



## **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



DemandSMART



EfficiencySMART



SupplySMART

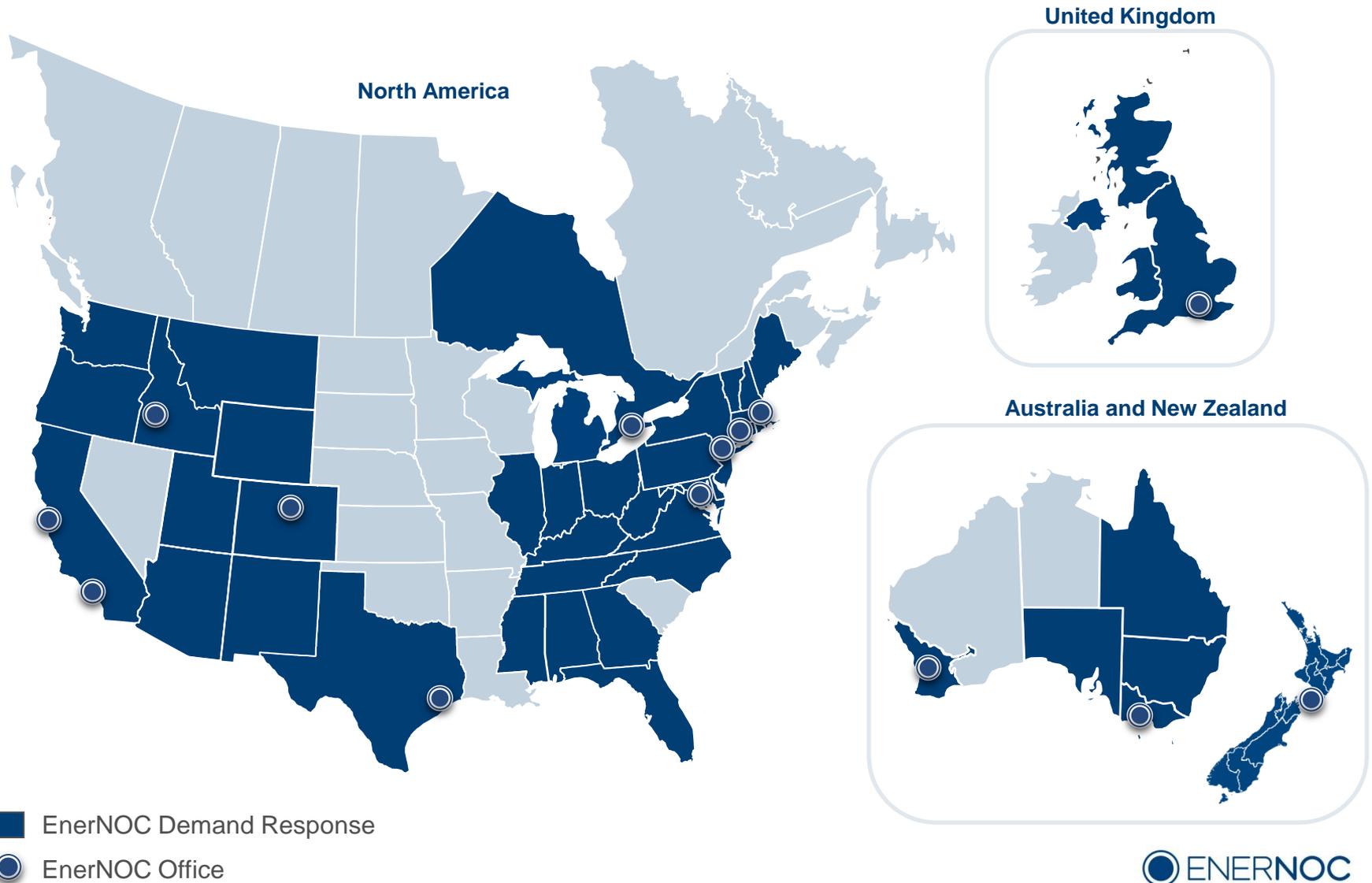


CarbonSMART

## Strong Financial Track Record

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

# 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)

# A multi-purpose resource



DemandSMART

## Capacity

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

## Energy

- Direct participation wholesale energy markets
- Price response programs

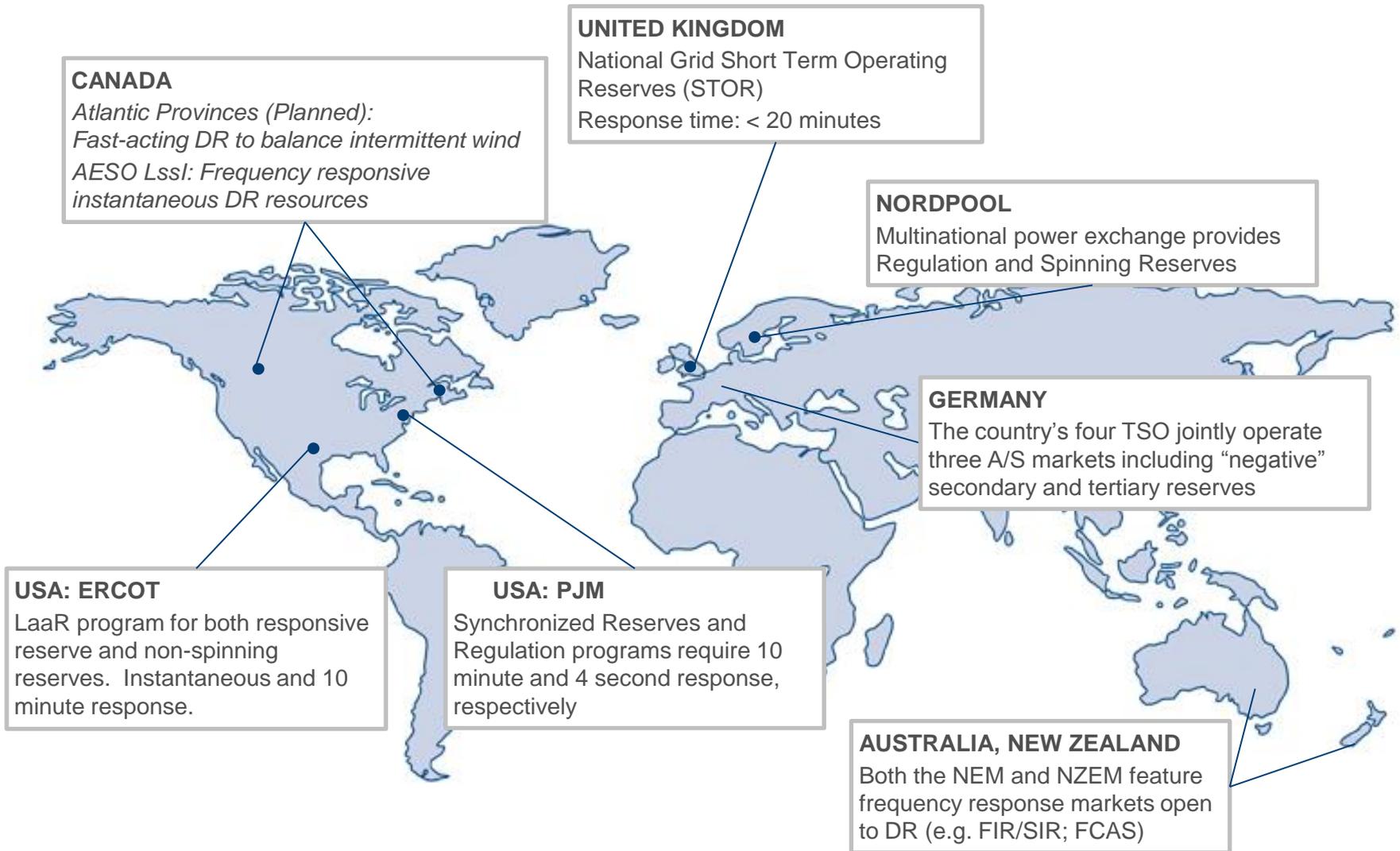
## Ancillary Services

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

# DR for A/S

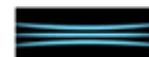
Wind Integration

# Demand Response Provides A/S Around the Globe



# 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
	Emergency Load Response Program	Capacity
PJM Interconnection	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	<b>Weekly</b>	<b>Bi-weekly</b>
Event Notification	<b>20 minutes</b>	<b>10 minutes</b>
Program Period	Year Round	Year Round
Program Hours	Program Hours vary slightly by season, generally: <ul style="list-style-type: none"> <li>•First Window: 07:30 to 14:00</li> <li>•Second Window: 16:00 to 21:30</li> </ul> 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	<b>1 minute interval metering Required integration with National Grid (SRD)</b>	<b>1-minute interval metering SCADA response at gen or meter (RTU)</b>
Capacity Payments	Yes	Yes
Event Payment	Yes	No

# Example A/S Markets for DR

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**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.**

# 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

UCILIA WANG: DECEMBER 10, 2008

## Texas Wind Farms Paying People to Take Power

Wind power generators are willing to pay the state grid operator to take so that they can get federal tax credits. An inadequate transmission system is to blame. Or is it?

A power producer typically gets paid for the power it generates. In Texas, some wind generators are paying to have someone take power off their hands.

Because of intense competition, the way wind tax credits are structured, the location of the farms and the fact that the wind often blows at a time when wind farms in Texas are generating power they can't sell. To get rid of the surplus, the state's main grid operator is paying it. \$40 a megawatt hour is roughly the going rate.

For the first half of this year, power producers at mostly wind farms, paid the grid operator to take power for nearly 20 percent of the time. It happened 33 percent of the time in 2007 and nearly 10 percent in October, said Mike Giberson, an energy business professor at the Texas A&M University. He recently wrote about this issue in his blog, Know the Grid.

The industry reluctance to paying someone to take the electricity is "negative pricing" happens mostly when power producers bid the selling prices in the negative territory because they can afford to pay someone to use the energy.

Why? Wind energy producers get money for generating renewable electricity, but for these federal tax credits, the generation must be purchased and led to an electric load. As long as the money paid to the grid operator to take excess or "unwanted" electricity is less than the federal tax credit, the wind producer can make a profit.

Texas's own state program also allows utilities and power producers to buy and sell renewable energy credits, which has increased the appeal of negative pricing.

With limited transmission capacity, power producers in various places have to compete to sell their electricity. But in the Lone Star state, the competition has more of a phenomenon not seen in the rest of the country.

"In other places, you might see a few hours of negative pricing here and there, but you don't see days and days in a row," Giberson said. "There are some days in March and April you have 14 hours of negative prices."

Negative pricing takes place when the grid is congested, prompting energy producers to sell electricity to the Electric Reliability Council of Texas (ERCOT), the electric grid operators in the state. ERCOT buys energy at various times throughout the day and night to make sure the grid has a cushion to deal with unexpected demand, such as a hurricane-rendered blackout or when power producers didn't generate enough juice.

**"Texas Wind Farms Paying People to Take Power"**

**WIND SOLAR WAVE BUSINESS GOVERNMENT**

**Arche**

**MAIN MENU**

**Danish wind farm owners face negative electricity prices**

Friday, 13 November 2009 09:00 AM

Effective 30th November 2008, the Nordic Power Exchange (NEX) has introduced the minimum price for a MWh of electricity from 0 Euro in order to increase the effectiveness of the market clearing process by reducing their electricity generation or leaving their turbines offline.

Whereas conventional power plants are not able to adjust their output to the market, wind farms are able to do so. This means that wind farms can be asked to pay to have their power taken off their hands.

Wind farm owners are being asked to pay to have their power taken off their hands. This is a new phenomenon in the industry. Over the last year, an average of 40 hours with zero prices. However, during 2009 there were 130 hours of zero-price electricity during the summer season, and this is expected to increase to 200 hours following the inauguration of the 200 MW offshore wind farm in the North Sea.

Before the 15 hour zero price cap, the Danish wind farm owners were only expected to pay negative price hours with prices considerably higher than the -200 Euro/MWh, but this assumption might change under pressure if more clusters of negative prices are accumulating. Currently, a new control system is being tested, where a communication line is installed in the wind turbine, which allows for start and stop of wind turbines by use of text messages. If the tests prove successful it might be the start of virtual control rooms being established for wind farms in Denmark.

Last updated: (Tuesday, 10 November 2009 10:49)

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**"Wind Farm Owners Face Negative Electricity Prices"**

**OregonLive.com**  
Everything Oregon

**BPA, wind developers argue over looming problem of too much power from renewables**

Published: Thursday, April 14, 2011, 9:10 PM Updated: Friday, April 15, 2011, 10:15 AM

**Ted Sickinger, The Oregonian**

By

**Under pressure from wind developers and investor-owned utilities around the region, the Bonneville Power Administration this week backed away from a plan to start pulling the plug on wind turbines when it has too much water and wind energy at the same time.**

**BPA Administrator Steve Wright is still reviewing a controversial plan to "curtail" wind farms in the region, a move the federal power regulator says is necessary to protect migrating salmon and avoid passing big costs onto its public utility customers.**

Wind developers and utilities, however, say such shutdowns are discriminatory, will reduce the economic viability of wind farms and compromise wind-farm economics because the projects rely on lucrative production tax credits and the sale of renewable energy credits that are generated only when turbine blades are spinning.

The plan to maintain the plan is simply unnecessary, a sop to public utility customers that can be solved by other means.

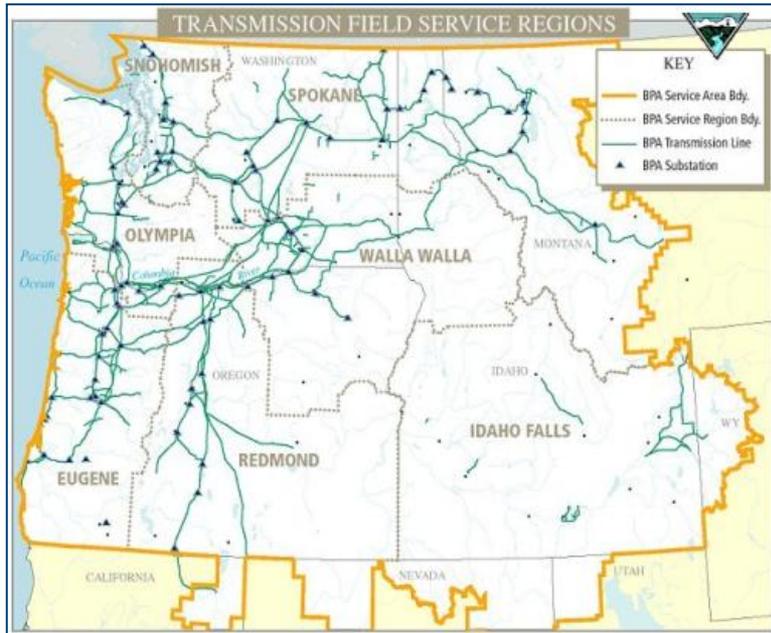
In one sense, the debate is simply the latest wrinkle in the perennial debate over who should bear the costs and benefits of operating the federal hydroelectric dams and transmission system. But it illustrates the growing complexity of integrating into the grid intermittent sources of renewable energy.

"This is going to be a major issue for the region," said John Saven, chief executive of the Northwest

**"Problem of Too Much Power From Renewables"**

# 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 DEC (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 <b>Shut off chillers and AHUs</b> <b>Remotely raise chilled water temperature points several degrees</b>
College/Univ.	<b>Shut off 600 ton chiller</b> <b>300 kW from spare capacity on 6 CHP Units</b>
Foil Processing Plant	Shut down etching machines and rectifier lines
Food Processing	<b>Control of spiral chillers, compressors, refrigeration motors, and HVAC</b> <b>Switch off refrigeration plant and butter mixer plant</b>
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	<b>Remote control of refrigeration equipment</b>
Water/Wastewater	<b>Control booster pumps</b>

# 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)

# Program Development

Getting the details right is a time-consuming process

# NYISO Demand-Side Ancillary Services Program (DSASP)

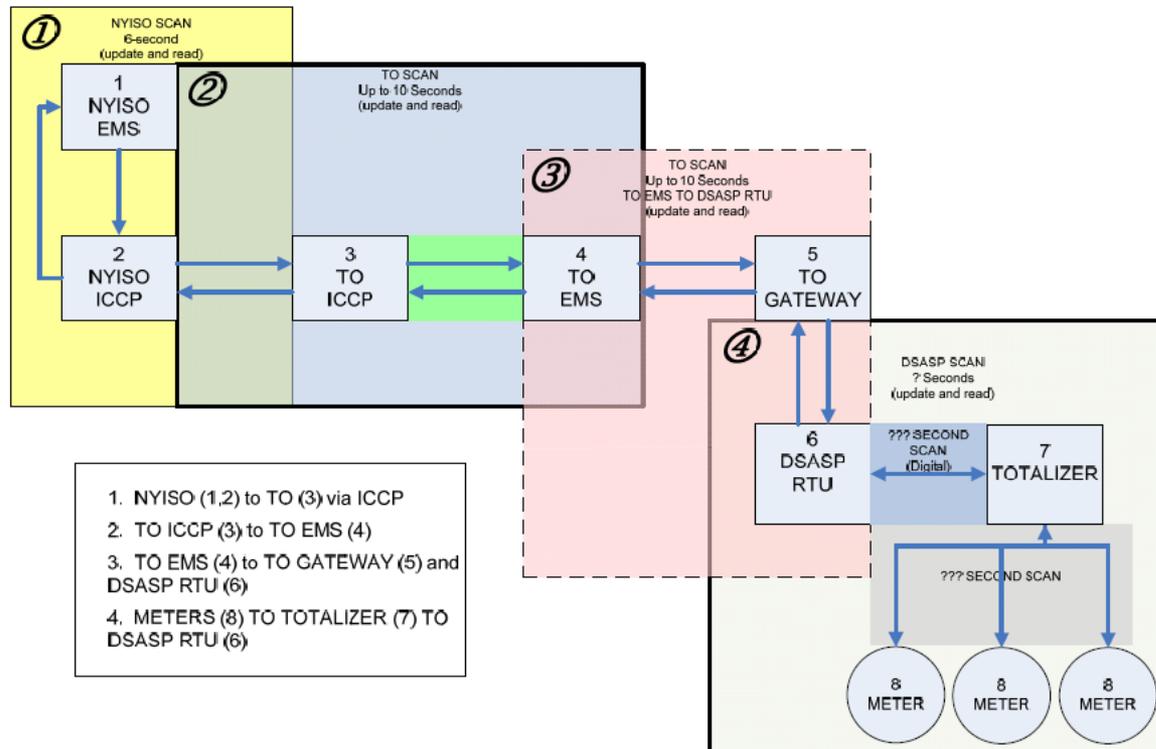
- Current DSASP rules in place since 2008
  - All Ancillary Services open to DR
  - Minimum requirement: 1 MW sustainable for 1 hr (Reserves)
  - Communication: Leased line
  - Telemetry: Real-time ICCP to NYISO and utility, regulation must respond to 6 second AGC signals
  - Currently no active participants
- 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

# NYISO Demand-Side Ancillary Services Program (DSASP)

## Current Communications Configuration



## Sample Communication Path Through Transmission Owner



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# NYISO Demand-Side Ancillary Services Program (DSASP)

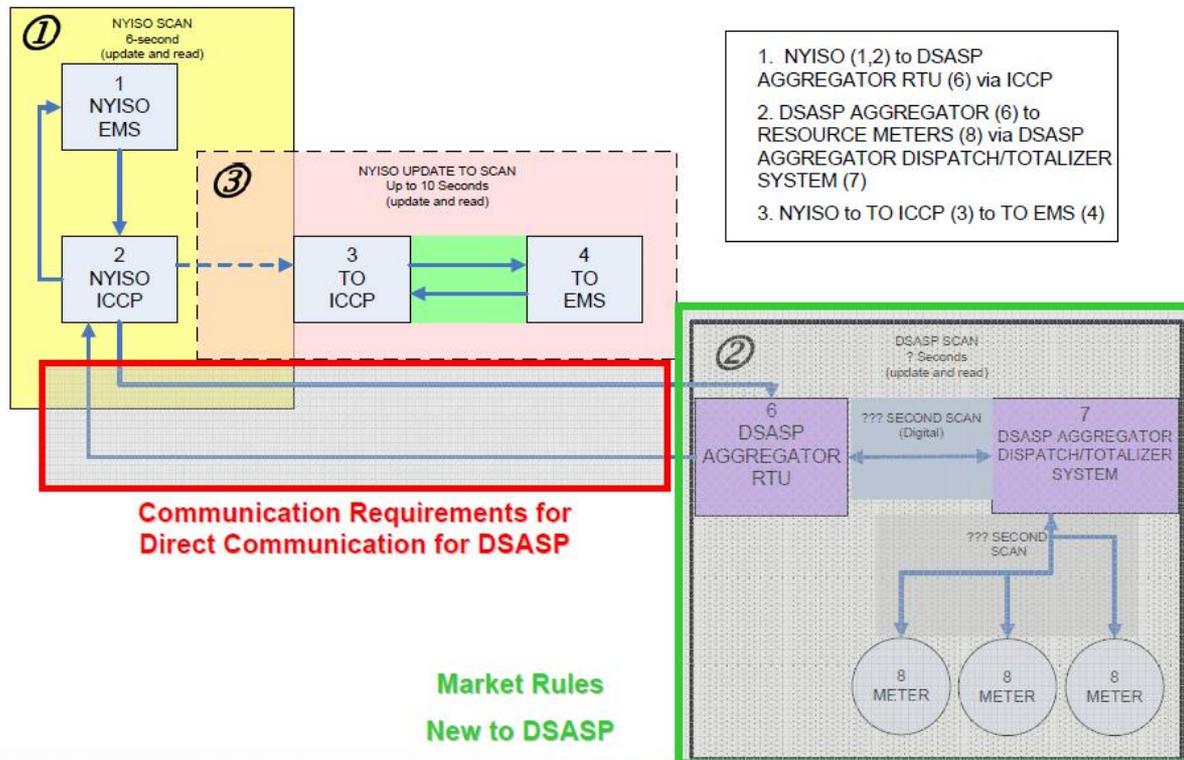
- DSASP Aggregation rules first proposed discussed in 2009, no rules in place
  - Minimum requirement: 1 MW sustainable for 1 hr (Reserves)
  - Communication: Leased line to aggregator
  - Telemetry: Real-time from aggregator ICCP to NYISO, regulation must respond to 6 second AGC signals
  - Program 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

# NYISO Demand-Side Ancillary Services Program (DSASP)

## Current Communications Configuration



### Sample Direct Communication Path for DSASP Aggregation



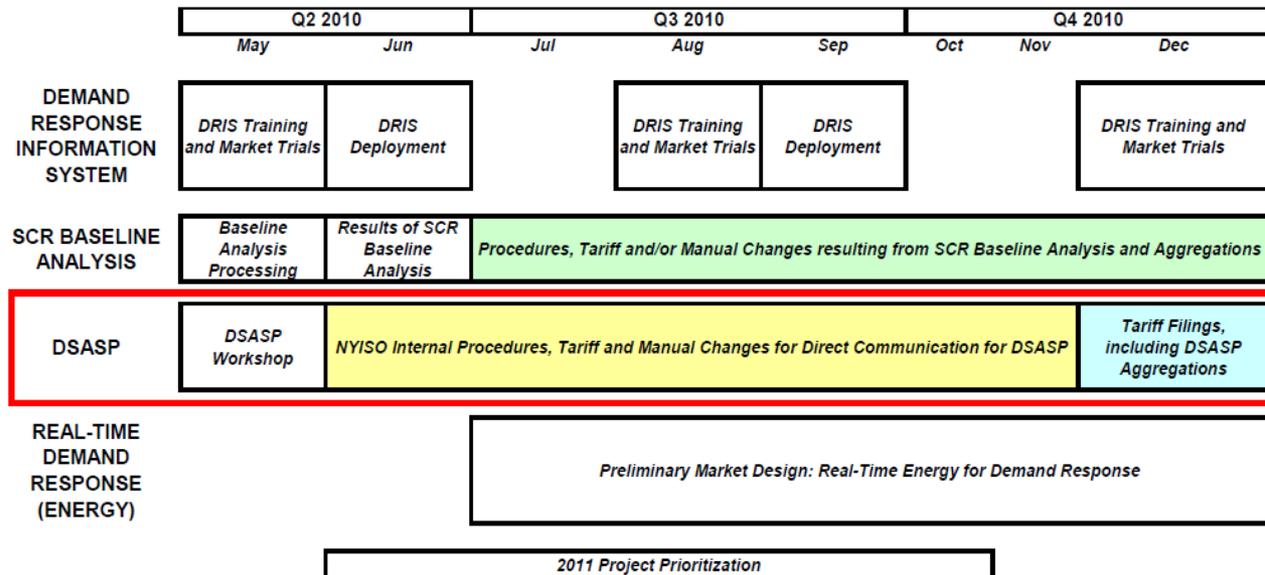
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# NYISO Demand-Side Ancillary Services Program (DSASP)

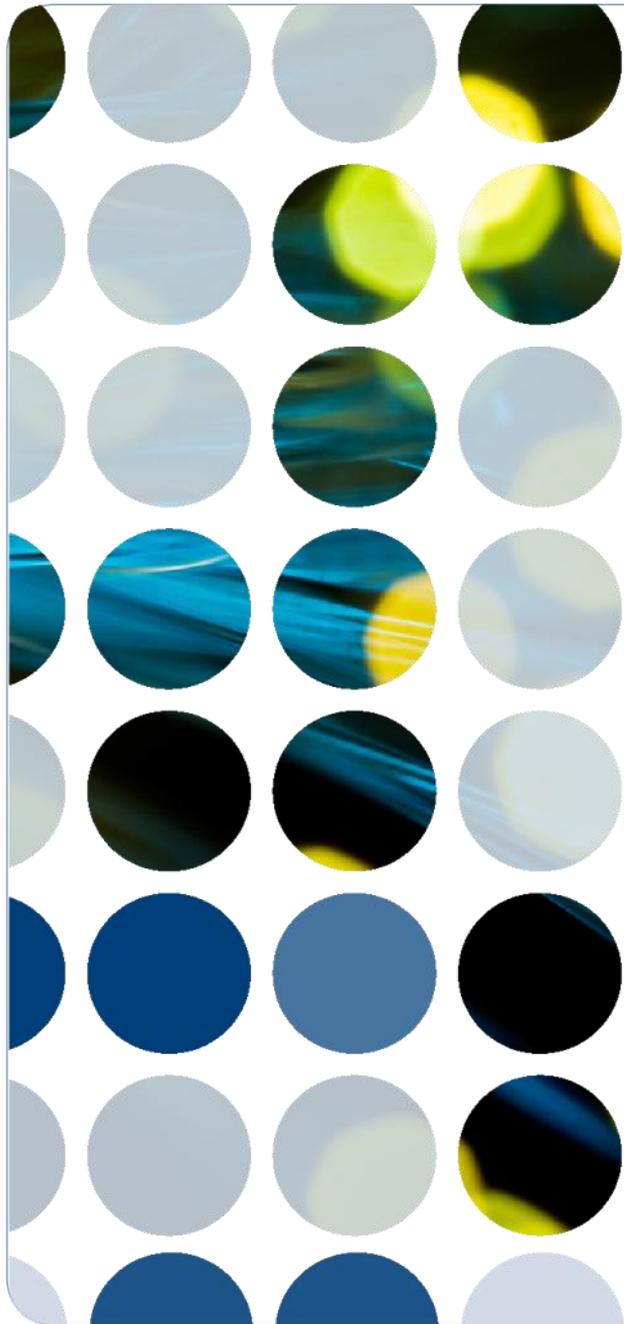
Competing Priorities and Tie to Real-Time Economic Program have Delayed Initiative



## Schedule Prioritization with other Demand Response Initiatives



Schedule prioritization subject to change as necessary to comply with regulatory orders



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