



Storage Technologies in the ERCOT Market

Summary of 4/13/2010 Storage Workshop

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Agenda

- **Current rules and requirements for Nodal**
- **Storage Workshop**
 - Technologies presented
 - Compressed Air Energy Storage presented by Haddington
 - Flywheels presented by Beacon
 - Batteries presented by AES
- **Summary of Workshop**
- **Conclusions**

Current Nodal Protocol Minimum Requirements

- **Must register the storage device with ERCOT**
 - Client Services Registration process
 - Definition in the protocols should be added
 - Storage devices are considered generation resources when charged or deploying power Load when in re-charging mode
- **Must meet all Resource requirements**
 - Telemetry and Modeling
 - Should be treated as a generation resource when charged or discharging
 - Should be treated as a load when charging
 - Real Time telemetry should be updated to reflect HSL capability and output
 - Separate telemetry required for both potential states (generator or load).
 - Outage reporting
 - Scheduling
- **Need to add protocol language to address the primary frequency response requirement for storage**
 - Similar to language for wind in PRR 824 (when operating in Generation Resource mode)
 - Need to act like a Controlled Load Resource (CLR) when in Load Resource mode
- **3.15 Voltage Support - All Generation Resources greater than 20 MVA must provide Voltage Support Services (VSS)**
 - Must be able to operate in voltage control mode and follow the voltage schedule at Point of Interconnection (language may need to be added around AVR requirement)
 - Must meet 0.95 lead/lag requirement

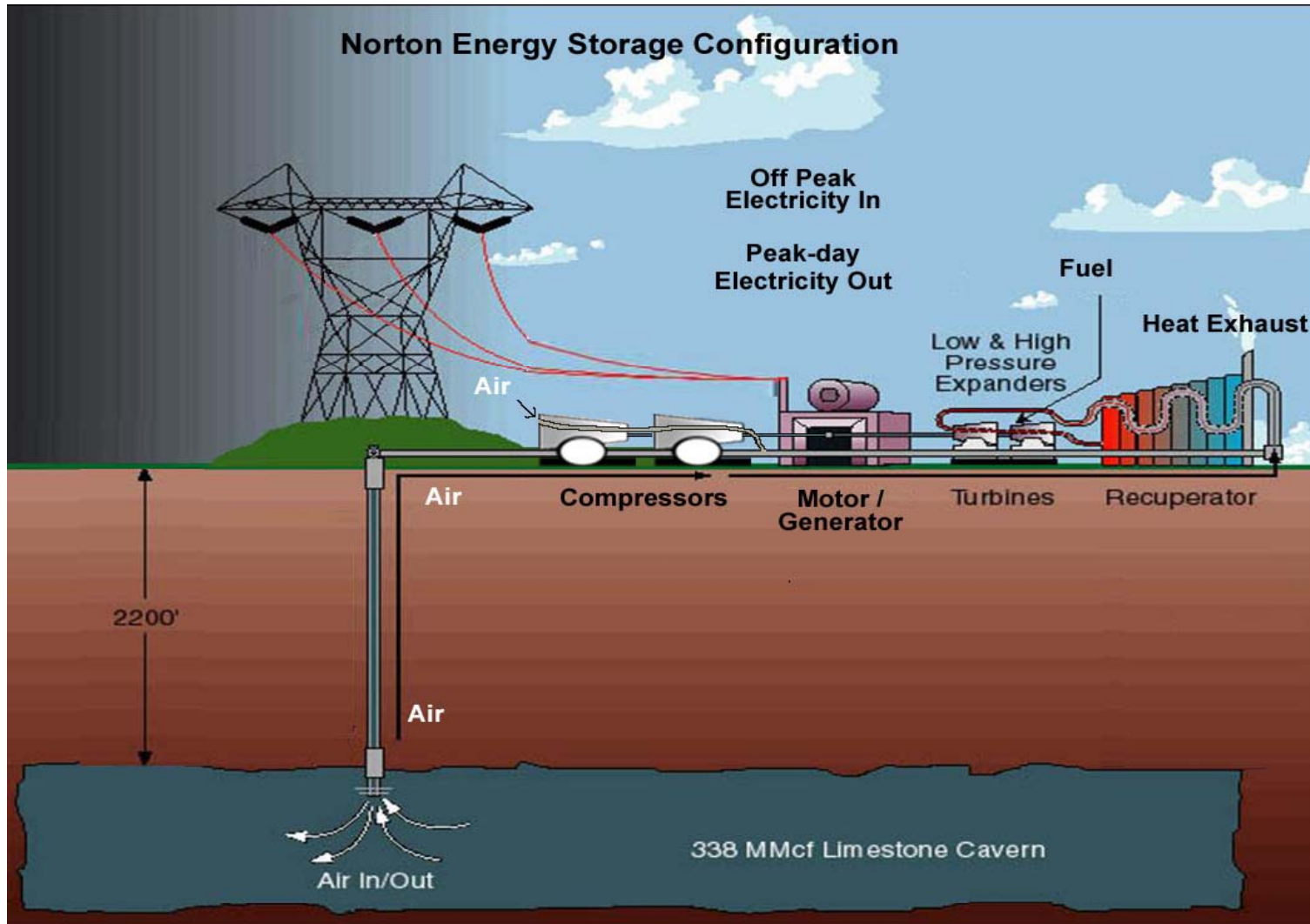
Nodal Protocol Ancillary Service Requirements

- **3.17.1 (1) Regulation Up Service**
 - In Generation Resource mode must be capable of increasing output when deployed and decrease energy output when recalled
 - In Load Resource mode must act as a CLR and be capable of decreasing load when deployed and increase energy output when recalled
- **3.17.1 (2) Regulation Down Service**
 - In Generation Resource mode must be capable of a scheduled positive output which can be lowered in response to regulation deployments
 - In Load Resource mode must act as a CLR and be capable of increasing load when deployed and decreasing energy load when recalled
- **3.17.2 Responsive Reserve Service**
 - Language should be added to allow storage devices to participate
 - Add language to require that when providing RRS as a Load Resource, must be as a CLR
- **3.17.3 Non-Spinning Reserve Service**
 - Must be capable of running at a specific output level for at least one hour
- **8.1.1.2.1.1 Regulation Service Qualification**
 - Test is performed during a continuous 60 – minute period
 - A separate test is required for Generation and Load Resource modes
- **8.1.1.2.1.2 Responsive Reserve Service Qualification**
 - Must be able to maintain the scheduled level of deployment for the period of service commitment (existing language)
- **8.1.1.2.1.3 Non-Spinning Reserve Service Qualification**
 - Must be capable of providing the amount for which the QSE is requesting to be qualified.

Nodal Protocol Market Impact

- **4.4.9.2.3 Startup Offer and Minimum-Energy Offer Generic Caps**
 - Add generic category for power storage. Does there need to be a category for different types of devices?
- **4.4.9.3.3 Energy Offer Curve Caps for Make-Whole Calculation Purposes**
 - Assign existing or add Energy Offer Curve cap for power storage.
- **4.4.9.4 Mitigated Offer Cap and Mitigated Offer Floor**
 - Determine whether power storage offer curves should be mitigated.

Compressed Air Energy Storage (CAES)



How can CAES be Utilized in ERCOT?

- **CAES can participate across all products in the ERCOT Market**
 - Day-ahead
 - Real-time
 - Ancillary Services
- **CAES can quickly respond to dispatch instructions**
- **Advantages to CAES**
 - Store energy in off peak hours
 - Generate during on peak hours
- **Issues/challenges:**
 - Economic models for projects assume load pays at the node and not a weighted zonal average
 - Ramp curve on compression not smooth and 1 minute “dead-zone” when swinging from full compression to full generation

Short-Term Energy Storage in A/S Markets

Midwest ISO: 1/1/10

Demonstrated:

- 2 MW AES Altairnano batteries

Operating:

- 15 MW Alcoa Reynolds DR



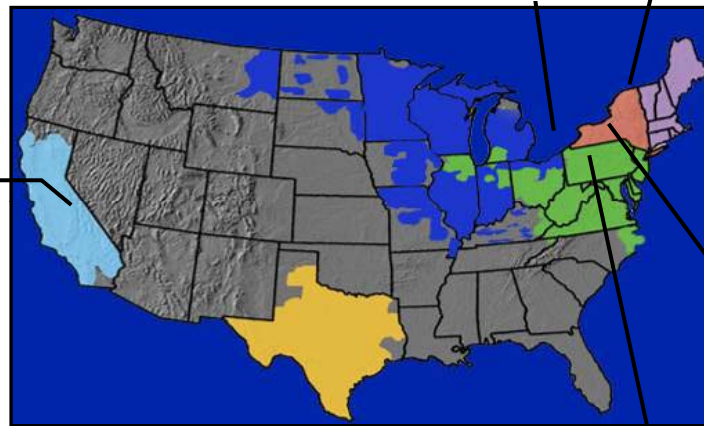
California ISO

Demonstrated:

- 100 kW Beacon Flywheel

Interconnected:

- 2 MW AES A123 batteries



PJM: Spring 2009

Operating:

- 1 MW AES Altairnano batteries at PJM HQ

Planned:

- 20 MW Beacon flywheel plant (Chicago)
- 20 MW Battery plant (PA)

ISO New England

Operating: 3 MW Beacon Flywheels



New York ISO: 5/12/09

Demonstrated:

- 100 kW Beacon flywheels

Planned:

- (2) 20 MW Beacon flywheel plants (Stephentown, Glenville)
- (3) 20 MW AES battery plant



How can Limited Energy Storage be Utilized in ERCOT?

- **Provide Regulation Service**
- **Advantages to LES**
 - Fast Response to frequency deviations
- **Issues/challenges:**
 - Limited deployment duration (typically 15 minutes)
 - Unable to meet the Ancillary Services requirements (one hour)
 - Development of a Separate Regulation dispatch signal for “fast” responding resources
 - Load pays a weighted zonal average, not LMP at node
 - ERCOT systems (i.e. EMS/MMS)
 - Require separate telemetry for load and generation
 - Can not handle negative numbers

Workshop Roundtable Discussion

- **Desired Changes by Storage**

- Treat storage when withdrawing as negative generation and not as Load
 - Pay LMP at node for energy
 - Do not pay load fees such as uplift, TDSP delivery charge
 - Zonal energy prices for load is part of the PUC rule 25.501. Would rule apply to a new category of storage?
- Change the deployment duration requirements
- Pay-for-Performance or regulation energy usage
- Develop code to deploy LES similar to PJM/NYISO
 - Two separate signals (one for fast response & one for slower)

- **Opposition to Changes**

- Current market rules accommodate participation for generation and Load Resources
- If Storage is given an exemption from uplift and TDSP delivery charges, then all Load Resources should be given same exemption

Conclusions

- **Concern was expressed about ERCOT systems allowing resources to provide Regulation and not participate in the energy market**
 - These capabilities do exist
- **Duration of deployment appears to be the main technical barrier for storage resources**
 - System modifications are needed in order to manage regulation deployments and state of charge
 - AS definition requires the service to be fully deployable for an hour
 - Current Qualification for AS can not be met by Limited Energy Storage Devices
- **Main Economic Barrier**
 - Zonal energy prices for loads, as oppose to being settled at the node LMP
 - Load fees and TDSP delivery charges

Questions?

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