Grid Scale Lithium Ion Battery Storage Arrays: Reliability and Resiliency

Institute for Regulatory Policy Studies

Illinois State University

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Session 2 – An Outlook on Energy Storage

Emerging Challenges for the Public Utility Industry:
Data Access, Energy Storage,
Source Water Development,
and Electricity Market Re-regulation

IPL is a regulated investor-owned electric utility engaged primarily in generating, transmitting, distributing, and selling electric energy to approximately 490,000 retail customers in the city of Indianapolis and neighboring areas within the state of Indiana. IPL is a transmission system owner member of MISO. IPL owns and operates the IPL Advancion Energy Storage Array, the Harding Street Station Battery Energy Storage System ("HSS BESS").

First Grid-scale Lithium Ion Battery in the MISO Footprint

Placed in service May 20, 2016

Highlights

- Lithium Ion Technology
- 20 MW or Flexible 40 MW Lithium ion battery array
- Provides frequency control continuously; It is the leading state of the art frequency control solution
- Moves from a neutral state to full injection/withdraw in less than 1 second
- Always available; Always Charged
- Can qualify to provide all ancillary services in the MISO tariff; tested annually
- Provides 5 MWs capacity – can deliver 5 MWs continuously over 4 hours of the peak (IPL does not include the HSS BESS as a load modifying resource in its FRAP)
- For IPL the device is a transmission asset intended to be part of our rate base
- An integral component of grid resiliency
- All in cost $25.4 million (2015-2016); constructed in 12 months. Costs and time to construct have declined since then.

Noteworthy Regulatory Dockets

The wheels of regulatory change

Energy Storage as a Transmission Asset

• 2006	EL06-278-000	FERC denied a filing by Nevada Hydro to treat its pumped storage facility as a transmission asset
• April 6, 2009	Order of the Texas PUC, Docket No. 35994	
• January 21, 2010	EL10-19-000	Western Grid
• July 18, 2013	Order 784	Reporting for Electric Storage Technologies
• January 19, 2017	PL17-2-000	Policy Statement on Cost Recovery by Electric Storage Resources

Design of the Facility

Battery Arrays are designed to fit the specific purpose they will serve; design differences can change some of the operating characteristics.

- Array server monitors and controls entire system; and is connected to the server in each core
- The HSS BESS is designed to autonomously contribute to frequency control; reacting at its full directed capacity in less than one second
- There are 8 2.5 MW cores with a total of 244 nodes
- The system is monitored and controlled through using the AES Advancion software with imbedded SCADA and HMI; Monitors over 20 thousand data points within each core
- Node = 20 battery trays with 20 wafer batteries each. Total of 97,600 lithium ion battery cells

Interior View of Battery Room

Batteries on the grid

Modular, scalable arrays with high availability from current technology

BATTERY CELLS

BATTERY PACKS

BATTERY MODULES

ADVANCION NODES

ADVANCION ARRAY

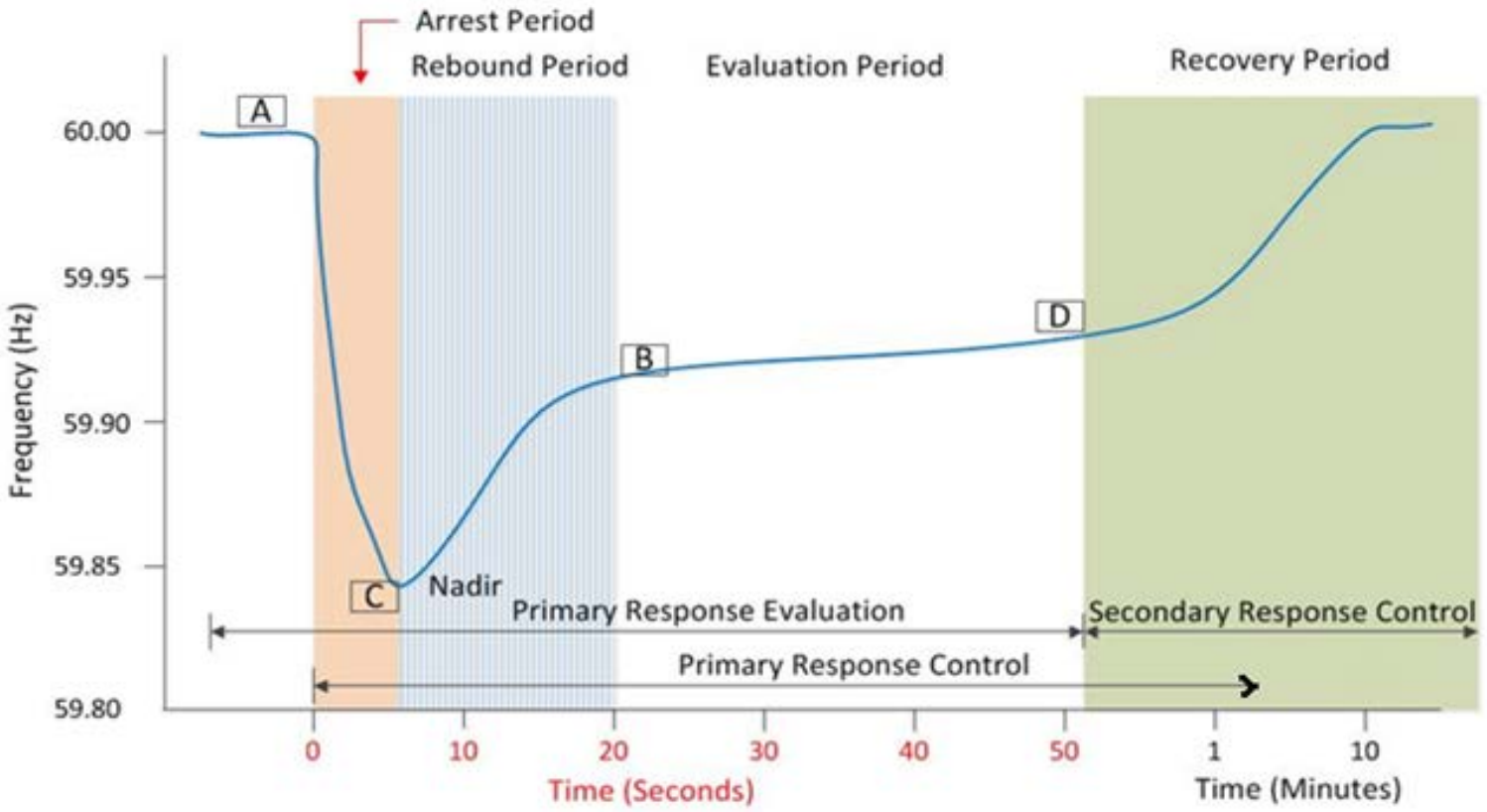
The Secret Sauce

Over 20,000 data points for each core are captured every 2 seconds; data is used for monitoring, analysis, and can provide critical actual performance information in any granularity down to 2 seconds nearly instantaneously at the end of the desired time period.

Highlights

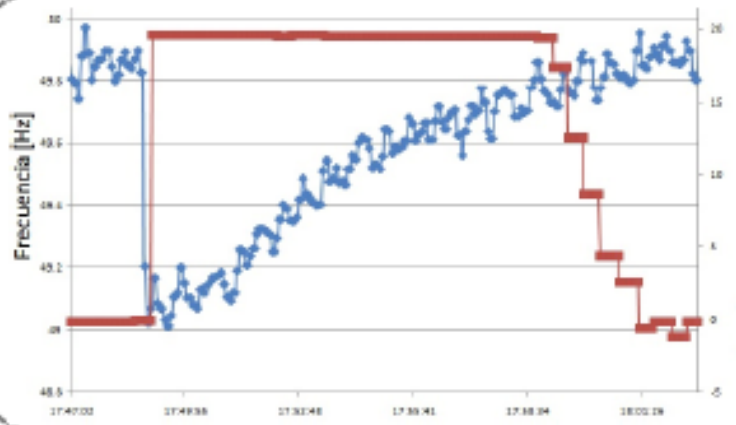
- The Vendor Proprietary operating software is the key to efficient and safe operation and the ability to modify instructions to adapt to evolving system needs.
  - Optimizes performance and battery life
  - Manages the State of charge
  - Programmed change from one service to next; can change within 1 second
  - Provides real time information to inform maintenance needs
  - Modular design
- Battery packs are readily available from many manufacturers to your specifications
- Fewer providers of inverters but still readily available
- Construction of the device regardless of MW capacity occurs in less than 12 months

Primary Frequency Response



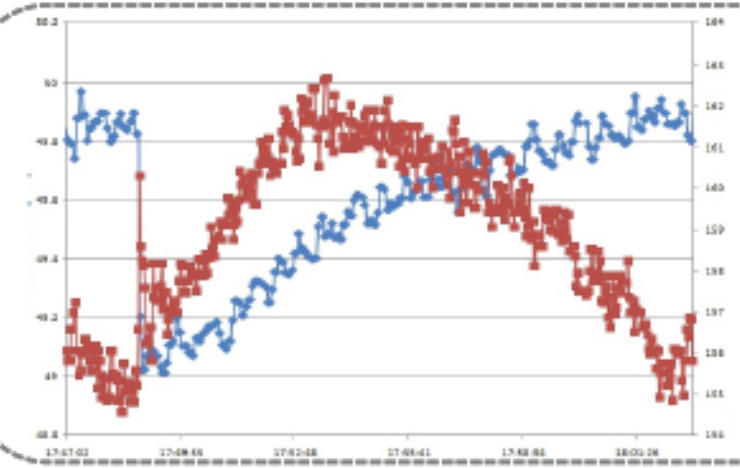
Source: NERC Guidelines Primary Frequency Response

Actual Performance: Angamos Storage Resource's Quick, Precise Response to Maintain Grid Frequency



Angamos BESS Response

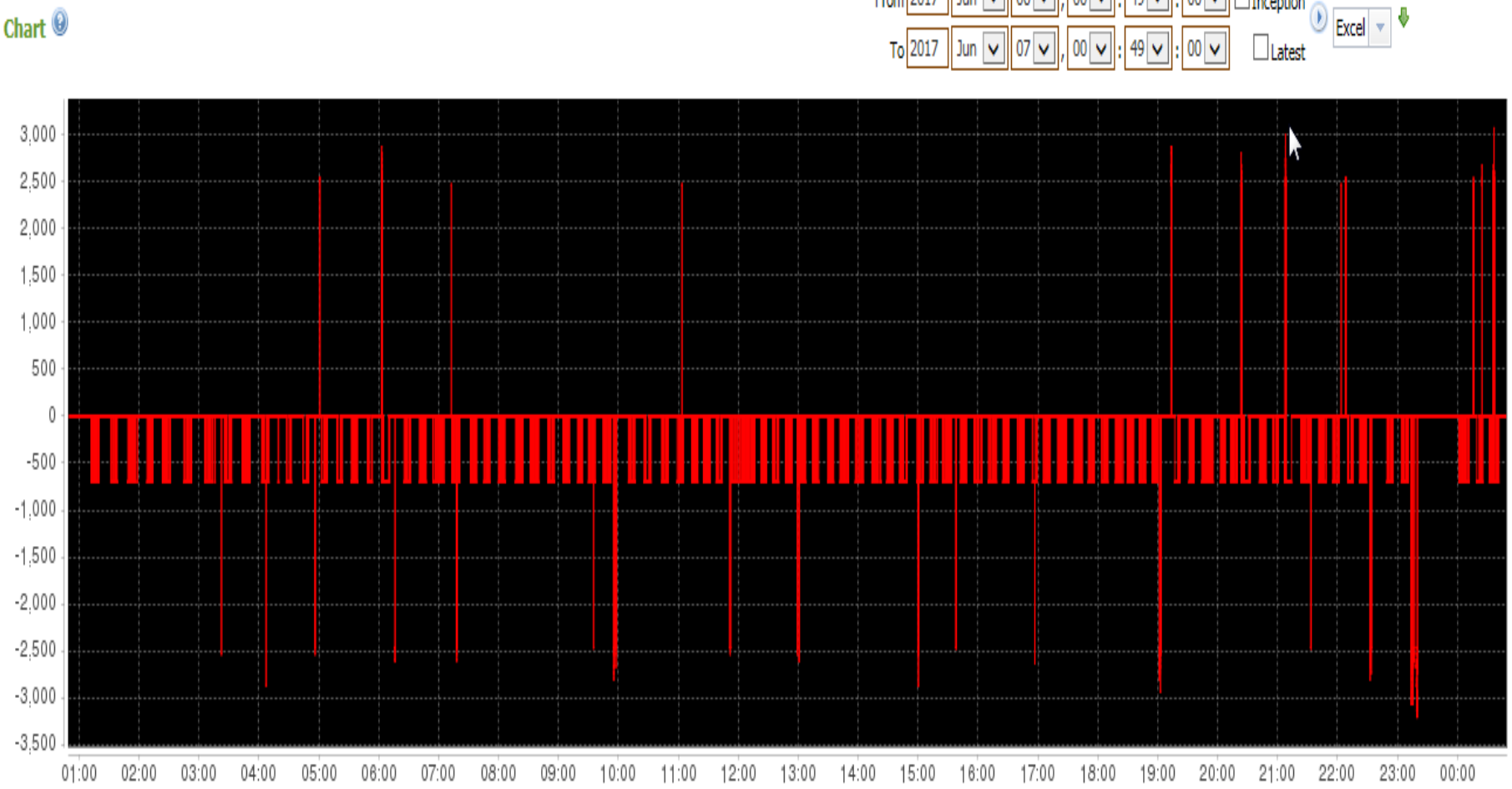
- ✓ Angamos BESS responds with rapid increase of output from 0MW to 20MW
- ✓ Autonomous response according to programmed profile
- ✓ Output sustained until stability restored



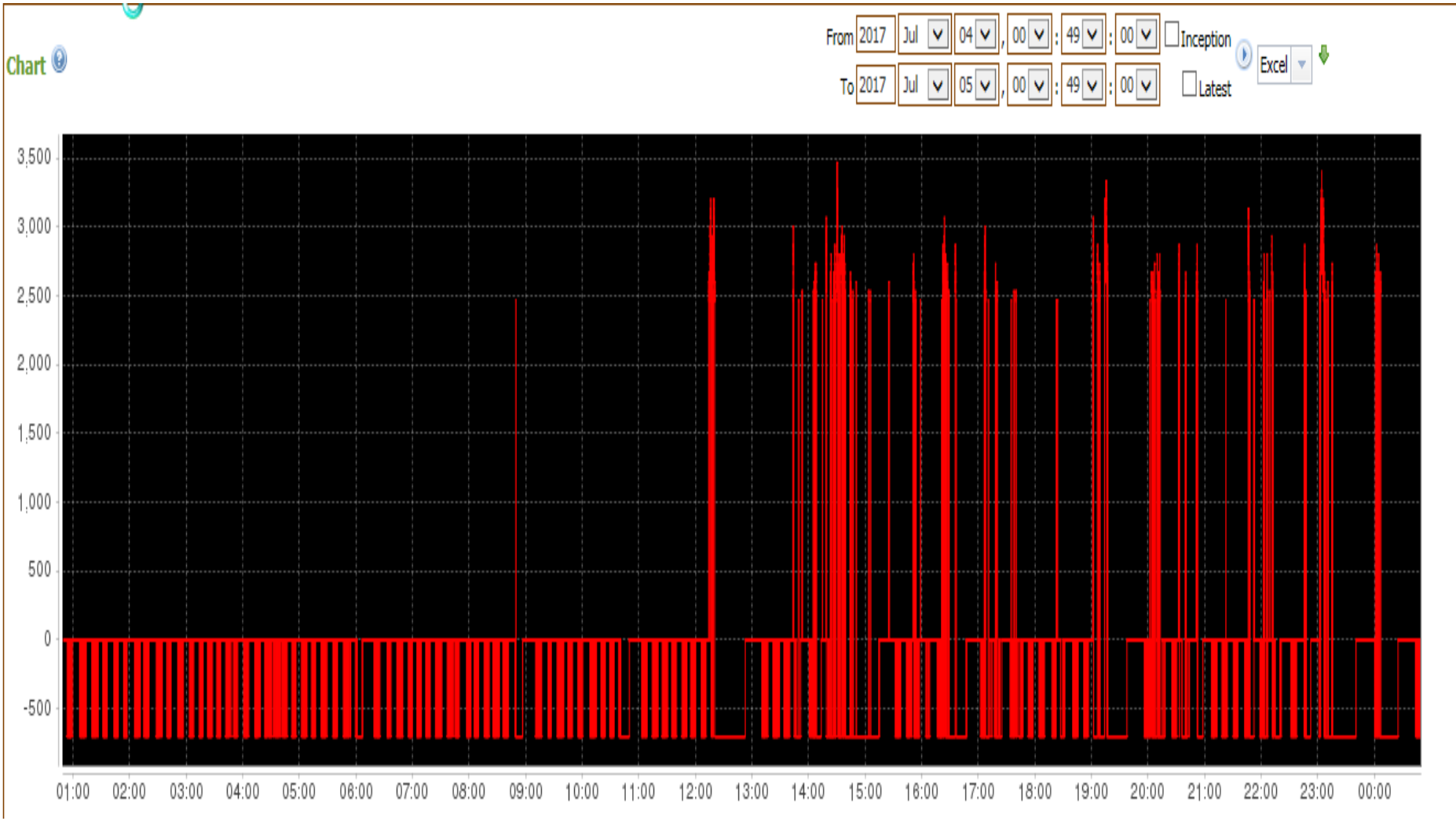
Thermal Units

- ❖ Thermal unit responds with 4MW burst, then output drops off
- ❖ Gradually ramps up in oscillating manner to 7MW output increase over 4 minutes

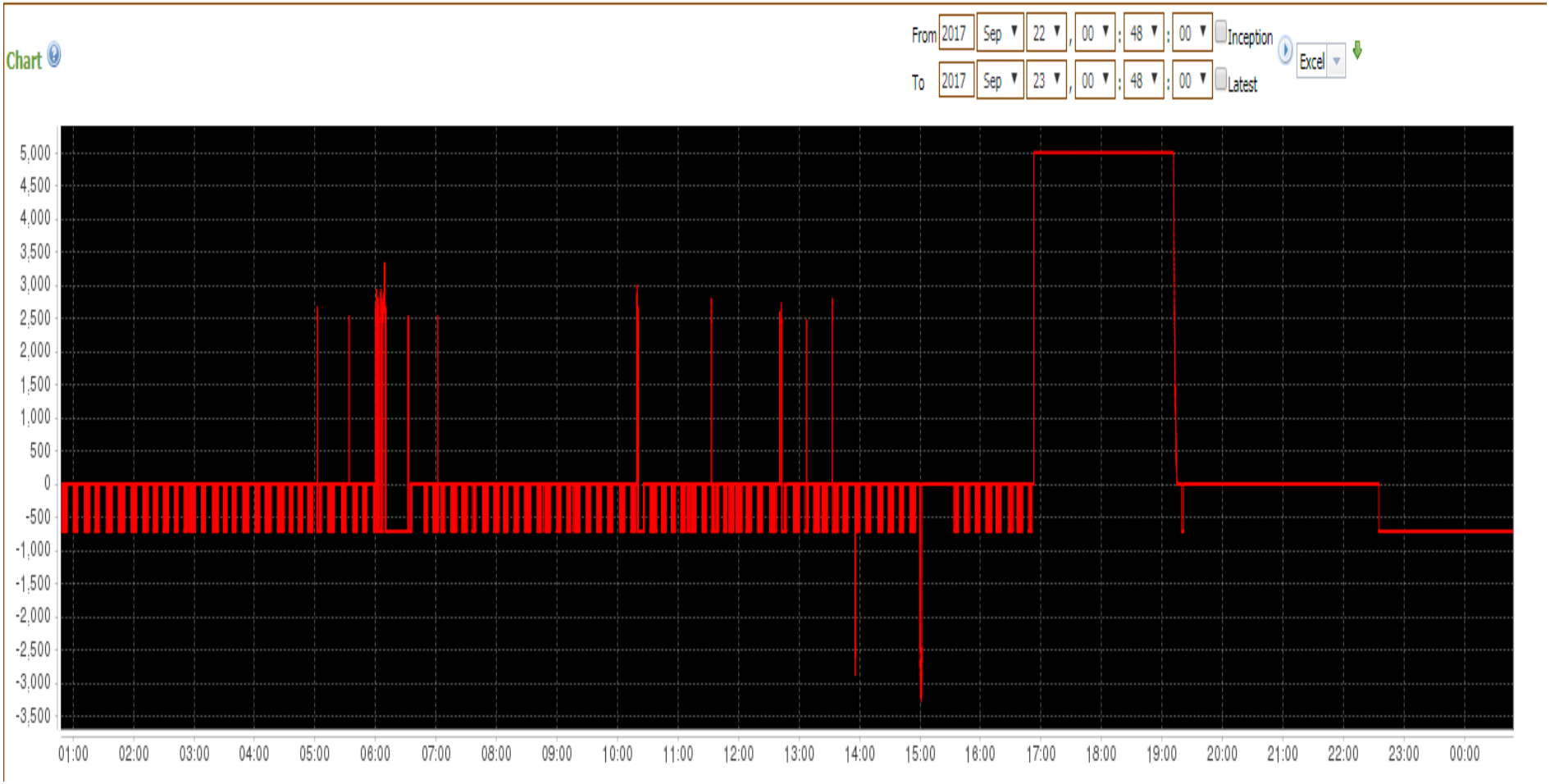
June 6, 2017 – Typical day



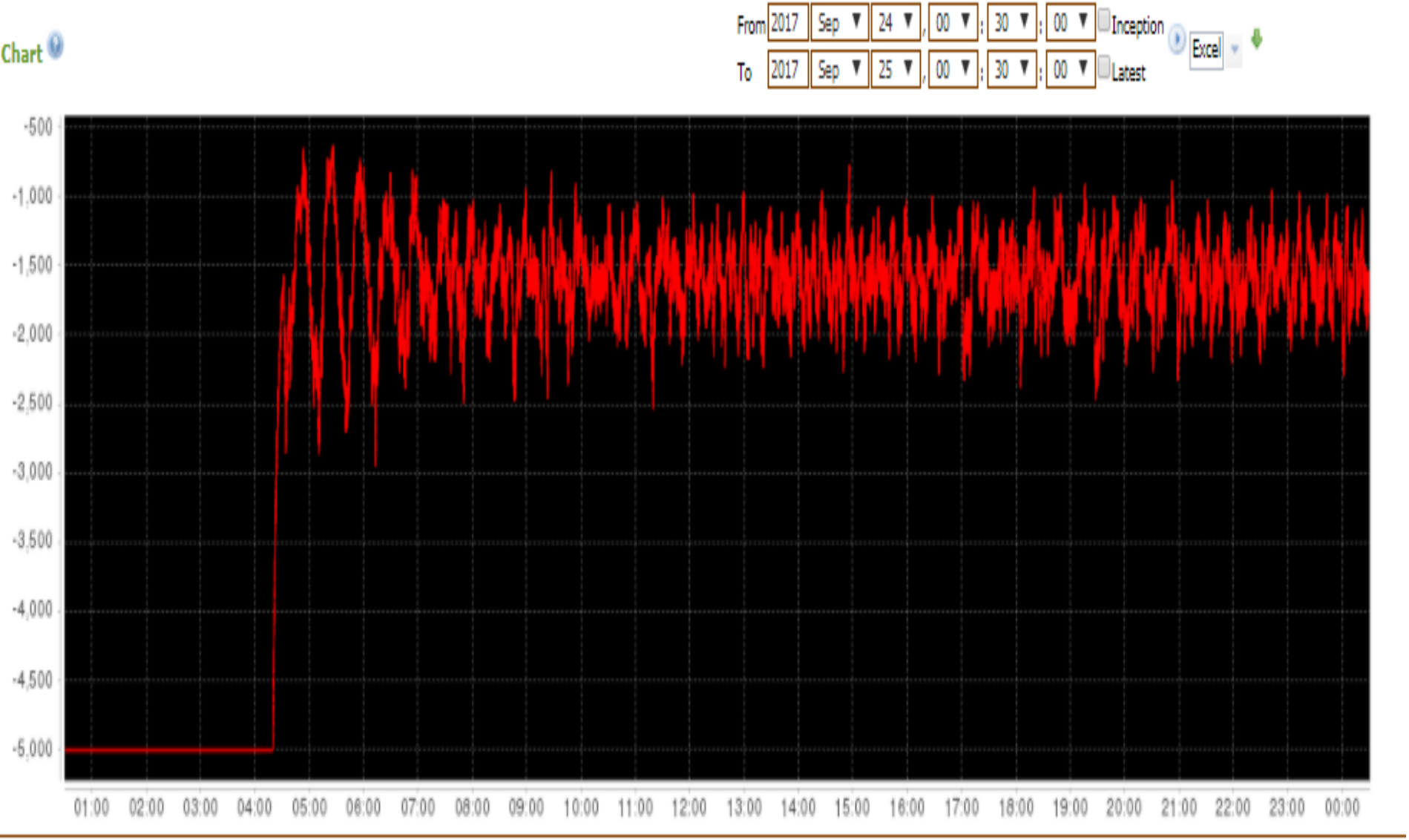
July 4, 2017 – Anomaly



September 22, 2017 Peak Contribution



September 24, 2017 – Return to Normal



Performance Take-a-ways

- Although not designed as a peaker, can provide energy over the peak to help prevent load shed
- Can charge to full capacity fast or slow – sliding scale – operator's choice
- Can provide frequency response until needed for peak and return to providing frequency control in a few minutes after full discharge
- Instantly at full directed capacity – no ramp – like turning on a light switch
- The faster a frequency deviation is mitigated the fewer MWs it takes

Resiliency

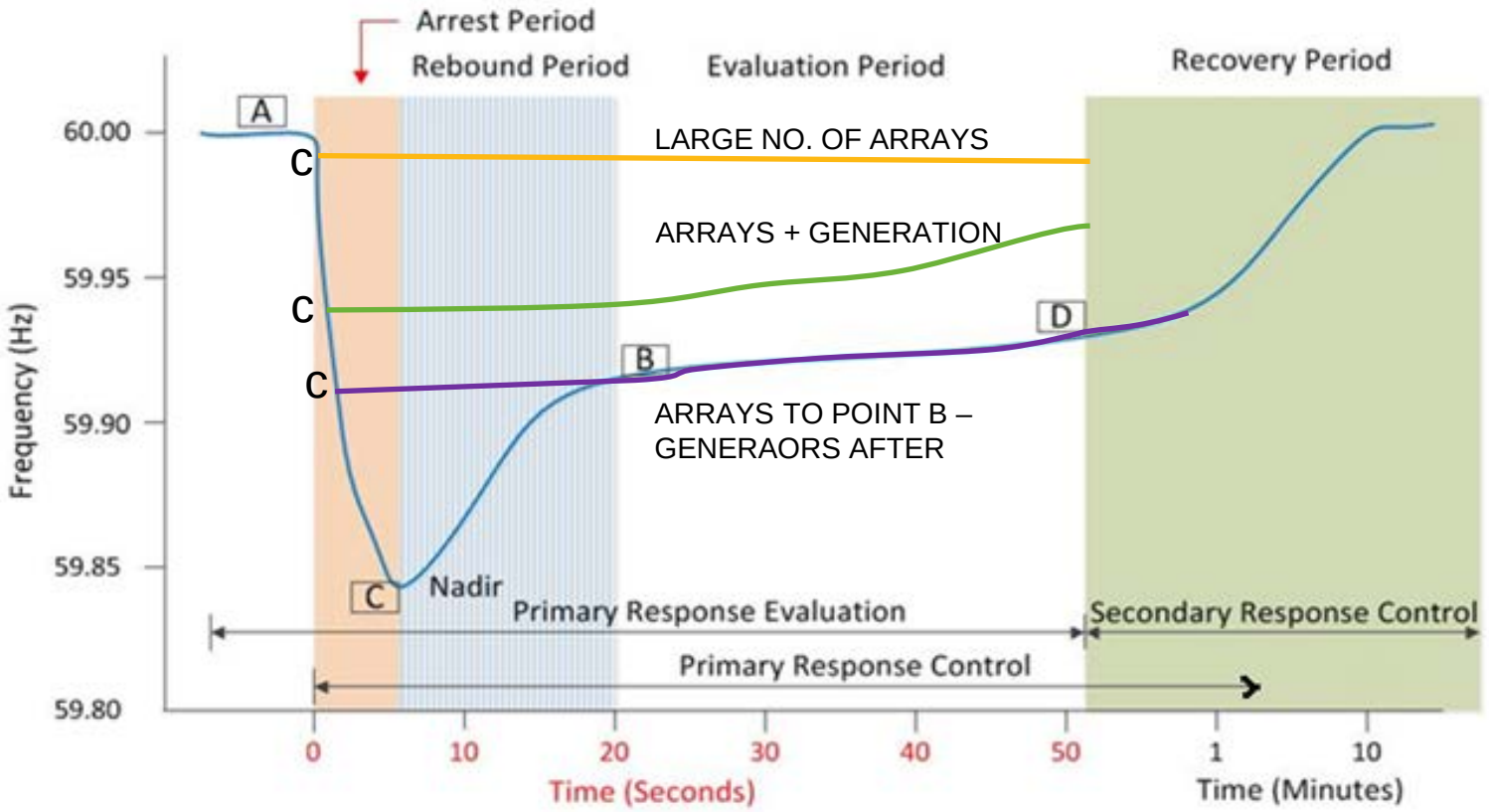
An ability to recover from an event

- Through an existing and continuous NERC process of event analysis changes are made to existing NERC standards and guidelines
- Events can range from a cyber security issue to “ride through” requirements that are technology specific.
- As with reliability resiliency comes at a cost

Increased grid resiliency with battery arrays

ILLUSTRATIVE

A HIGHER NADIR REDUCES THE RISK OF CASCADING



Source: NERC Guidelines Primary Frequency Response
Modified for resiliency benefits of batteries – future state