DOE Transmission Reliability R&D Program

Eastern Interconnection Situational Awareness Monitoring System (ESAMS) Prototype Demonstration Project

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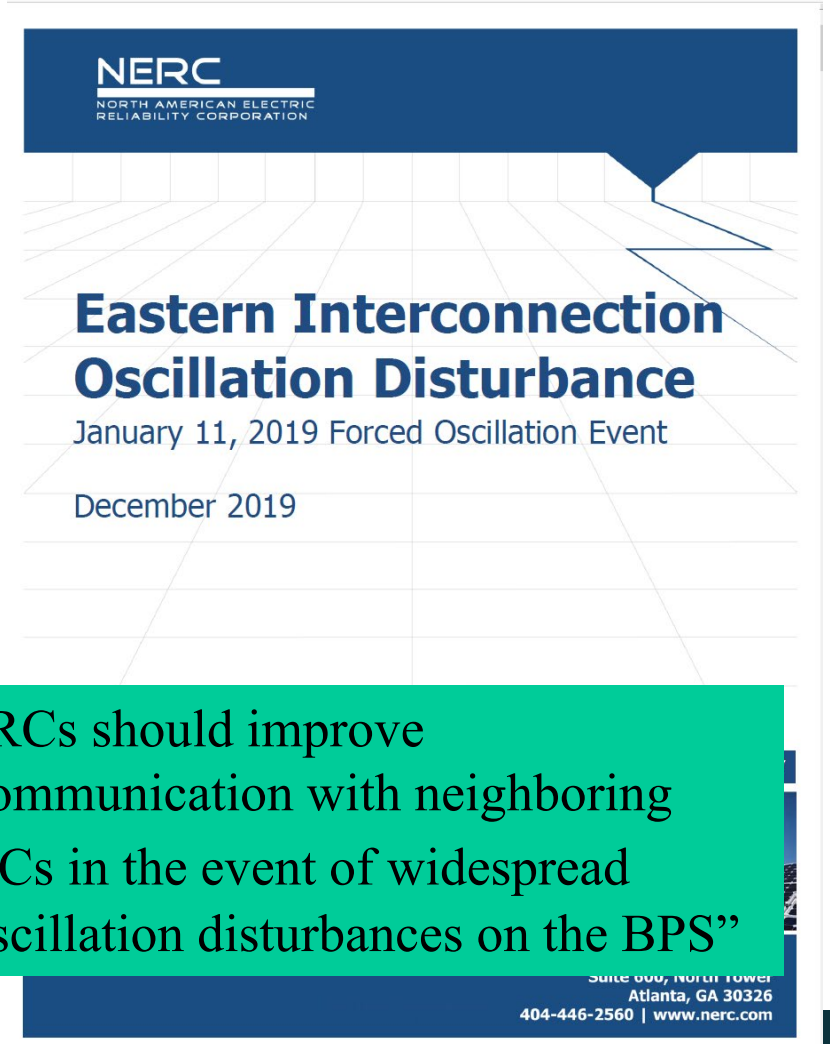
Motivation

- Reliability events can affect the behavior of an entire interconnection
- Yet, while operators have *excellent visibility within their footprints….*
  …. improving visibility outside their footprints is always desirable



"RCs should improve communication with neighboring RCs in the event of widespread oscillation disturbances on the BPS"

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Eastern Interconnection Situational Awareness Monitoring System (ESAMS) Prototype Demonstration

Overall Project Objectives:

To demonstrate how a common, high-level, synchrophasor-based view of the Eastern Interconnection can:

***Facilitate discussions** among Reliability Coordinators; and*

***Support information sharing** among operating entities*

Key Elements:

- Identification of the Reliability Coordinator footprint that is the source of a forced oscillation
- Monitoring and tracking trends in oscillatory modes and damping
- Monitoring and tracking trends in wide-area phase angle pairs

Information Delivery:

Daily emailed reports

Near real-time information on source location of forced oscillations - *forthcoming*

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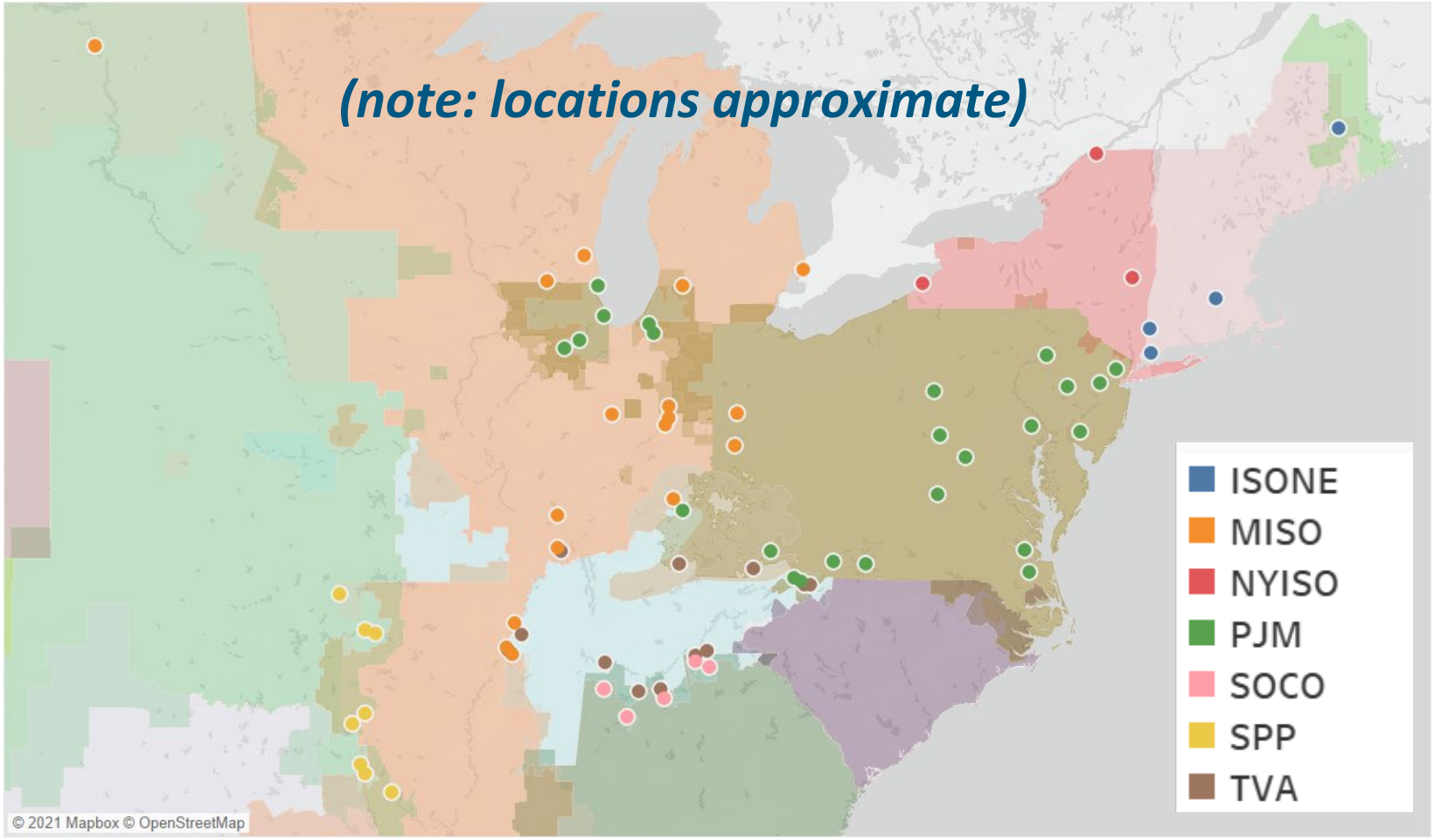
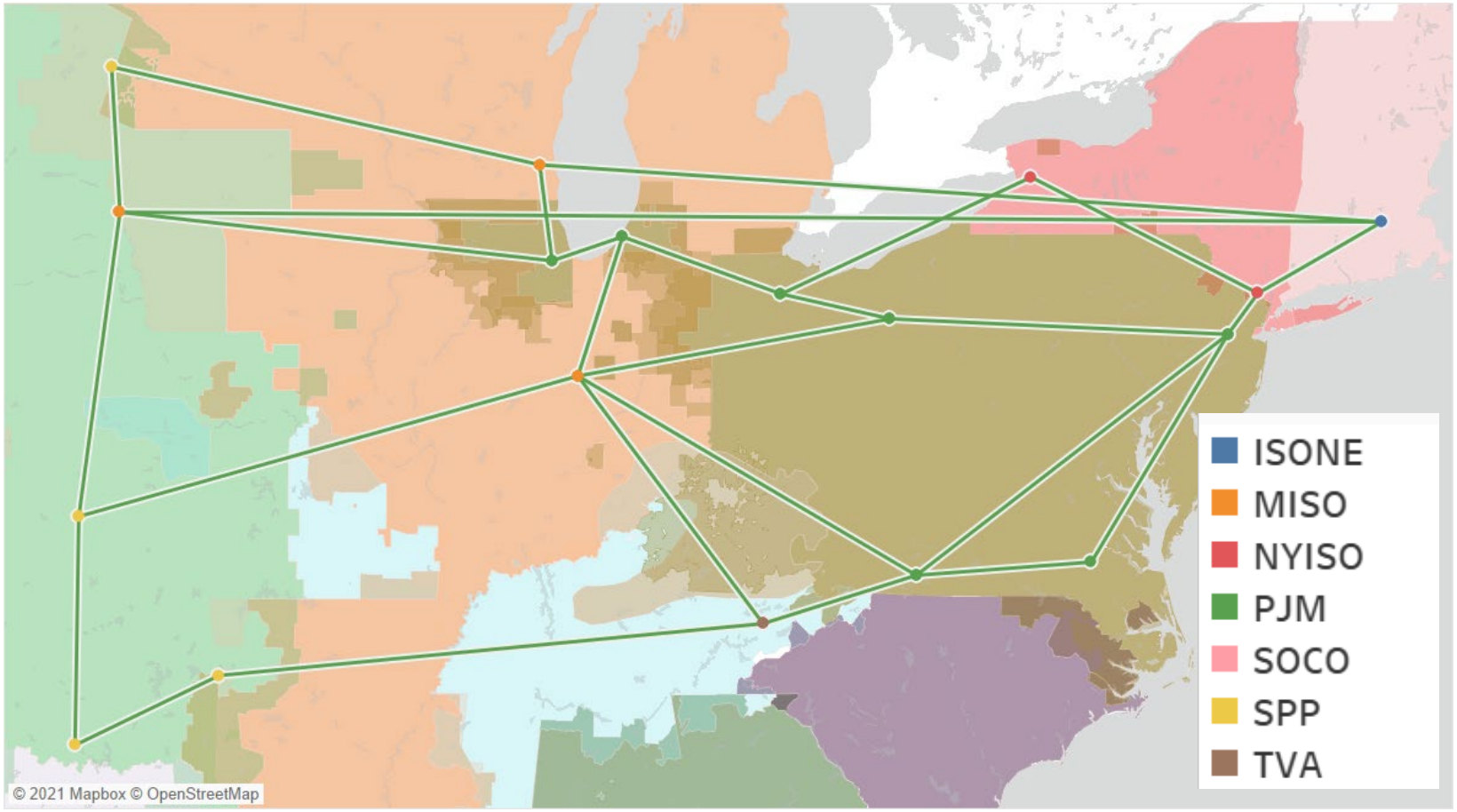
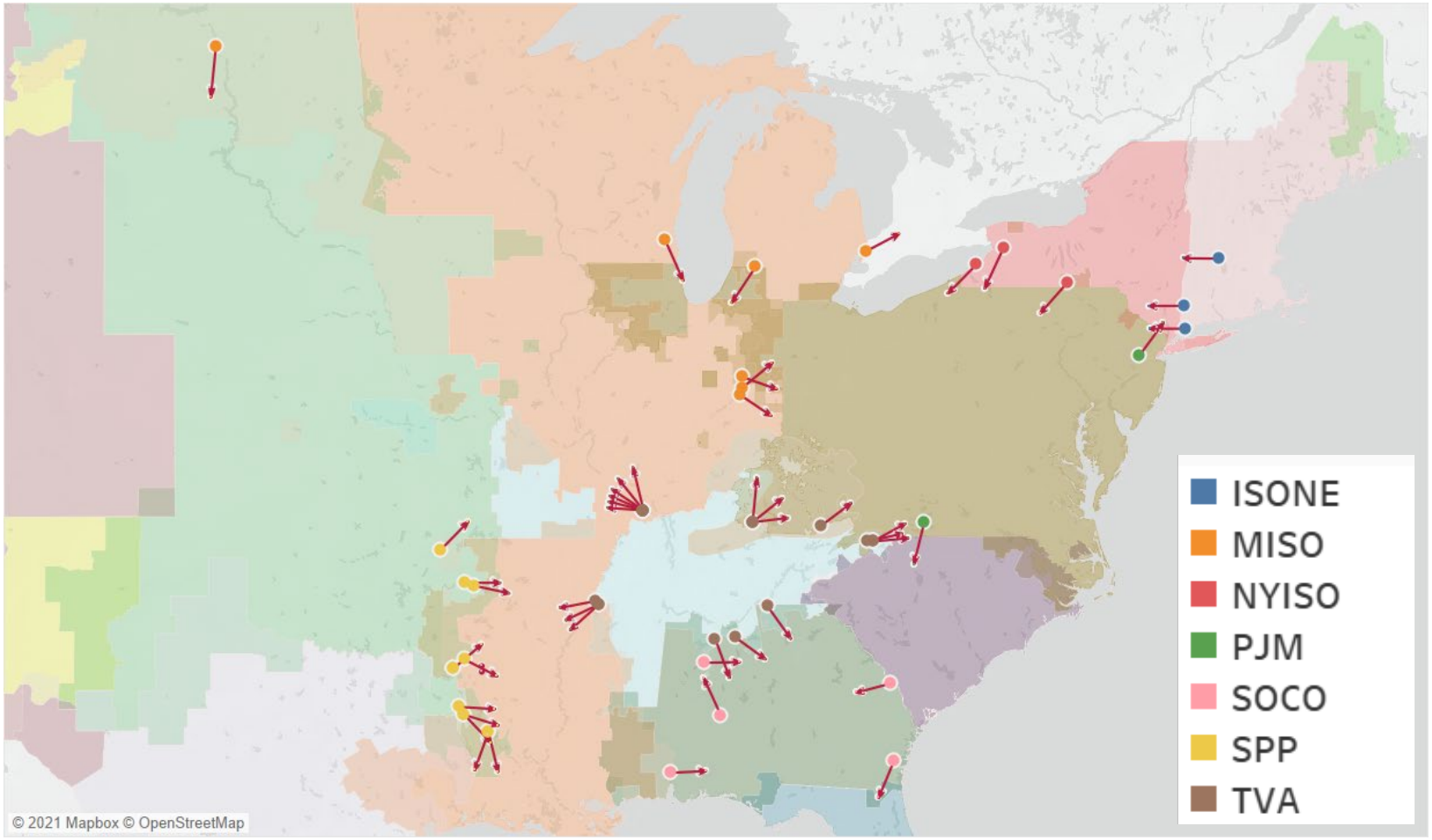
Locations of PMU signals currently streaming into ESAMS



Location of signals currently supporting Phase Angle Analyses



Location of signals currently supporting Forced Oscillation Source Location



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Daily Report Summary

Summary (Eastern Daylight Time, 24-Hour Format)

Event Type	Event Time (EDT)	Additional Information
Interconnection Oscillatory Behavior & Phenomenon		
Forced Oscillation Detection & Source Location	**15:33-15:45** *Time for event with highest energy*	**3 forced oscillation event(s) detected** Key info for event with highest energy: • Signal: SUB_A_SignalS1 • Type: Real Power • Frequency: 0.362 Hz • Value: 11.732 MW • Source Area: RC_1
Dominant Natural Oscillation Baselining		**Daily Report on Natural Oscillations**
Ringdown Detection	**06:42-06:50** *Time for event with earliest event time*	**1 ringdown event detected** List of angle pair(s) for event with earliest time: SUB_A – SUB_B SUB_B – SUB_C
Wide Area Phase Angles		
Rapid Step Changes	**20:50** *Time for event with most angle pairs participating*	**4 events with rapid step changes detected** Key info for event with the most angle pairs participating: • Number of Angle Pairs participating: 5 • Most sensitive angle pair during the event: SUB_A – SUB_B
Very Large Angles Compared to Recent Observations	**10:00-10:04** *Time for event with longest period of large angles*	**2 events with large angles detected** Angle pair with the longest time under stress: • Angle Pair: SUB_C–SUB_D
Atypical Combinations of Rapid Step Changes and Large Angles	**05:40** *Time for event with most angle pairs participating*	**5 Atypical Combinations detected** List of angle pair(s) with highest contribution to the event with most angle pairs: SUB_E – SUB_F SUB_F – SUB_G
PMU Data Quality Daily Report on PMU Data Quality		

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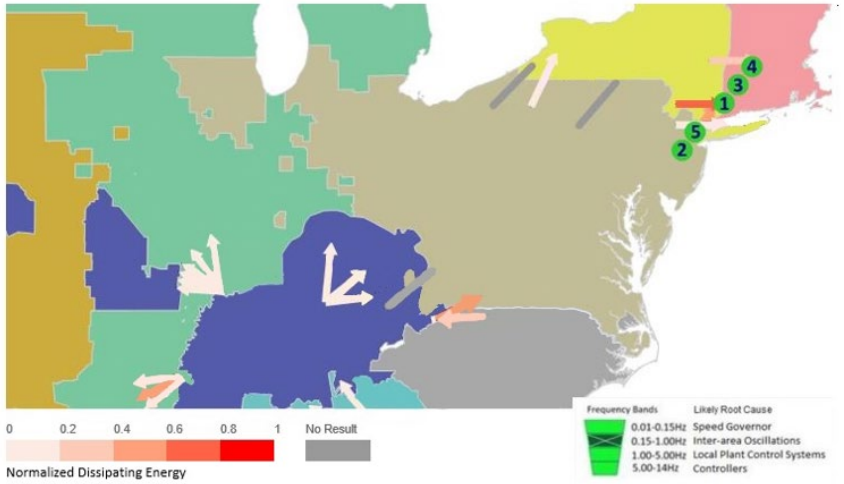
Forced Oscillation RC Source Location

Forced Oscillation Detection & Source Location

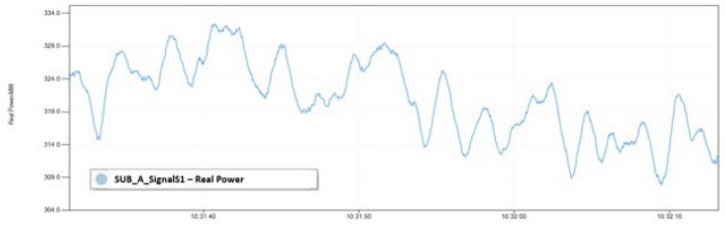
Forced Oscillation observed for [redacted]

1) Forced Oscillation event was detected by signal SUB_A_SignalS1,[redacted]5:33 - 09/02/2021 15:45, Source Area: RC_1



Time (EDT): 10:31 - 10:44; Frequency: 0.36 Hz; Oscillation Type: Inter-area Oscillations

Rank	Oscillation Detected at	Peak to Peak Amplitude	Oscillation Band RMS Energy
1	SUB_A_SignalS1	12 MW	7 MW
2	SUB_B_SignalS2	7 MW	4 MW
3	SUB_C_SignalS3	6 MW	4 MW
4	SUB_D_SignalS4	6 MW	3 MW
5	SUB_E_SignalS5	4 MW	2 MW



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Project Milestones and Schedule

Initiation of field demonstration (ISO-NE, MISO, NYISO, PJM)	June 2021
Bi-weekly review of events	Ongoing
Incorporate signals from TVA, SPP, Southern Co	September 2021
Near real-time notifications (RC footprint location of a forced oscillation)	November 2021
Conclusion of field demonstration	December 2021
EIDSN Advisory Committee evaluation*	Proposed to begin in Winter 2021-22

*Note that DOE, LBNL, EPG, and PNNL are not participants in this evaluation

ESAMS Demonstration Partners

ISO-NE – Frankie Zhang, Slava Maslennikov, Xiaochuan Liu

MISO – Keith Mitchell

NYISO – Emily Fernandez, Shubhrajit Bhattacharajee

Southern Co – Clifton Black, Chris Wakefield, Mark Newman, Michael Breuhl

SPP – Cody Parker

TVA – Tim Fritch, Gary Kobet, Phillip Crittenden

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ESAMS Project Team

PJM – Ryan Nice, David Hislop, Eric Hsia, Christopher Callaghan, Hamed Golestani, (formerly, also Shaun Murphy)

EPG – Neeraj Nayak, Simon Mo, Ken Martin, Horacio Silva-Saravia, Song Xue

PNNL – Jim Follum, Nick Betzsold

LBNL – Joe Eto