



CCET Board of Directors Annual Meeting

Jeff Gates – Duke Energy

Bobby Jones – Duke Energy

Audrey Fogarty – Xtreme Power

October 18, 2013



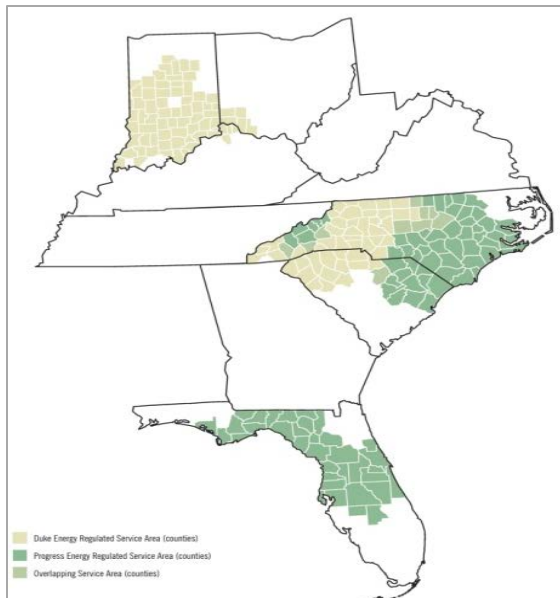
U.S. DEPARTMENT OF **ENERGY**

- Acknowledgment: "This material is based upon work supported by the Department of Energy under Award Number(s) DE-OE0000195."
- Disclaimer: "This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

Duke Energy Corporation



- Regulated electric and gas utility
- 7.2 M customers, headquartered in Charlotte, NC
- A Fortune 250 company; (DUK), \$114 B of assets
- 28,000 employees, 58 GW of generating capacity
- **Cost Effective Energy that is Reliable, Clean**
- Technology Agnostic – “All of the Above”



Duke Energy Commercial Businesses



Renewables

- Wholly owned by Duke Energy
- Focus on solar PV and wind projects
- \$3 B of capital invested since 2007
- 1.7 GW of net operating capacity



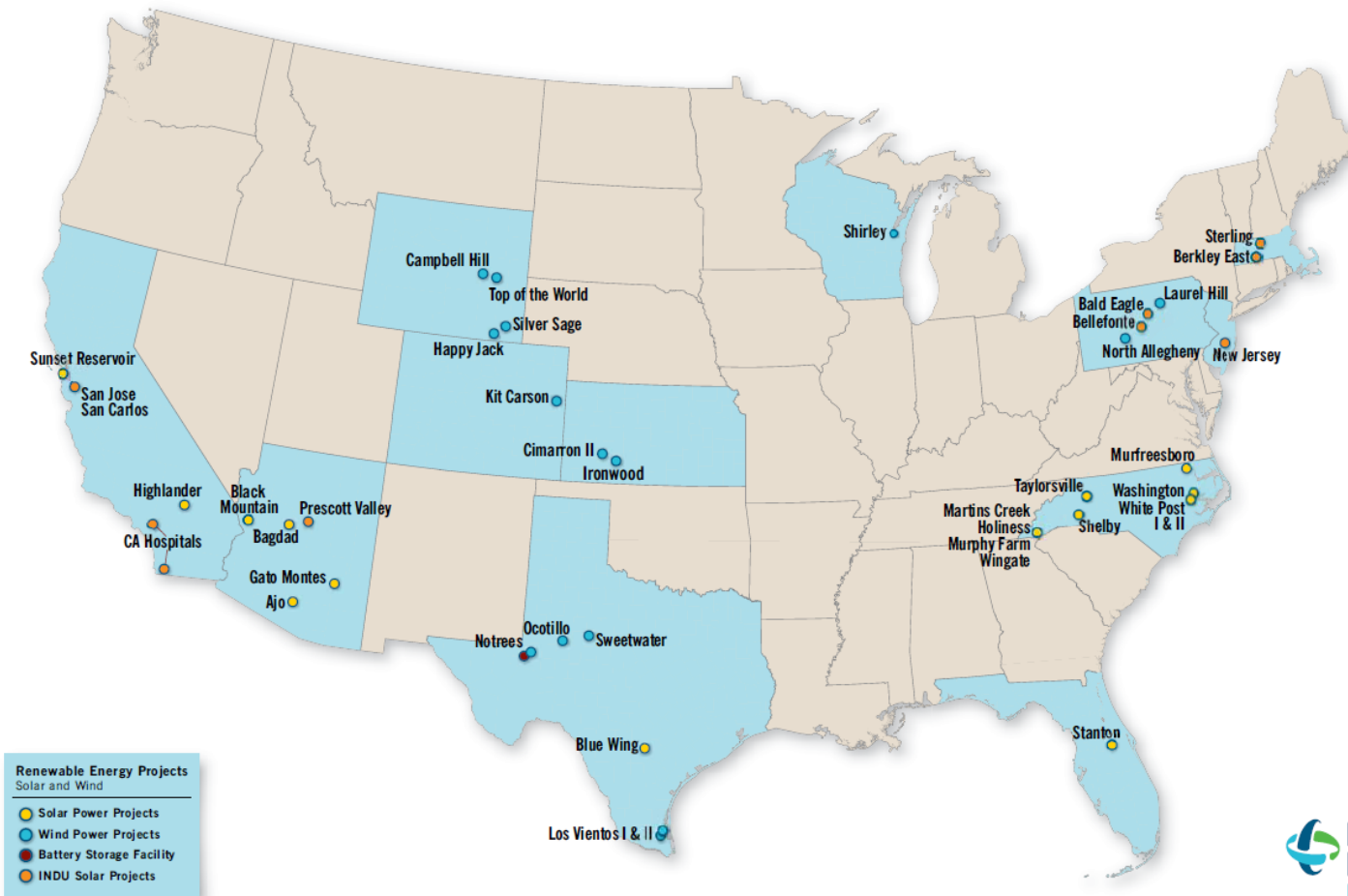
Transmission and Storage

- Transmission Development through JVs:
 - Pioneer project with AEP and NIPSCO - \$1B
 - Duke-American Transmission Company JV
 - Acquired majority interest in PATH 15
 - Developing 8 projects in N. America - \$9B
 - Active development in CAISO, WECC, ERCOT, SPP, MISO and PJM
- 36 MW Notrees Battery Storage project
- Multiple storage demonstration projects

Duke Energy Renewables – Portfolio

Wind = 1700MW
Solar = 105MW

Duke Energy Renewables U.S. Portfolio



Project site

- Notrees wind farm, owned and operated by Duke Energy Renewables
- Located in west Texas – Ector and Winkler Counties
- 156MW total wind generation capacity



Notrees Battery Project

- Developed by Duke Energy and Xtreme Power (XP)
- 36 MW / 24 MWh output
- Advanced lead-acid battery technology
- 24 Dynamic Power Modules with 1.5 MW / 1.0 MWh
- Modules housed in ~ 20,000 sq. ft. building
- Construction Oct 2011 to full operations December 2012
- Primary Commercial Market - ERCOT
 - ERCOT Freq Regulation
 - FRRS Pilot
- Potential future markets:
 - Energy Arbitrage
 - Voltage Support
 - Wind Firming
 - Curtailment Mitigation



Project Activities to Date

- Site construction began December 2011
- COD December 2012
- FRRS Pilot resource – Feb 2013 through present



Energy Storage: Rules Matter

- ✓ Is it a generator, a load, or a transmission or distribution system device? YES
- ✓ Presidio NaS battery treatment
- ✓ SB 943, 82nd Texas Legislature
- ✓ PUCT Rules
- ✓ ERCOT Protocols
- ✓ ERCOT registration as a Generator Resource **and** a Load Resource

Questions for Integrating Storage Identified by ERCOT

Areas Where Experience Is Needed

- a) Interconnection Requirements and Process
- b) Registration
- c) Testing and Qualifications for providing AS
- d) Operations
- e) Metering and Data Aggregation
- f) Modeling
- g) Impact on Load Forecasting
- h) DAM
- i) Real-time
- j) Outage Scheduler
- k) Current Operating Plan (COP) Submittals
- l) Telemetry
- m) Settlement
- n) Compliance
- o) QSE Responsibilities
- p) Capacity Demand Reserve (CDR) implications

Registration of new storage resource

■ Year-long registration process

9/22/2011 *ERCOT Registration meeting kick-off*

Dec-11 *GEN and LOAD RARF drafts*

Jan-12 *1st RARF submissions ****Errors*****

Feb-12 *Supplemental Operating/Unit information review*

Mar-12 *2nd RARF submissions - New GEN and LOAD RARF Forms - ****Errors*****

Apr-12 *Operations/Modelling/Telemetry review*

May-12 *Operations/Modelling/Telemetry review*

Jun-12 *RARF revisions*

Jul-12 *RARF revisions; Supplemental Operating/Unit Information*

Aug-12 *Completion of updated Stability study*

Sep-12 *Completion of ERCOT review*

9/28/2012 *ERCOT database load*

Oct-12 *Commence Inverter testing*

Dec-12 *Commercial Operations*

*Ongoing
ERCOT/Duke/ XP
meetings*

- Primary source of revisions/discussion on how to 'fit' Storage technology into existing framework for 'conventional' resources



Summary of Recent Developments

- ✓ Texas Legislature
 - ✓ SB 943 passed in 2011 to clarify rights of storage resources providing wholesale service(s) in competitive areas
- ✓ Public Utility Commission of Texas
 - ✓ Multiple projects and rulemakings to explore issues and remove barriers for storage, including establishing settlement rules and granting authority for ERCOT to establish pilot projects for emerging technologies
- ✓ ERCOT
 - ✓ Emerging Technologies Working Group (ETWG)
 - ✓ Fast Responding Regulation Service (FRRS) pilot
 - ✓ Settlement protocols
 - ✓ Discussion of other market participation rules/protocols
 - ✓ Generic cost determinations
 - ✓ HSL/LSL
 - ✓ Pay for Performance?

SB 943 Details

- ✓ Texas Legislature passed TESA bill in 2011 clarifying that energy storage resources offering services in the competitive wholesale market have the same rights as a generator
 - ✓ Solved immediate issues of storage's right to interconnect and who pays the related costs
- ✓ Consensus bill did not address TDSP ownership of storage, settlement issues, or load charges
- ✓ PUC and ERCOT have been implementing requirements and addressing related issues
- ✓ Ambiguity/uncertainty remains for storage in other markets and applications

Public Utility Commission Details

Specific Actions:

- ✓ Project 39764 explored general storage issues
- ✓ Project 39657 was the rulemaking to implement SB 943
- ✓ Project 40150 was the rulemaking for ERCOT pilot project authority
- ✓ Project 39917 was the rulemaking for settlement issues
 - ✓ Also exempted storage from retail load fees and 4CP cost allocation methods
- ✓ "We need to remove as many impediments to storage as we can." - Texas PUC, September 2011

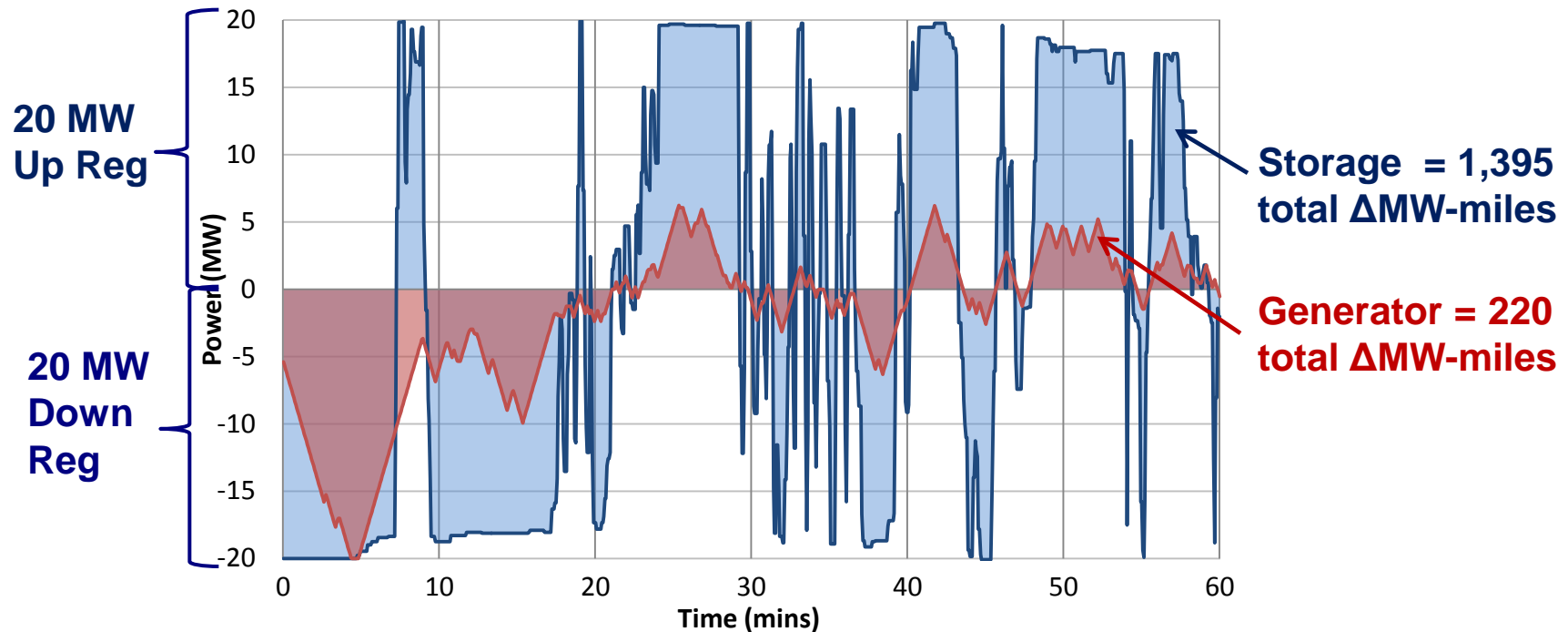
ERCOT Details

Specific Actions:

- ✓ Established Emerging Technologies Working Group (ETWG)
- ✓ Establishing Fast Responding Regulation Service (FRRS) pilot
- ✓ Implemented NPPR 461 to comply with PUCT rulemaking that addressed WSL (Wholesale Storage Load)
- ✓ May modify other market participation rules and protocols as needed

Key Question: Why develop the FRRS pilot?

FERC Order 755: Two-Part Payment Being Developed in Other Markets



Capacity Payment

- Amount set-aside
- Including **Opportunity Cost**

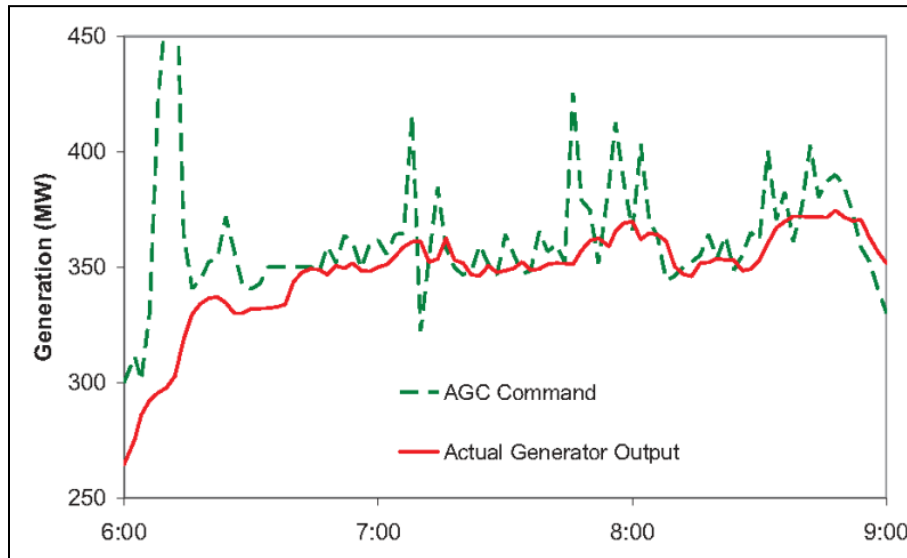
Source:



Performance Payment

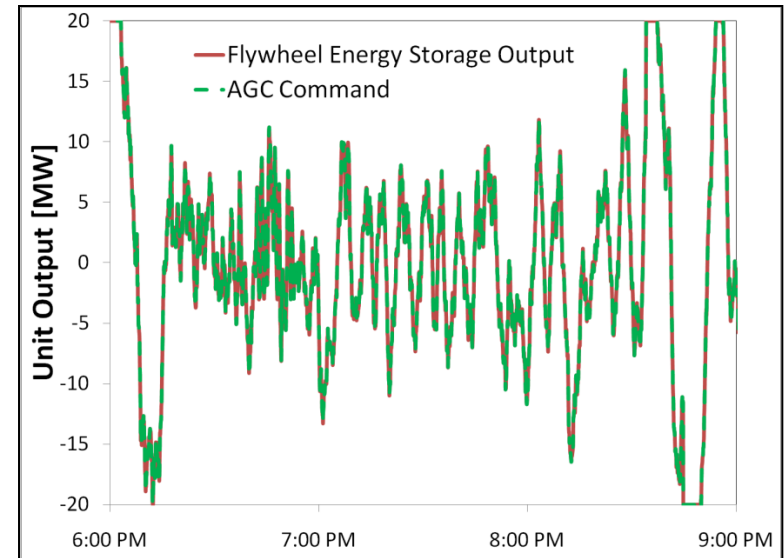
- Sum of up and down movement **“mileage”**
- Adjusted by **accuracy**

Speed Matters: FRRS pilot developed in response



Slow ramping Generator

vs.



Advanced Energy Storage

New Storage resources have a speed and precision of response which is unattainable by traditional generator ramp limitations

Fast response capability demonstrated in ISO-NE, NY, CA, PJM, Midwest

What is Fast Responding Regulation Service (FRRS)?

- ✓ FRRS is intended to complement current regulation service.
- ✓ FRRS can be ramped to its full output within 60 cycles.
- ✓ FRRS is intended to respond first and help slow down the frequency decay while other resources start to respond.
- ✓ FRRS is intended to respond to large frequency drops to promptly help arrest the frequency decay.
- ✓ California ISO, New York ISO, PJM, ISO New England and MISO will have or already have fast responding regulation.

FRRS-pilot Qualification Criteria

- ✓ Resources providing FRRS must be able to follow FRRS signal.
- ✓ Resources requesting FRRS-up qualification
 - ✓ Must be able to respond to large frequency decay triggered by loss of generation.
 - ✓ Resources providing FRRS-up must provide full MW response within 60 cycles after frequency hits 59.91 Hz trigger.
- ✓ Resources requesting FRRS-down qualification
 - ✓ Must be able to respond to high frequency.
 - ✓ Resources providing FRRS-down must provide full MW response within 60 cycles after frequency hits 60.09 Hz trigger.

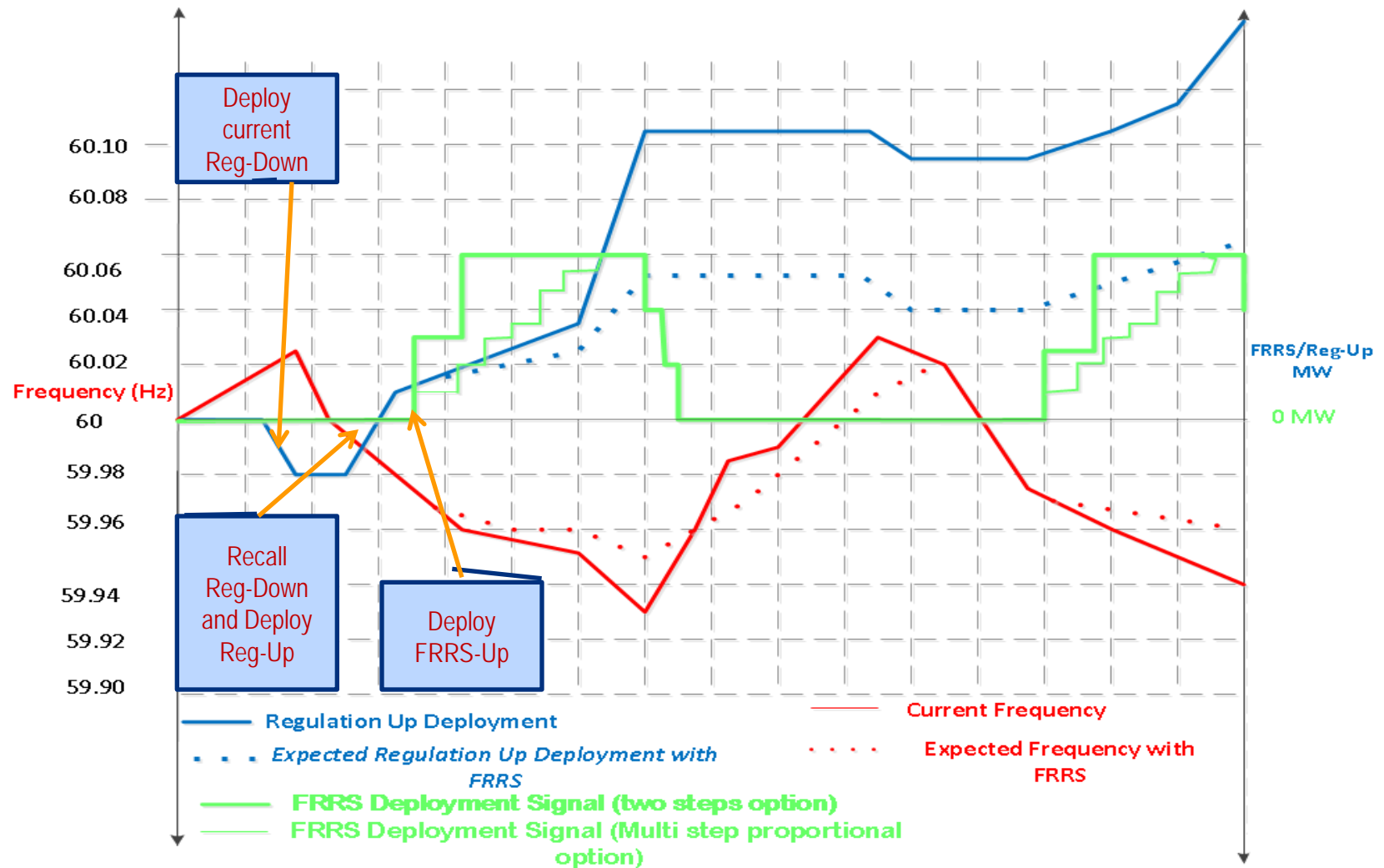
Pilot FRRS Qualification Criteria (continued)

- ✓ Resources providing FRRS (Up and Down) must be able to continuously remain deployed for up to 8 minutes with 95% or more of the requested MW for successful qualification.
- ✓ Resources that successfully demonstrate the requirement above will be qualified as FRRS capable Resources for the capacity that was requested for qualification.

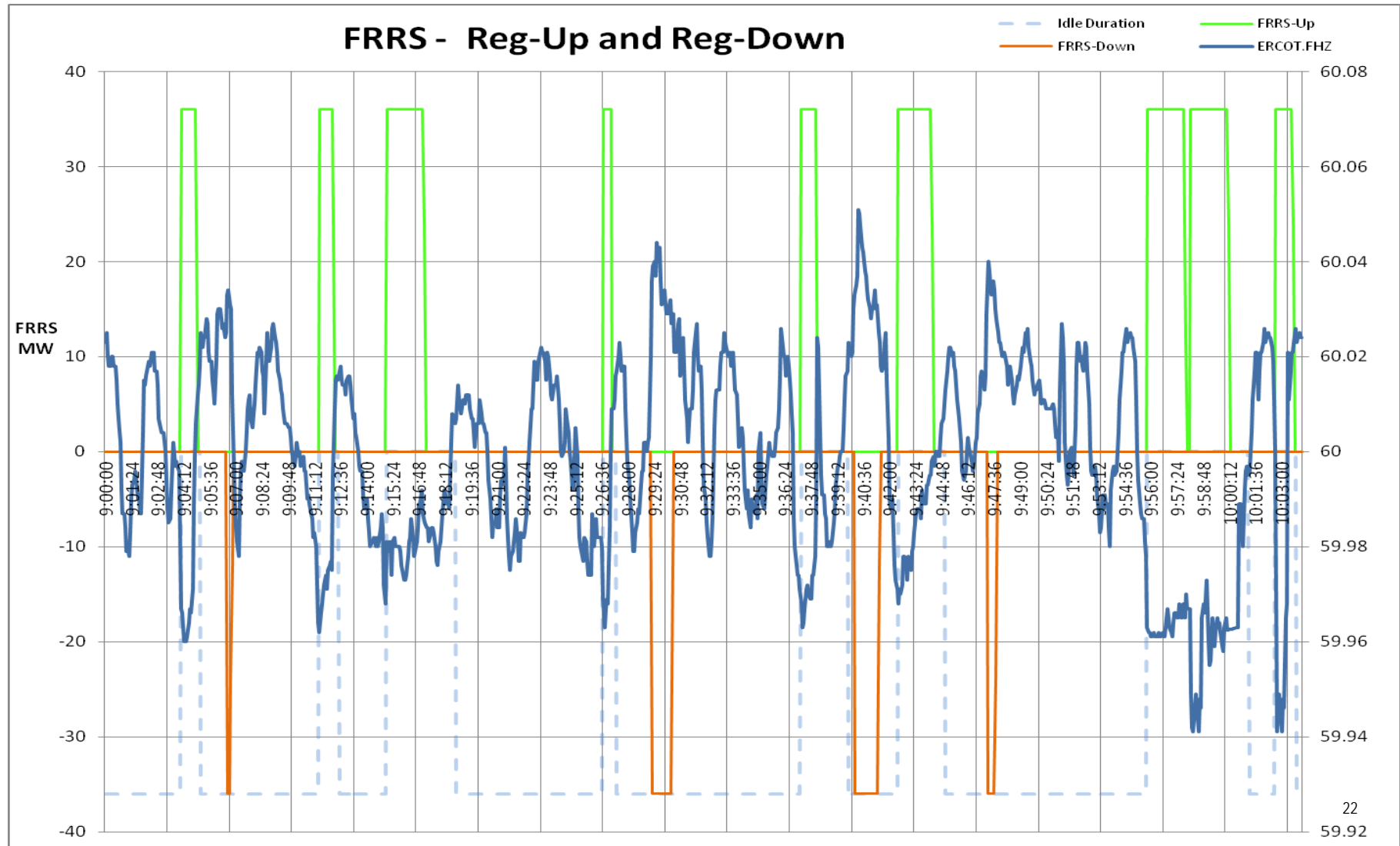
How is FRRS Procured during the Pilot?

- ✓ FRRS-up and FRRS-down amounts are specified in advance for each hour. For the pilot, ERCOT will procure up to 65 MW per hour for FRRS-up and will procure up to 35 MW per hour for FRRS-down. No changes are made to the existing REGUP and REGDN requirements.
- ✓ ERCOT has a list of "Qualified" FRRS Pilot Resources. Each Tuesday QSEs inform ERCOT of the amounts available for Saturday through Friday.
- ✓ ERCOT prorates amounts to Pilot Resources as necessary. Final quantities sent to QSEs (for the upcoming week).

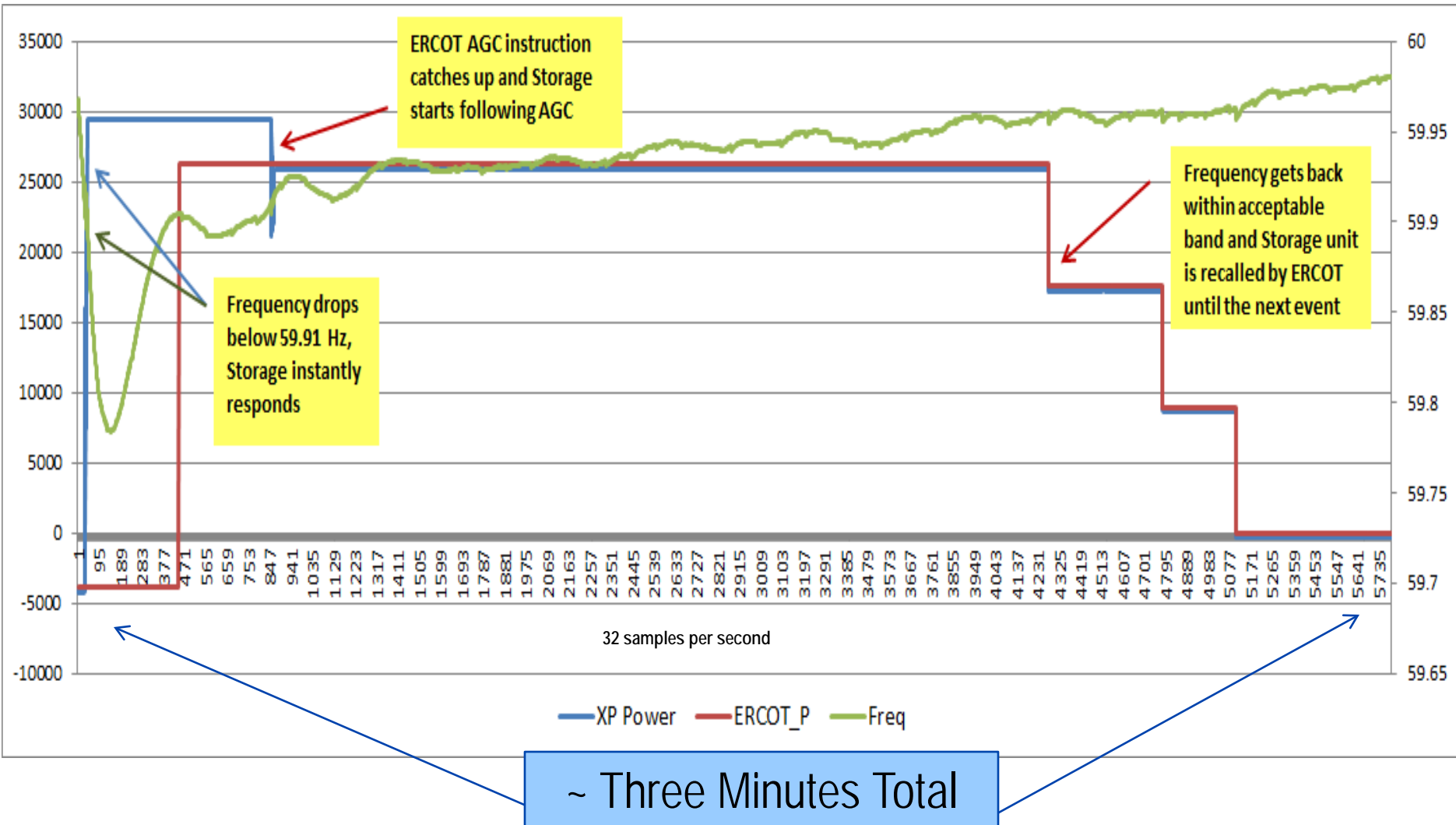
Example: FRRS Deployment Logic and Expected Impact



Example of FRRS calls in a given hour

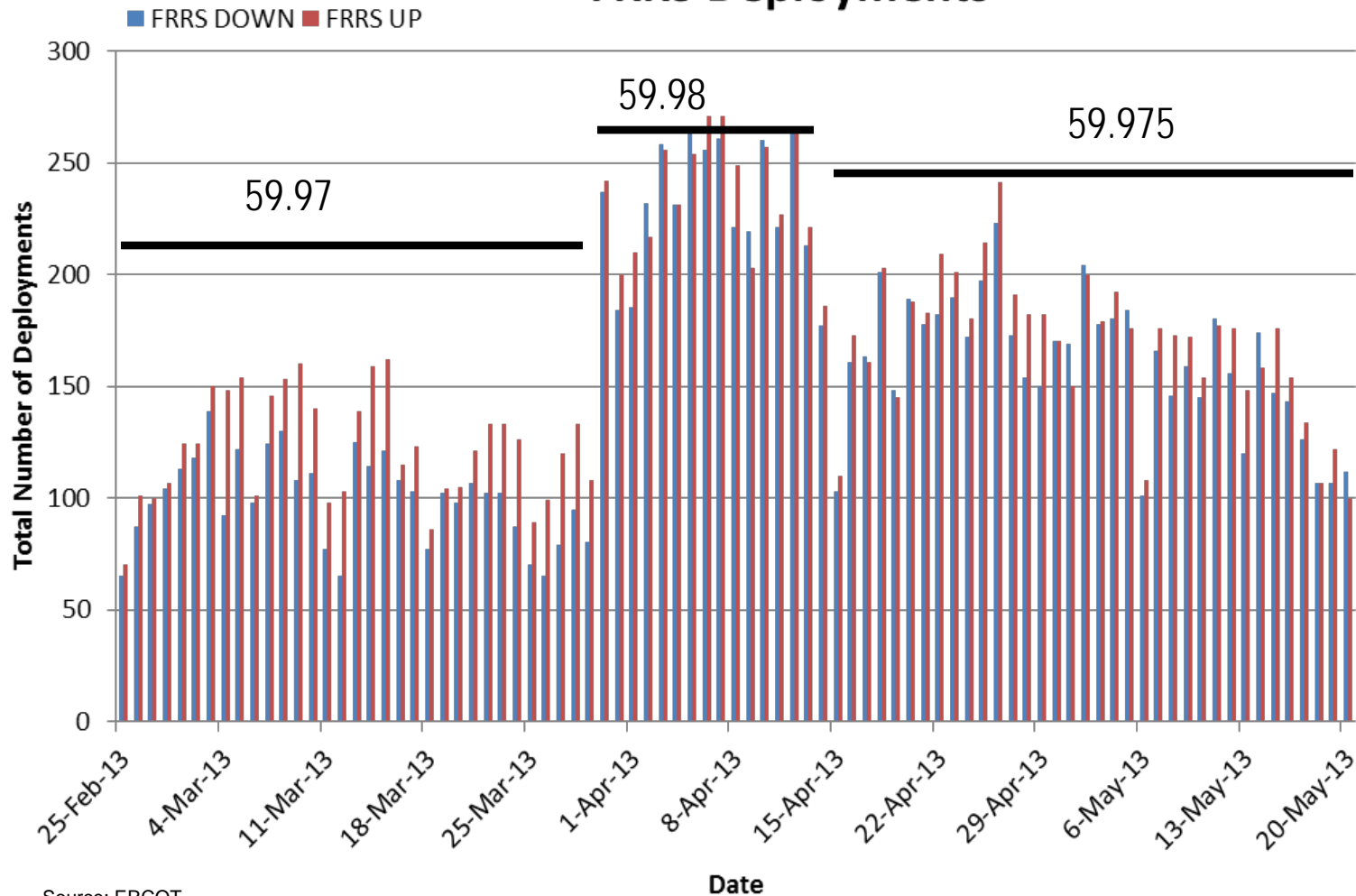


Arresting extreme frequency deviations in ERCOT Market



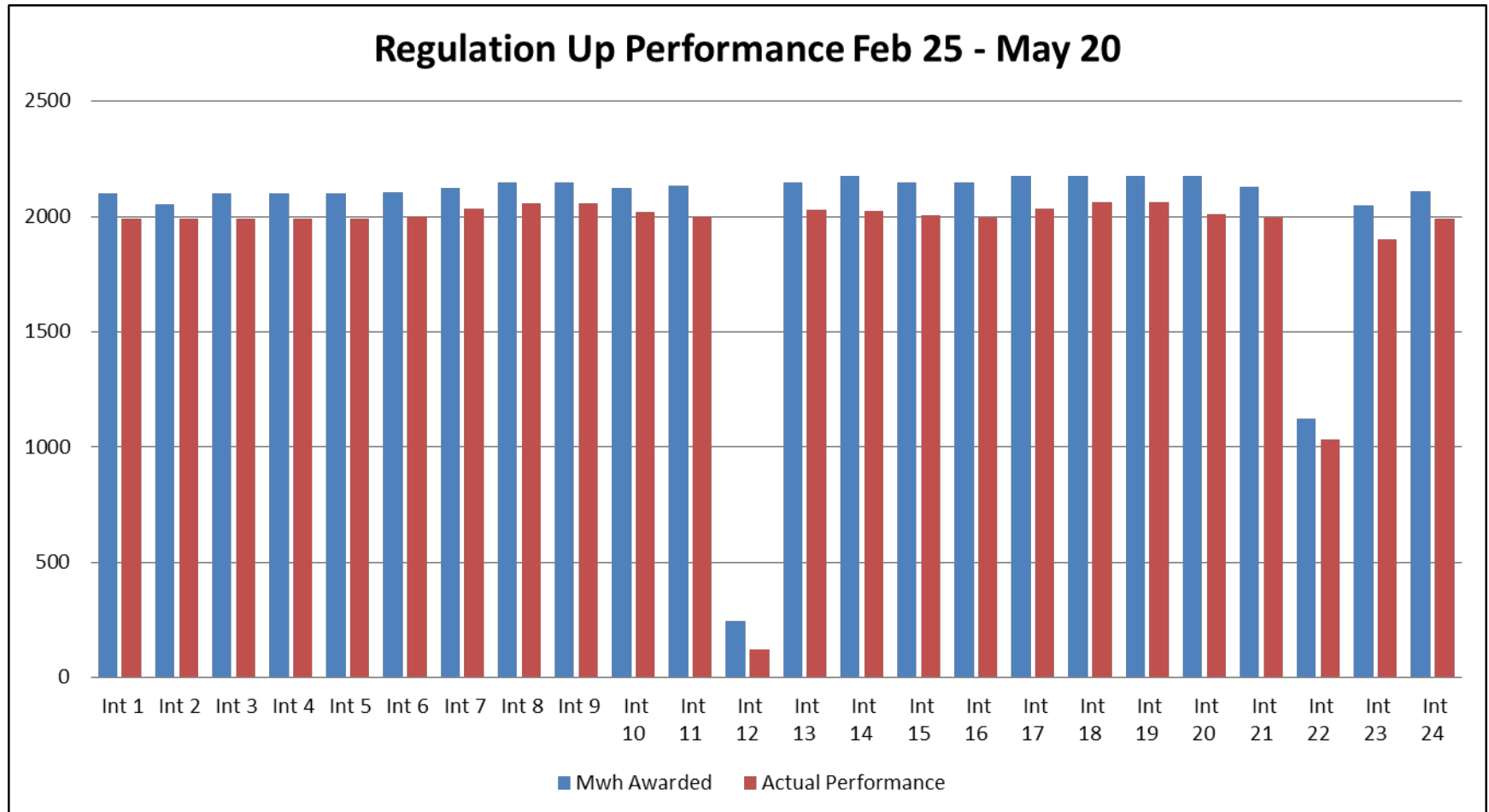
Number of FRRS Deployments

FRRS Deployments



Source: ERCOT

FRRS-Up Performance



Source: ERCOT

Performance Rate for First 13 Weeks

FRRS MWh Awards vs Actual Performance			
Date Range Feb 25 - May 20			
FRRS Service	MwH Awarded	Performance	Overall Rate
Total RegDN	7,167	4,750	66%
Total RegUP	48,206	45,378	94%

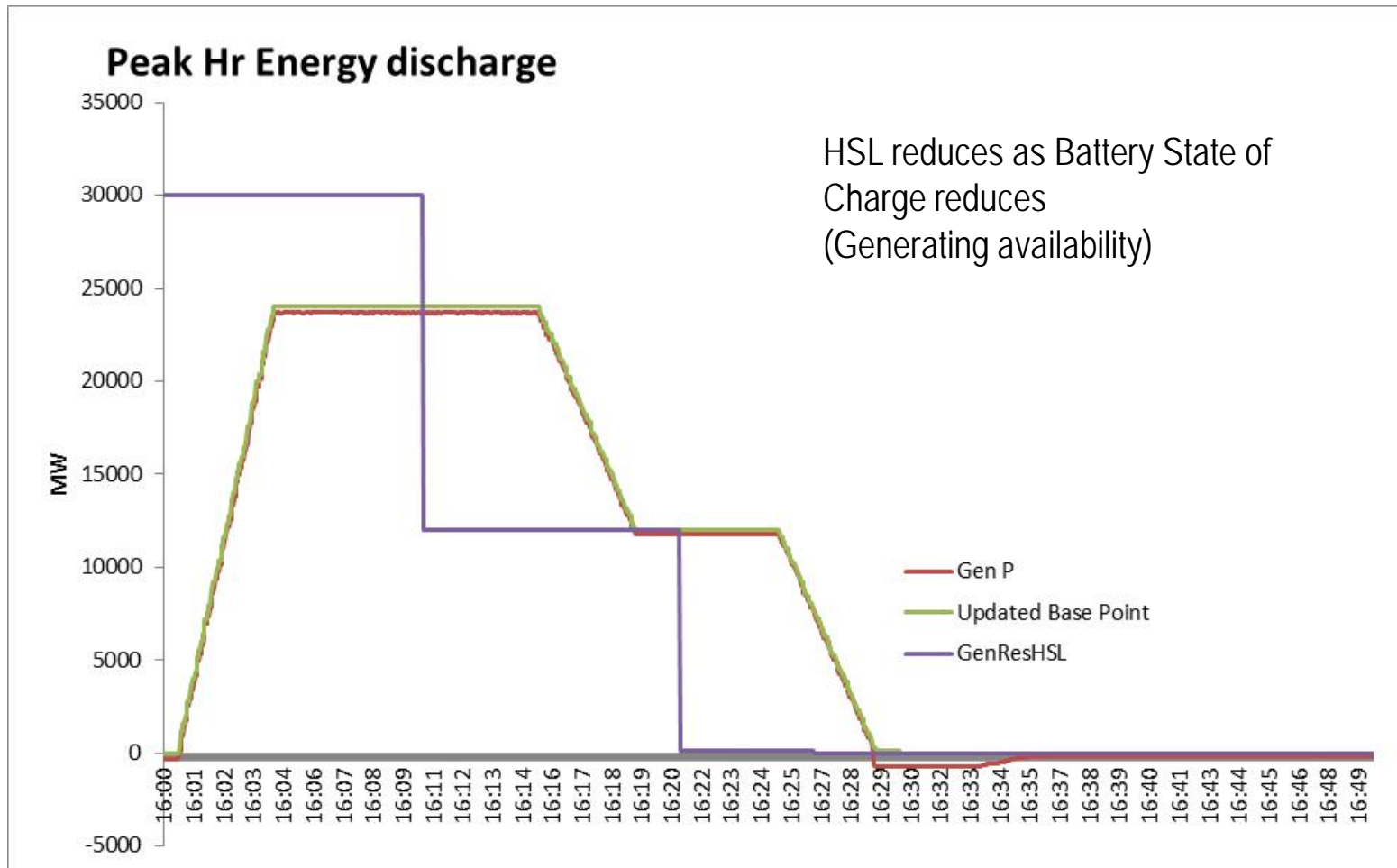
Source: ERCOT

What Next

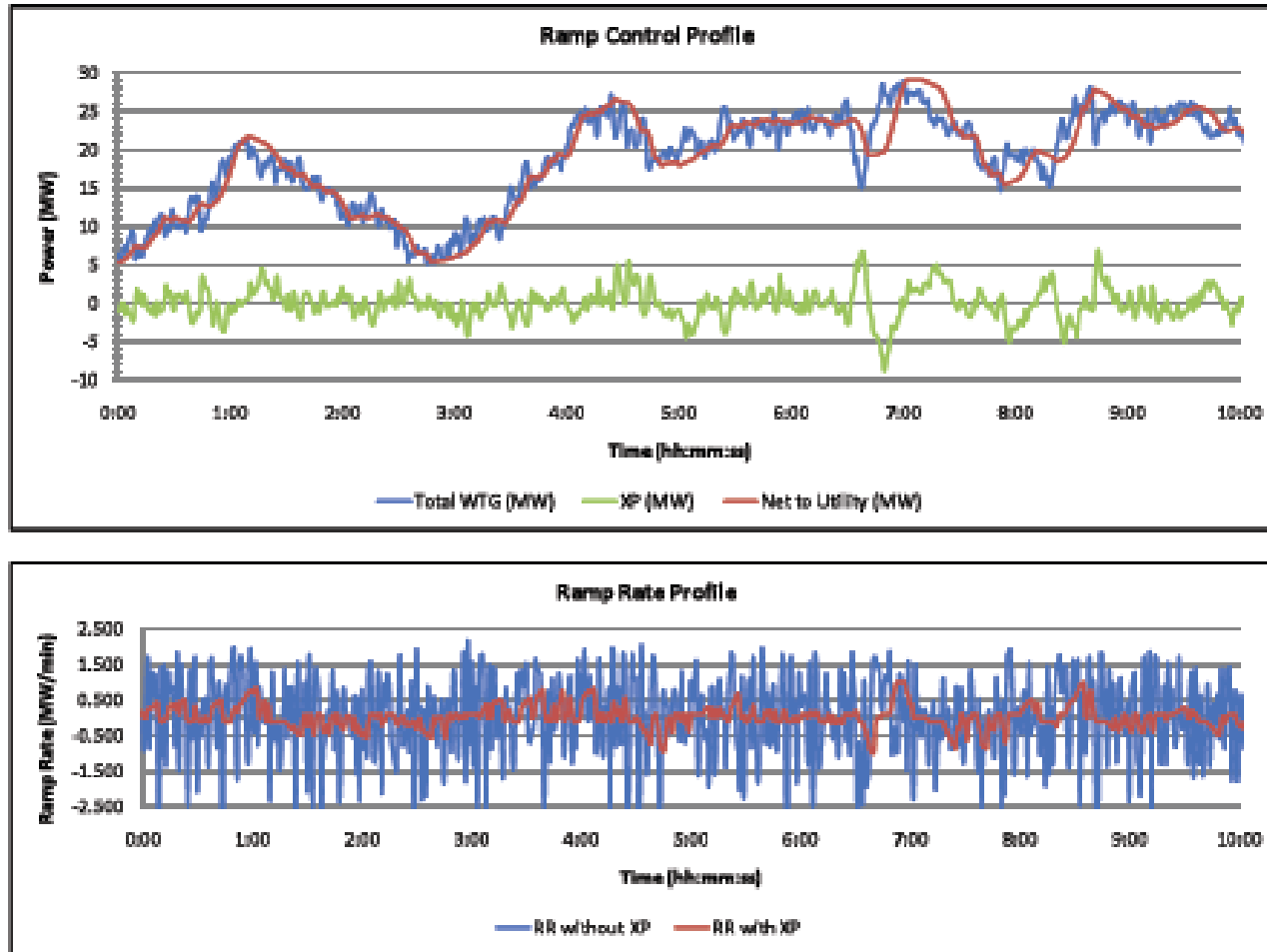
- In ERCOT
 - Finalize rules for new regulation service
 - Finalize treatment of WSL
 - Streamline process for interconnection of storage resources
 - Incentivize development of new storage resources, to further contribute to grid stability
 - Continue to refine operating parameters to optimize system performance
- Outside ERCOT
 - Share lessons learned, to demonstrate the effectiveness of the technology
 - Develop market rules to realize operational benefits and incent storage projects
 - Deploy projects to continue to bring costs down

Appendix

Representative ERCOT Energy Dispatch



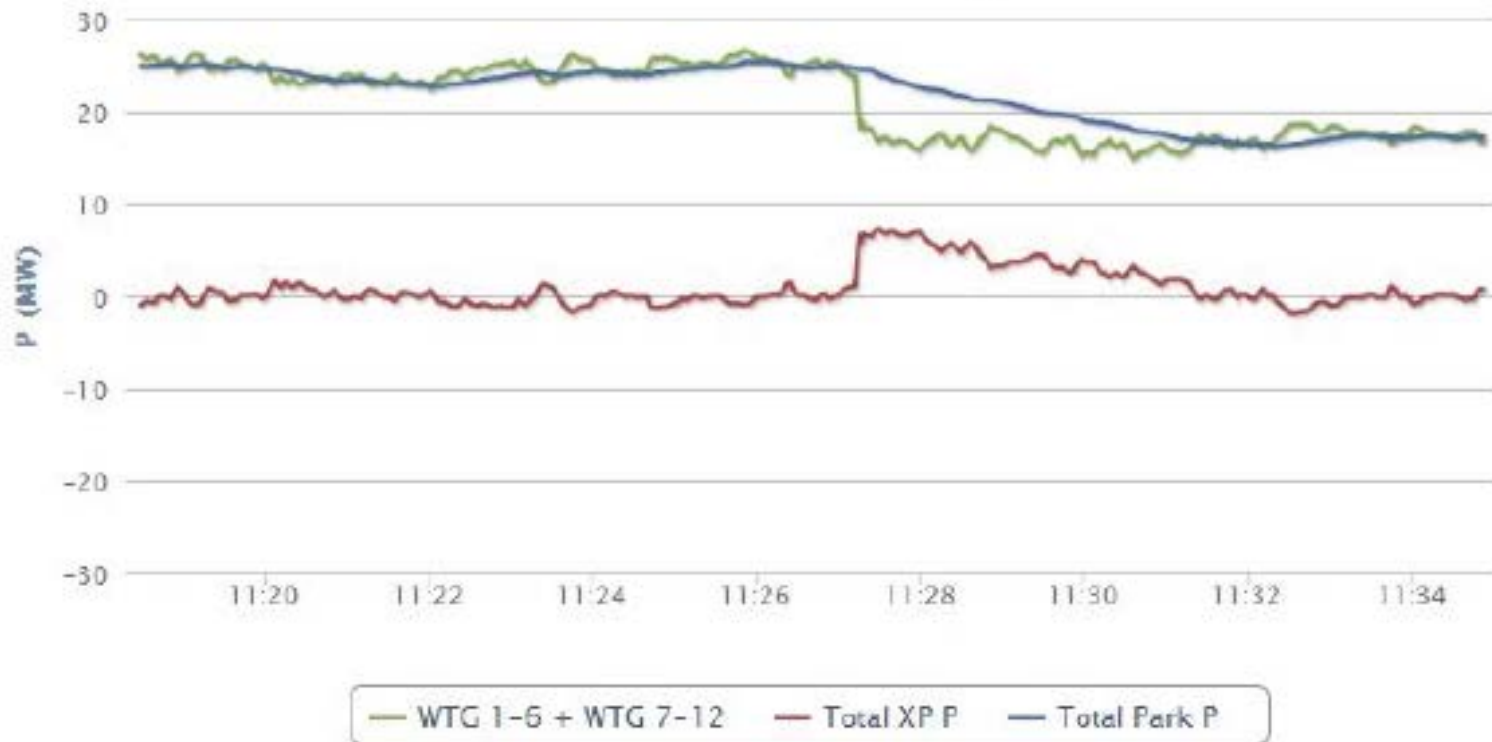
Storage System Benefits (Details)



Source: Xtreme Power

Storage System Benefits (Details)

Kahuku WTG Trip Event



- Four WTG's tripped offline causing an ~8 MW drop in power
- DPR immediately discharges ~8 MW, ramps down park successfully



Lewis & Clark
VOYAGE OF DISCOVERY