from microgrids?

The pathway/transition

- How do we get from today to this grand future?
- Interoperability of autonomous energy grids and conventional power systems
- Issues already faced regarding high DER penetrations: reverse power flow, T&D operations and coordination, protection

Solution brainstorming

- Major technological challenges that need to be overcome to reach this vision
  - Communication reliability/latency issues
  - High IBR penetration levels/grid-forming converters
  - Protection
  - T&D interface
- Technology needs
- Grid code needs
- Model needs
- Tool needs