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Get More From Energy

Potential of Demand Response for Renewable Integration

IEEE's Integration of Renewable Resources - Challenges & Solutions

November 15, 2010

Agenda

- Overview
- Anatomy of a Demand Response Resource
- Customer Engagement
- Conclusions and Next Steps

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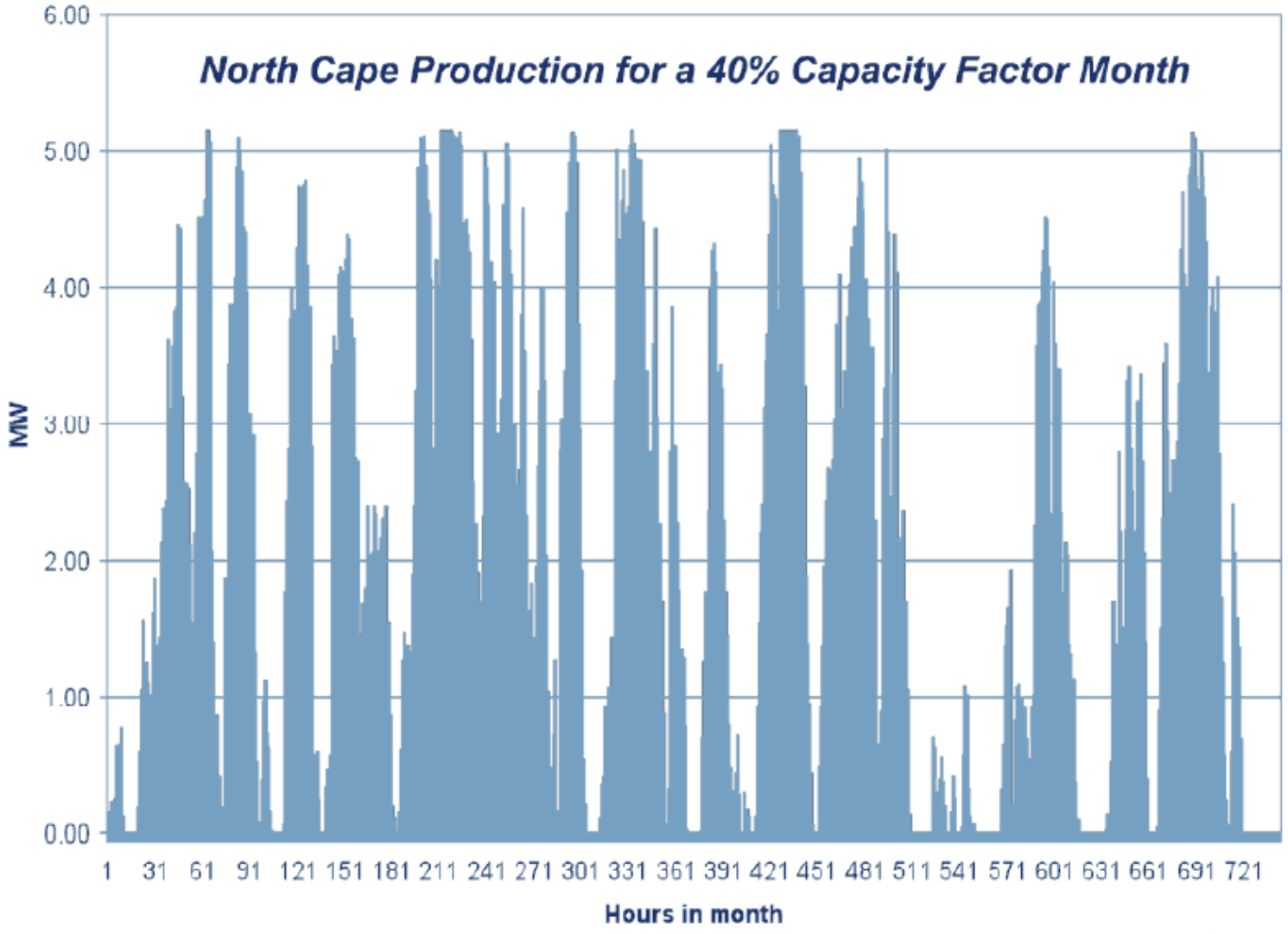
Overview

Wind Power Intermittency is a Well-documented Challenge



Source: Canada Natural Resources Clean Energy Fund and Renewable and Clean Demonstration Projects

Demand Response is Part of the Solution

- One key impact of the increased penetration of renewable resources will be more demand for Ancillary Services (A/S), even if the market is long on capacity[1]
- Demand Response (DR) adds value to the electric grid as a cost-effective and clean resource for providing A/S, and many utilities and grid operators are beginning to consider meeting their A/S requirements through DR
  - Quick start CTs are more expensive than peaking units that can respond in 30 minutes
  - DR can provide ancillary services or qualify as a non-spin reserve resource
- Utilizing DR presents both an opportunity to optimize the grid and an operational challenge

[1] California ISO, "Renewable Integration: Market and Product Review" page 16 (July 8, 2010)

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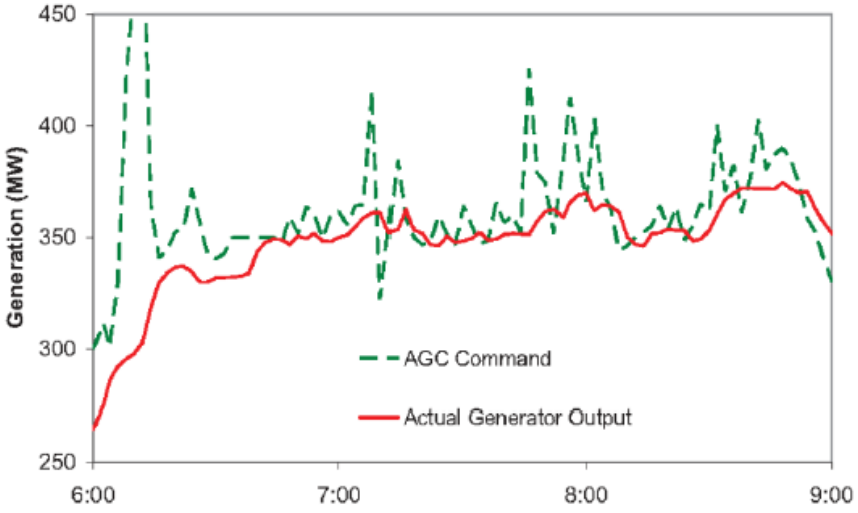
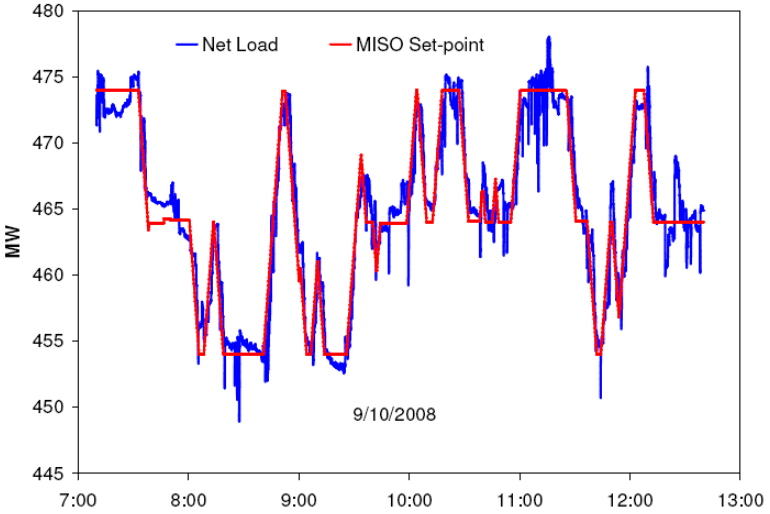
DR Provides a High Quality Ancillary Services Resource

DR resources can be dispatched more quickly and controlled more precisely than typical generator resources, providing greater value to grid operators

Generator A/S Load Profile[1]



Demand Response A/S Load Profile[2]



[1] Beacon Power company materials, "Smart Grid Rulemaking and Integration of Renewables and Energy Storage"

[2] Alcoa company materials, "Demand Response in the A/S Market," January 2009

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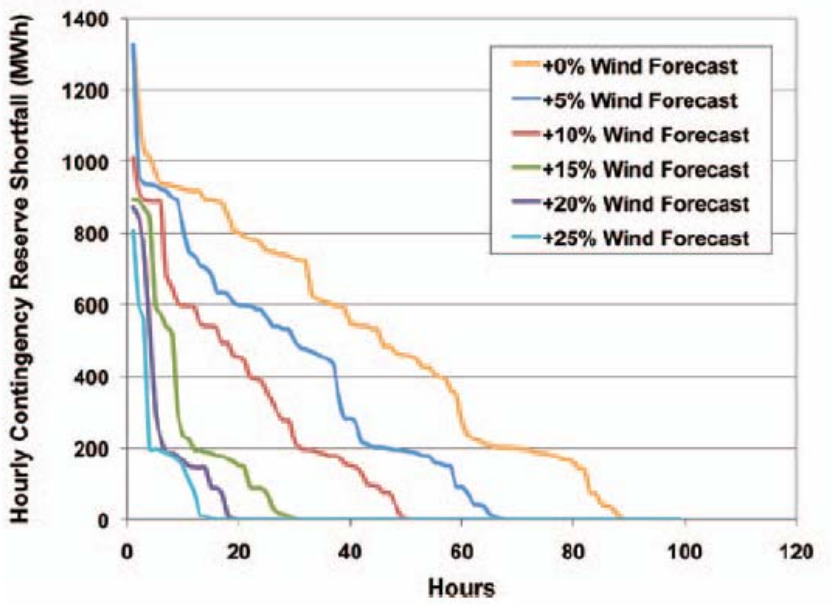
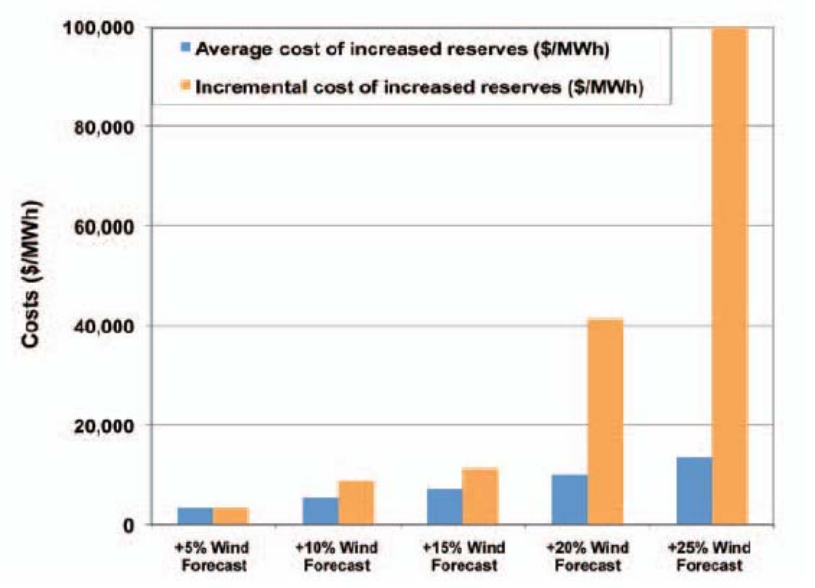
DR is a Cost-Effective Way to Integrate Renewables

- A recent NREL study investigated the operational impact of up to 35% energy penetration of wind, photovoltaics (PVs), and concentrating solar power (CSP) on the WestConnect power system
- Study found that it is more cost-effective to have DR address the 89 hours of contingency reserve shortfalls rather than increase spin for 8,760 hours of the year
- Increasing spinning reserves is expensive, and DR can save up to $600M/yr ($510M/yr in 2009$) in operating costs versus committing additional spinning reserves

Reserve-shortfall Duration Curves



Cost of Increasing Spinning Reserve



Source: National Renewable Energy Laboratory (NREL) “Western Wind and Solar Integration Study” (May 2010)

Opportunities for DR to Provide Ancillary Services

Response Time

Service	Response Time	Detail	DR Suitability	% of Peak
Regulation	Instantaneous to <10 minutes	Load-following, balances supply and demand in real time (i.e., on second-to-second basis)	Bidirectional regulation can be a challenge; suitable only for loads with specific characteristics; requires advanced technology (e.g., UFRs) and finely-tuned curtailment strategies	~0.5-1%
Spinning Reserves	< 10 minutes	Capacity that is unloaded and synchronized to the grid that can respond immediately to correct for generation/load imbalances caused by generation and transmission outages	Loads must be able to automatically respond to drops in frequency, which can limit market size	~1-2%
Supplemental / Non-spinning Reserves	< 30 minutes	Unloaded generating capacity and curtailable load to correct for generation/load imbalances caused by outages	DR very well positioned, response time requires full-control for most sites and specialized dispatch equipment	~1-5%

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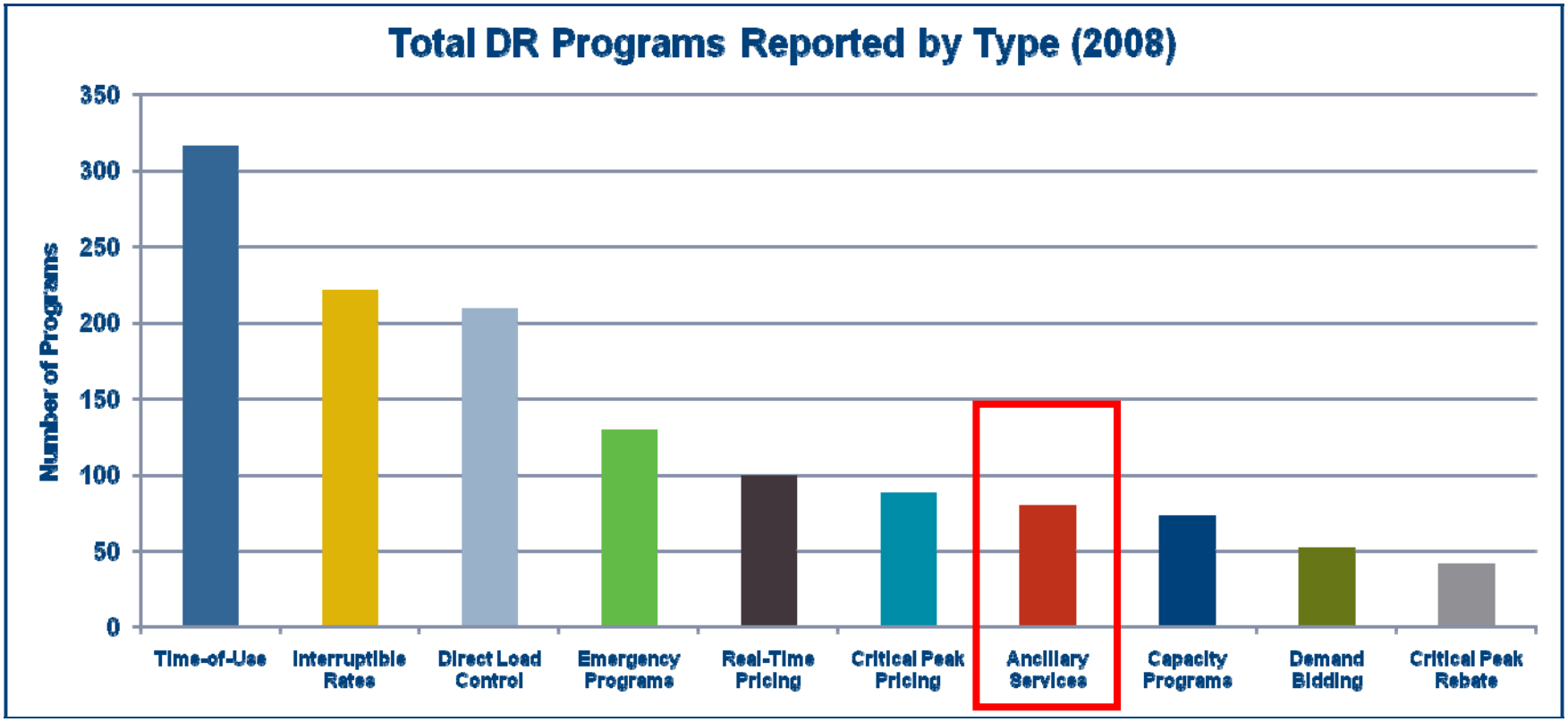
A/S Represents a Small but Growing Portion of DR Resources



Source: FERC, *Assessment of Demand Response & Advanced Metering,* December 2008, Appendix F

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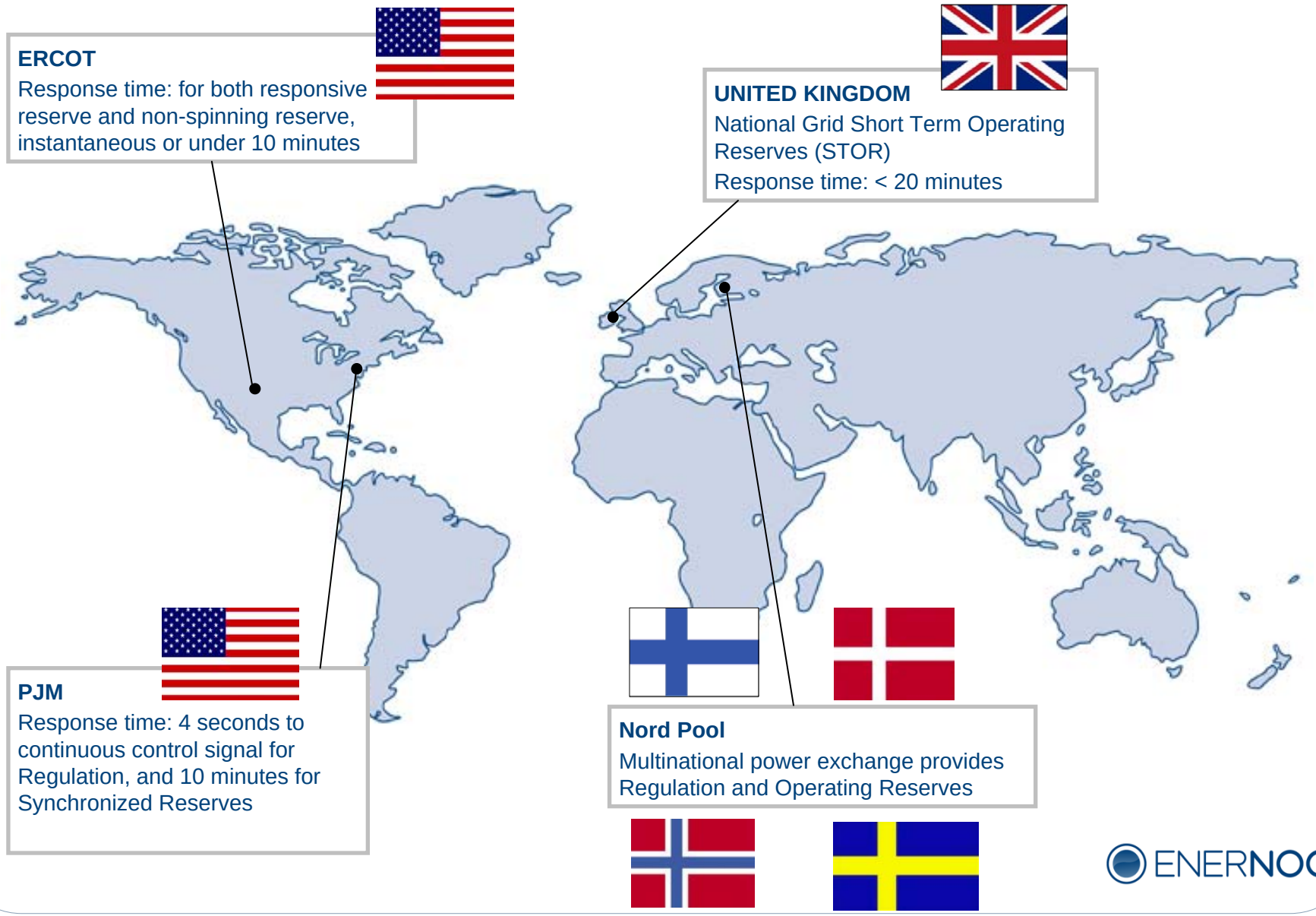
Demand Response providing A/S *Around the Globe*



Public Service Company of New Mexico (PNM)

PNM Peak Saver, an innovative demand response program, automatically reduces use by commercial and industrial customers

Program Name	PNM Peak Saver
Program Period	June - September
Program Hours	8 AM – 8 PM, weekdays
Event Notification	10 minutes
Event Duration	Up to 6 hours
Demand Response Strategies	Curtailment and permitted generation
Response Method	Automatic and manual

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Anatomy of a Demand Response Resource

Quick Dispatch DR: Opportunities and Challenges

- Quick dispatch DR resources present unique operational challenges due to demanding program parameters
- ENOC has successfully implemented a variety of quick dispatch resources

	Program	Notification	Event Length
Restructured Market	PJM Synchronized Reserves Market (SRM)	10 min	Max 30 minutes Average ~23 minutes
	ERCOT Load acting as a Resource (LaaR) - Responsive and Non-spinning Reserves	Instantaneous to 10 min	No maximum
	National Grid (UK) Short-Term Operating Reserves Market (STOR)	20 min	Up to 4 hours Average 45 minutes
Utility Bilateral	San Diego Gas & Electric Clean Gen	10 min	Up to 8 hours
	PNM Peak Saver	10 min	Up to 6 hours
	Salt River Project Power Partner	10 min; 30 min	Up to 6 hours

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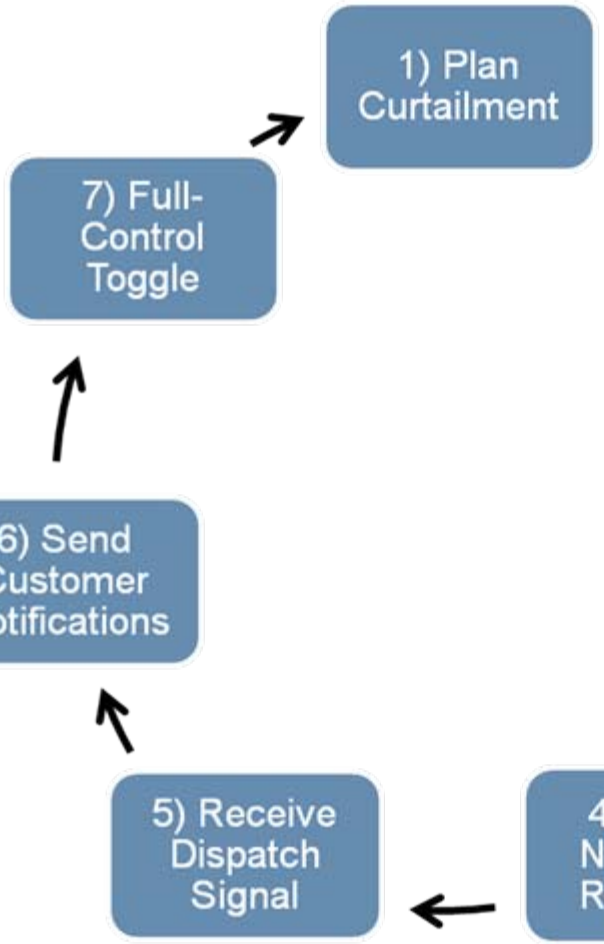
Execution of an A/S Resource



Create 'library' of highly repeatable curtailment plans, both manual and full control

1 minute meter reads with ~3 minutes latency that provide near real-time, settlement-quality data

Maintain flexibility around control (Building Management System, Programmable Logic Controllers, relay, etc.)

Ensure sites meet stringent performance requirements

Requires successful integration with system, e.g., PJM ARCOM, ISO-NE RTU

Customers automatically notified of dispatch

On/off toggle within 1 to 2 minutes of dispatch is required; insufficient time for human intervention

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Lesson Learned from Ancillary Services and Quick Dispatch DR

- A/S requires 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 and tie directly into BMS wherever possible
  - Ensure expected curtailment through rigorous acceptance testing
- Rapid notification and initiation of curtailment protocols are crucial
  - Manage the resource with a sophisticated software platform, which can automatically receive 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 give operators real-time visibility into resource availability and performance

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Auto DR Case Study – Packaged Ice Producer

Curtailment:
Remote curtailment of blast freezer compressors and ice-making equipment

Nomination
1,500 kW

Notification

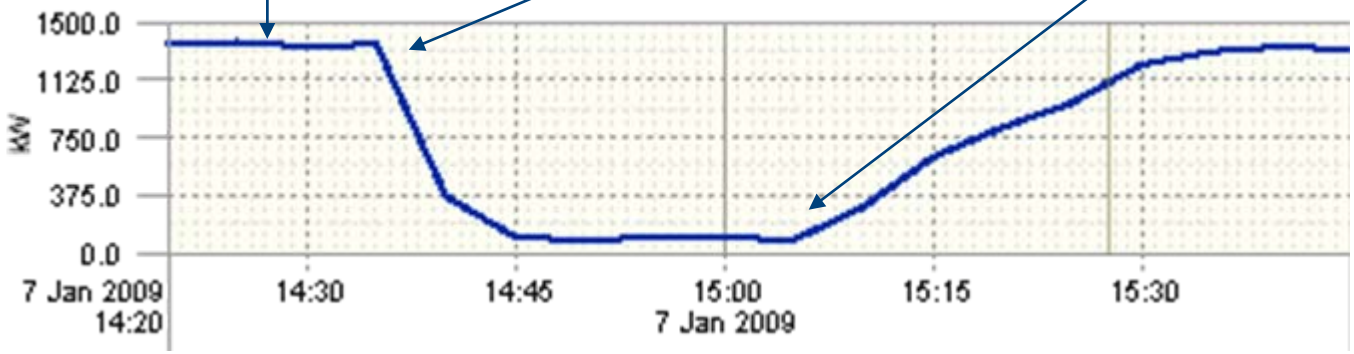
- Flash strobe lights and send phone and email notification to facility managers at 2 locations
- Facility managers confirm participation

Start Dispatch

- Remotely curtail ice-making equipment and blast freezer compressors
- 10 minute lead safely clears product from equipment

End Dispatch

- Remotely restore power to all equipment
- Strobe lights stop and courtesy phone call confirms end of event



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Customer Engagement

Customer Recruitment

- A/S requirements are more demanding, but customers still enroll if there is a direct sales approach, streamlined enrollment process, and protection from penalty risk
- Focusing on enrolling suitable customers is key, as stringent rules and frequent activations associated with A/S programs significantly reduce total market potential
  - Some verticals aren't a good fit for A/S due to long shut-down times
  - Other verticals see reduced nominations due to the number of events

Examples of Suitable A/S Customer Loads

- Water and Waste Water Treatment Systems
- High Volume Water Pumps
- Wood Chippers / Rock Crushers
- Large Battery Charging Stations
- Electric Boilers
- Chillers / Cold Storage / Refrigeration
- Energy From Waste (EFW) Generators
- HVACs with granular controls
- Variable Frequency Drive (VFD) pumps
- Lighting across a large number of grocery stores

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Customer Profiling

A snapshot of EnerNOC's A/S and quick dispatch customers shows a variety of potential customers, with a high concentration of college, manufacturing, and water & wastewater facility customers

EnerNOC Quick Dispatch Customers by Sector		
College/University	Alcohol/Beverages	Laboratory/R&D
Manufacturing	Distribution/Warehouse	Pharmaceutical
Water & Wastewater Facility	Hotel	Military/Federal
Data Center/Server Farm	Recreation	Other Light Industrial
Hospital	Agriculture	Graphics & Printing
Communication Providers	Energy/Mining	Shopping Center
Refrigerated Warehouse	Commercial Real Estate	Lumber
Other Heavy Industrial	Business Services	Grocer/Market
Composting/Recycling/Waste	Distributor	Industrial Supply
Primary/Secondary School	Broadcast Media	Corporate Office
City, County, State	Arena	Non-Profit Organization
Food Processing	Casino/Resort	Software
Foundries	Hardware	Chemicals
Asphalt, Concrete, Gravel	Big Box Retail	

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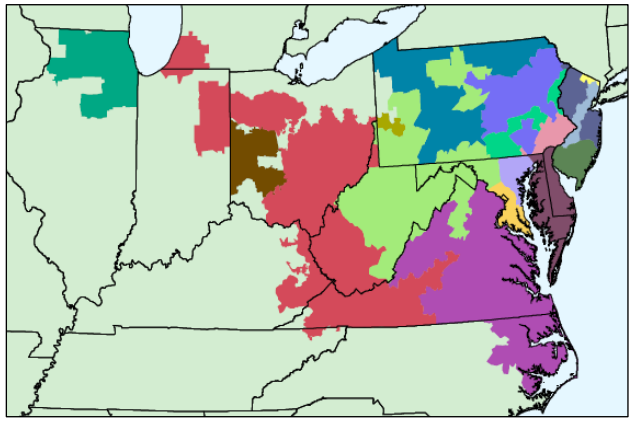
PJM's Synchronized Reserves Market (SRM)



Experience: EnerNOC was first CSP to enroll resources in SRM (Fall 2006)

Data Requirements:1-min interval data

Availability: As high as 24/7

Capacity: Currently approx. 35 MW

Example customers: Temple University, Aqua America, Cenveo, Four Seasons Produce, United Iron & Metal, and more

Customer: Four Seasons Produce

Location: Ephrata, PA

Facility: Refrigerated Warehouse

Nomination: 550 kW

Notification: Automated notification two minutes before event activation

Curtailment Strategy: EnerNOC remotely curtails refrigeration equipment

Conclusions and Next Steps

Key Considerations

- Regulatory challenges need to be overcome – DR does not qualify as a non-spin reserve in some markets
- Program design – for Utility/ISO or customer or both
- Opportunities to integrate DR more into the every day operations of the Utility and ISO (e.g. control room integration).

[1] California ISO, “Renewable Integration: Market and Product Review” page 16 (July 8, 2010)

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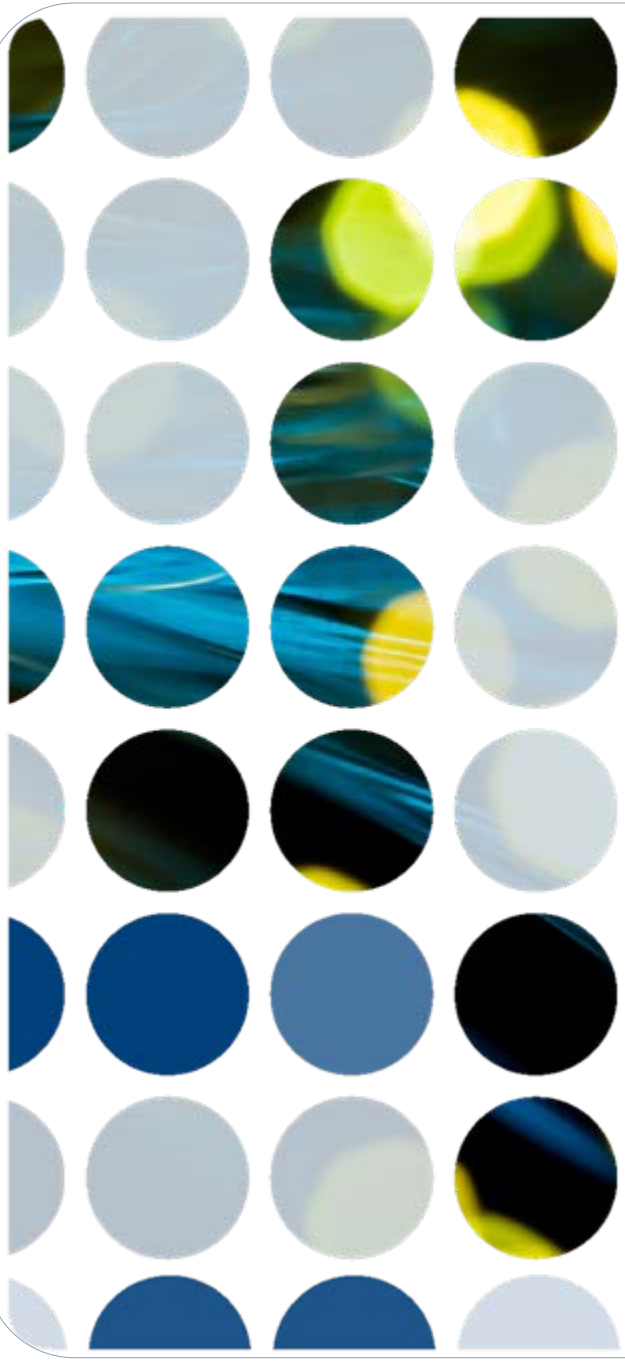

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