

# Resiliency & Microgrids Working Group

## Microgrid Integration and Interconnection

Resiliency and Microgrids Team, Energy Division  
November 18, 2021



California Public  
Utilities Commission

# WebEx and Call-In Information

## Join by Computer:

<https://cpuc.webex.com/cpuc/onstage/g.php?MTID=e4972611b4ee872b3a240eb4222523d4f>

Event Password: RMWG (case sensitive)

Meeting Number: 2495 245 9276

## Join by Phone:

- Please register using WebEx link to view phone number.  
(Staff recommends using your computer's audio if possible.)

## Notes:

- Today's presentations are available in the meeting invite (follow link above) and will be available shortly after the meeting on <https://www.cpuc.ca.gov/resiliencyandmicrogrids>.
- The presentations will be recorded. The question and answer segments will not be recorded. There will not be meeting minutes.

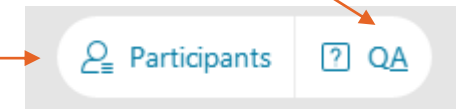
# WebEx Logistics

- All attendees are muted on entry by default.
- Questions can be asked verbally during Q&A segments using the “raise hand” function.
  - The host will unmute you during Q&A portions [and you will have a maximum of 2 minutes to ask your question].
  - Please lower your hand after you’ve asked your question by clicking on the “raise hand” again.
  - If you have another question, please “re-raise your hand” by clicking on the “raise hand” button twice.
- Questions can also be written in the Q&A box and will be answered verbally during Q&A segments.

## WebEx Tip

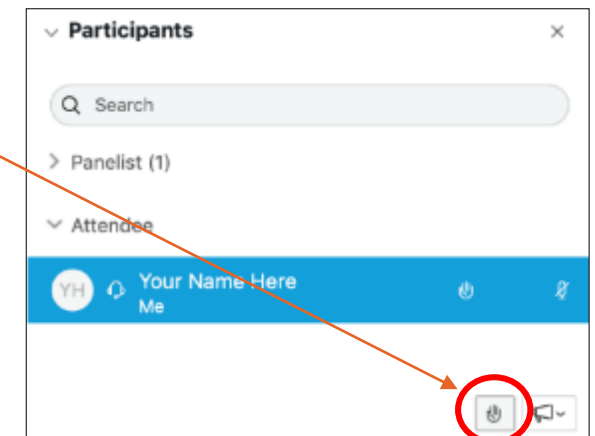
**1. Click here to access the attendee list to raise and lower your hand.**

**Access the written Q&A panel here**

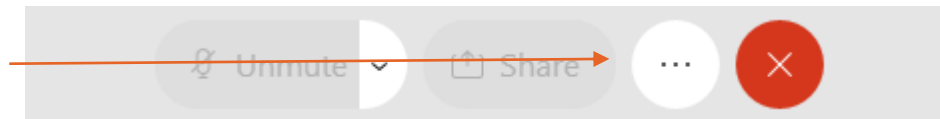


**2. Raise your hand by clicking the hand icon.**


**3. Lower it by clicking again.**



**Access your meeting audio settings here**



# WebEx Event Materials

Event Information: Resiliency and Microgrids Working Group Meeting 


Registration is required to join this event. If you have not registered, please do so now. [English](#) : [San Francisco Time](#)

**Event status:** Not started ([Register](#))

**Date and time:** Tuesday, March 2, 2021 9:30 am  
Pacific Standard Time (San Francisco, GMT-08:00)  
[Change time zone](#)

**Duration:** 1 hour

**Description:**



**Event material:** [RMWG Meeting Material\\_EXAMPLE.docx](#) (31.7 KB)

By joining this event, you are accepting the Cisco Webex [Terms of Service](#) and [Privacy Statement](#).

[Register](#) [Go Back](#)

Join Event Now

You cannot join the event now because it has not started.

**First name:**

**Last name:**

**Email address:**

[Join Now](#)

[Join by browser](#) **NEW!**

# Preliminary Resiliency & Microgrids Working Group Schedule

Month	Resiliency and Microgrids Working Group Topics			
February	Standby Charges	Multi-Property Microgrid Tariff		
March				
April				
May				
June			Value of Resiliency	
July				
August				
September				Microgrid Interconnection
October				
November	Customer-Facing Microgrid Tariff Revisit			
December				
January				
February				

**Interconnection:** Working group participants will discuss interconnection and related issues as they specifically relate to microgrids. Topics will include interconnection requirements for grid-connected mode microgrid operations, controls, communications, and islanded mode microgrid operations where interconnection requirements are not applicable.

# Agenda

- |   |                      |
|---|----------------------|
| <b>I. Introduction</b> <i>(CPUC Staff)</i>  | <b>2:00p – 2:10p</b> |
| <ul style="list-style-type: none"><li>• WebEx logistics, agenda review</li></ul>                  |                      |
| <b>II. Schweitzer Engineering Laboratories – Controls and Protection</b><br><i>(Scott Manson)</i> | <b>2:10p – 3:55p</b> |
| <ul style="list-style-type: none"><li>• Presentation</li><li>• Q&amp;A</li></ul>                  |                      |
| <b>III. Closing Remarks, Adjourn</b> <i>(CPUC Staff)</i>  | <b>3:55p – 4:00p</b> |
| <ul style="list-style-type: none"><li>• Provide information on the next meeting</li></ul>         |                      |

# Today's Speaker

**Scott Manson** received his M.S.E.E. from the University of Wisconsin–Madison and his B.S.E.E. from Washington State University. Scott is the engineering services technology director at Schweitzer Engineering Laboratories (SEL), Inc. Scott is a registered professional engineer in six states and holds 20 patents. Scott can be reached at [scott\\_manson@selinc.com](mailto:scott_manson@selinc.com).

**Schweitzer Engineering Laboratories** (SEL) specializes in digital products and systems that protect, control, and automate power systems. <https://selinc.com>.

# Microgrid Challenges and Solutions



Scott Manson, ES Technology Director



# Making Electric Power Safer, More Reliable, and More Economical

Safer means Protecting Humans, the Environment,  
and Assets with SEL Protective Relays



87%

# #1 Favorite Relay Supplier of U.S. Utilities

2019-21 Newton-Evans Survey



SEL

3%

GE

3%

Basler

2%

Beckwith

1%

ABB

1%

ERLPhase

1%

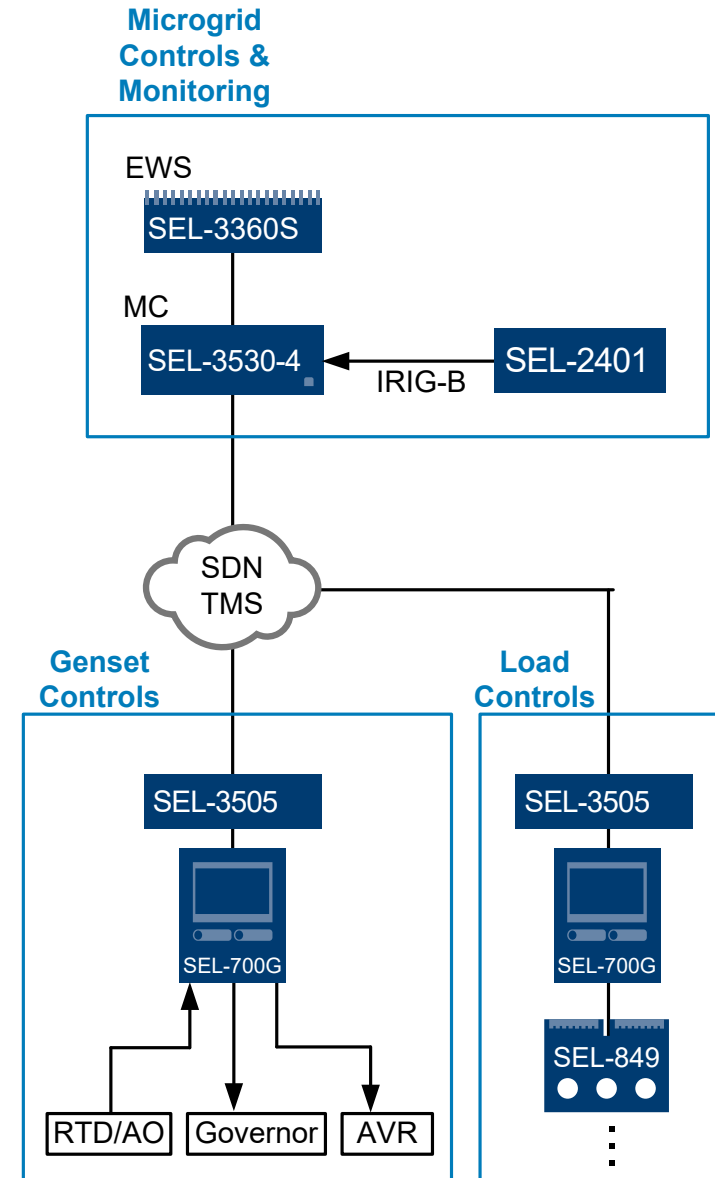
Siemens

# SEL Relays Are North America's favorite Microgrid Controllers

- Multifunction protection
- Metering
- Programmable logic controller
- Sequential Events Recorder (SER)
- Oscillography recorder
- Human-machine interface



**SEL POWERMAX® is a FULLY INTEGRATED solution including relays, controllers, communication, Cybersecurity, and remote monitoring**



# SEL POWERMAX Development Timeline

2002

POWERMAX  
Industrial

2008

POWERMAX  
Utility

2014

POWERMAX  
Commercial

2018

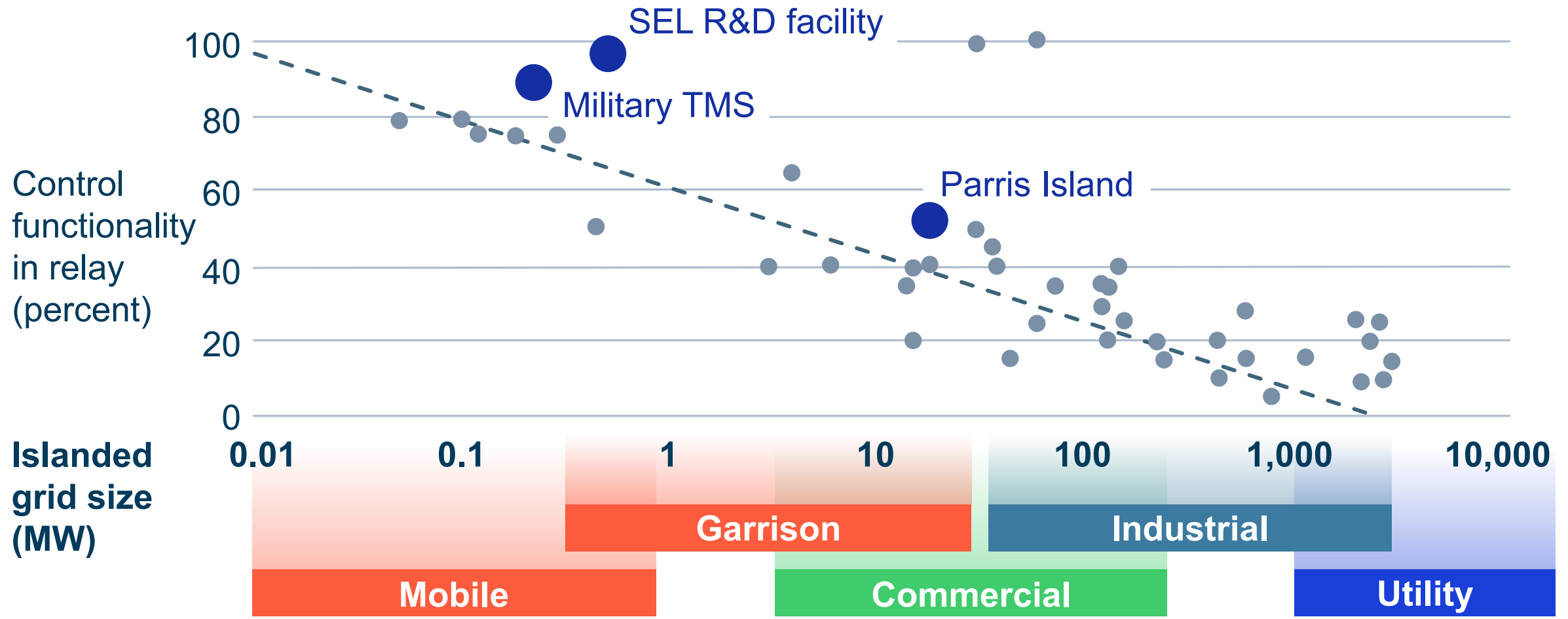
POWERMAX  
Mobile

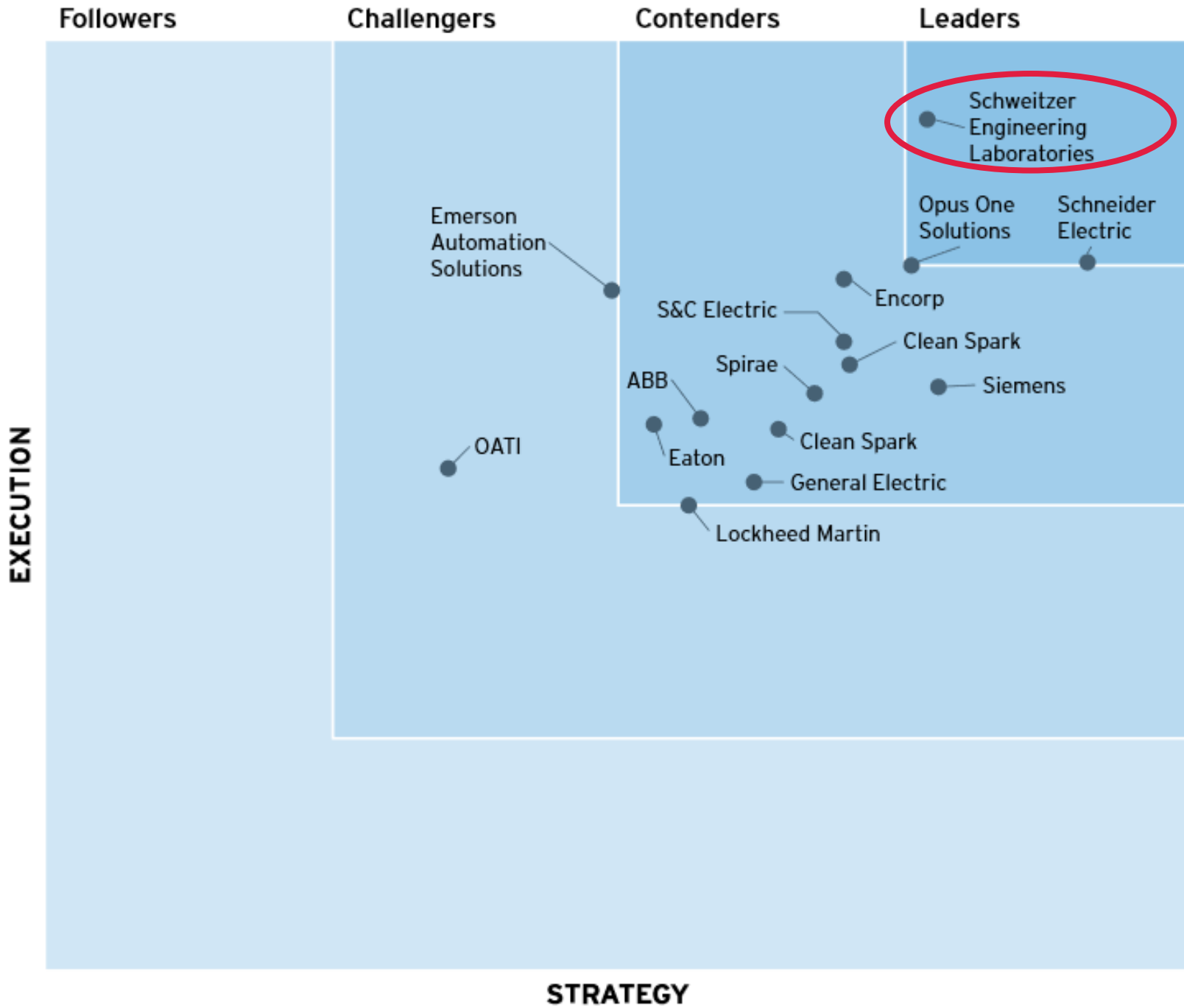
2019

POWERMAX  
Garrison



# Relay-Based POWERMAX Solutions Scale to Any Size Power System





**SEL  
POWERMAX  
is the worlds  
highest  
performance  
microgrid  
system**

# Example: SEL Relay Controlling a TESLA Powerpack

**SEL** SCHWEITZER ENGINEERING LABORATORIES **SEL-700GT** INTERTIE PROTECTION RELAY

TARGET RESET  
 ENABLED  
 TRIP  
 E-STOP  
 OC TRIP  
 DIFF. TRIP  
 POWER TRIP  
 INVERTER TRIP  
 CHECK DISPLAY  
 LG PULSE  
 FREQ ↑  
 SM PULSE  
 FREQ ↓  
 LG PULSE  
 VOLT ↑  
 SM PULSE  
 VOLT ↓  
 LG PULSE  
 SOURCE ON  
 STRT/STP  
 SOURCING ON  
 LOCAL MODE  
 REMOTE  
 OK TO CONNECT  
 CONNECT  
 BRKR CLOSED  
 BATTLE SHRT  
 DISCONNECT  
 BRKR OPEN

PORT F

BLINKING LED

**TESLA POWERPACK 70kW** **SEL**

**RESTART DELAY**  
 SOURCING  
 RUNNING

Fbias: 1234.5 %  
 Vbias: 1234.5 %  
 Max Apparent: 1234 kVA  
 Max Discharge: 1234 kW  
 Max Charge: 1234 kW

P: 1234 kW  
 Q: 1234 kVAR  
 I: 123.4 A

**JUMP START**  
 INV L.O.

SOC: 123.4 % **LO**  
 Panel: 123.4 VDC **H/L**

FX: 12.3 Hz  
 VX: 123.4 V  
 FY: 12.3 Hz  
 VY: 123.4 V

480  
 208  
 MCB  
 CB L.O.  
 LCB

**ALARMS/TRIPS**

**PHASE SEQ**

**SOURCING FAIL**  
 BRKR FAIL  
 DEAD BUS DETECTED

**STRT/RUN FAIL**  
 GOOSE FAIL  
 BATTLE SHORT  
 BATT COMMS FAIL  
 BATT FAULT  
 TPP COMMS FAIL  
 TESLA 24VDC  
 TESLA NOT READY

**CONTROL LOOP DETAILS**

**FREQUENCY LOOP**

PRSP: 12345 kW  
 P\_SP: 12345 kW  
 Fbias: 12345 %  
 P3X: 12345 kW

**VOLTAGE LOOP**

QRSP: 12345 kVAR  
 Q\_SP: 12345 kVAR  
 Vbias: 12345 %  
 Q3X: 12345 kVAR

**AUTO**





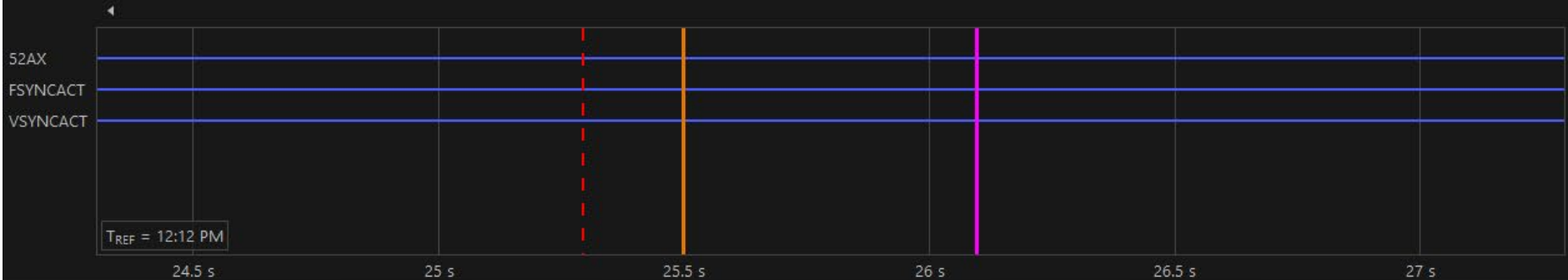
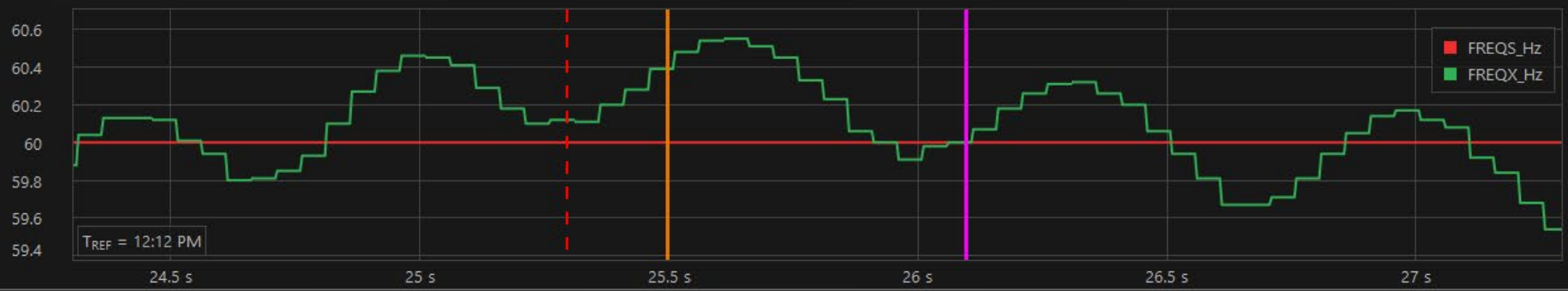
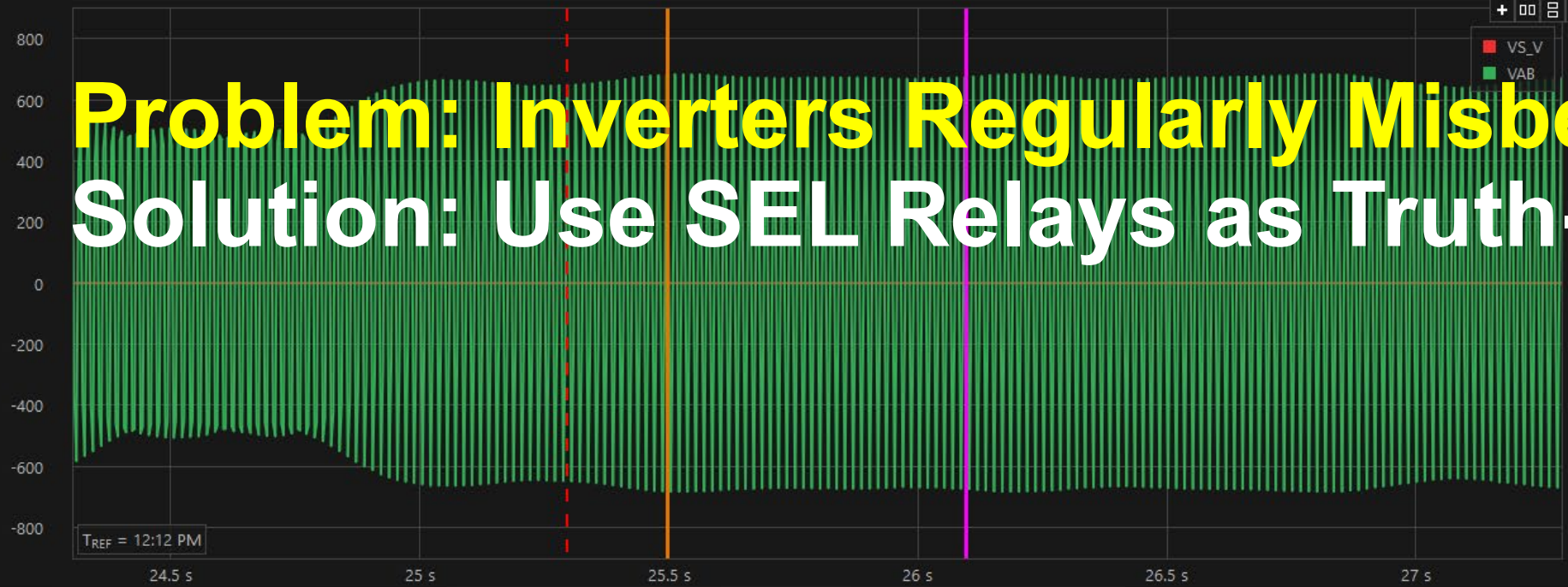
# The bad news: Inverter Based Resources have created new protection & control challenges

- Human preference
- DQ transformations
- PLL
- Human error
- DER faster than protection
- Sensitivity to load composition changes
- Disparate standards
- Excessive complexity
- Inconsistent fault currents



# Problem: Inverters Regularly Misbehave

## Solution: Use SEL Relays as Truth-tellers



&gt;&gt; Events

Open

1
SEL-700G-R301-V0-Z007004-D20200930
Time: 08/21/2021 12:25:296000 PM
File: CEV_10088.CEV
FID=SEL-700G-R301-V0-Z007004-D20200930
Event: Trigger
Sample Rate: 4 Samples/Cycle

Calculations

This feature is available in the advanced version of SynchroWAVE Event. To learn more, please visit the SEL website.

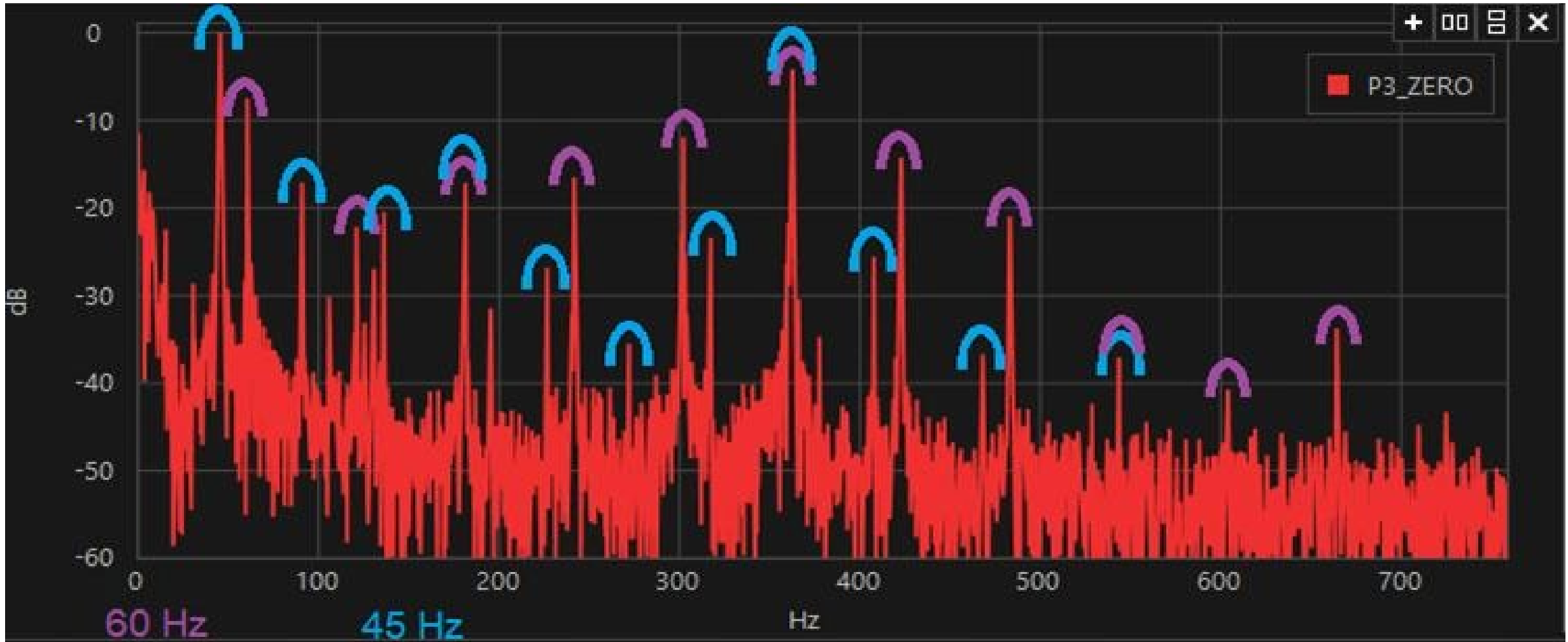
SynchroWAVE Event Basic

To add advanced features click Activate.

Activate

# Problem: Inverter produce Unusual Harmonics

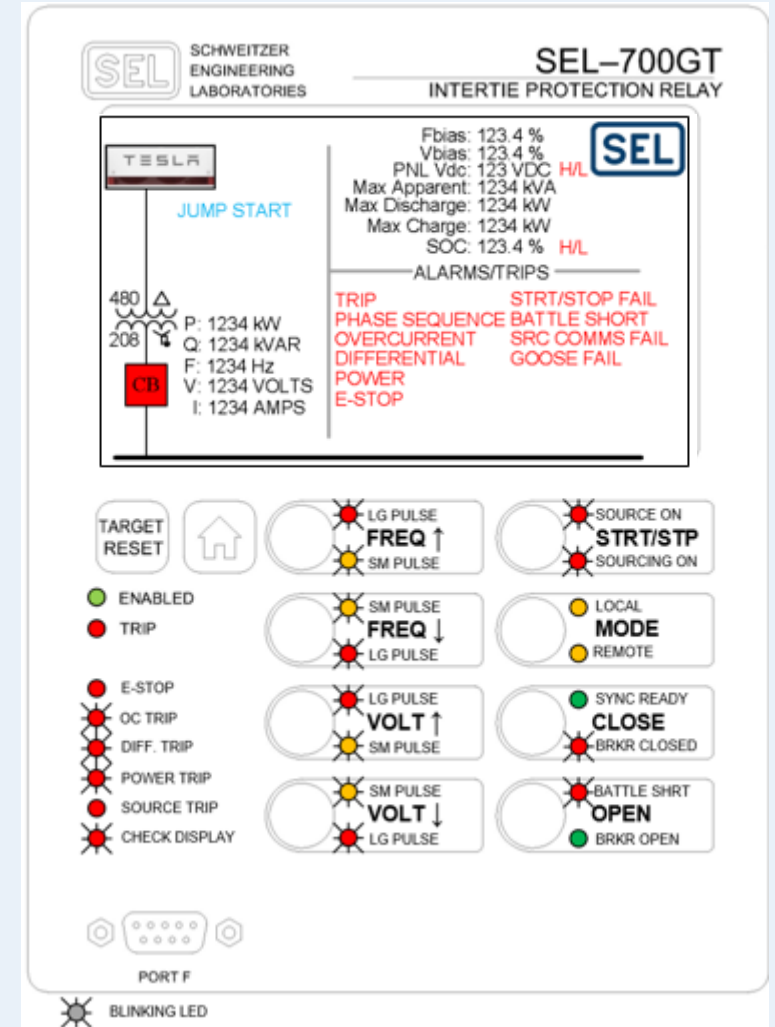
Solution: Use SEL Relays + Synchrowave Event Software to decode the noise



# Problem: Integration is hard

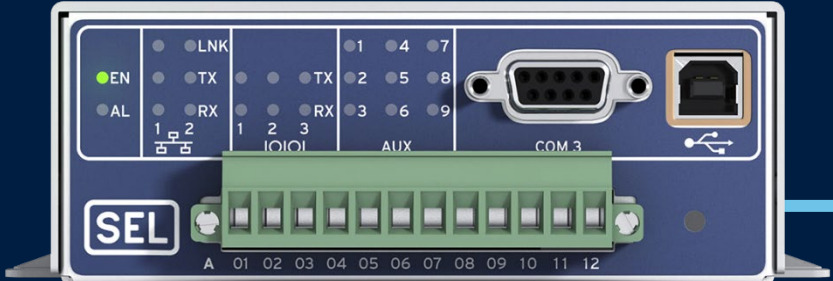
## Solution: Use SEL relays to Simplify Integration

- Identical interface for all inverters and gensets
- Simplifying user's experience
- Advanced controls and visualization
- Superior protection and diagnostics
- Ensures interoperability between DER
- Plug and play communication
- Incremental procurement and commissioning



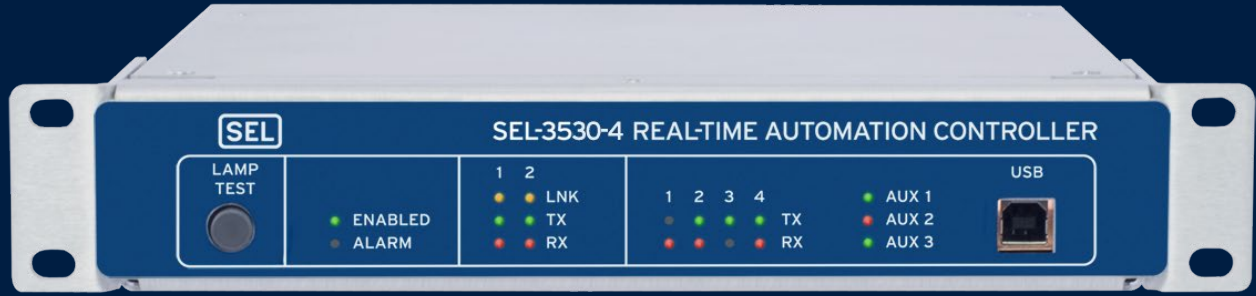
# Problem: Integration is Expensive

# Solution: Use POWERMAX Plug and Play Communications



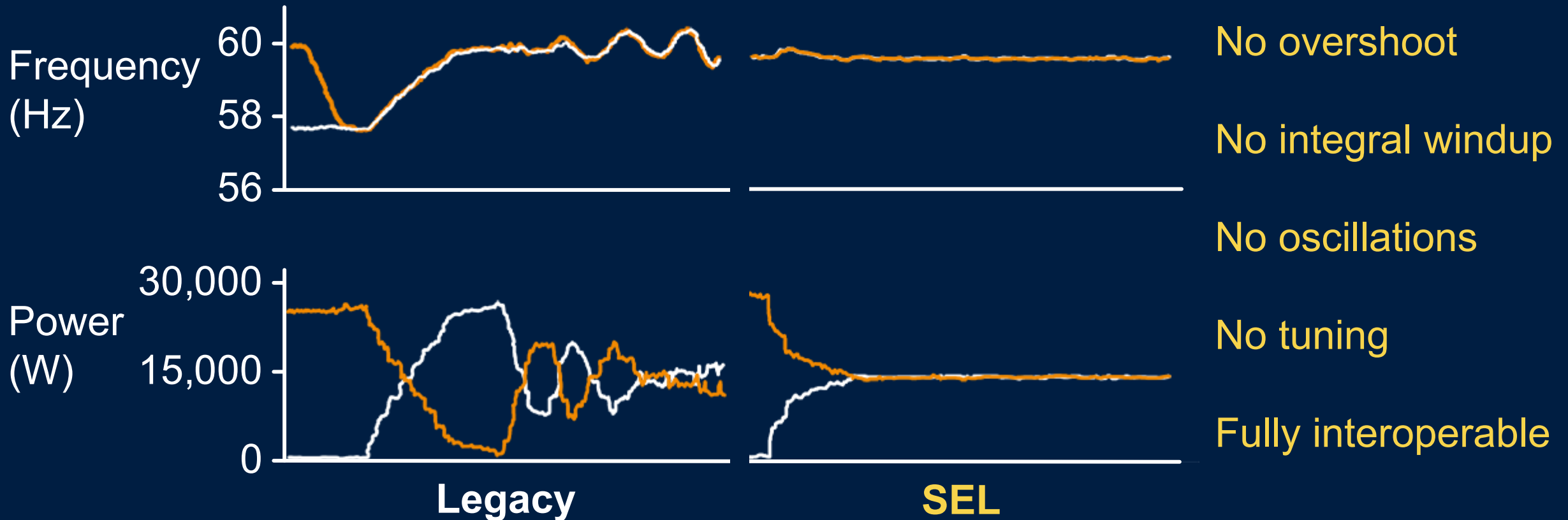
Hi! I'm a generator.

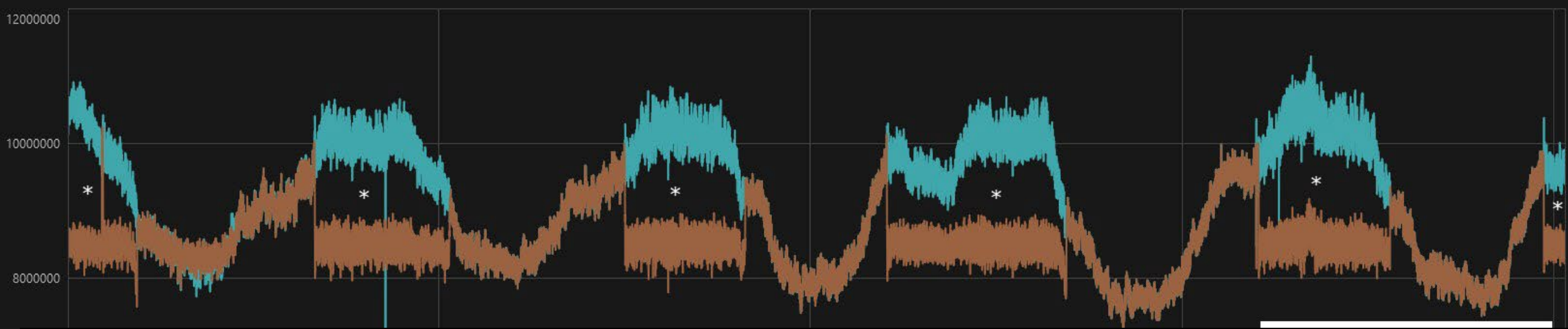
Great! Send me data.



# Problem: Legacy Load Balancing Algorithms are Difficult to configure and Tune

Solution: SEL POWERMAX Advanced Control Algorithms Ensure Universal DER Interoperability





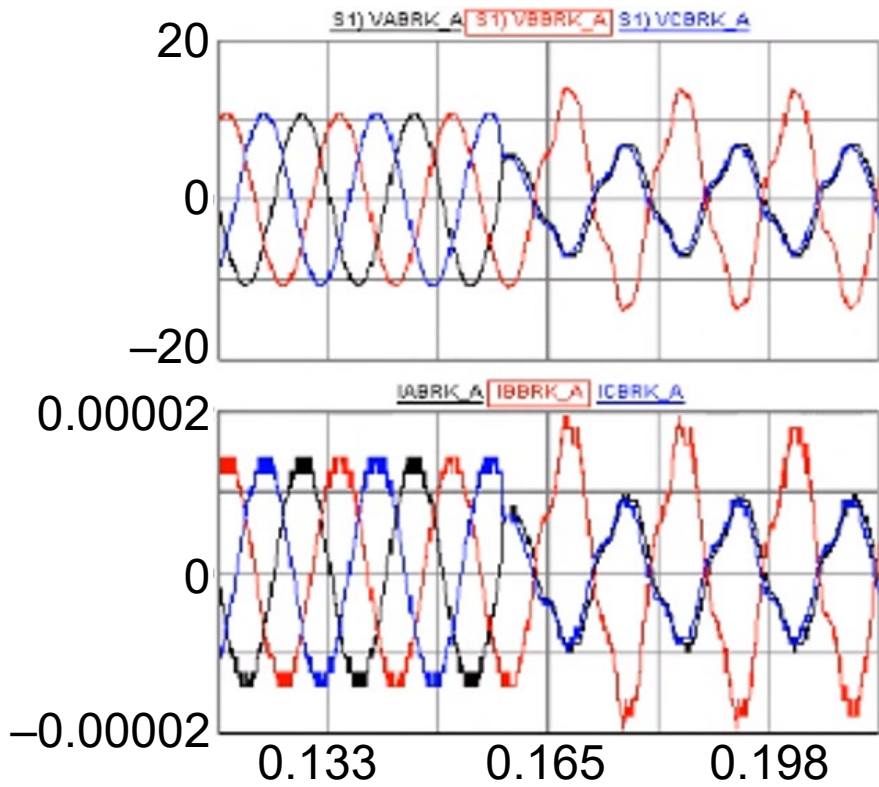
**Problem: Is your microgrid working right?**  
**Solution: Use Synchrowave Operations Historian as your daily dashboard**



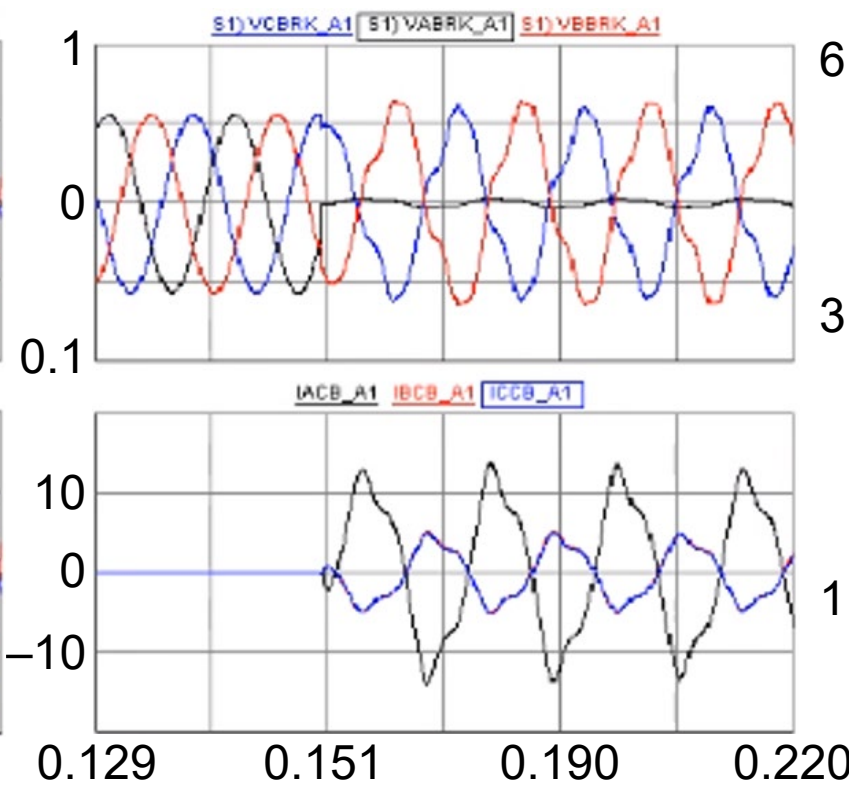
# Problem: IBR create unusual currents

Solution – Use SEL relays with advanced signal processing

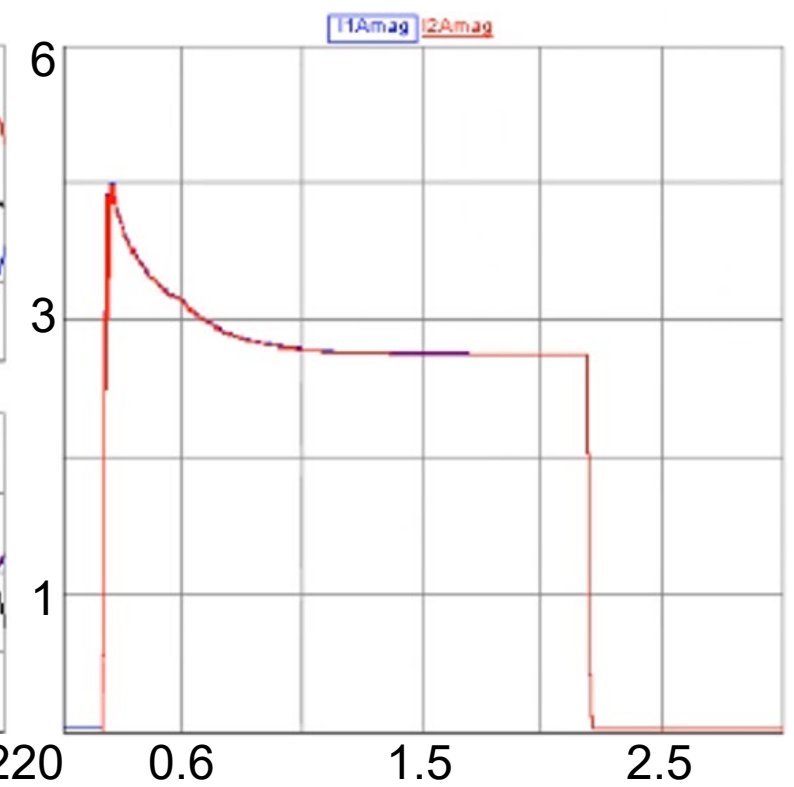
Subsystem 1



Subsystem 1



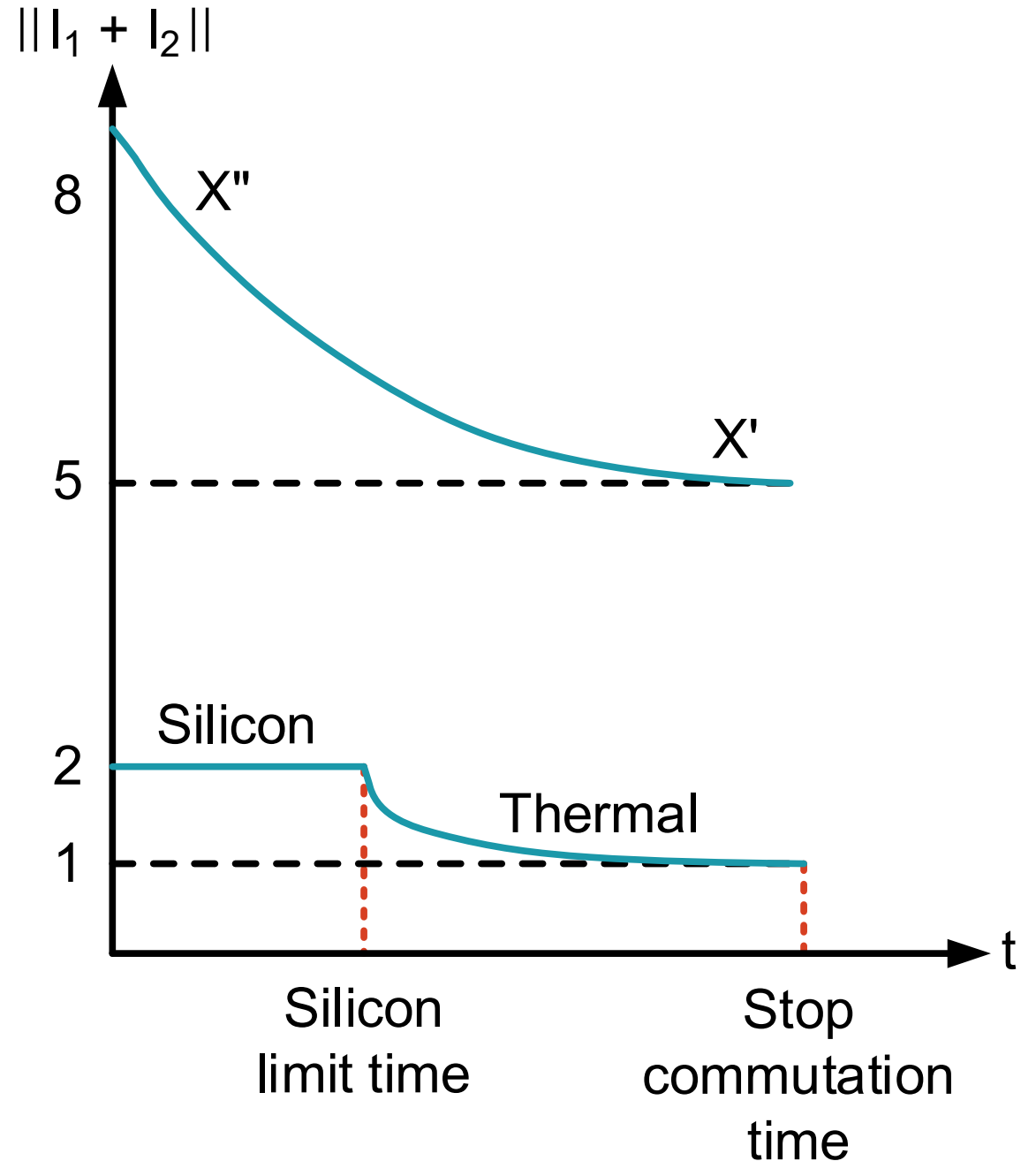
Subsystem 1 (CTLs, VARs)





# Problem: Inverters produce much less fault current than generators

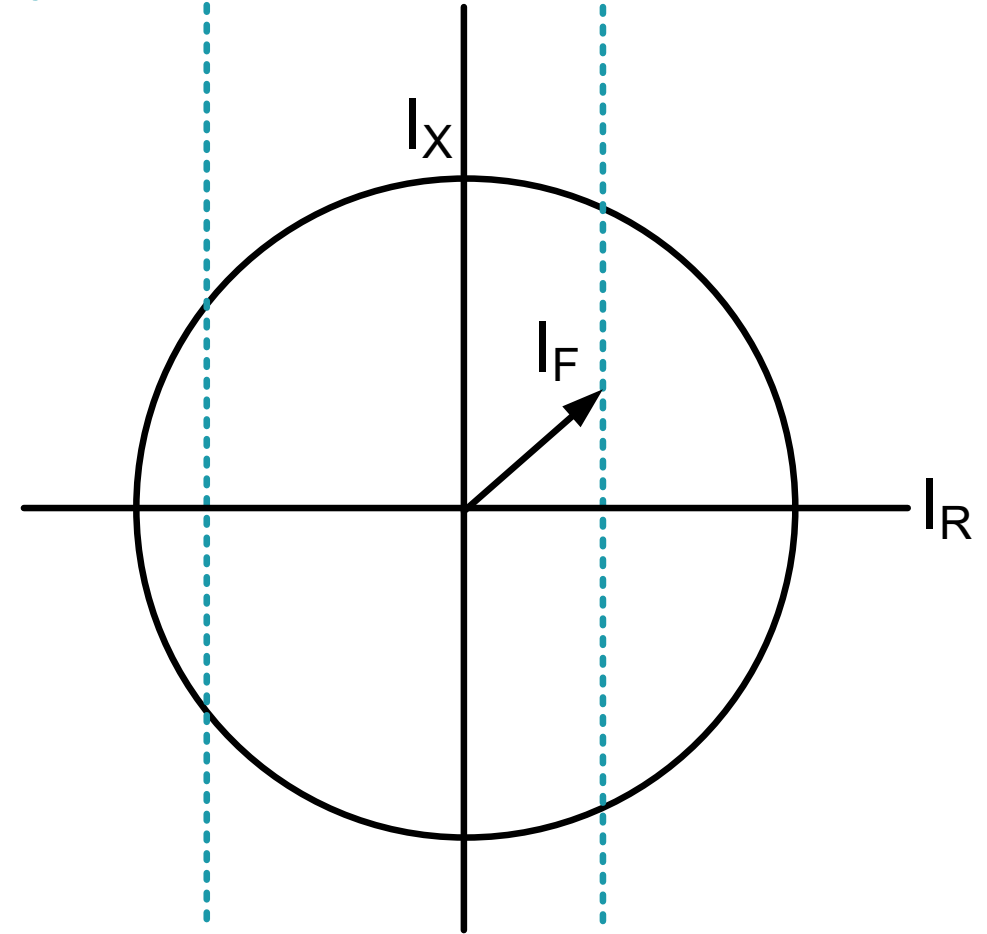
Solution: Use advanced SEL relay protection algorithms which can detect an inverter overload



**Problem: Inverter fault currents are restricted by health of inverter and battery**

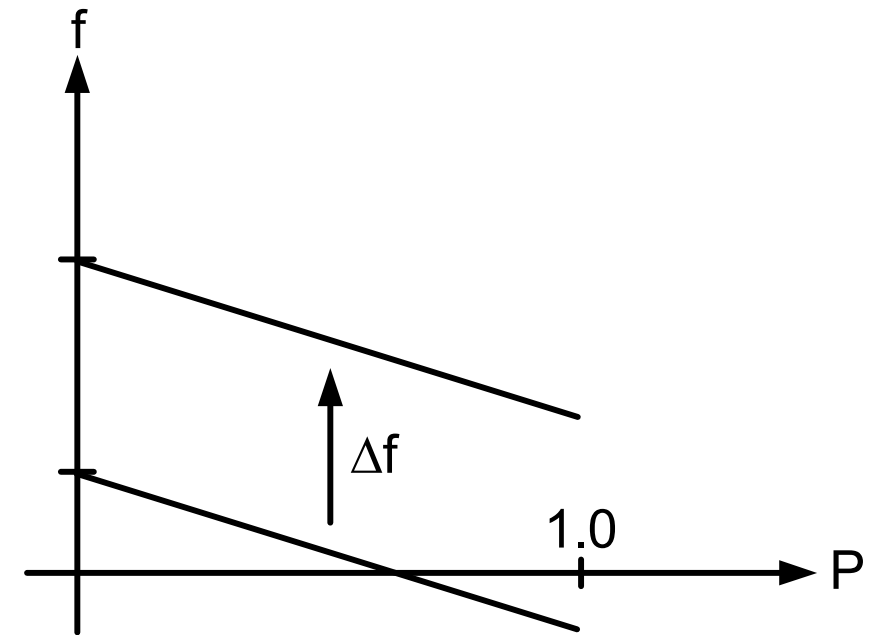
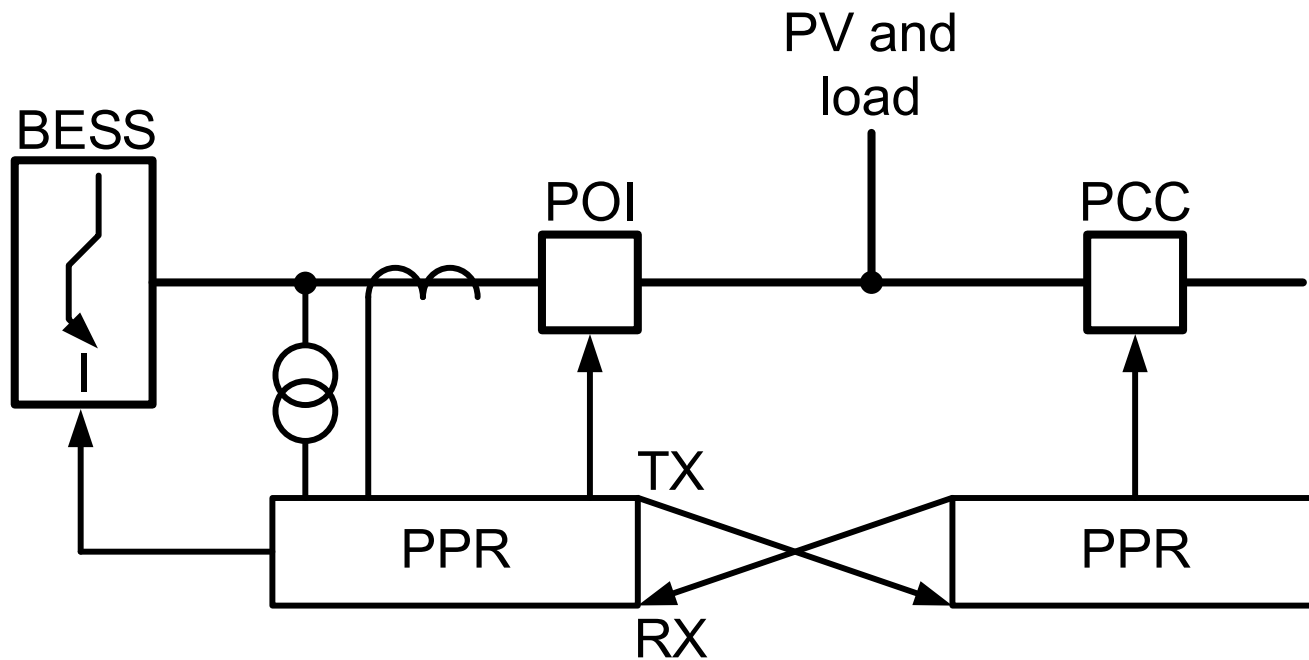
Solution: Use SEL Axion to Manage Batteries and Adapt Protection in SEL Relay

Battery SoC dynamic limits



# Problem: Variable fault currents require adapting downstream protective relays

Solution: Communicate between SEL relays with frequency shifting

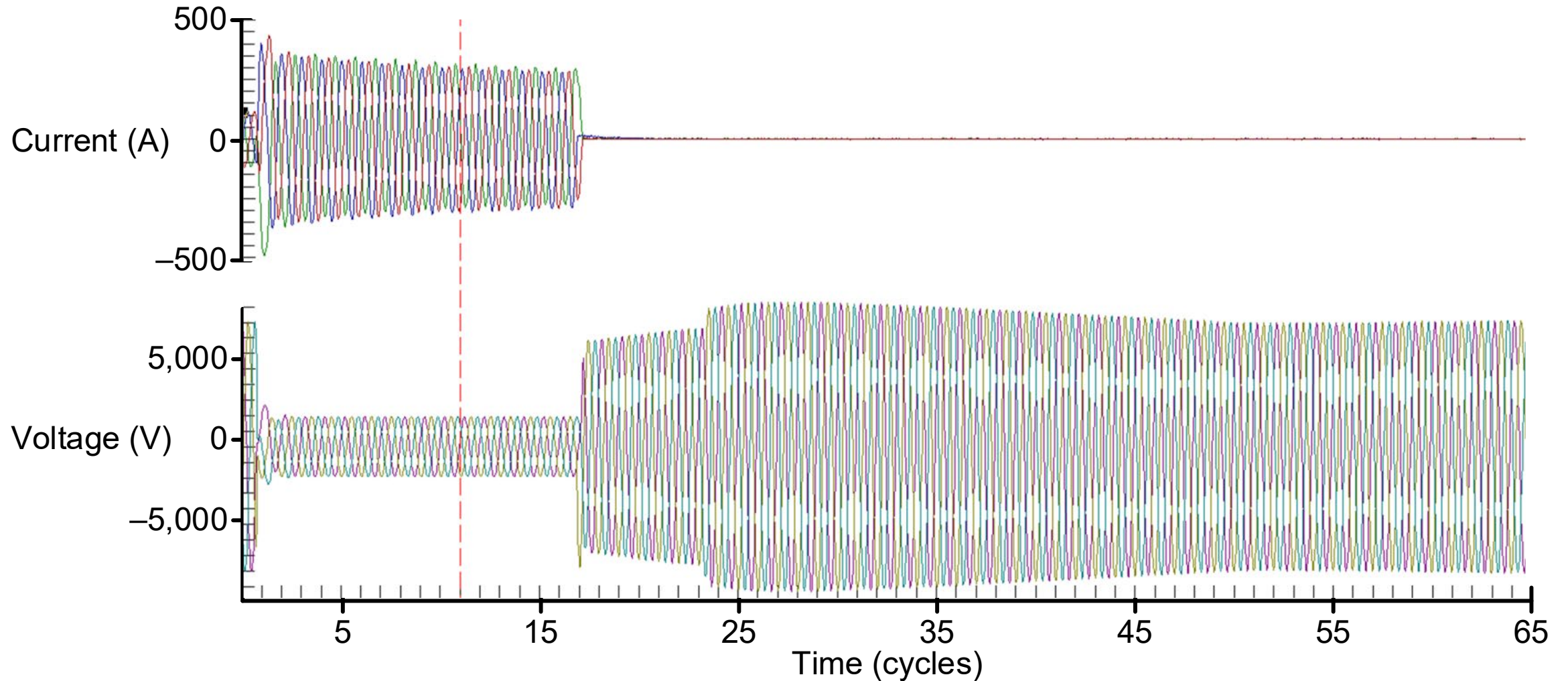


# Problem: IBR are faster than Protection!

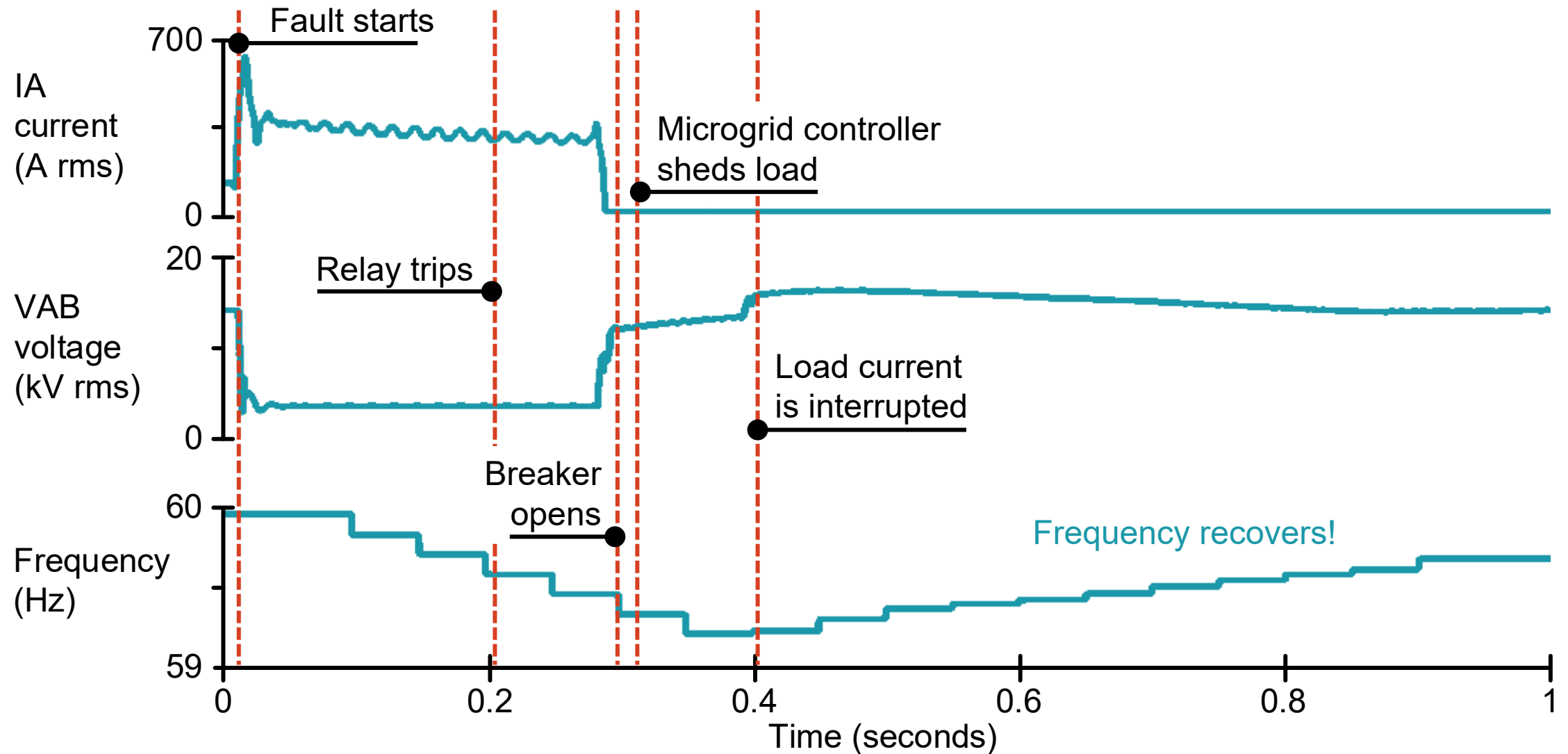
Solution: Use SEL relays to control inverters...at the RIGHT speed

Type	Time (seconds)
Governor	~1.000
AVR	~0.100
Load-shedding protection	~0.016
Distance protection	~0.006
Traveling-wave protection	~0.001
Inverters	It depends...

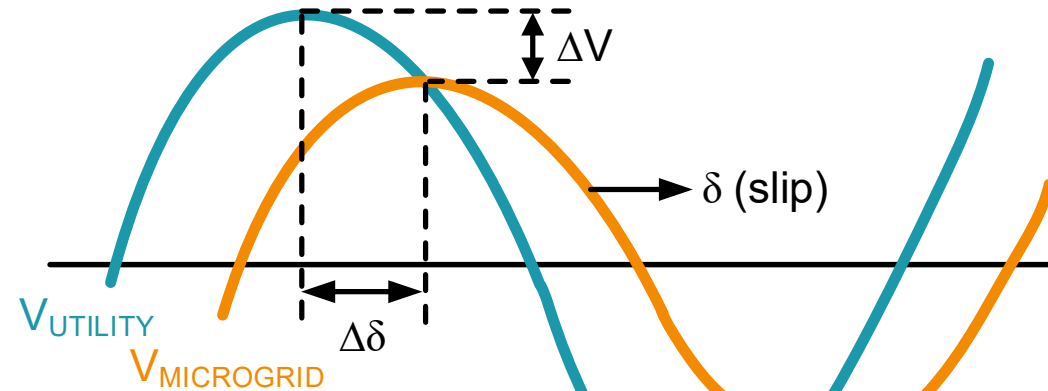
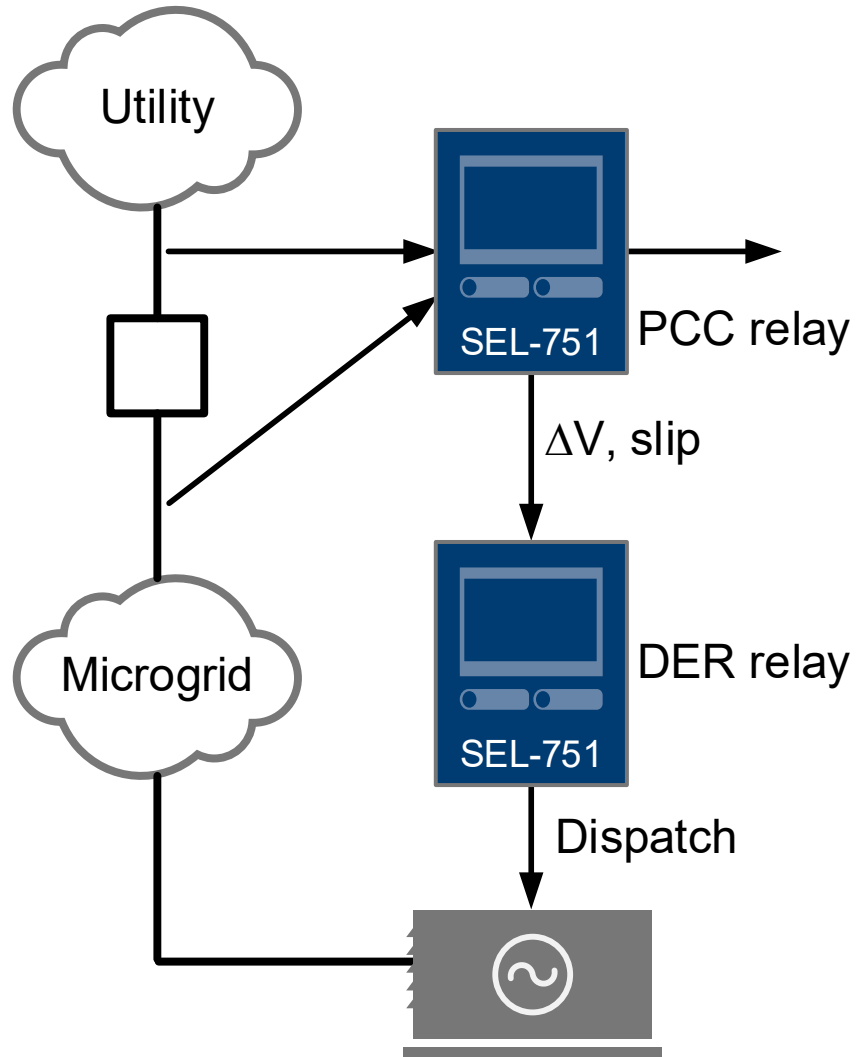
# SEL Relays provide Seamless Islanding after a Utility fault



# SEL Relays provide Seamless Islanding after a Utility fault



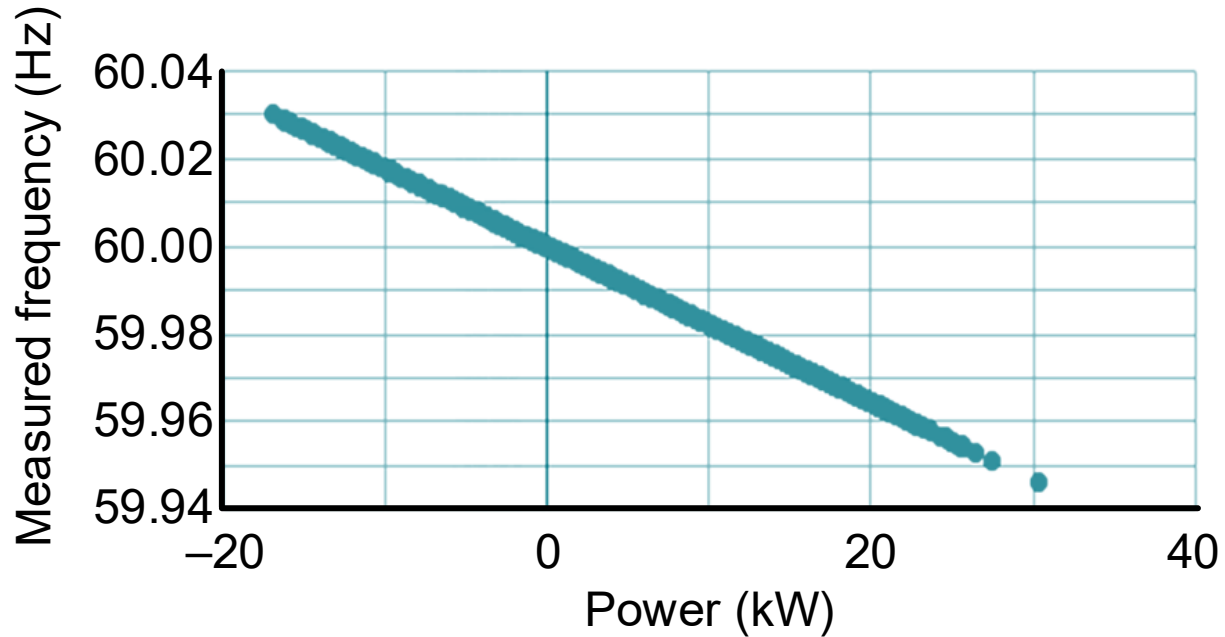
# SEL Relays provide Seamless Reconnection after the Utility recovers



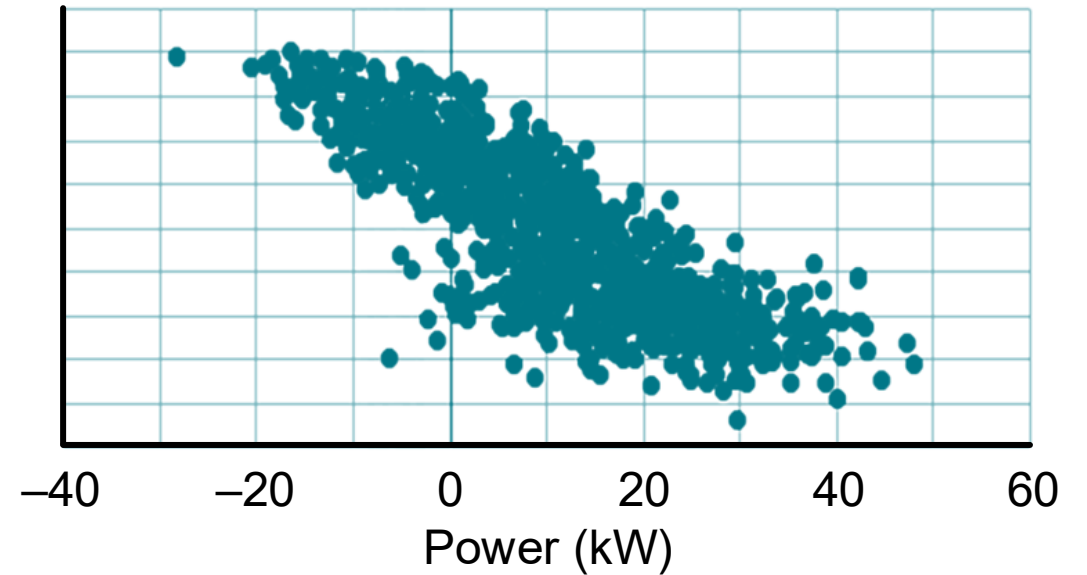
# Problem: IBR controls are non deterministic

Solution: Use SEL Relays as controllers

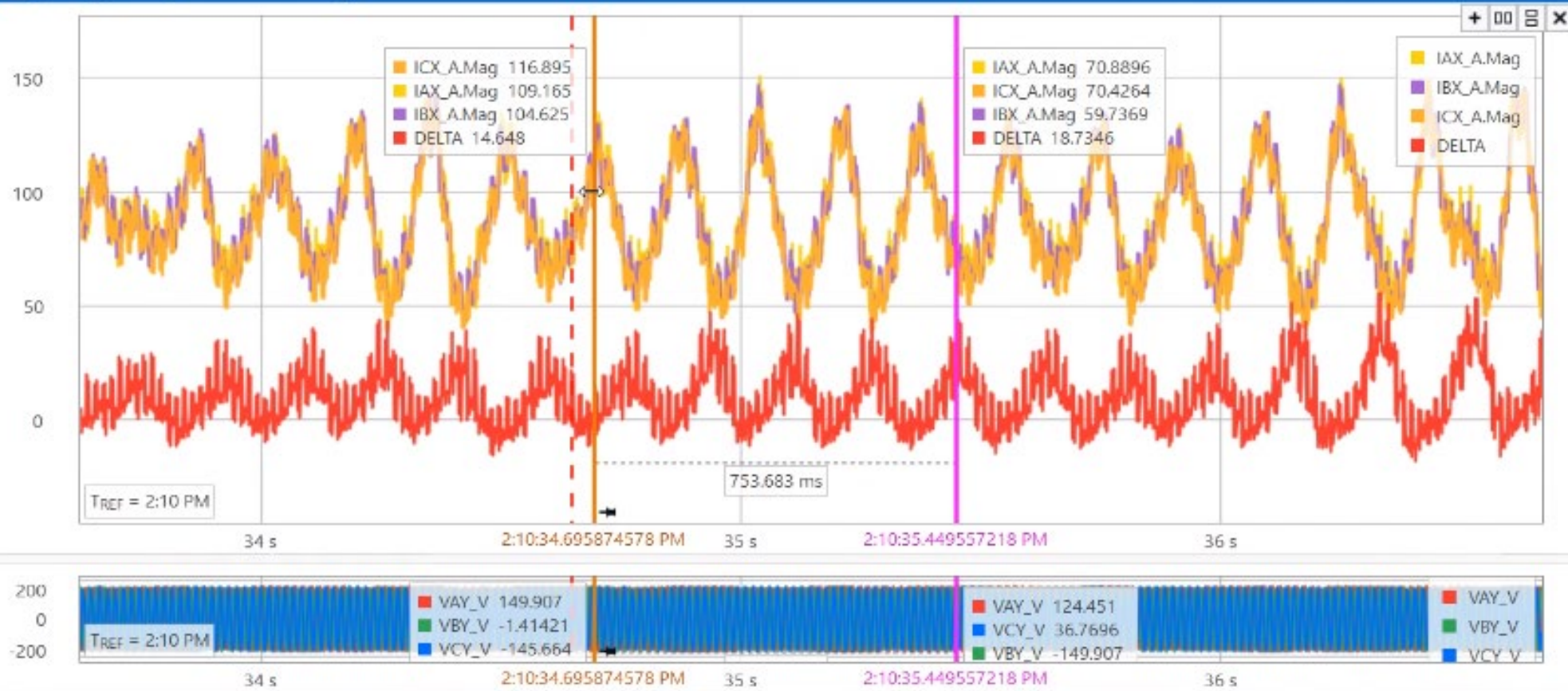
## SEL Relay control



## IBR erratic control







Orange Cursor Time

10/02/20 02:10:34.695 PM

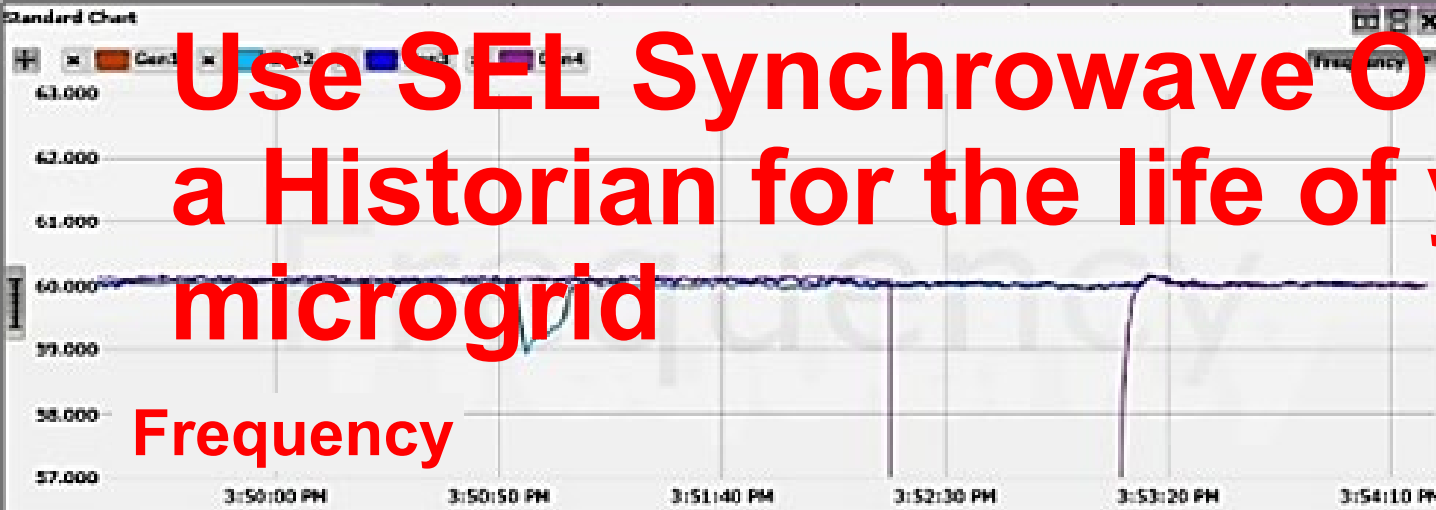
Phasor Calculations

Color	Name	Mag	Ang
Red	IAX_A.Phasor	109.165	113.1
Green	IBX_A.Phasor	102.162	-10.5
Blue	ICX_A.Phasor	116.08	-119
Yellow	VAX_V.Phasor	120.208	118.1

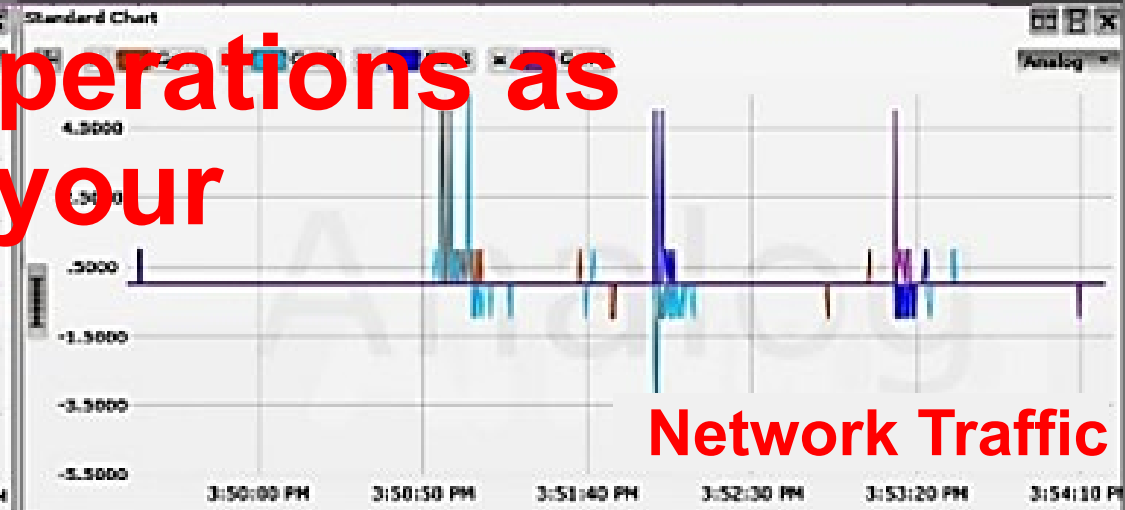
**Problem: Inverters**  
**commonly require custom tuning**  
**Solution: Use SEL Relays as High Fidelity Data Recorders**

# Use SEL Synchrowave Operations as a Historian for the life of your microgrid

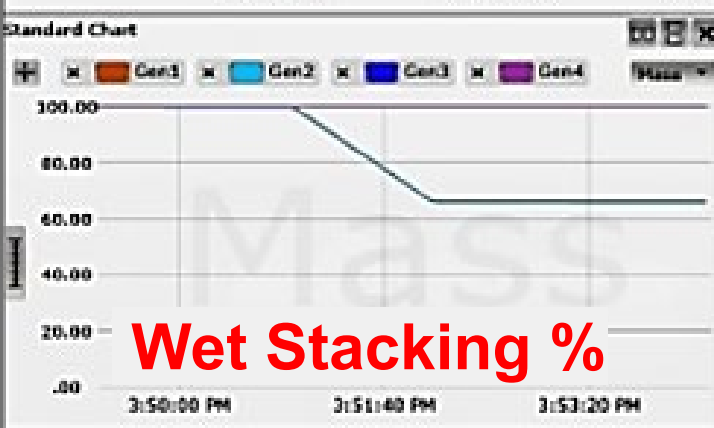
Frequency



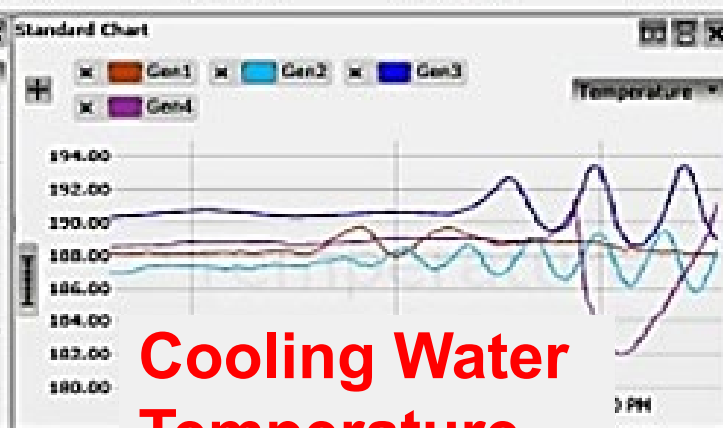
Network Traffic



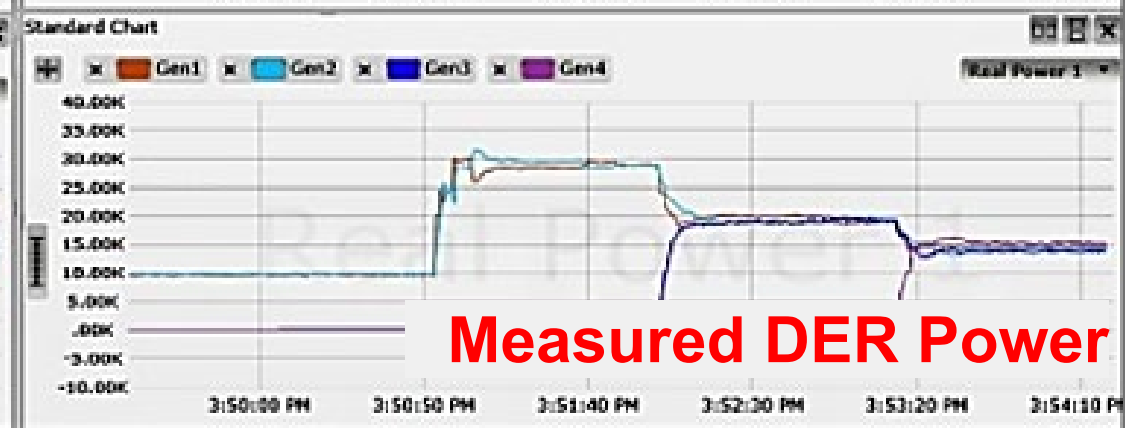
Wet Stacking %



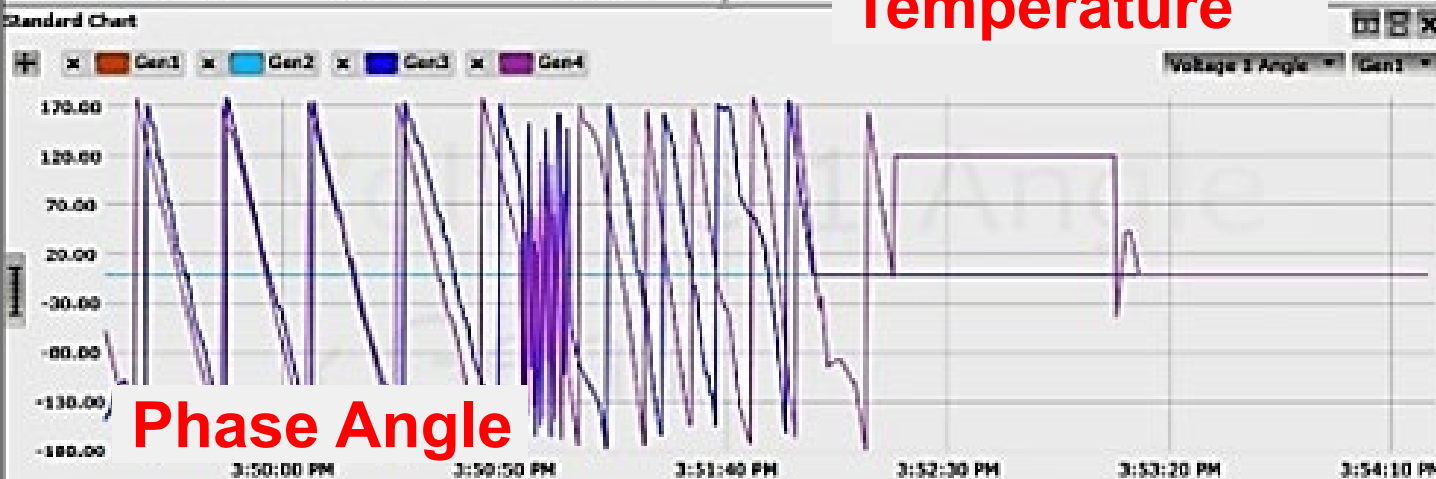
Cooling Water Temperature



Measured DER Power



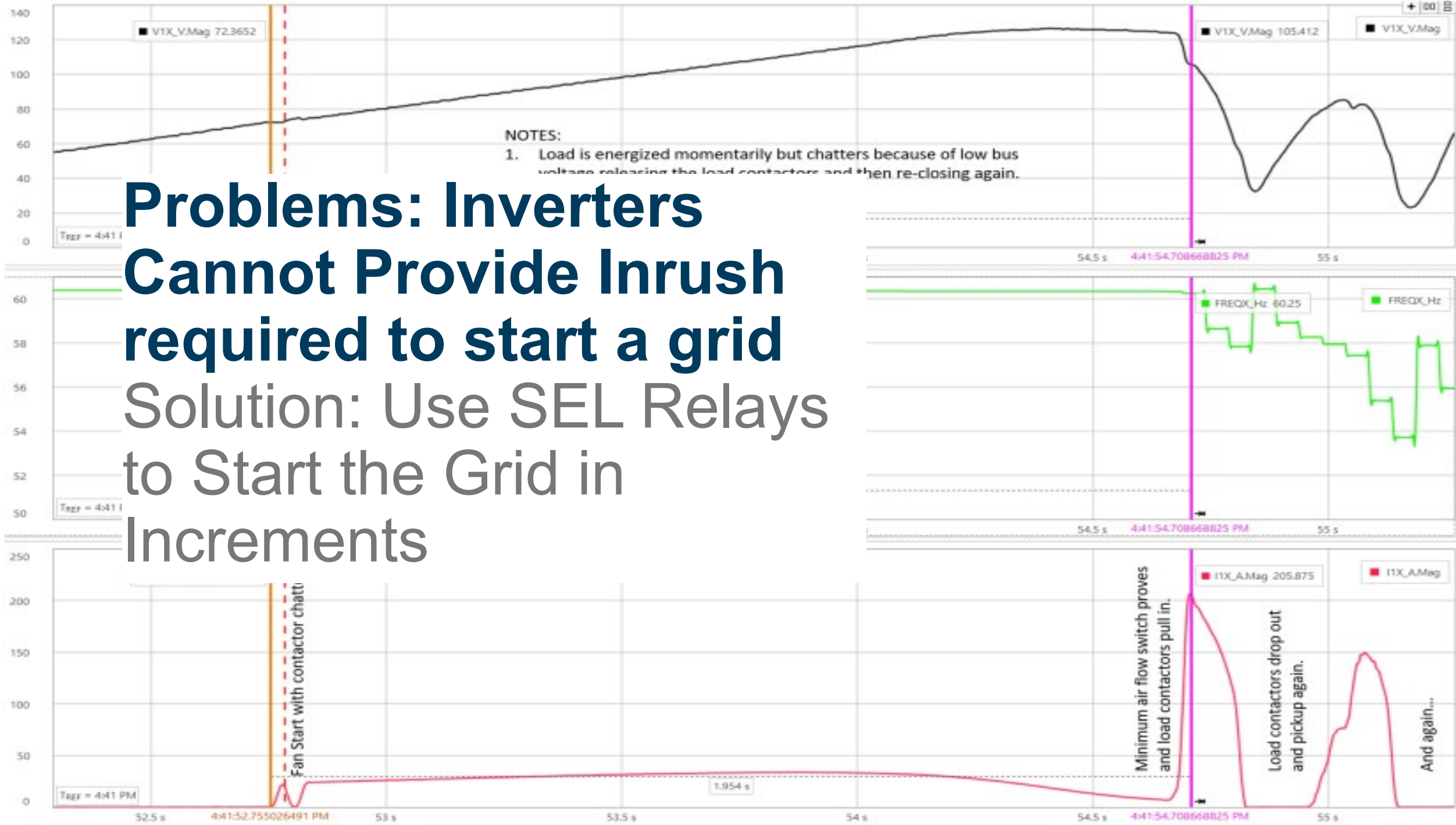
Phase Angle



Dispatch Set Point



**Problems: Inverters  
Cannot Provide Inrush  
required to start a grid**  
Solution: Use SEL Relays  
to Start the Grid in  
Increments





# SEL POWERMAX Microgrid Solution Plays Big On Campus

Montclair State University, New Jersey, U.S.A.

# SEL POWERMAX System Prevents Blackouts Across Entire Country

The Republic of Georgia



and protected by SEL POWERMAX



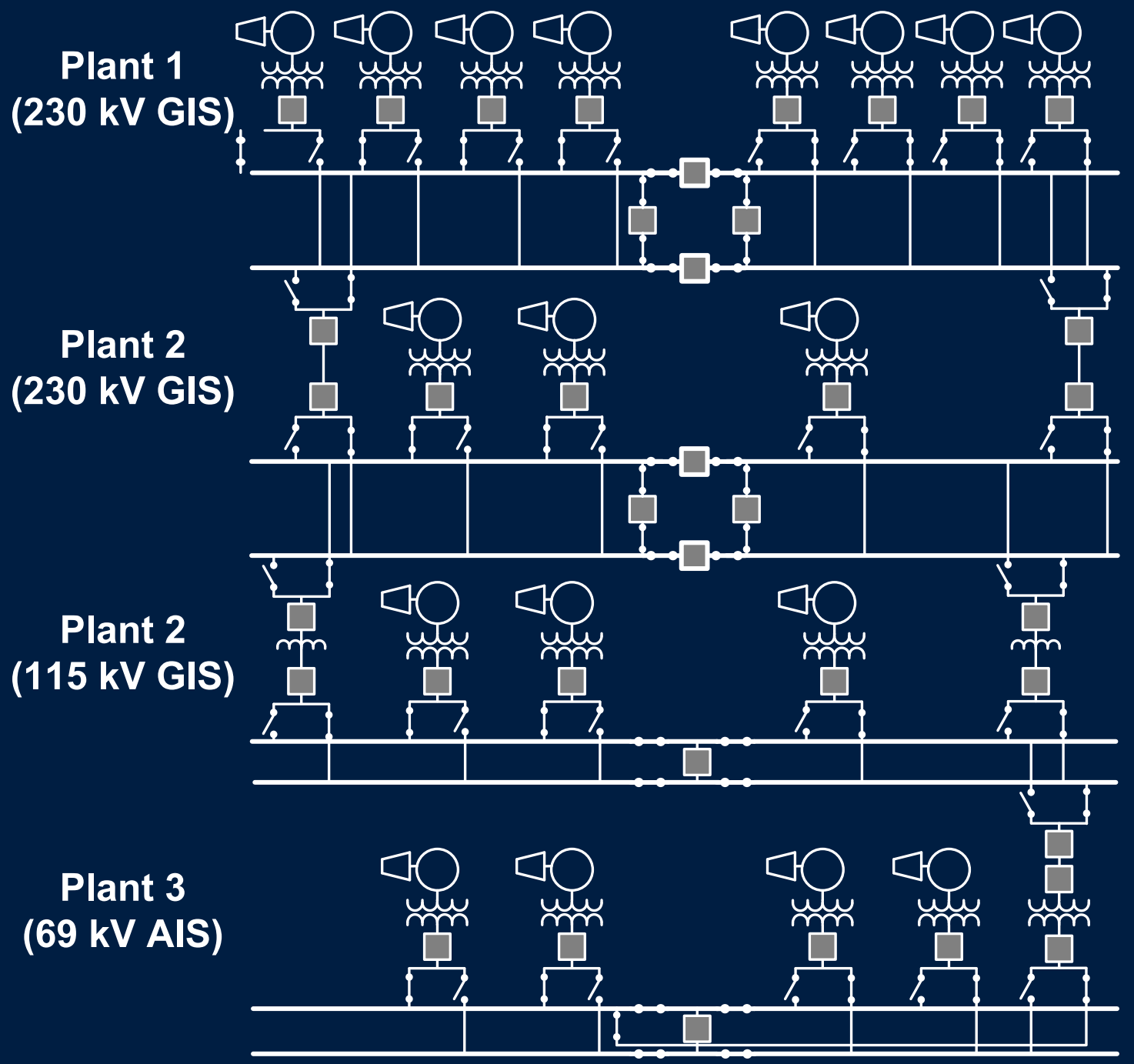


**4 Megawatt battery controlled and  
protected by SEL POWERMAX**

Presidio, Texas, U.S.A.

# SEL POWERMAX prevents Blackout at the Worlds most Valuable Oil Field

Shaybah, Saudi Arabia



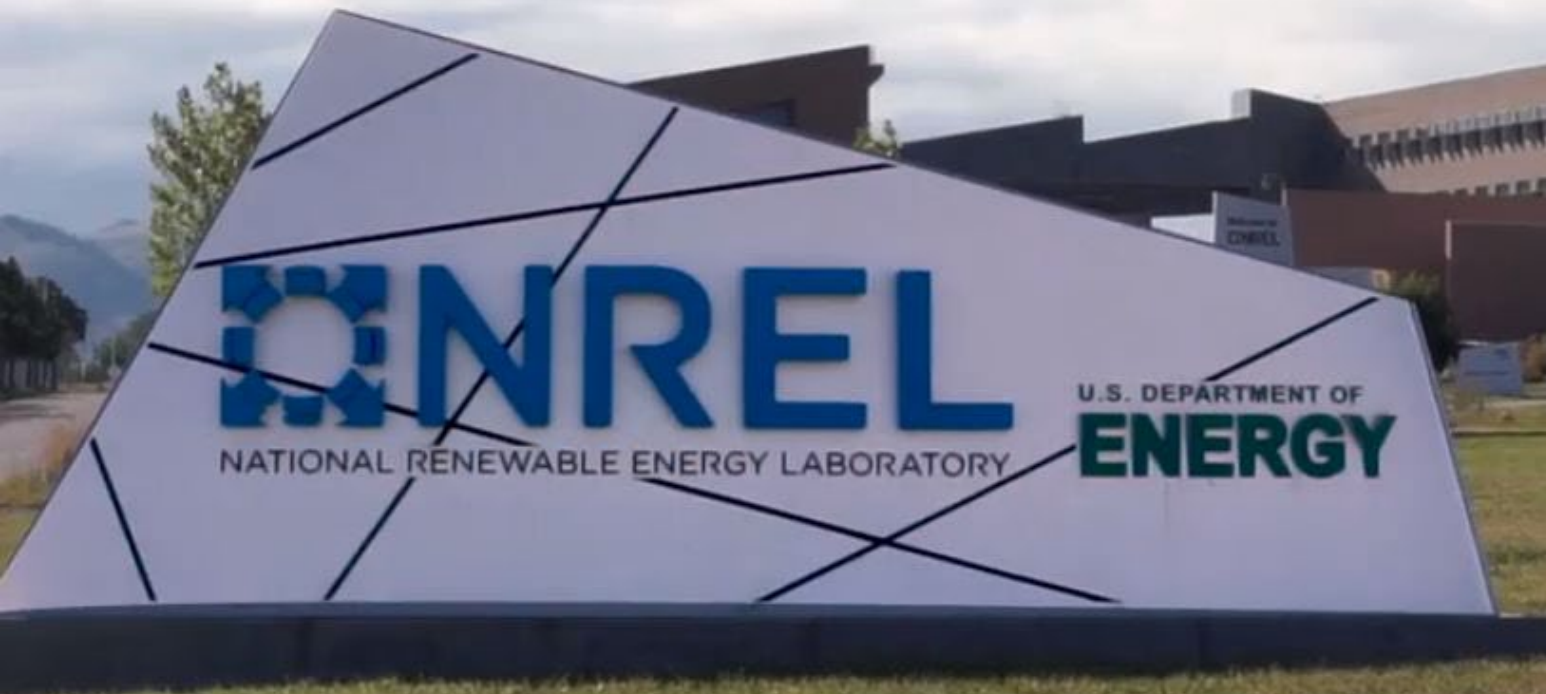


# SEL POWERMAX Brings Reliable Power to MIT Boston Campus



# SEL POWERMAX Outperforms Competitors in a Microgrid Shootout

Colorado, U.S.A.



# Sign up for a free SEL POWERMAX and Relay Controls Demonstration

[selmicrogriddemo@selinc.com](mailto:selmicrogriddemo@selinc.com)





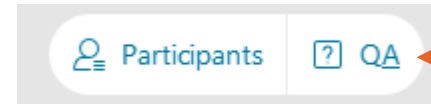
**Connect with us**  
[info@selinc.com](mailto:info@selinc.com)



# Q&A and Discussion

## WebEx Tip

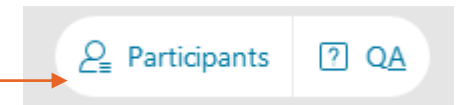
Option 1:



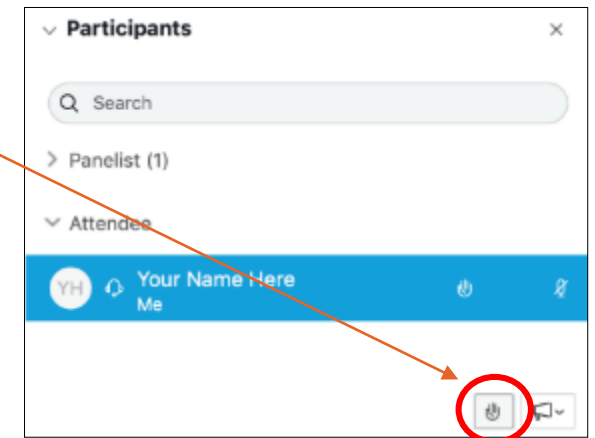
Access the written Q&A panel here

Option 2:

1. Click here to access the attendee list to raise and lower your hand.



2. Raise your hand by clicking the hand icon.

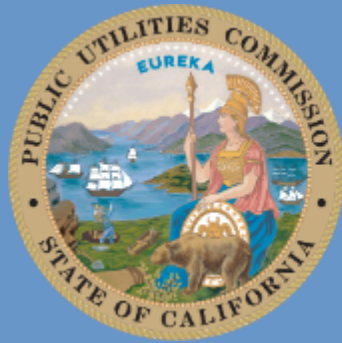


3. Lower it by clicking again.

# Closing and Upcoming Meetings

# Upcoming Meetings

- **Thursday, December 9, 2021 (2 pm – 4 pm) (tentative)**
  - Selective De-energization Within a Microgrid Island
  - Additional Participant Presentations on Interconnection Concerns
- **Thursday, January 6, 2022 (2 pm – 4 pm) (tentative)**
  - DC Metering Standard (brief re-visit)
  - Recap of Interconnection Sessions and Recommendations



# California Public Utilities Commission

Patrick.Saxton@cpuc.ca.gov

<https://www.cpuc.ca.gov/resiliencyandmicrogrids/>