Load Participation in Ancillary Services

DOE Framing Workshop

October 25-26, 2011

Proposed Agenda

- EnerNOC Overview
- Who, Where, How and What we do
- Demand Response for Ancillary Services
- Wholesale Markets
- Bilateral Programs
- Lessons Learned
- Program Development Challenges
- NYISO Experience

EnerNOC Overview

Market Leader in Demand Response

- Largest C&I DR provider in the world
- Over 6.6 GW from more than 10,700 sites
- 100+ utility and grid operator customers

Innovative Suite of Applications

Strong Financial Track Record

- Publicly traded on NASDAQ (ENOC)
- 2010 Revenue of ~$280M
- ~600 full-time employees

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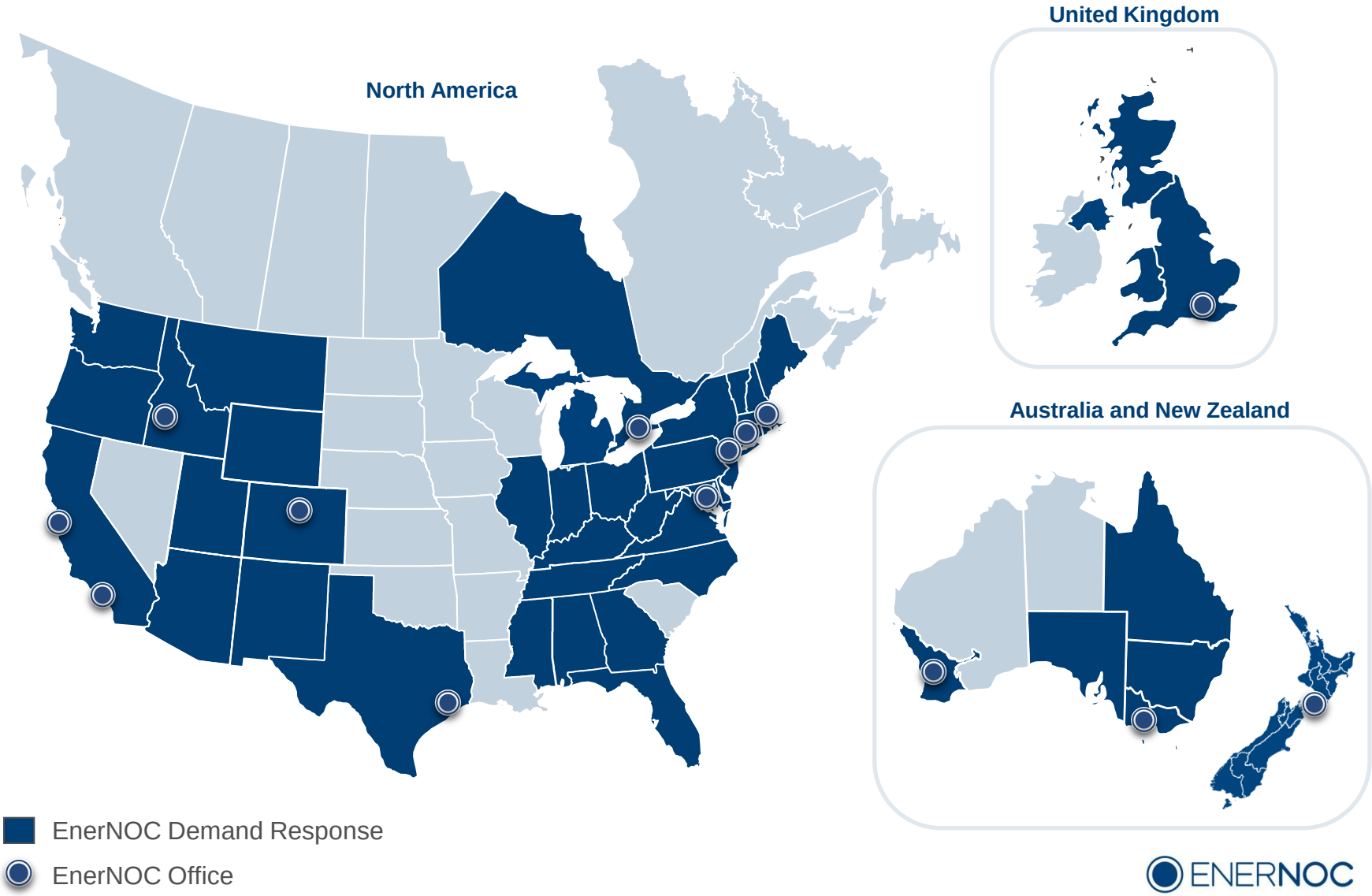
EnerNOC's Demand Response Footprint



Technology Platform

EnerNOC's highly-scalable technology platform provides a foundation for consistent and reliable DR dispatch performance, real-time performance measurement, and verification.

EnerNOC Site Server (ESS)

- Gateway device that establishes communication with EnerNOC's network
- Provides near-real time visibility into end-user energy usage
- Allows the NOC to remotely curtail loads

Network Operations Center

- 2 NOCs (3 with M2M)
- Staffed 24x7x365
- Advanced technology, specialized staff
- NOC (and ESS) are OpenADR compliant

DemandSMART

- Proprietary web-based energy management platform
- Monitors energy consumption and enables end-user load control
- Provides utilities and end-users with a web portal for monitoring (and dispatch)

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A multi-purpose resource

DemandSMART

Capacity

- Peak Management / CT Alternative
- Emergency / Reliability
- Network Support

Energy

- Direct participation wholesale energy markets
- Price response programs

Ancillary Services

- Load-Following/Wind integration (bi-directional)
- Spinning and non-spinning reserves
- Regulation
- Frequency responsive reserves

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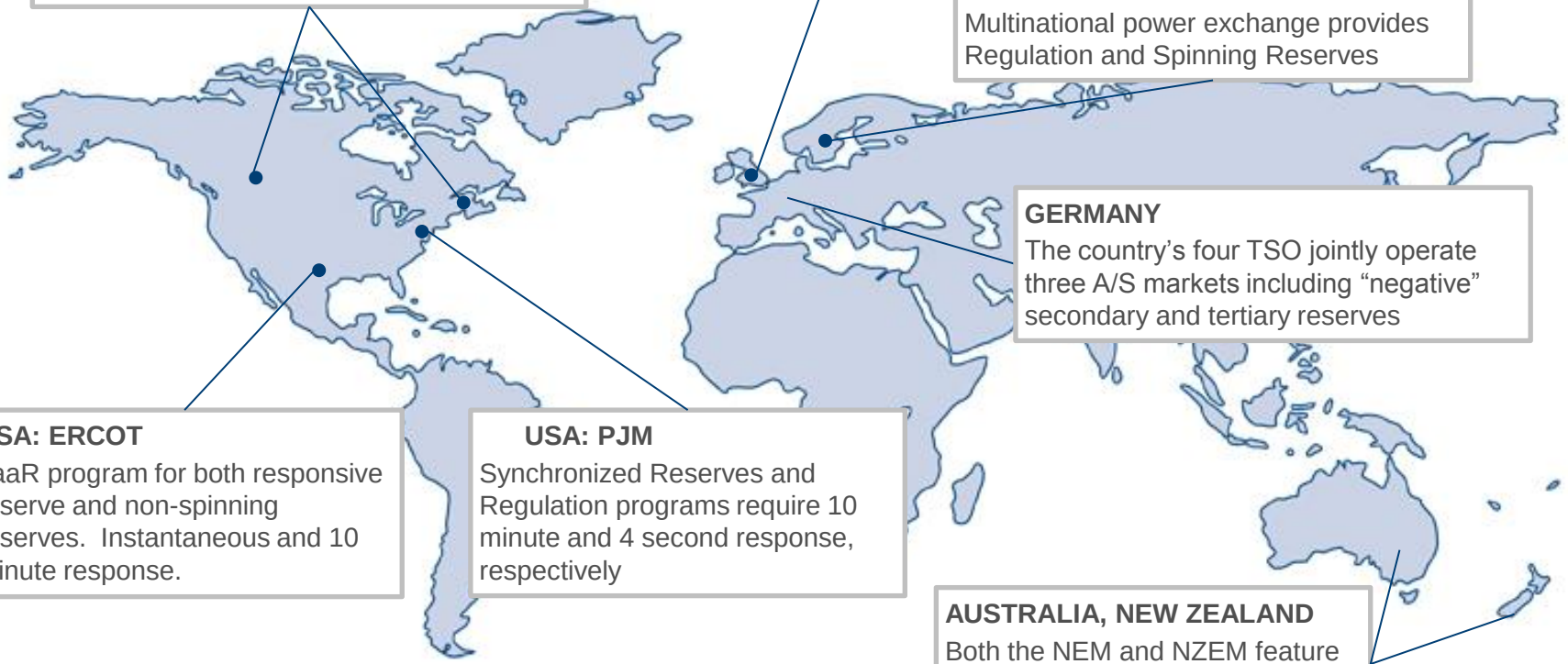
DR for A/S

Wind Integration

Demand Response Provides A/S Around the Globe



CANADA

Atlantic Provinces (Planned):
Fast-acting DR to balance intermittent wind

AESO LssI: Frequency responsive instantaneous DR resources

UNITED KINGDOM

National Grid Short Term Operating Reserves (STOR)

Response time: < 20 minutes

NORDPOOL

Multinational power exchange provides Regulation and Spinning Reserves

GERMANY

The country's four TSO jointly operate three A/S markets including "negative" secondary and tertiary reserves

USA: ERCOT

LaaR program for both responsive reserve and non-spinning reserves. Instantaneous and 10 minute response.

USA: PJM

Synchronized Reserves and Regulation programs require 10 minute and 4 second response, respectively

AUSTRALIA, NEW ZEALAND

Both the NEM and NZEM feature frequency response markets open to DR (e.g. FIR/SIR; FCAS)

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EnerNOC DR in Wholesale Markets

ISO/RTO	Wholesale Market	Product
Electric Reliability Council of Texas (ERCOT)	Emergency Interruptible Load Service	Capacity
ISO New England	Forward Capacity Market	Capacity
	Day Ahead Load Response	Day-ahead
	Demand Response Reserves Pilot	Ancillary Services
New York ISO	Special Case Resources	Capacity
	Con Edison Distributed Load Relief Program	Capacity
Ontario Power Authority	Demand Response 3 Program	Capacity
PJM Interconnection	Emergency Load Response Program	Capacity
	Economic Load Response Program	Energy
	Synchronized Reserves Market	Ancillary Services
National Grid UK	Short Term Operating Reserve (STOR) Market	Ancillary Services
Independent Market Operator (Western Australia)	Wholesale Electricity Market (WEM)	Capacity
Transpower (New Zealand)	Instantaneous Reserves	Ancillary Services
Australia Electricity Market Operator (AEMO)	National Electricity Market (NEM)	Energy

Example A/S Markets for DR

	National Grid STOR Programme (UK)	PJM Synchronized Reserves Program (USA)
Demand Response Types	Load curtailment and generation	Load curtailment and generation
Expected Event Frequency	**Weekly**	**Bi-weekly**
Event Notification	**20 minutes**	**10 minutes**
Program Period	Year Round	Year Round
Program Hours	Program Hours vary slightly by season, generally: •First Window: 07:30 to 14:00 •Second Window: 16:00 to 21:30 Bank holidays not included 6 or 7 day/week availability	24/7
Maximum Events	At aggregator's discretion	At customer's discretion
Response Duration	15 minutes to 4 hours	Up to 30 minutes. Average of ~12 minutes.
Technology Requirement	**1 minute interval metering** **Required integration with National Grid (SRD)**	**1-minute interval metering** **SCADA response at gen or meter (RTU)**
Capacity Payments	Yes	Yes
Event Payment	Yes	No

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Example A/S Markets for DR

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Demand Response Types	Load curtailment and generation	Load curtailment and generation
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Maximum Events	At aggreg	tion
Response Duration	15 minute	verage of ~12 minutes.
Technology Requirement	**1 minute in** **Required integration with National Grid (SRD)**	**metering** **SCADA response at gen or meter (RTU)**
Capacity Payments	Yes	Yes
Event Payment	Yes	No

Wind capacity on the National Grid UK system is expected to grow from 3.8 GW today to more than 26 GW in 2020.

As a result, National Grid plans to double the Short Term Operating Reserves Requirement from 4GW to 8 GW.

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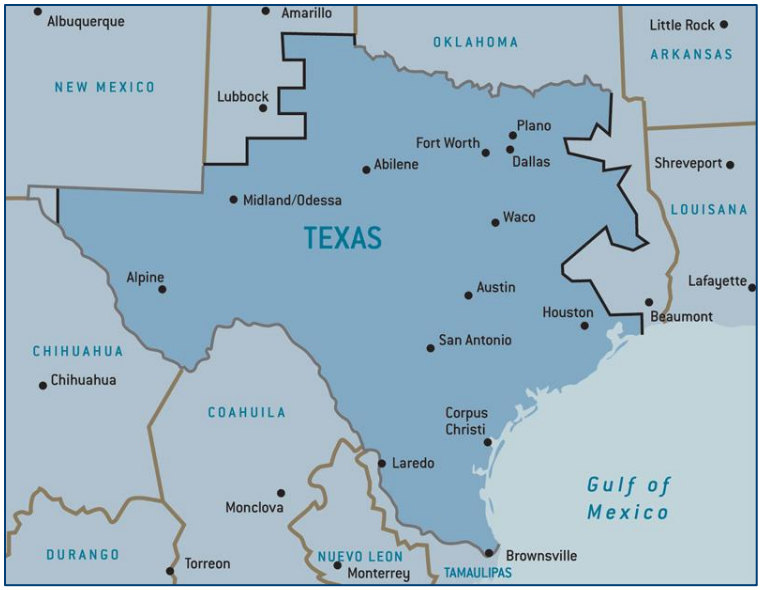
Increasingly Fast Response Times

Case Study: ERCOT Interruptible Load Response (ILR)



DR can provide cost-effective and reliable Responsive Reserve Services (RRS) and Non-spinning Responsive Reserve Services (NSRS); DR can provide up to a 1,150 MW cap and there is ~2,100 MW of registered LR capacity

Demand Response as Responsive Reserves

Technology Requirements

- Under frequency relay (UFR)
- Real-time telemetry

Event Triggers

- Grid frequency drops below 59.7 Hz
- ERCOT operator discretion

Advance Notice

- Instantaneous when tripped by UFR
- 10 minute when dispatch by phone

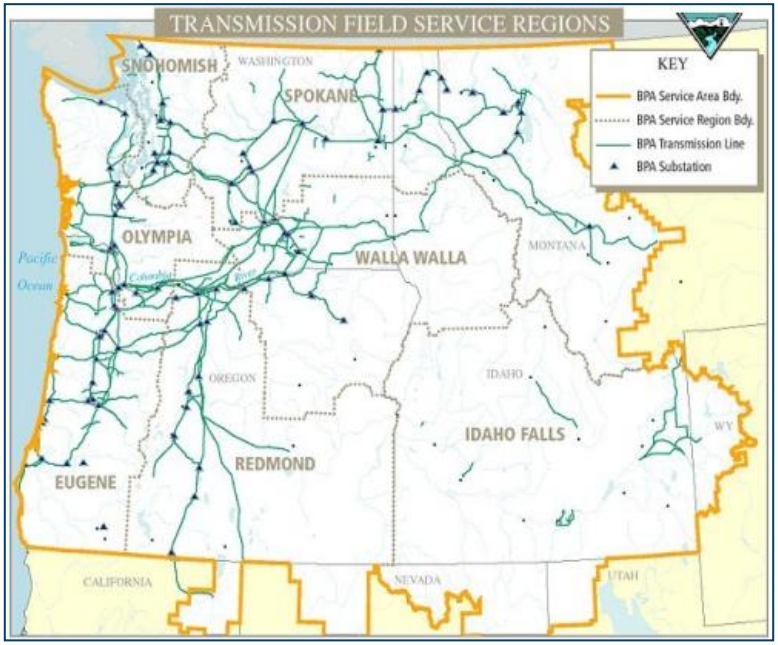
Event Details

- 24/7/365 resource availability
- No minimum or maximum event duration
- Performance must be maintained, on a second-by-second basis, throughout the entire duration of the event

Wind Integration Challenges Around the World

Controlling Loads Both Up and Down

Case Study: Bonneville Power Administration Pilots



Pace of wind power development in the Pacific Northwest is dramatically exceeding expectations, with 3,000 MW online today and another 6,000 MW 'in-process'.

Demand Response to Balance Wind

Technology Requirements

- Automated remote load control
- Real-time interval metering

Resource Details

- Capability to provide both INCs (load decreases) and DECs (load increases)
- Sub 10-minute notice
- 24/7/365 resource availability

Pilot Projects

- Refrigerated Warehouses
- Residential Hot Water Heaters
- Municipal Water Pumps
- Industrial Processes
- Irrigation Pumps

DR Strategies for Wind Balancing

Only a subset of traditional DR strategies will also work for wind balancing- DR plans in red below represent candidates for bi-directional load control.

Industry Vertical	Example Demand Response Plans
Agriculture	Control central pivot irrigation pumps
Asphalt, Concrete, Gravel	Curtail kilns, crushers, washers, and screening load centers. Shut off water pumps
Commercial Property/Office	Remotely curtail 1/3 of lighting Shut off chillers and AHUs Remotely raise chilled water temperature points several degrees
College/Univ.	Shut off 600 ton chiller 300 kW from spare capacity on 6 CHP Units
Foil Processing Plant	Shut down etching machines and rectifier lines
Food Processing	Control of spiral chillers, compressors, refrigeration motors, and HVAC Switch off refrigeration plant and butter mixer plant
Hospital	Transfer load to back-up generator
Lumber/Forestry	Curtail pole line, log sorting line, debarker, sawline, planing and grading
Printing	Shut down printing presses, binding equipment, compressors
Recycling	Curtail shredder, compactor and conveyor Shut down shredder and balers
Refrigerated Warehouse	Remote control of refrigeration equipment
Water/Wastewater	Control booster pumps

Lessons Learned From Ancillary Service DR

- Ancillary services require a more technical sales and enablement process than emergency DR resources
  - Resource requirements are more demanding, so need to set customer expectations through education
  - Seek highly-repeatable curtailment strategies
  - Enable remotely-controlled curtailment
  - Ensure expected curtailment through rigorous acceptance testing
- Rapid notification and initiation of curtailment protocols are crucial
  - Manage the resource with a sophisticated software platform, that can automatically receive and act on dispatch signals from utilities and grid operators
  - Facilities must allow full access to directly curtail loads
  - Schedule auto-curtailment protocols to begin 0-5 minutes from notification
- Continuously monitor each site to ensure connectivity and performance
  - Utilize a 24/7/365 Network Operating Center, in order to provide real-time visibility into resource availability and performance
  - Leverage very granular interval meter data (1 min intervals with short latency)

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Program Development

Getting the details right is a time-consuming process

NYISO Demand-Side Ancillary Services Program (DSASP)

- Current DSASP rules in place since 2008
  - All Ancillary Services open to DR
  - Minimum requirement: 1 MW sustainable for 1 hr (Reserves)
  - Communication: Leased line
  - Telemetry: Real-time ICCP to NYISO and utility, regulation must respond to 6 second AGC signals
  - Currently no active participants
- Current DSASP Barriers
  - Burdensome and expensive metering and communication requirements ($50-100k/site)
  - Aggregations not yet permitted
  - Full integration with energy market means A/S dispatches are economic, not event-based
  - No energy payment until new real-time economic program implemented

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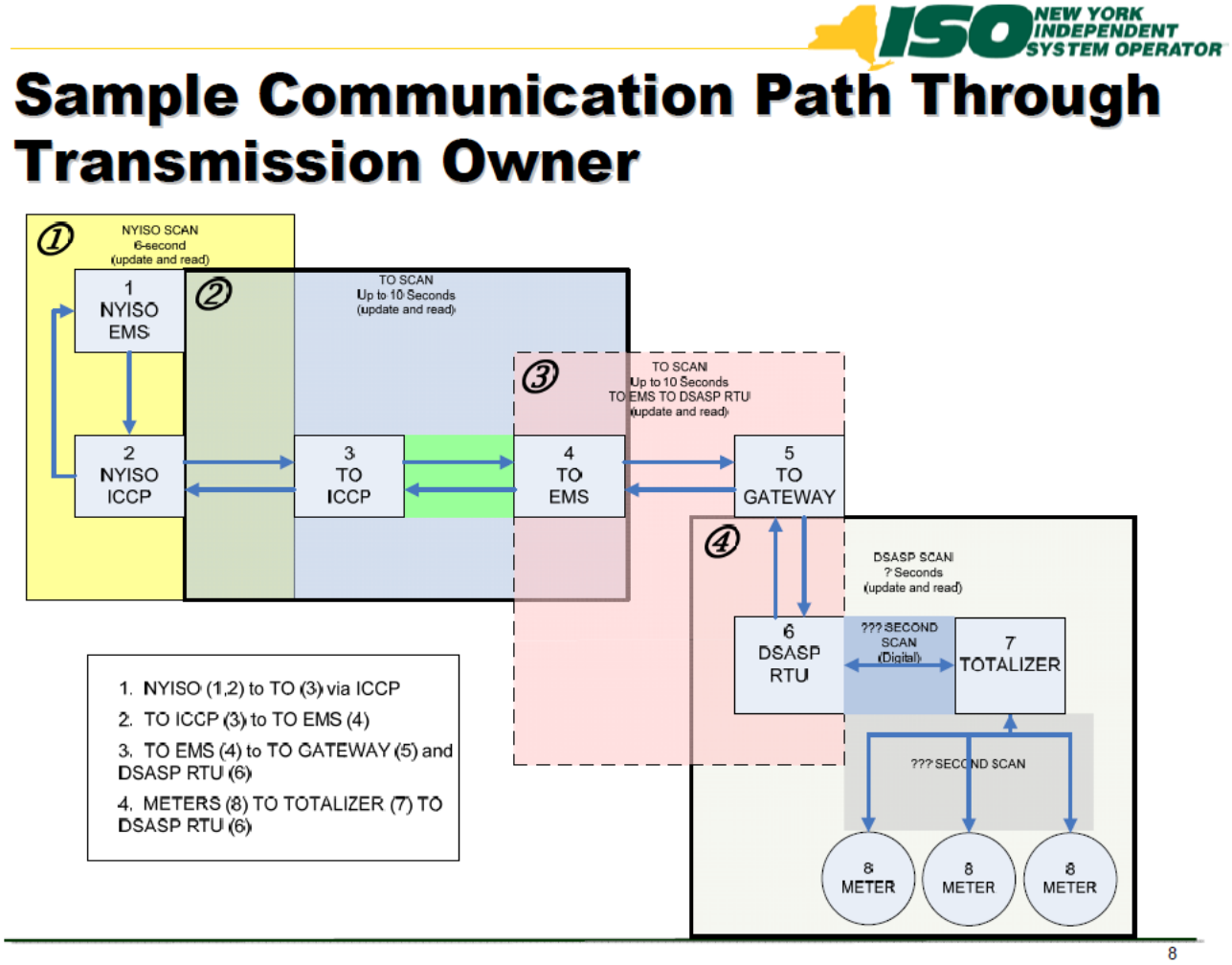
NYISO Demand-Side Ancillary Services Program (DSASP)

Current Communications Configuration



NYISO Demand-Side Ancillary Services Program (DSASP)

- DSASP Aggregation rules first proposed discussed in 2009, no rules in place
  - Minimum requirement: 1 MW sustainable for 1 hr (Reserves)
  - Communication: Leased line to aggregator
  - Telemetry: Real-time from aggregator ICCP to NYISO, regulation must respond to 6 second AGC signals
  - Program not yet implemented

- DSASP Aggregations
  - Mandated by Order 719
  - Initial discussions began in 2009 but details remain undeveloped
  - Premise: Aggregators communicate aggregate data to NYISO (and utility?) using ICCP over leased line. Aggregators communicate with resources using internet-based protocols

- Outstanding Concerns
  - Full integration with energy market means A/S dispatches are economic, not event-based
  - No energy payment until new real-time economic program implemented
  - Network latency may preclude aggregations participating in regulation markets if resource to aggregator to NYISO data must comply with 6 second AGC scan rates

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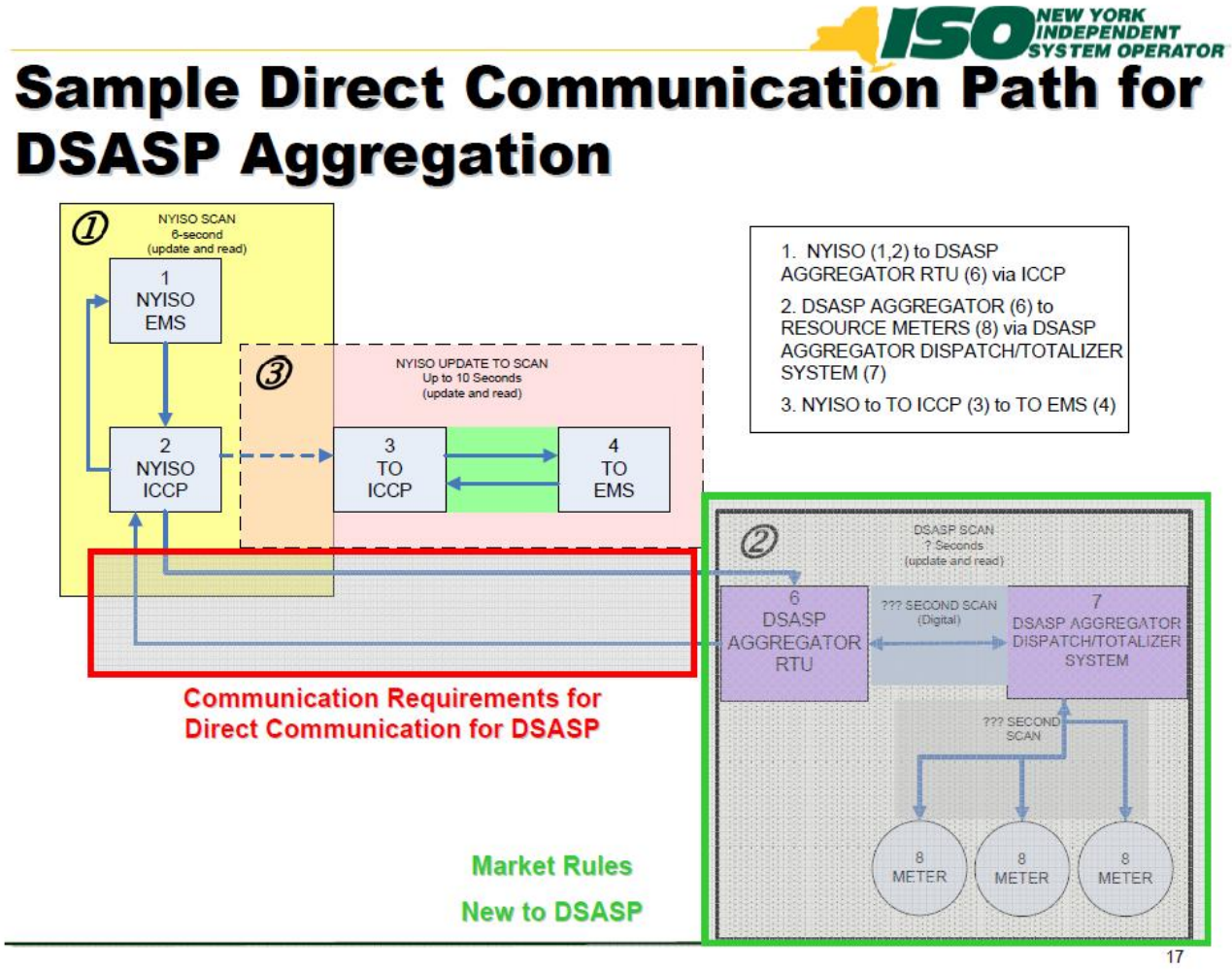
NYISO Demand-Side Ancillary Services Program (DSASP)

Current Communications Configuration



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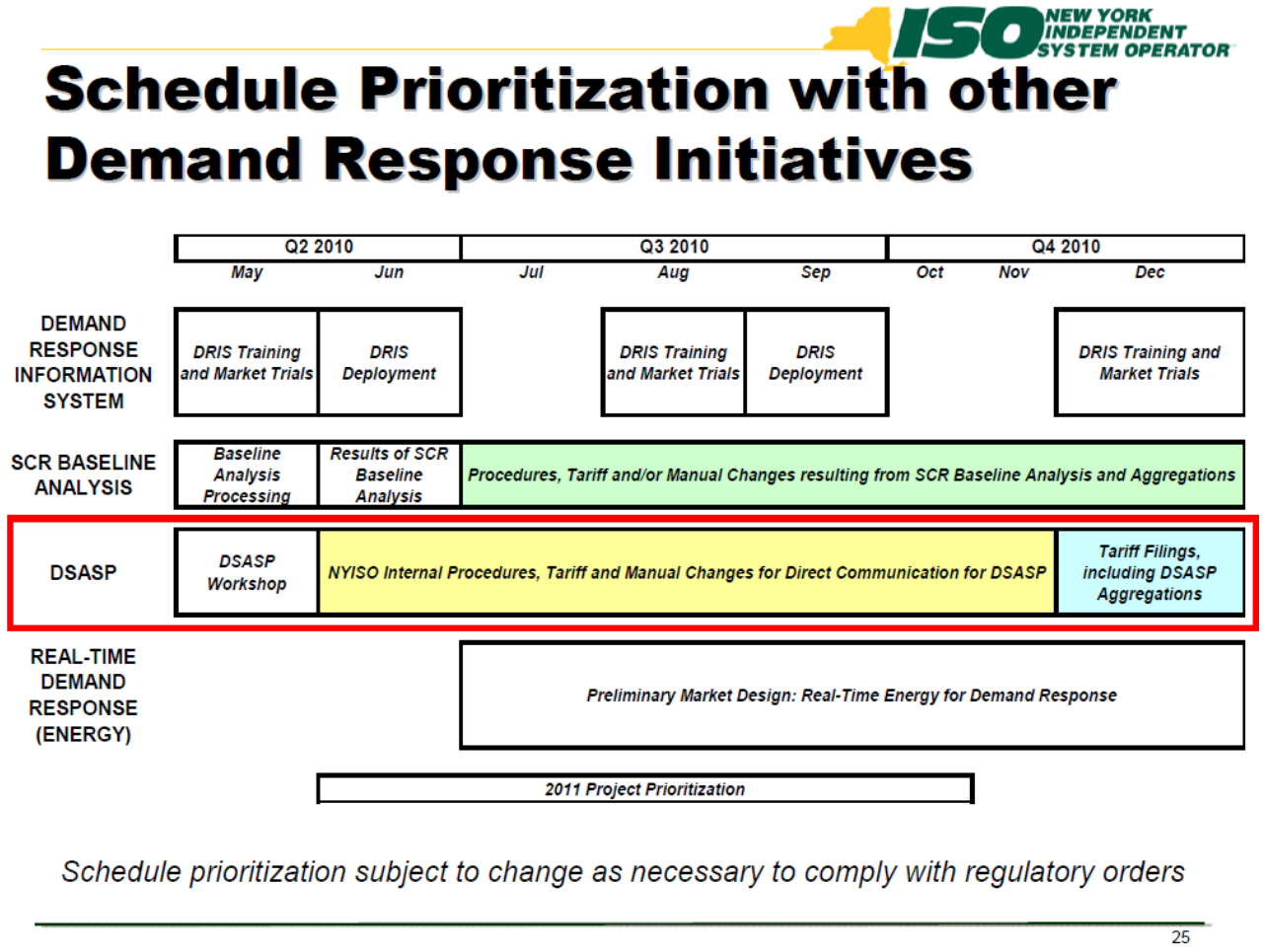
NYISO Demand-Side Ancillary Services Program (DSASP)

Competing Priorities and Tie to Real-Time Economic Program have Delayed Initiative



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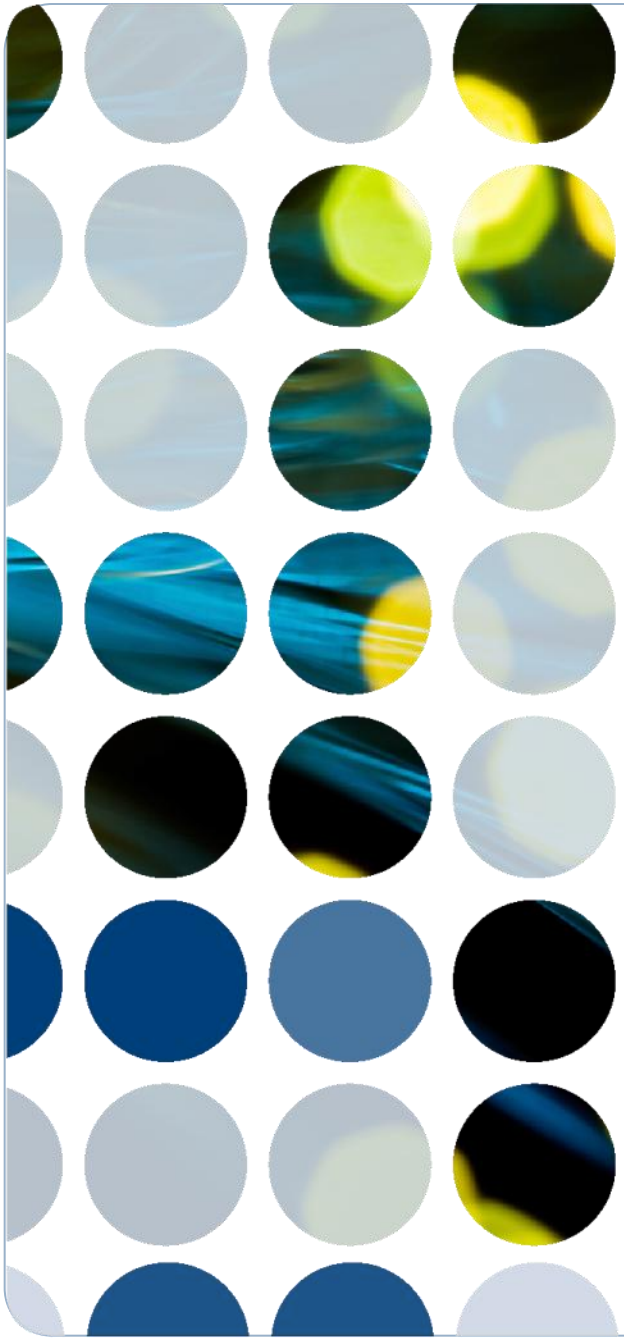

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