



The Power to Control.



Storage to Reinforce Electric Grids:
Kahuku Case Study
July 12, 2011

Storage Target Applications

Renewable Integration



Ramp Control

Curtailment Mitigation

Firming/Shaping

Interconnection Compliance

Grid Services

Transmission & Distribution Providers



T&D Deferral

Voltage Support

Power Quality

Grid Reliability Enhancement

Ancillary Service Providers



Frequency Regulation

Voltage Regulation

Responsive Reserves

Commercial & Industrial



Peak Shaving

Load Leveling

Power Quality

Real Projects, Real Solutions

Project	Application	DPR™	COD	Services
South Pole Telescope	Microgrid	0.5 MW / 0.1 MWh	Q4 2006	Peak-Shaving, Load-leveling
Maui	Wind	1.5 MW / 1.0 MWh	Q3 2009	Ramp Control
Kahuku	Wind	15 MW / 10 MWh	Q1 2011	Ramp Control, Voltage Regulation
Xcel	Solar	1.5 MW / 1.0 MWh	Q1 2011	Ramp Control, Ancillary Services, Firming/Shaping
Lanai	Solar	1.125 MW / 0.5 MWh	Q2 2011	Ramp Control, Ancillary Services
Ford	End-User	0.75 MW / 2.0 MWh	Q2 2011	Peak-Shaving, Load-leveling
KIUC	Solar	1.5 MW / 1.0 MWh	Q3 2011	Responsive Reserves, Ramp Control, Ancillary Services
KWP II	Wind	10 MW / 20 MWh	Q4 2011	Ramp Control, Curtailment Capture, Responsive Reserves
Fosters*	End-User	3.0 MW/ 2.0 MWh	Q4 2011	Uninterruptible Power Supply
Duke Notrees	Wind	36 MW / 24 MWh	Q4 2012	Ramp Control, Ancillary Services
Tres Amigas	T&D	~ 100 MW / 200 MWh	Q2 2013	Ancillary Services

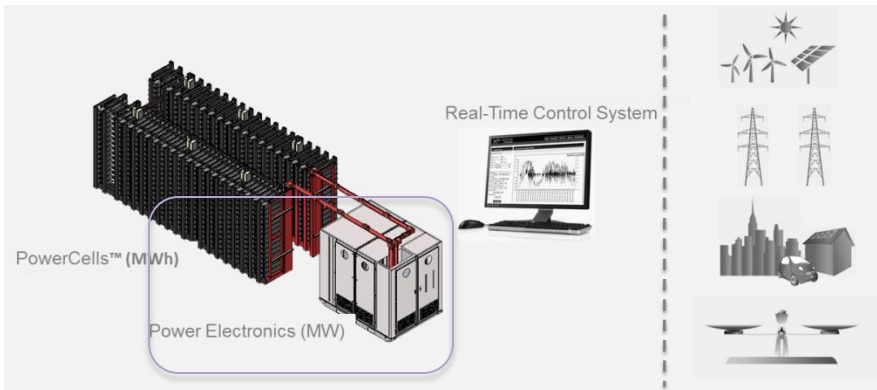
* Project not yet announced

Xtreme Power Technology

Power Electronics



- Bi-directional inverter/charger technology
- Full four quadrant performance, managing real & reactive power requirements
- Solid State
 - Microsecond response
 - Nominal O&M
- Closed-Loop Water Cooled



Kahuku Wind Power

Largest North American Installation with Wind

Location	Oahu, HI
Application	Wind
DPR™	15 MW / 10 MWh
COD	Q1 2011
Services	Ramp Control, Voltage Regulation



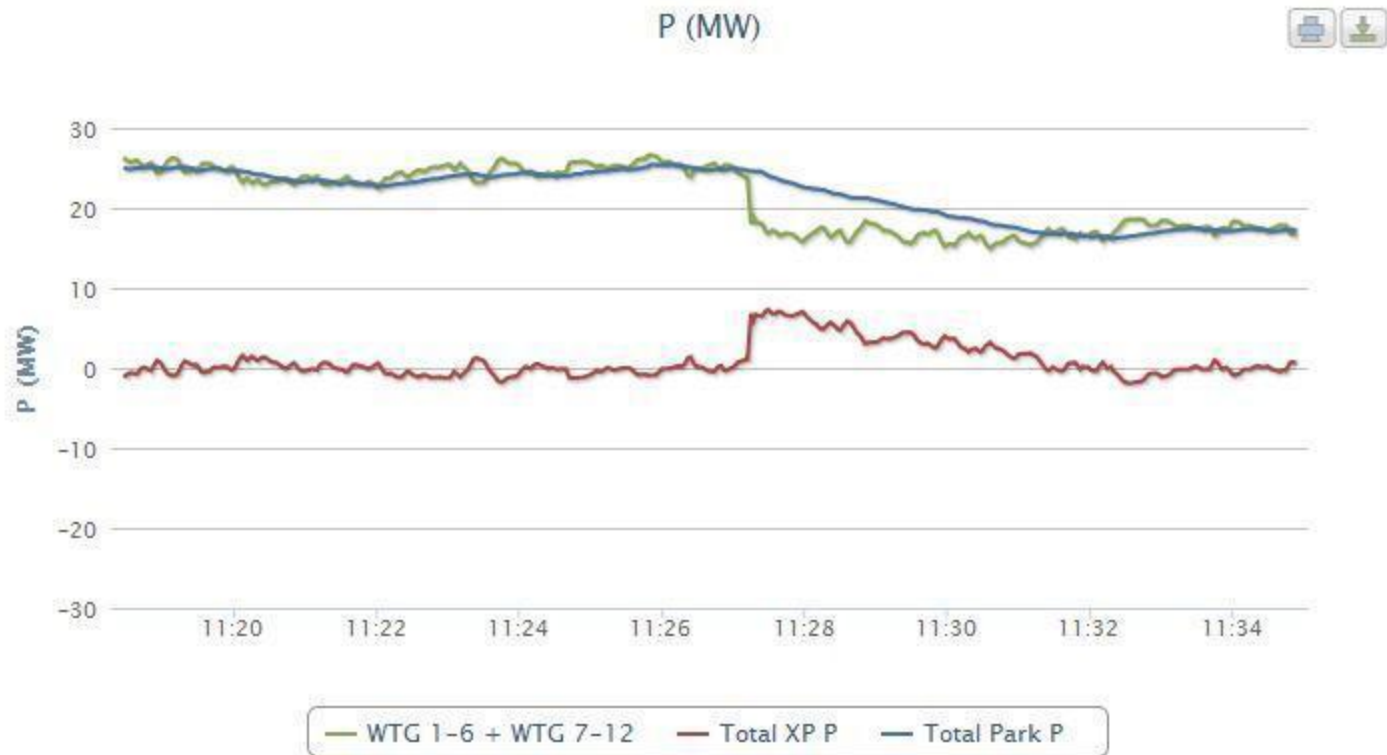
The DPR™ is integrated with the operation of First Wind's 30 MW Kahuku wind farm, enabling interconnection at the end of an existing 46 kV radial line and compliance with HECO's stringent PPA ramp control and smoothing requirements.

Capabilities at Kahuku

- Support Remote Generation
- Frequency Response
- Transmission Reinforcement
- Voltage Control

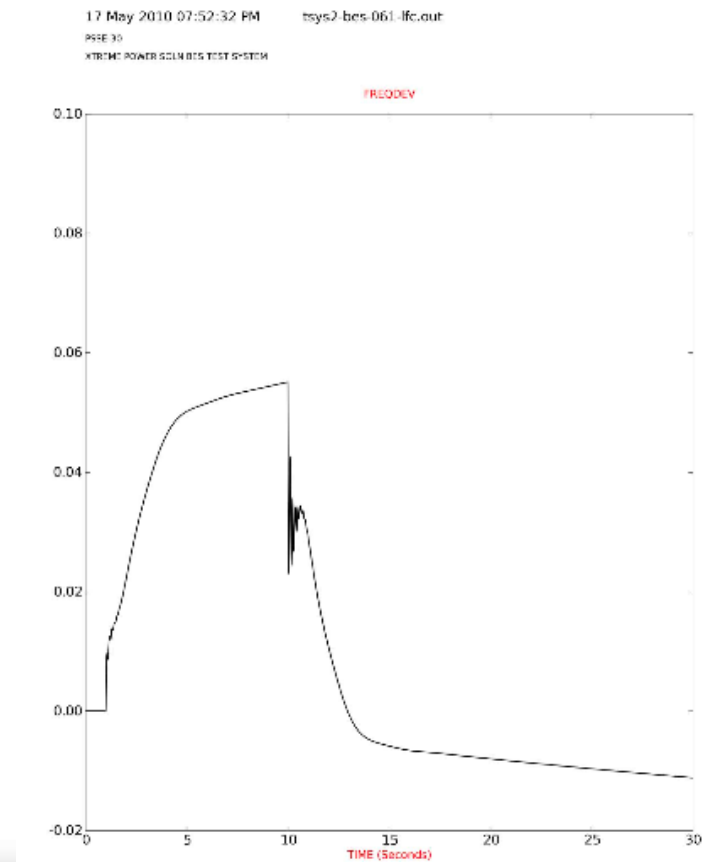
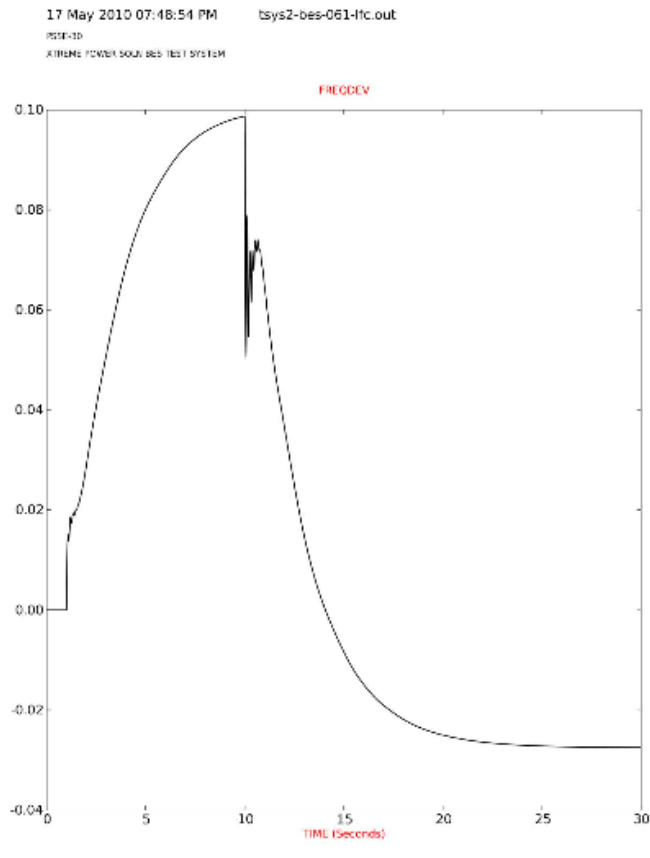
Response to Generator Trip

Xtreme Power's Kahuku Web Interface



Response to Load and Generator Trips

Grid modeled with DPR responding in 0.050 seconds



T&D networks normal operation

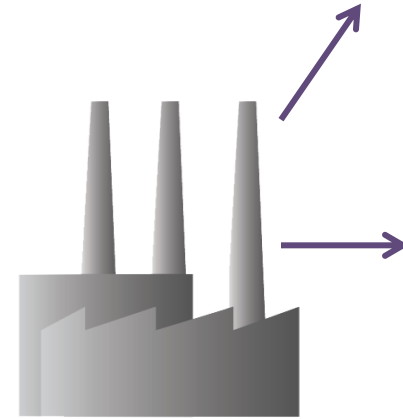


**Kahuku
Generator**

30 MW
→



Load: <20 MW



**Rest of Grid,
Generators**

Limits on the Grid

Loss of Line- need stability

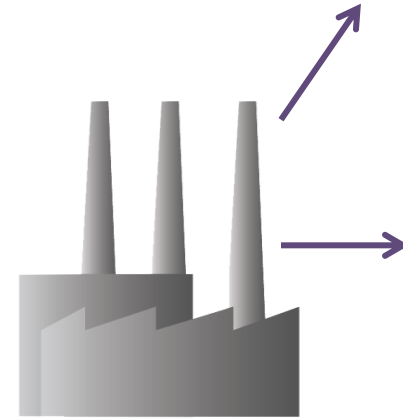


**Kahuku
Generator**

30 MW →



Load: <20 MW



**Rest of Grid,
Generators**

Trouble On Radial Line

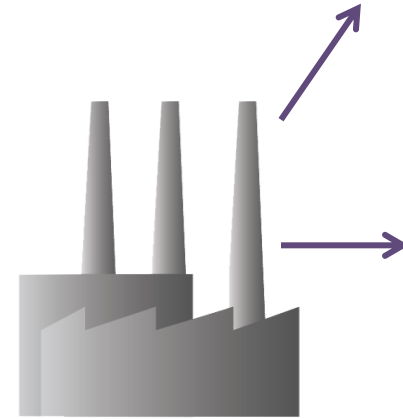
Loss of Line: Storage engages



**Kahuku
Generator**



Load: <20 MW



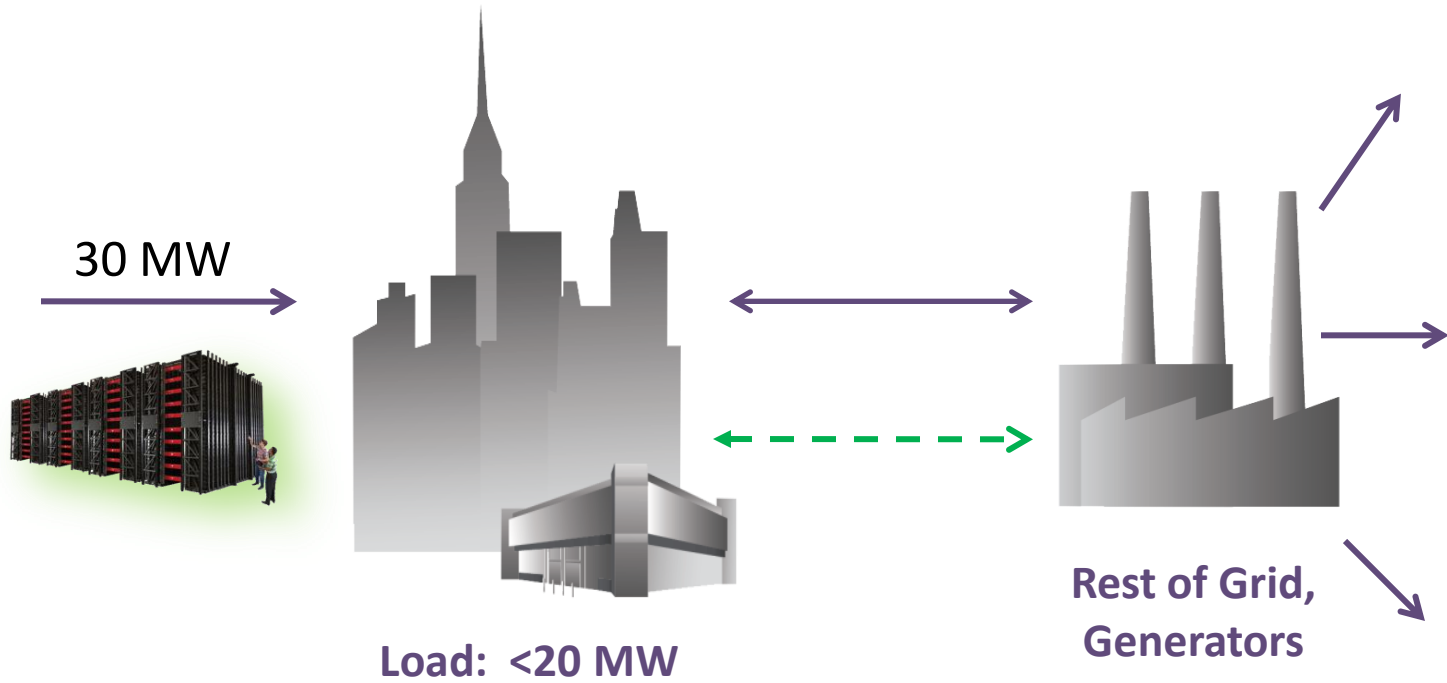
**Rest of Grid,
Generators**

Very Fast Response Protects System

Storage defers upgrades

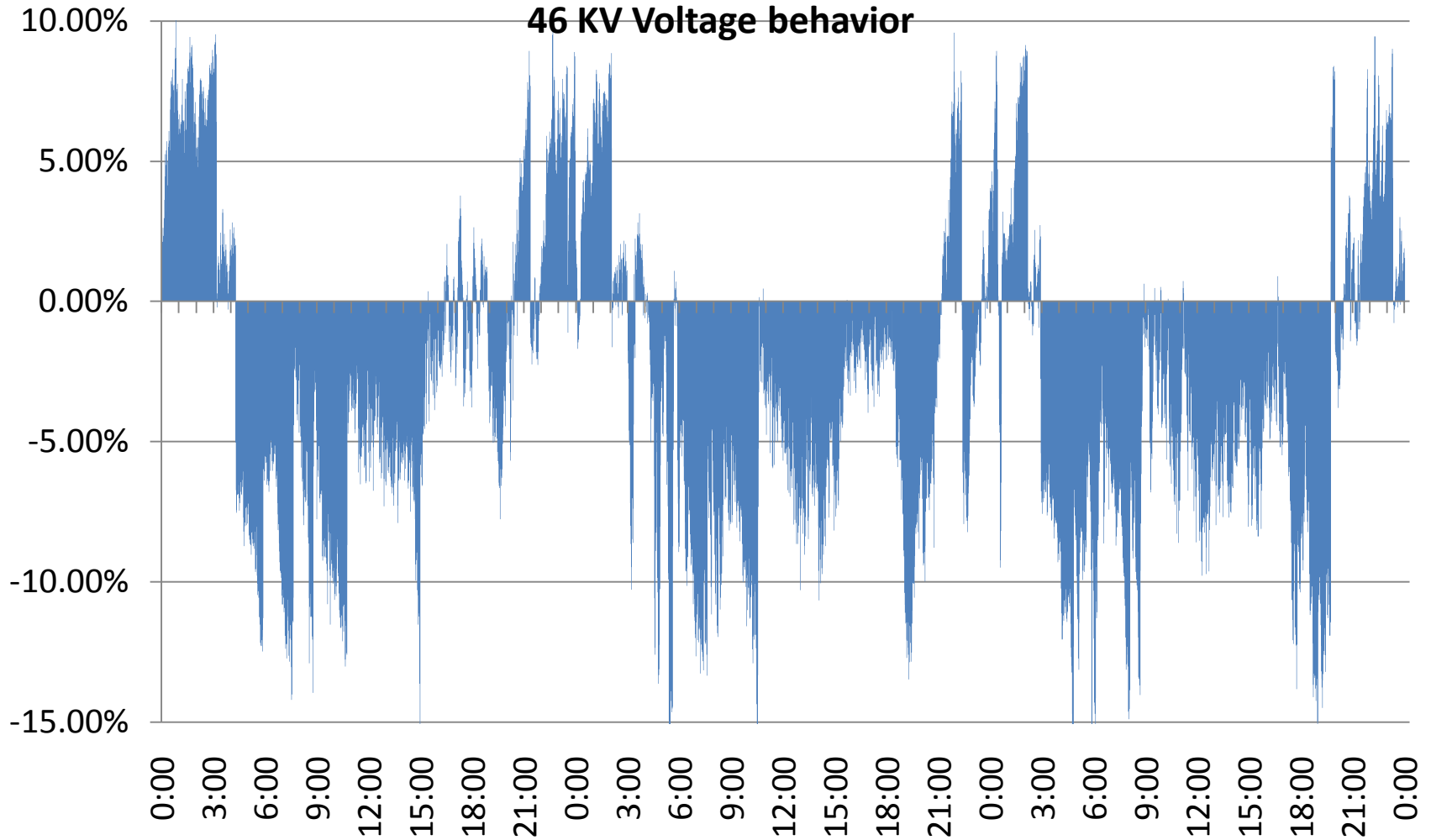


**Kahuku
Generator**



Lifting Limits on the Grid without New Line

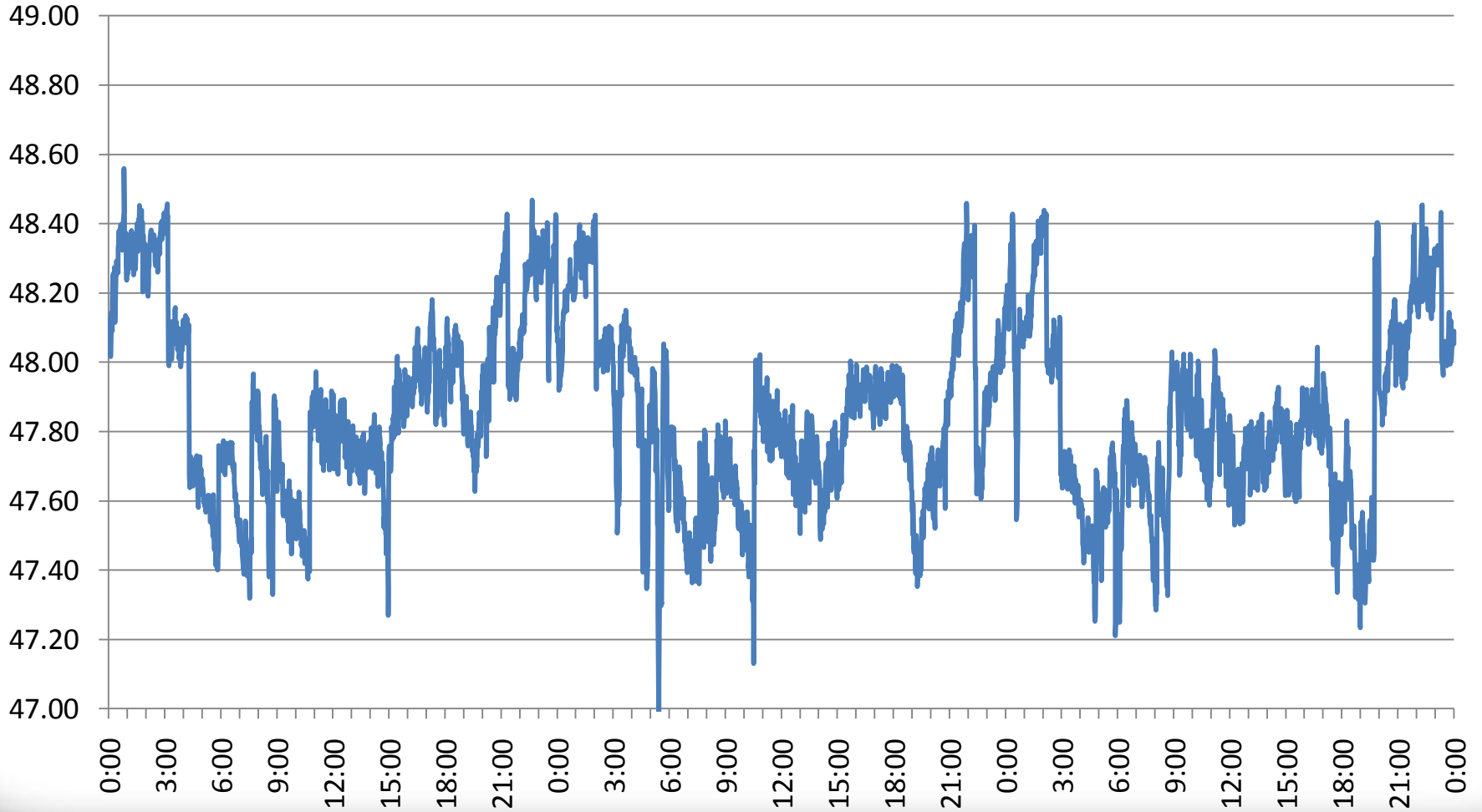
Radial line condition



Voltage w/o inverter VARs

Radial Line Voltage

— Grid V



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