h:ve

HiVE Energy Systems
January 2018

HiVE is a ground-breaking, renewable energy storage solution.

HiVE's technology is safe, reliable and cost-effective – truly a Next Generation technology.

h:ve
2045

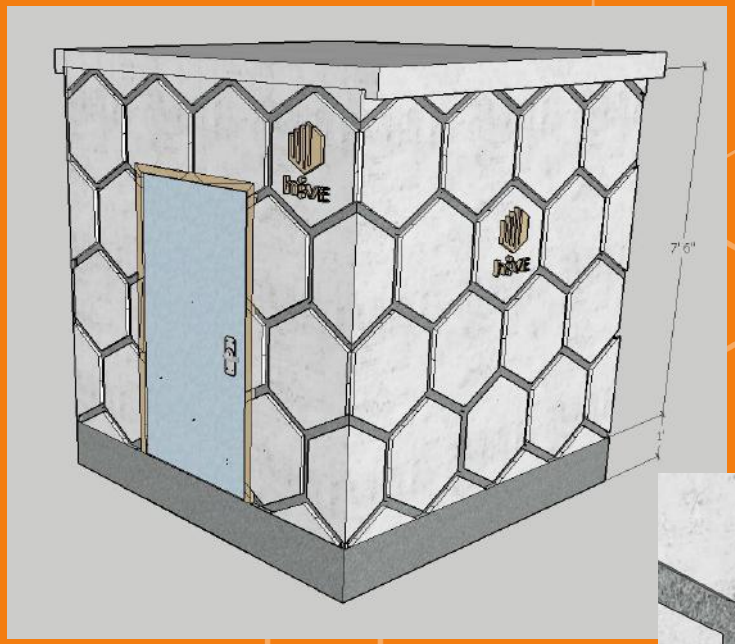
DIGITAL POWER FOR THE DIGITAL AGE

APPLICATIONS & MARKETS

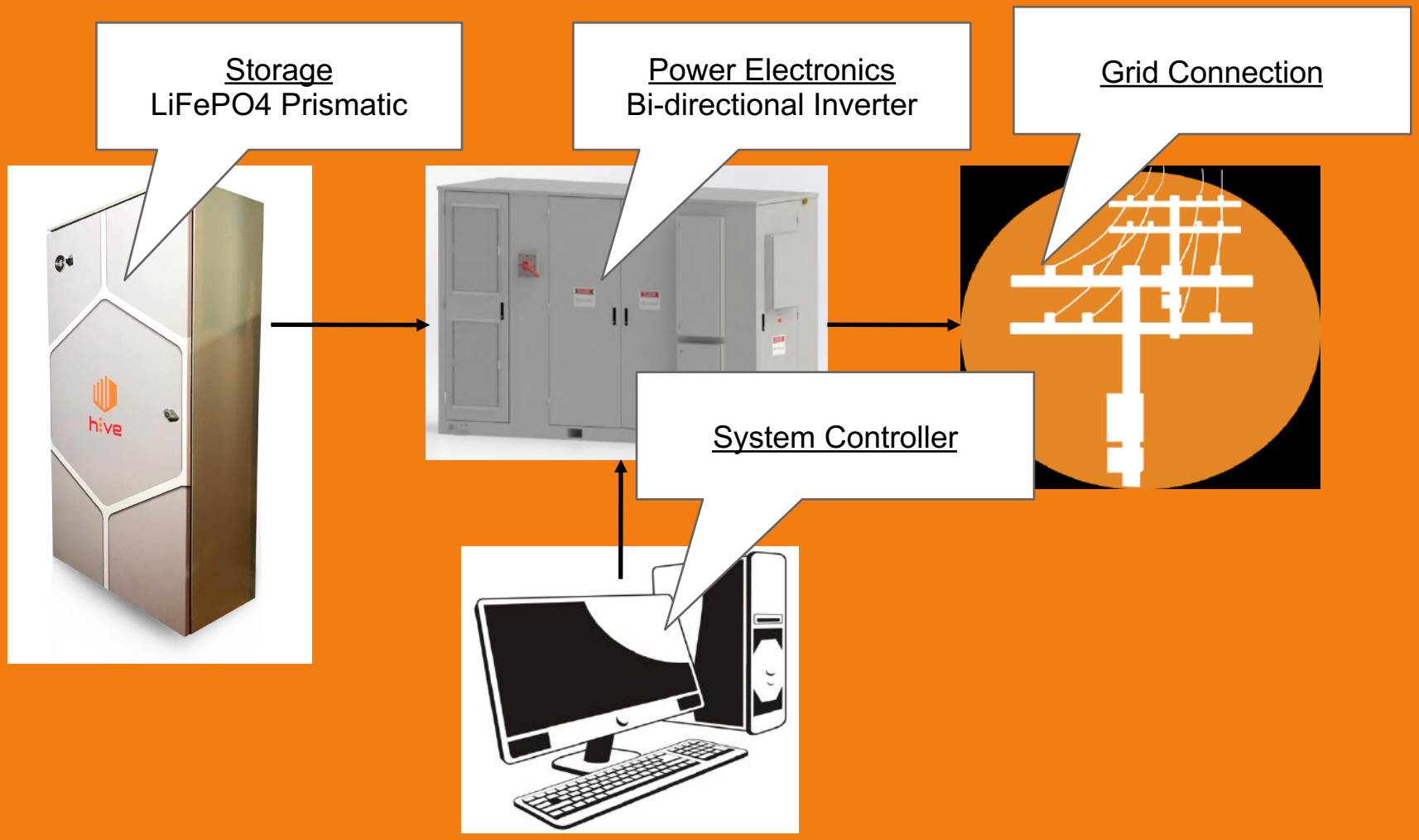
- ➔ HiVE is Modular and Scalable:
- ➔ Utility, Industrial, and Commercial Scale Energy Storage
- ➔ Residential Off-Grid | Grid-Tied Selectable
- ➔ Power Smoothing | Grid Management
- ➔ Peak Shaving
- ➔ Load Balancing AND Load Shifting
- ➔ Backup Power | UPS
- ➔ Digital Energy Storage

Commercial Applications

Industrial and Utility Applications



What is a Battery Energy Storage System (BESS)



Wind Farm BESS

Design-build construction of the 11MW/4.4 MWh BESS for a 24MW Wind Farm. The installation consisted of (9) 55’ containers containing battery modules, power electronics, switchgear, and chillers. The pictures below show the wind farm substation work site and a satellite image of the site.

Utility Substations

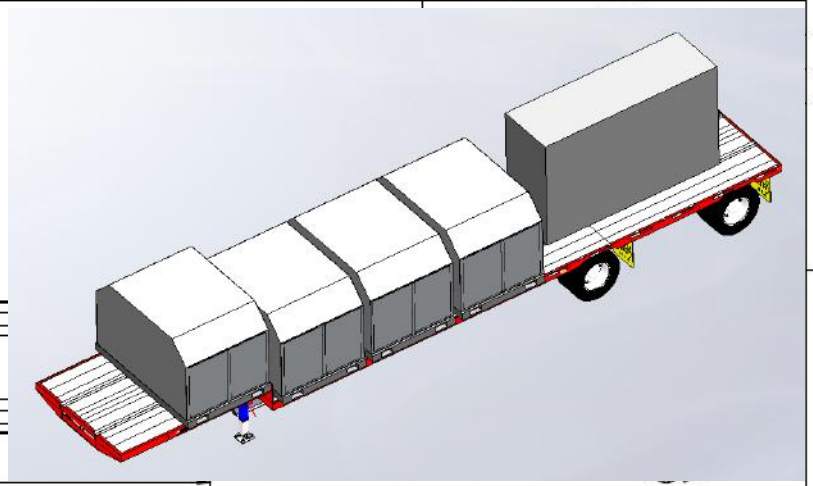
Selected as the design-build contractor for 1MW/1MWh BESS at Utility Substations. This BESS application peak shaves the top 15% of the evening peak demand (5pm - 9pm) to mitigate the need for additional generators. This project encompassed all aspects of installation and commissioning including SCADA. Batteries were large format, prismatic lithium iron phosphate. The below show the satellite image of the Substation and the 1MW/1MWh BESS.

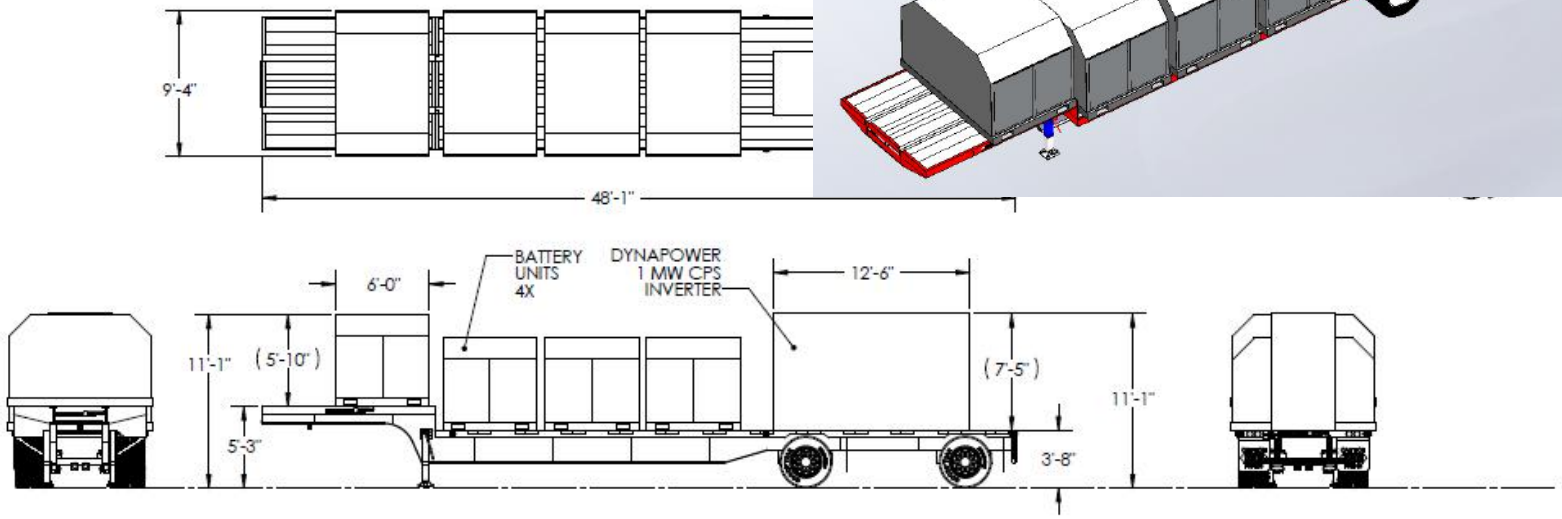
High Performance Computing Center

The super computing and data storage center PV project included a 200kWh battery energy storage system. This BESS installation provides critical backup power for a data center housed at the supercomputing center. Pictures show various views of the 100kW/200kWh BESS and the Data Center backup power.

U.S. Department of Energy 1MW/1MWH BESS

Portable HiVE Energy Storage





UNLESS OTHERWISE SPECIFIED:		NAME	DATE	HNU ENERGY 350 HOOHANA ST. KAHULUI, HI 96732	
*Dimensions are in inches and apply prior to finish * Drawing interpretations per * Surface Texture: * Symbols per ASME Y14.5 * Requirements per ASME B46.1 * 125 microinches (Ra) machined surface roughness *TOLERANCES: *ANGLES: ▲ 0° 30 MIN *DECIMALS: .xx ▲ .xxx ▲	DRAWN	MO	11/26/2013	TITLE: OMEGA Single Drop Trailer	
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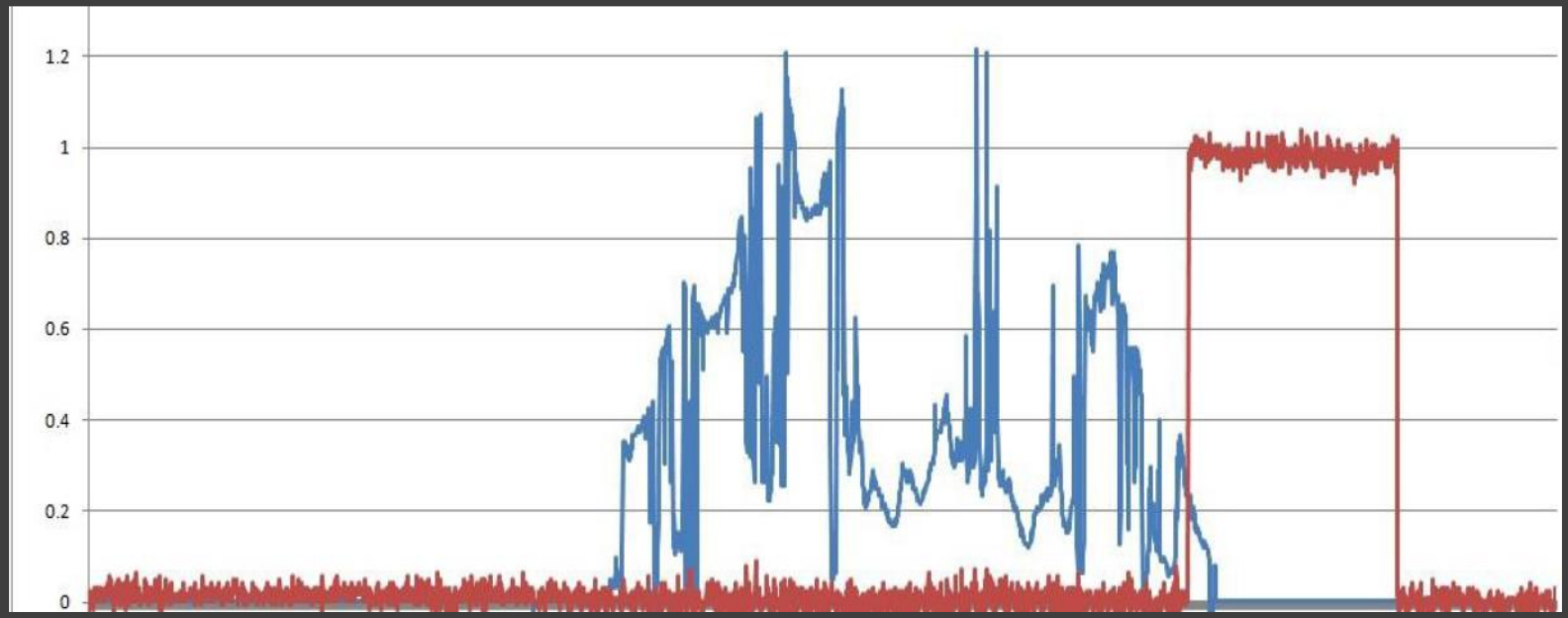
APPLICATION	DO NOT SCALE DRAWING				SHEET 1 OF 1

Daily Power Planning

Blue – actual generated raw power

Red – HiVE dispatched power as needed

HiVE “Digital Power”

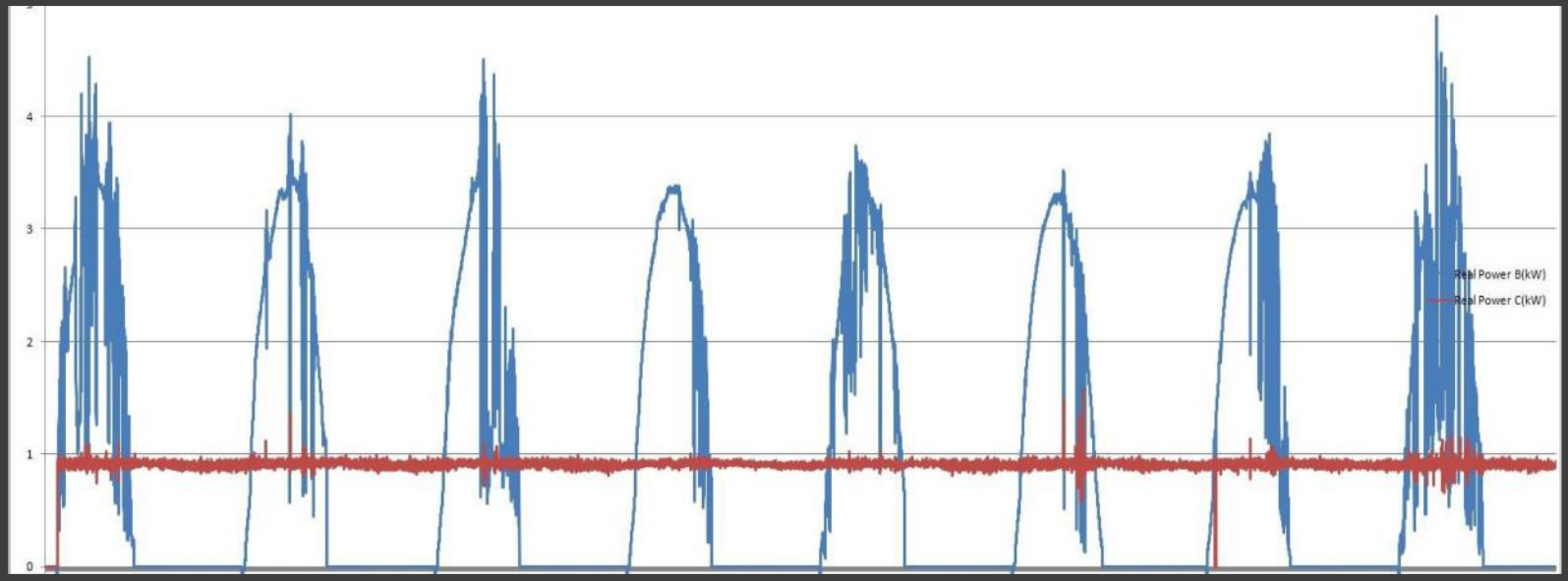


Weekly Power Smoothing

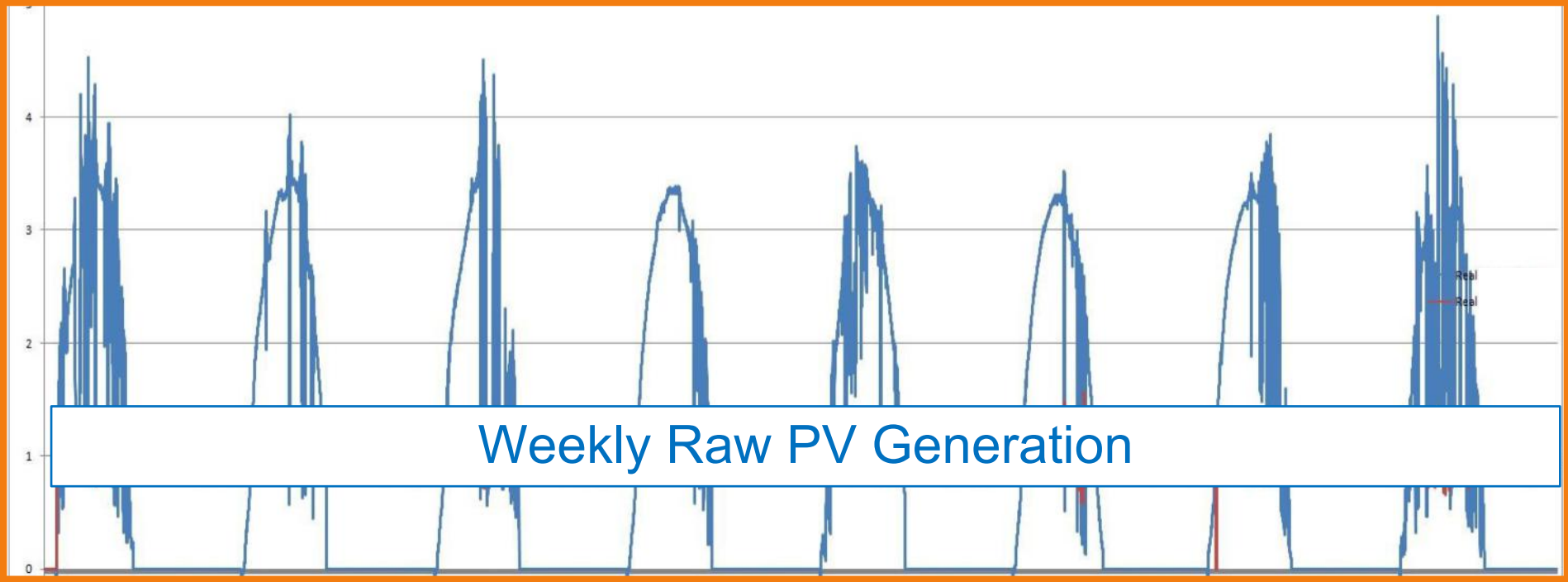
Blue – actual raw generated power

Red – HiVE generates smooth power for firm delivery

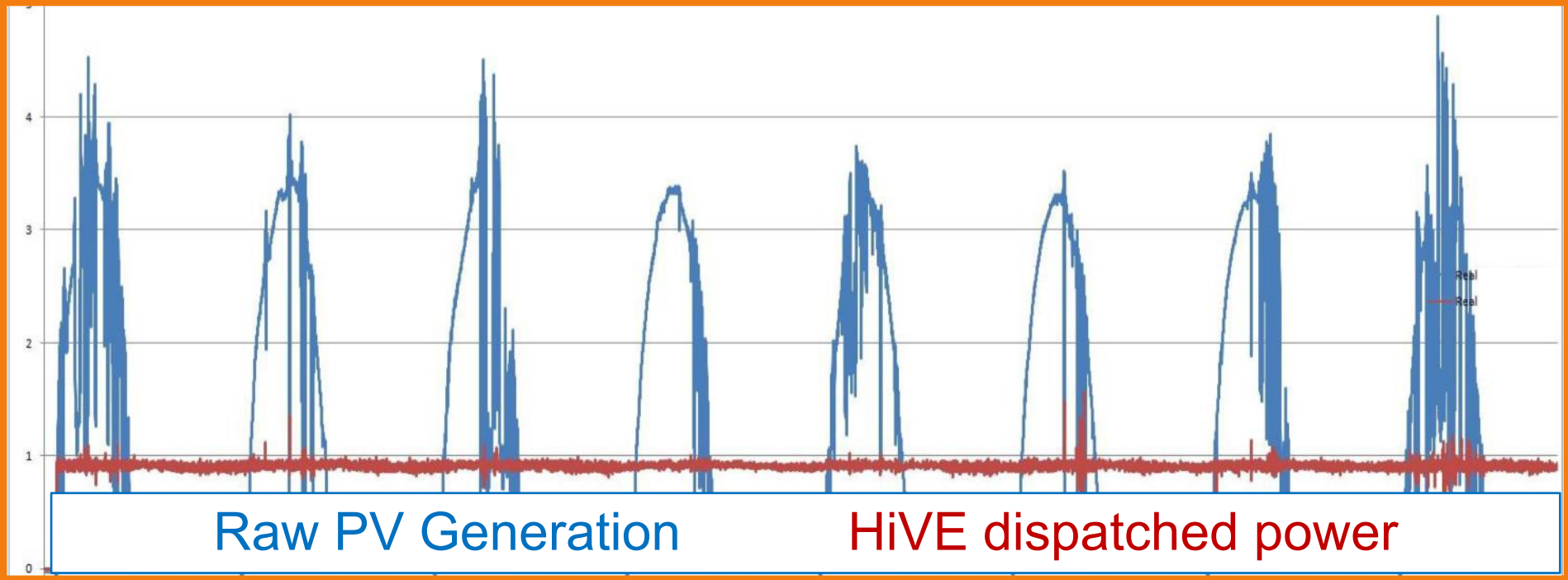
HiVE “Digital Power”



The Problem
- GRID INTERMITTENCY -



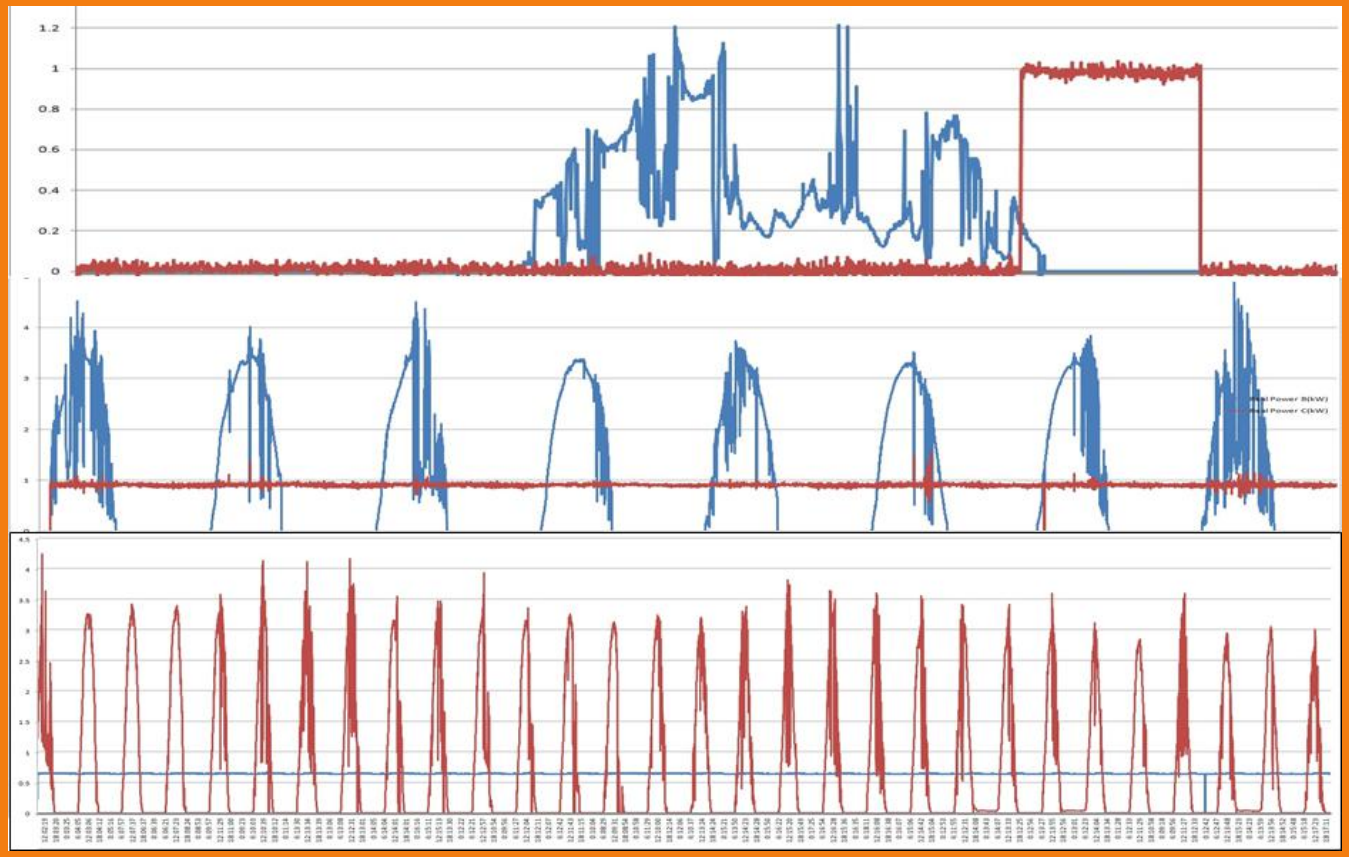
The Solution
- HiVE -



HiVE Predictable Power

HiVE has perfected a battery control and management tool called Predictable Power. Predictable Power is fully programmable, on-demand, firm, and proven. It converts renewable energy sources from “as-available” to “predictable”. The figure below illustrates how an intermittent renewable resource, such as photovoltaics, can be converted to a firm resource.

All the data shown was recorded in 2012. The top graph illustrates a single day with the solar generation curve showing significant dropouts. The solar energy is stored in our battery system and exported to the grid during the peak demand hours between 5-9pm. The middle graph illustrates a consecutive week of data, where the predictable power unit exports constant power 24 hours a day. The lower graph illustrates a consecutive month of constant power exported to the grid, regardless of the amount and profile of PV generation.



Power Electronics

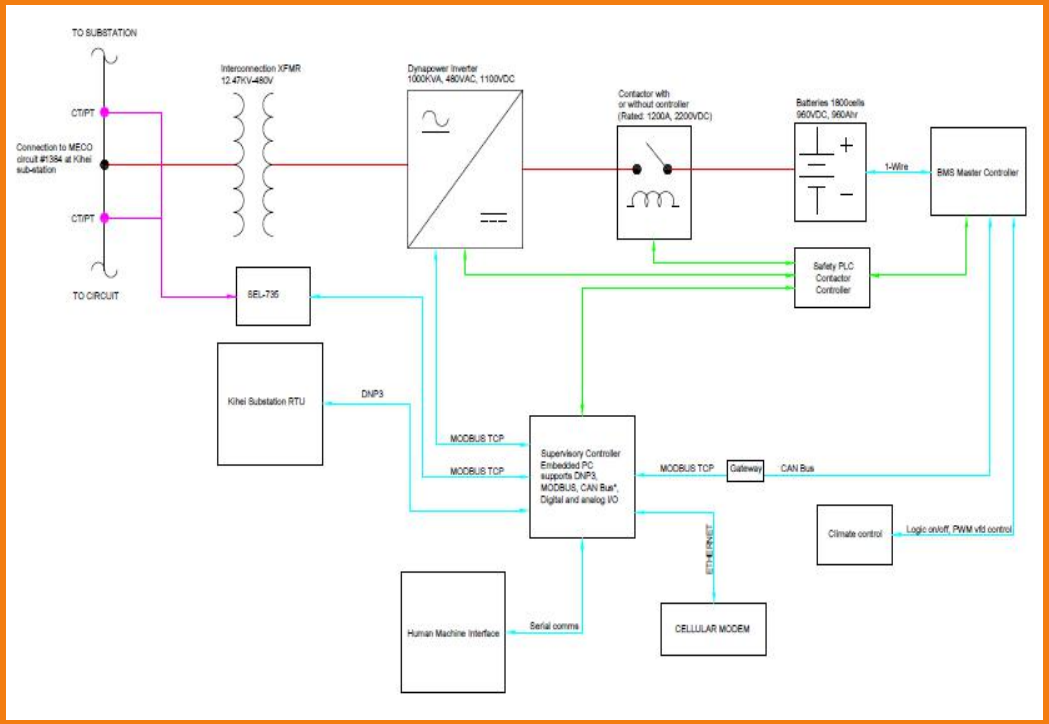
- Bi-directional operation
- 4-quadrant operation
- Independent real and reactive power control
- Typical 480VAC output

(Customizable with external transformer)

- On-board DSP provides protection for inverter

System Controller

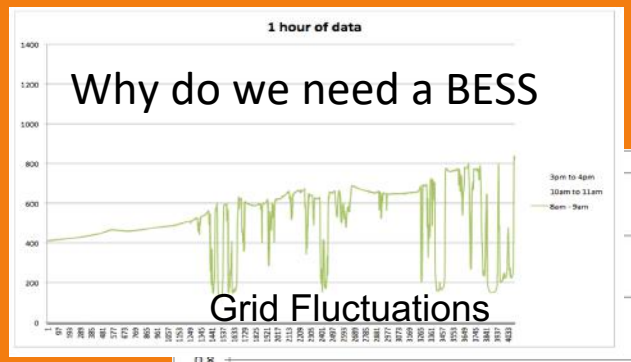
- Industrial Computer coordinates all activity
- Dynamic system allows for various operating functions
- Built-in safety systems to protect valuable assets

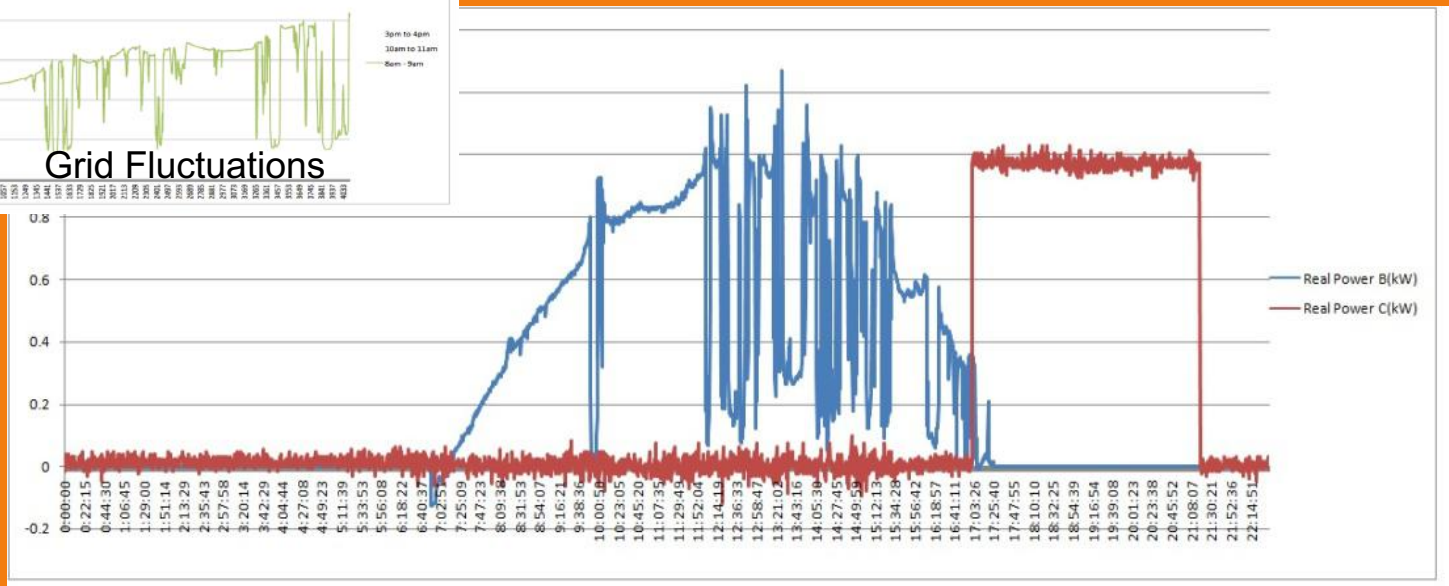


Why do we need a BESS

- Renewable Energy Buffering (Local and remote)
- Deferred Power (Peak shaving, Load Shifting, Firm Power)
- Grid Support (Voltage and Frequency)

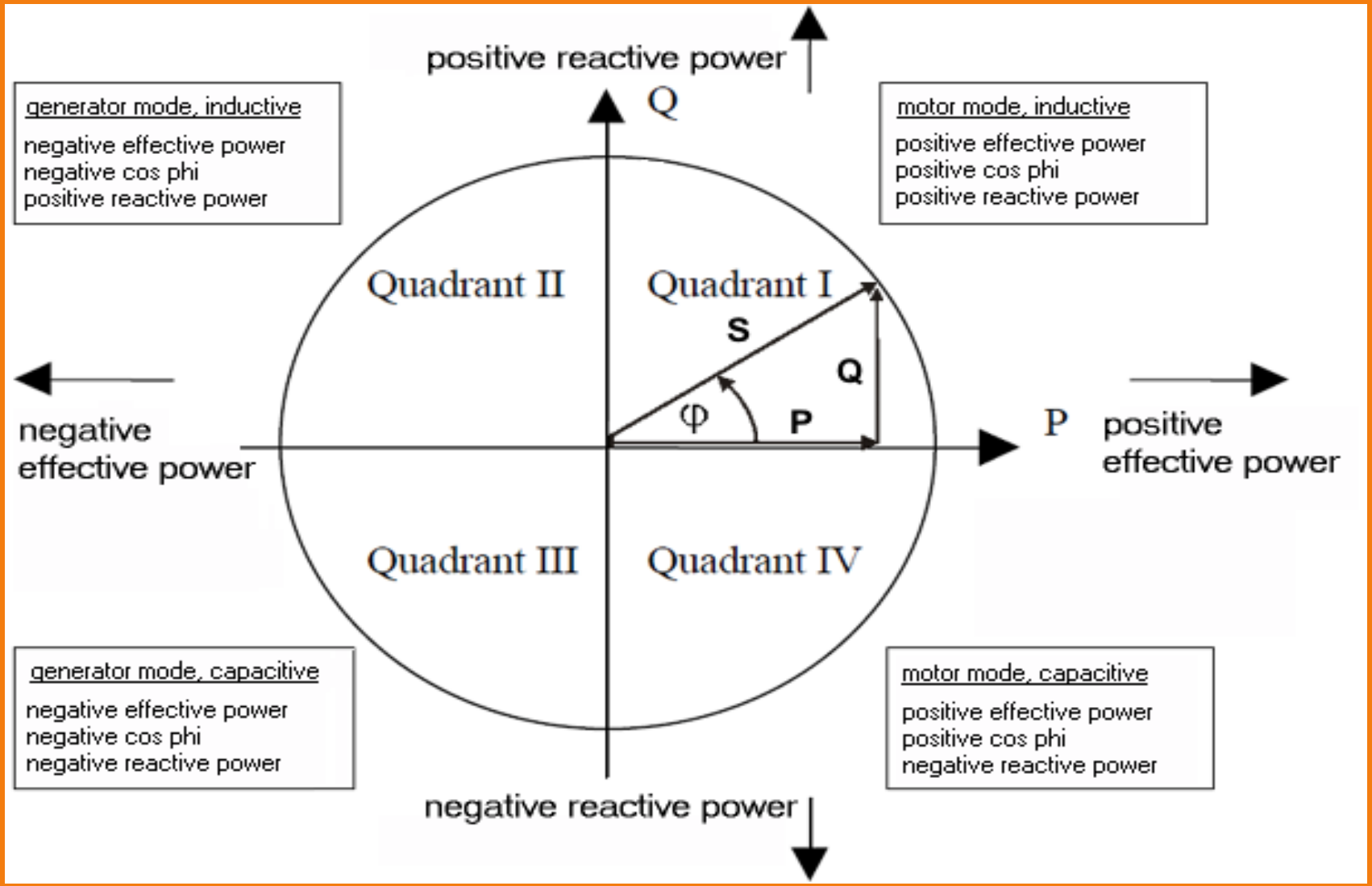
Charging and discharging can be independently controlled allowing systems to take advantage of Time Of Use rates as well as reduce renewable curtailment.





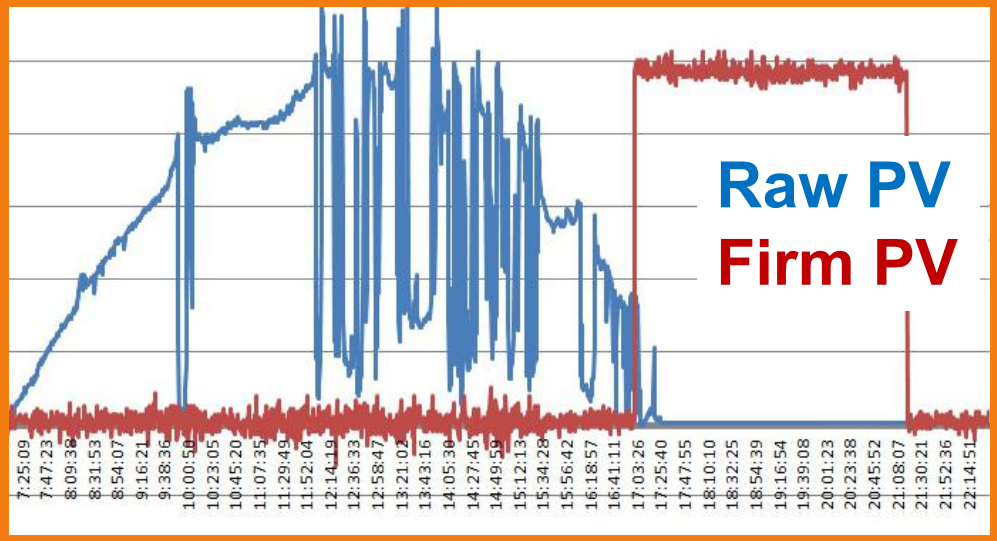
Solar PV output in the blue. HiVE output In the red.

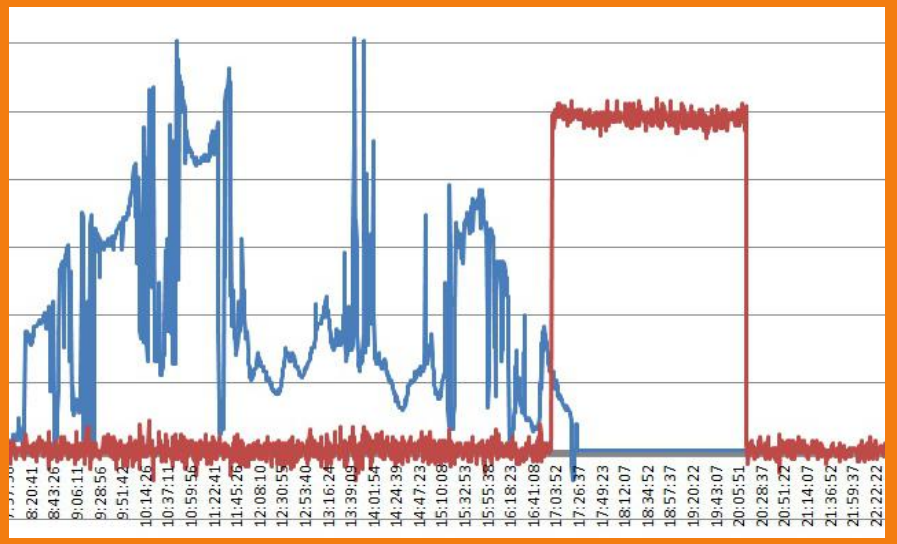
Why do we need a BESS



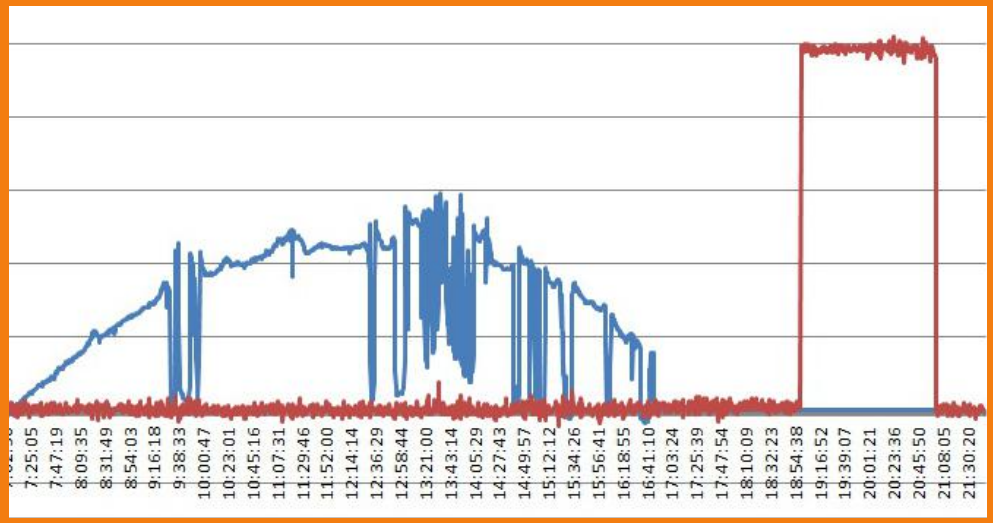
High C-rate battery paired with 4-quad bidirectional inverter provides for dynamic system control.

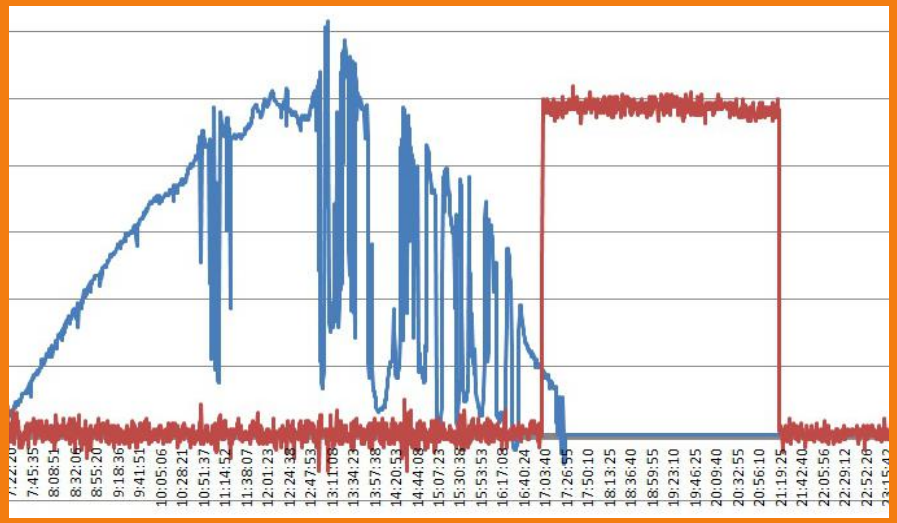
HiVE Digital Power is Programmable



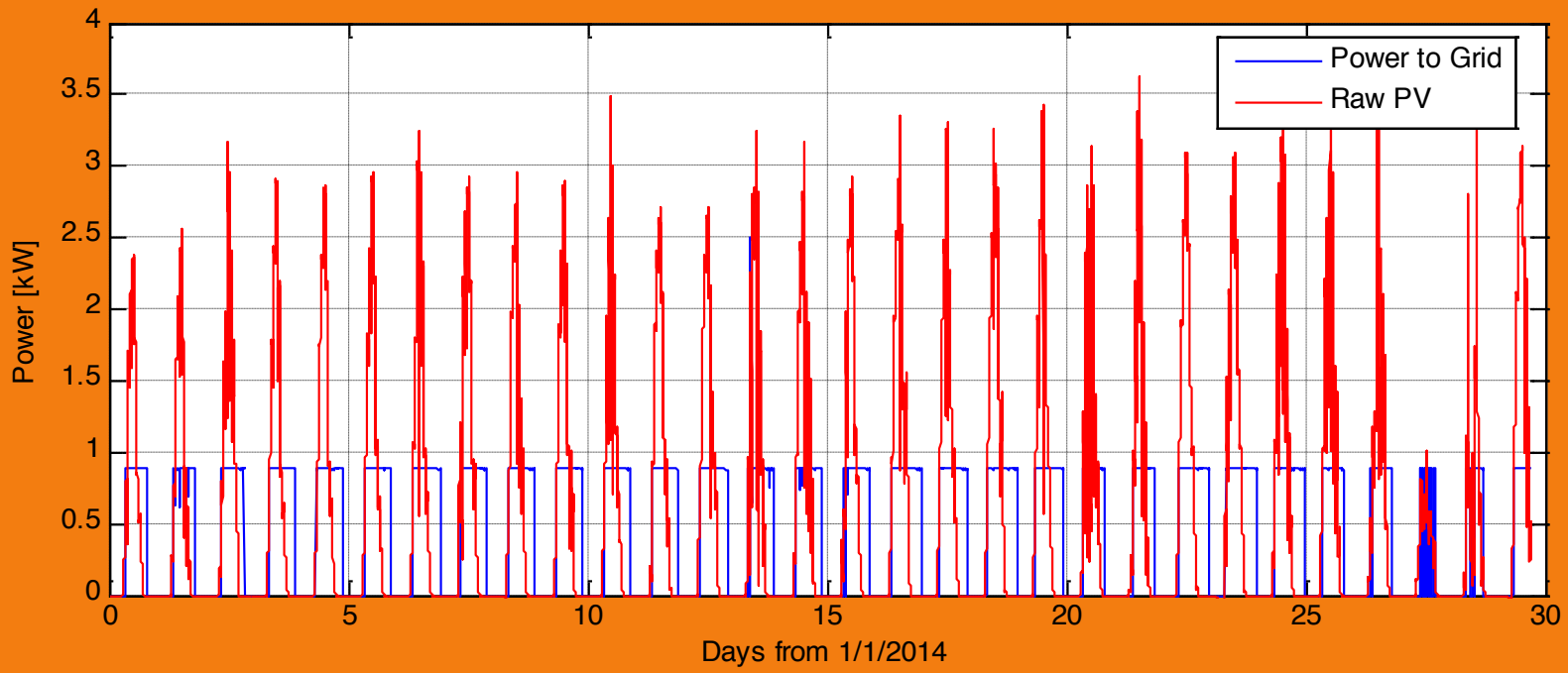


Power can be dispatched at any time for any duration



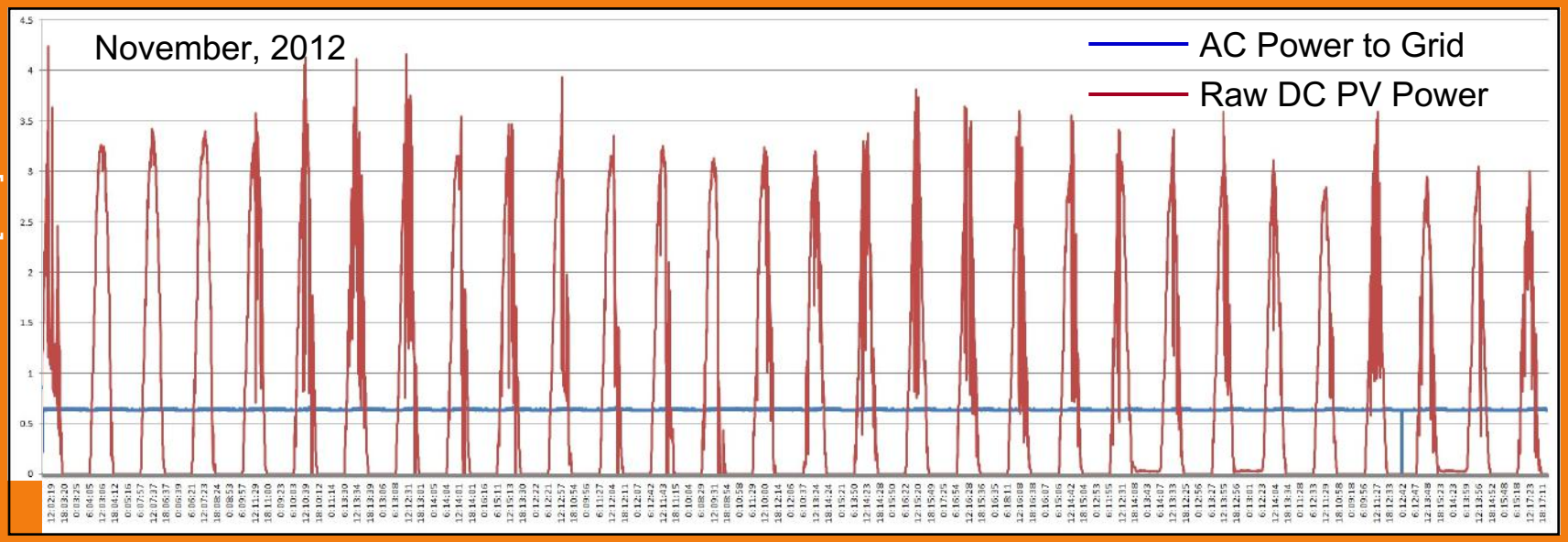


HiVE Digital Power –Daily Cycling



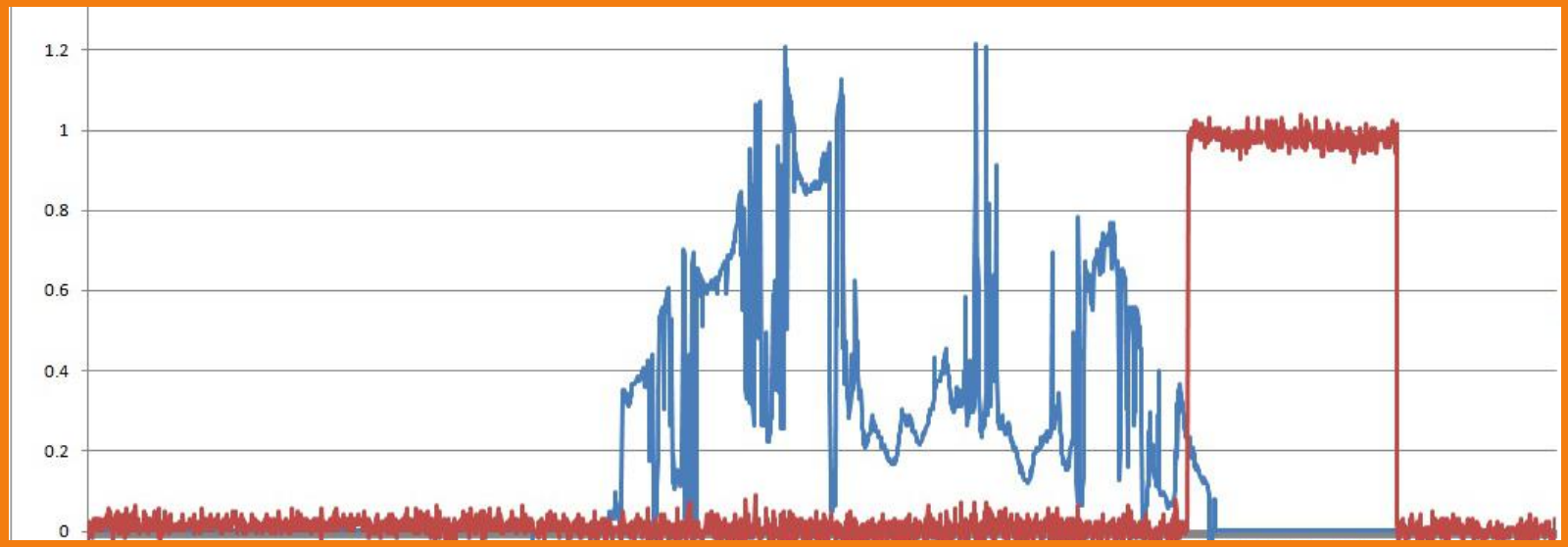
System can be programmed to deliver various amounts of power at various times of day

HiVE Digital Power –Constant Output

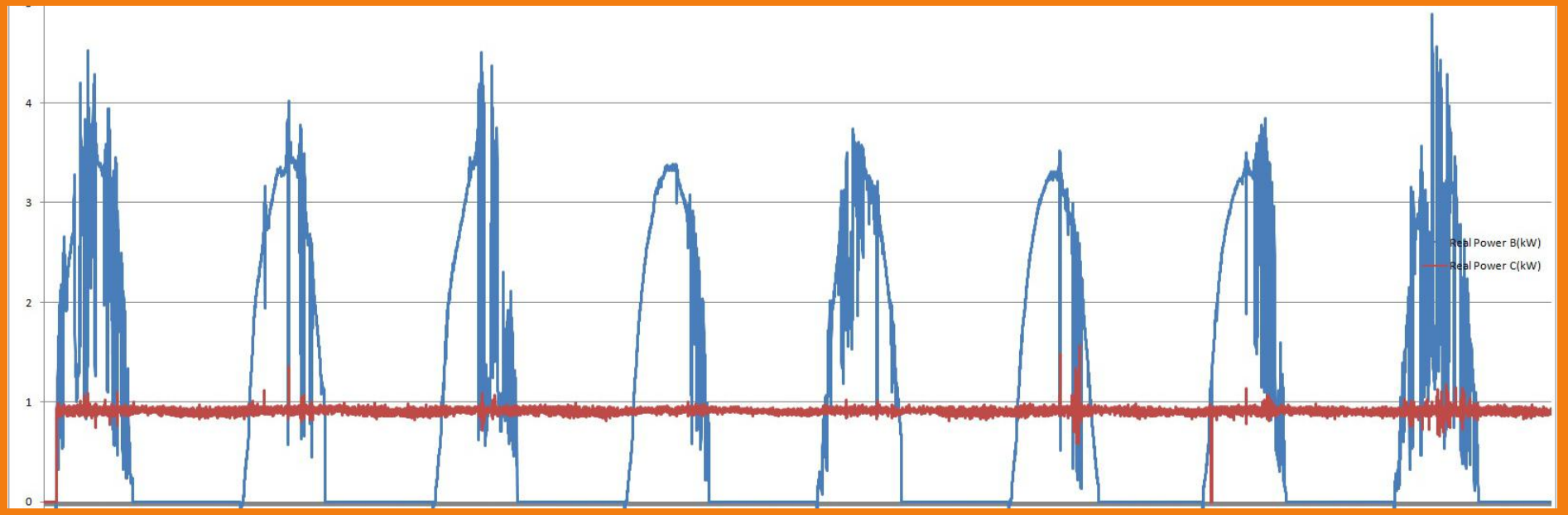


System can support custom algorithms simultaneously providing sower Smoothing and regional voltage support

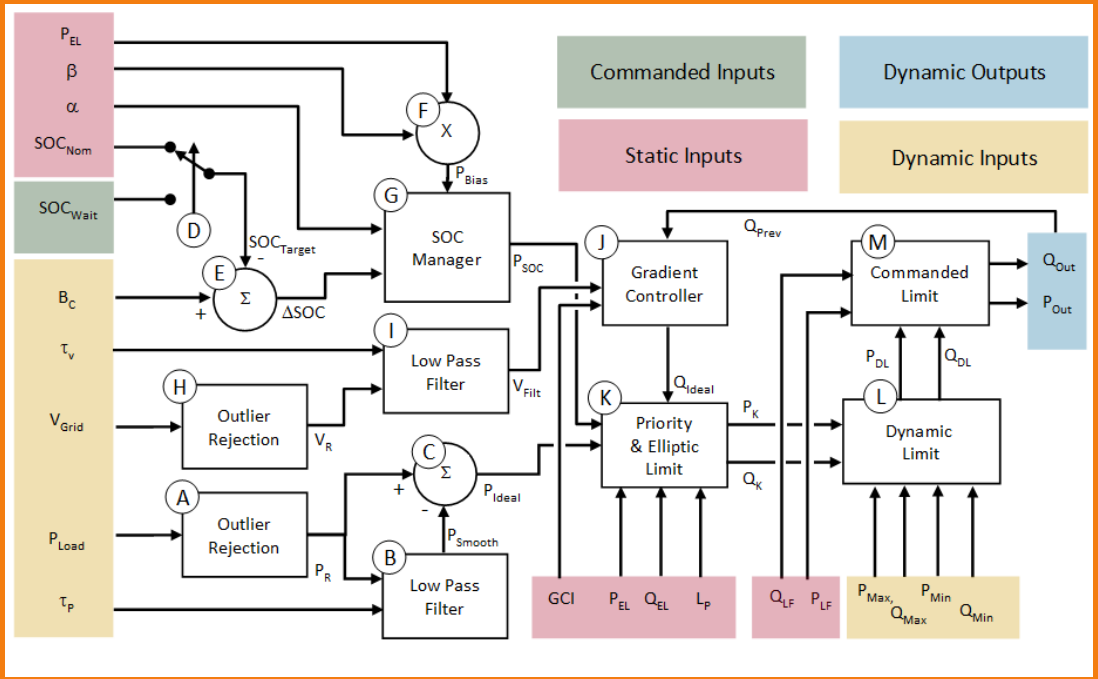
HiVE Digital Power - Dispatchable

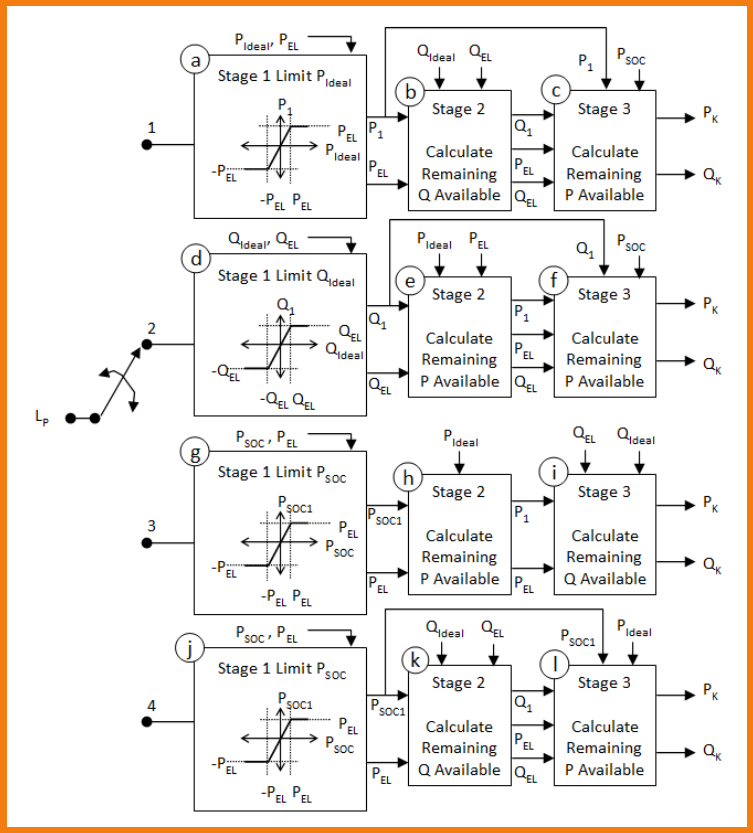


Raw PV
Firm PV



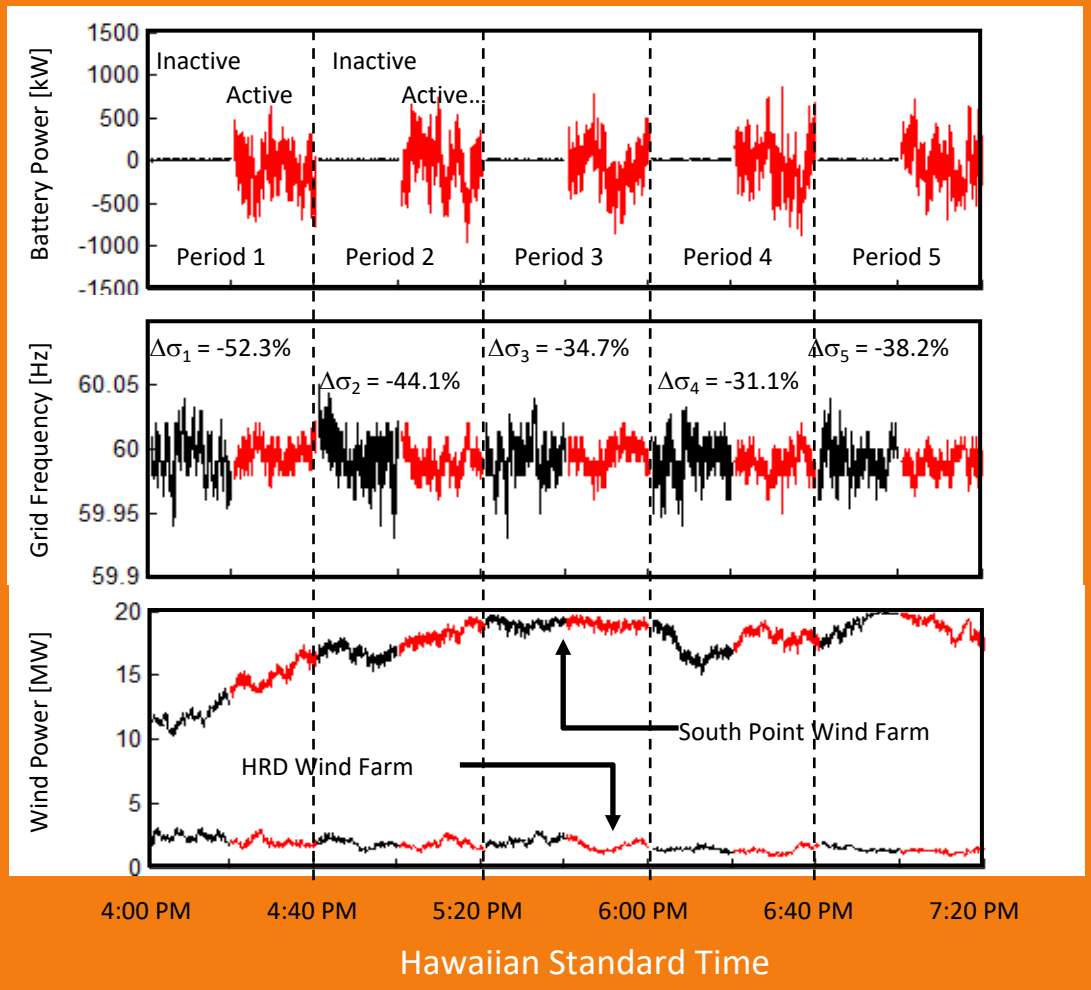
HiVE BESS Algorithm Design





HiVE developed integrated power smoothing and voltage regulation algorithms to serve industrial substations (1MW BESS)

Frequency Stability Results –Coupled to Wind and Solar PV Farms



Red: Algorithm "Active"

Black: Algorithm "Inactive"

Data from March, 2013

Reduction in frequency variability is visibly notable when the algorithm is Active

$\Delta\sigma_k$ is the percent change in standard deviation between inactive and active states for period k

The mean of this set of changes is -40.1%

During Period 3, both total wind power and variability from both wind farms are similar

The reduction in variability of the grid frequency is 40%

Thank You

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