

An Update From Kaua`i

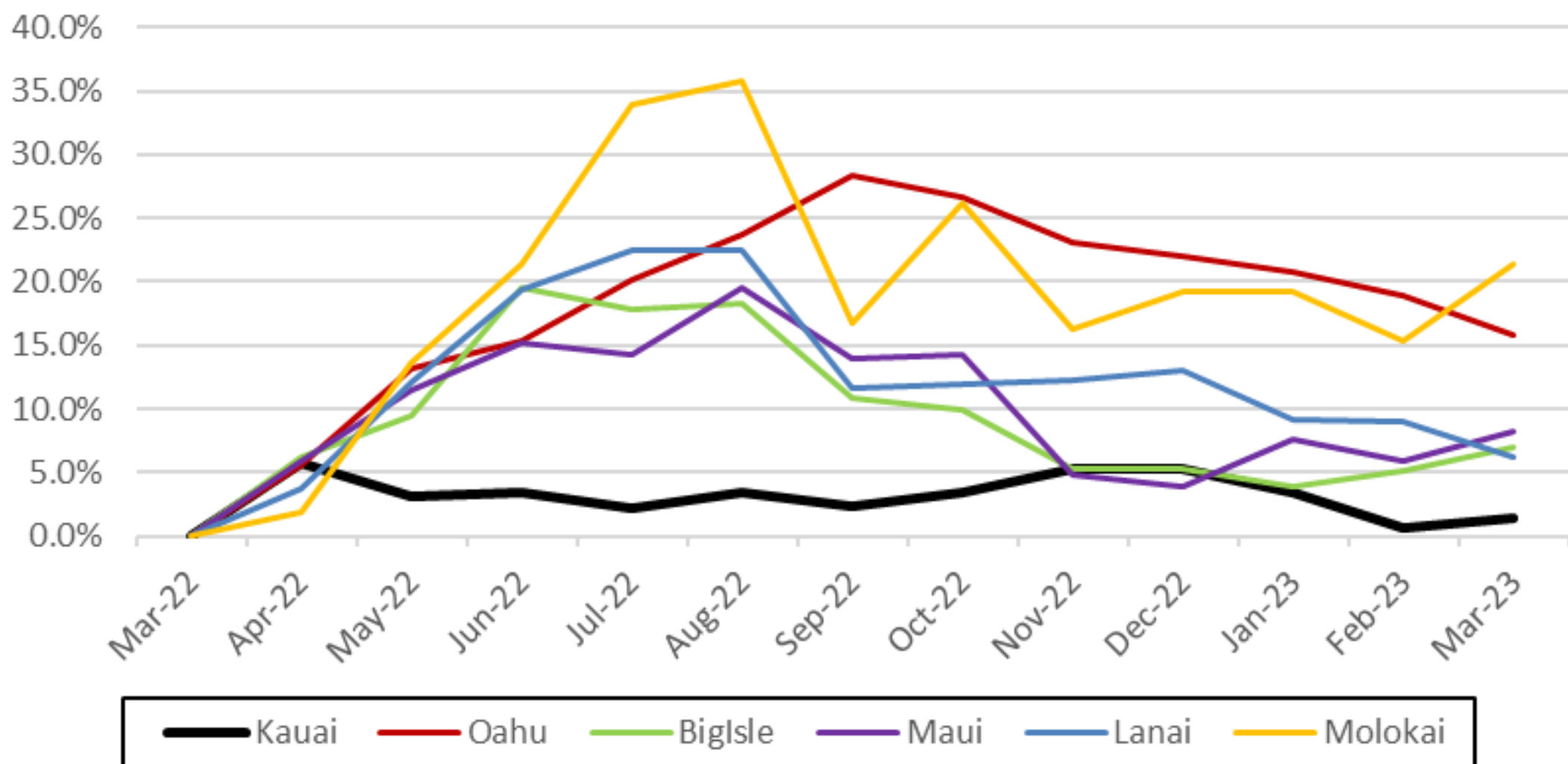
Cameron Kruse, P.E. | Engineering and Technology Manager
Kauai Island Utility Cooperative

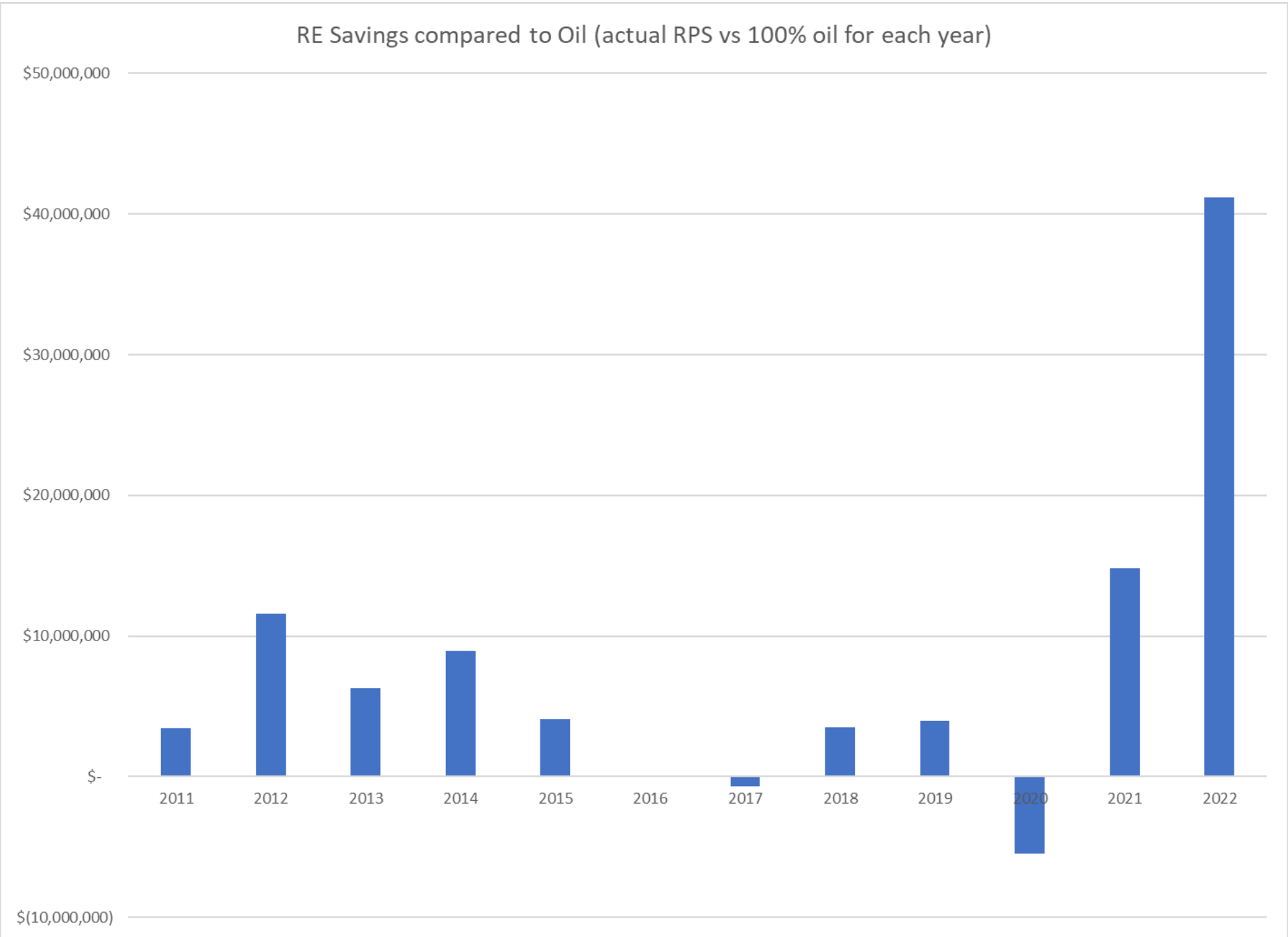
Phone 808.246.2324 | **Mobile** 808.635.9956
Web www.kiuc.coop | **Email** ckruse@kiuc.coop
4463 Pahee St. STE 1 Lihue, HI 96766



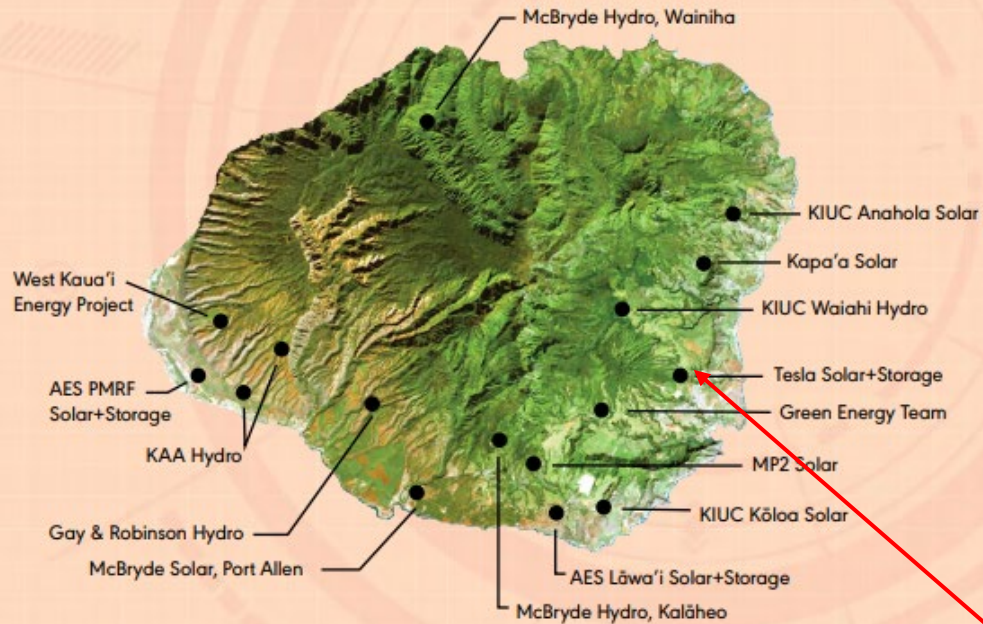


One Year 500 kWh Cost % Change





KIUC Renewable Map



Active In Use

	Type	MW	% of Sales
KIUC, Kōloa	Solar	12.0	4.6
KIUC, Anahola	Solar	12.0	4.6
Green Energy Team	Biomass	6.7	10.6
McBryde, Port Allen	Solar	6.0	2.5
McBryde, Wainiha/Kalāheo	Hydro	6.0	4.2
KIUC, Waihi	Hydro	1.5	0.7
Gay & Robinson, Olokele	Hydro	7.3	8.9
KAA, Waimea/Kekaha	Hydro	1.5	0.4
Kapa'a Solar	Solar	1.0	0.4
Tesla Solar+Storage	Solar	13.0	3.8
AES Lāwa'i Solar+Storage	Solar	20.0	8.6
AES PMRF Solar+Storage	Solar	14.0	5.5
MP2, 'Ōma'o	Solar	0.3	0.1
Customer Solar	Solar	40.6	14.6

Under Development

West Kaua'i Energy Project	Hydro	24.0	23.2
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Total Renewable
Energy in Service 2022

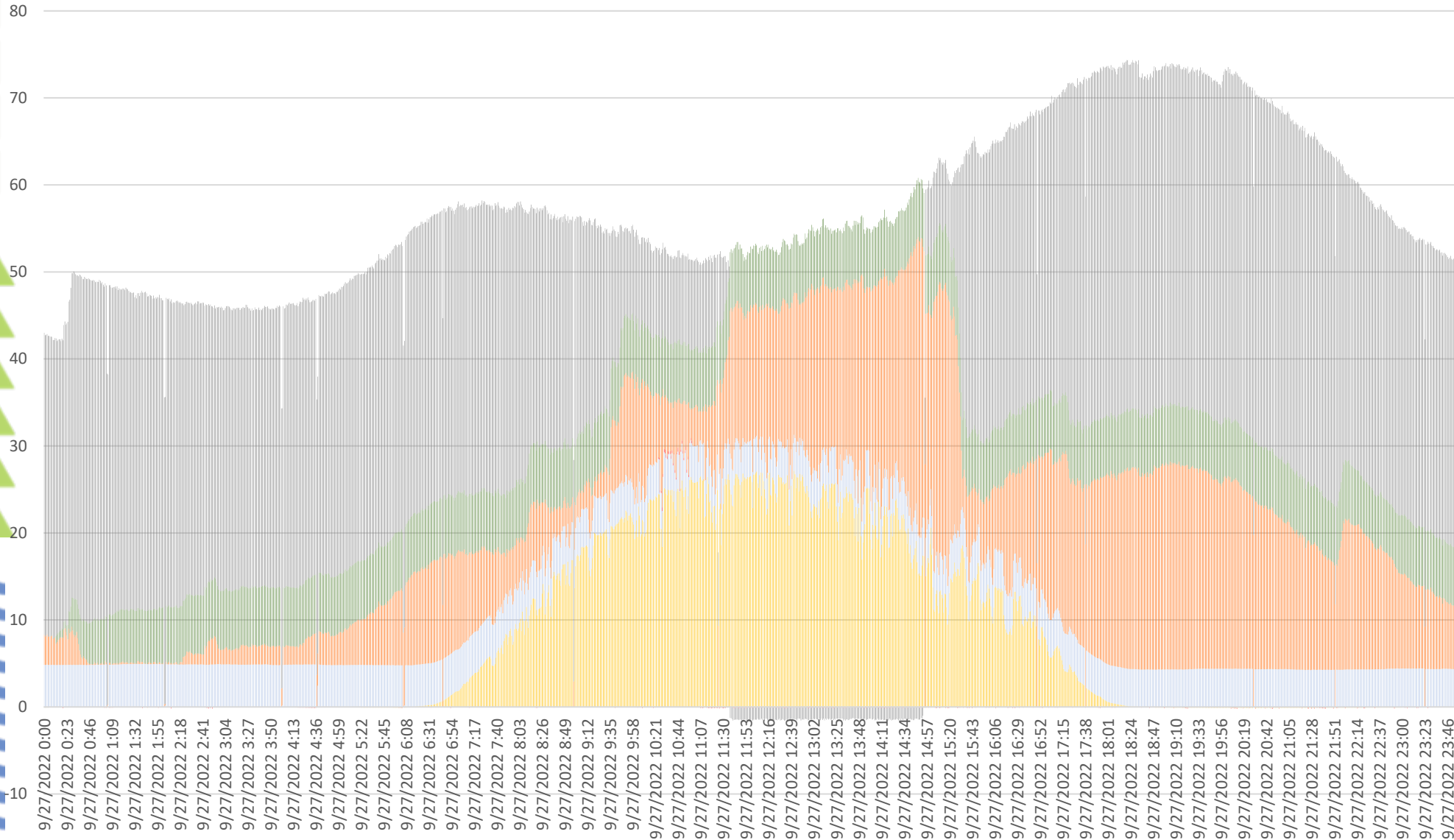
142.2 MW/67%

Potential Renewable
Energy in Service 2025

166.2 MW/85%

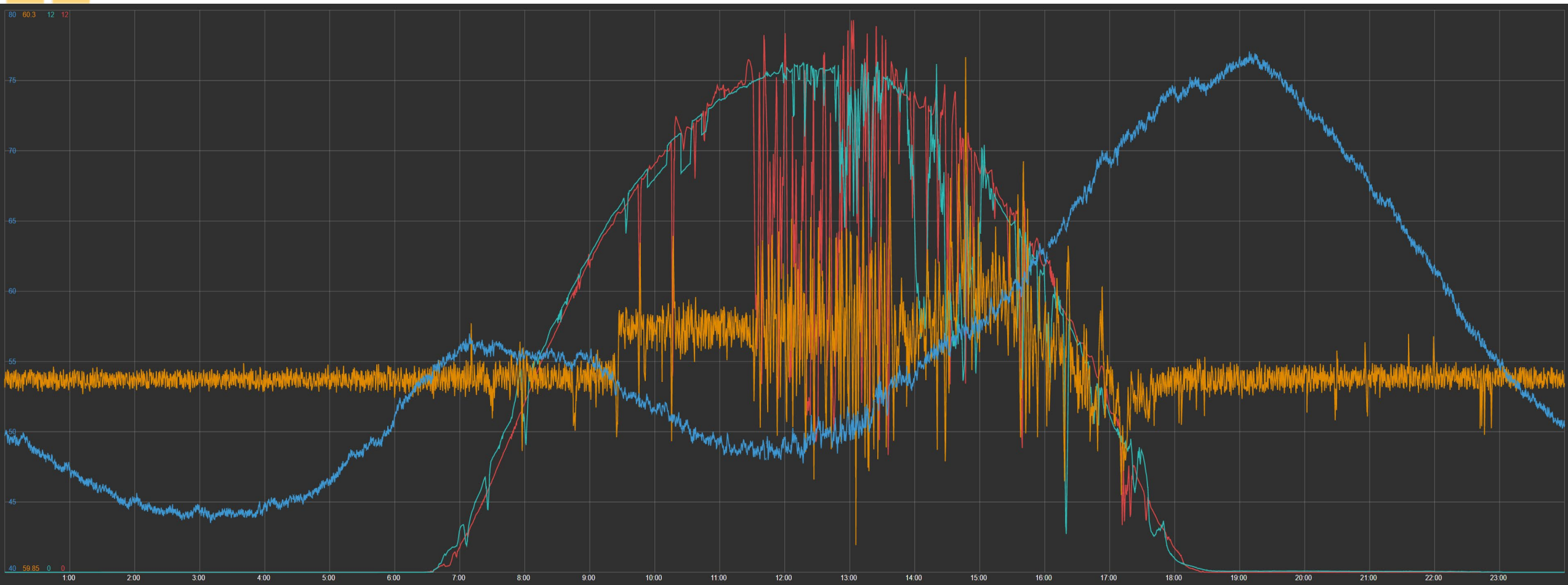
Kapaia – Generation and
Synchronous Condenser modes

KIUC Generation Profile – 9/27/2022



- Sum of Naptha/ULSD
- Sum of Biomass
- Sum of PV+BESS
- Sum of BESS
- Sum of Hydro
- Sum of D2G Solar

Steady State Challenges operating a high renewable grid

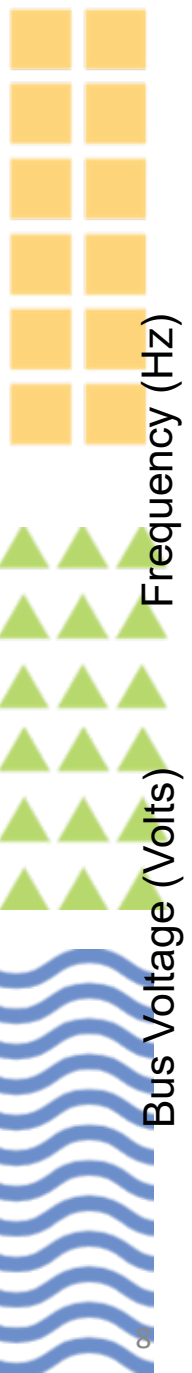


Lessons learned during grid-tied operation

Synchronous Machine Trip Offline – GFL and GFM response

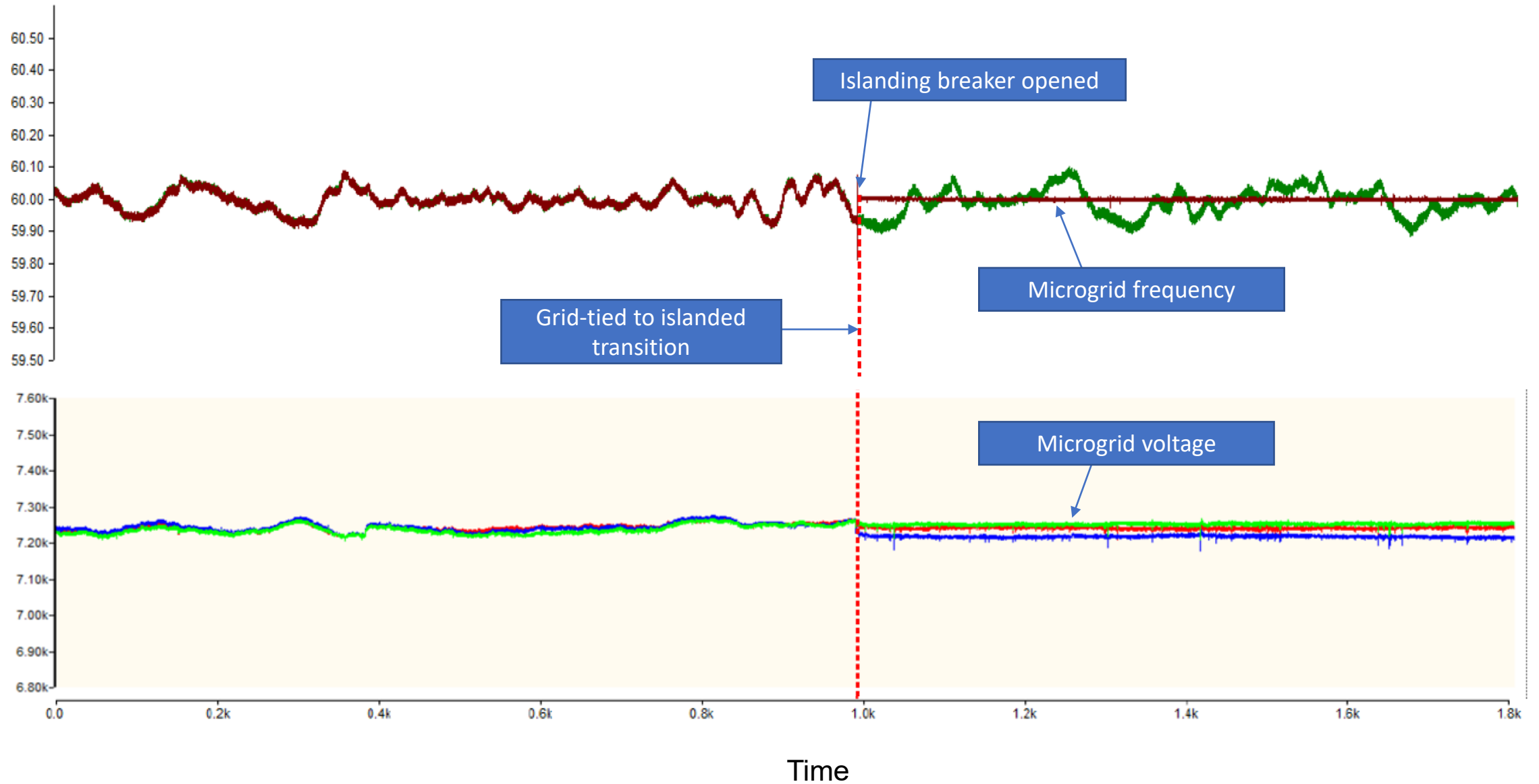


GFM Transitions - Planned Grid-tied to Islanded

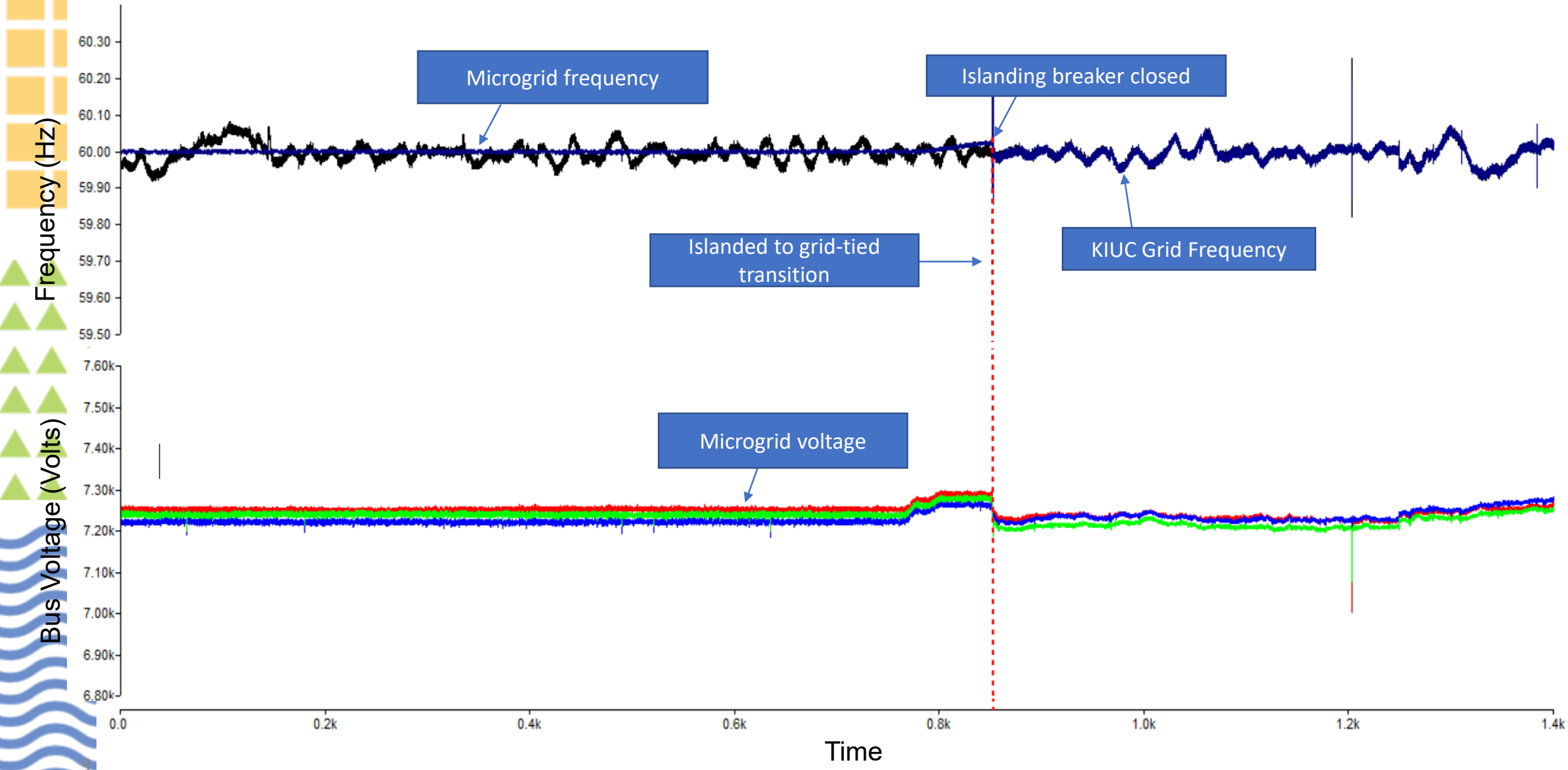


Frequency (Hz)

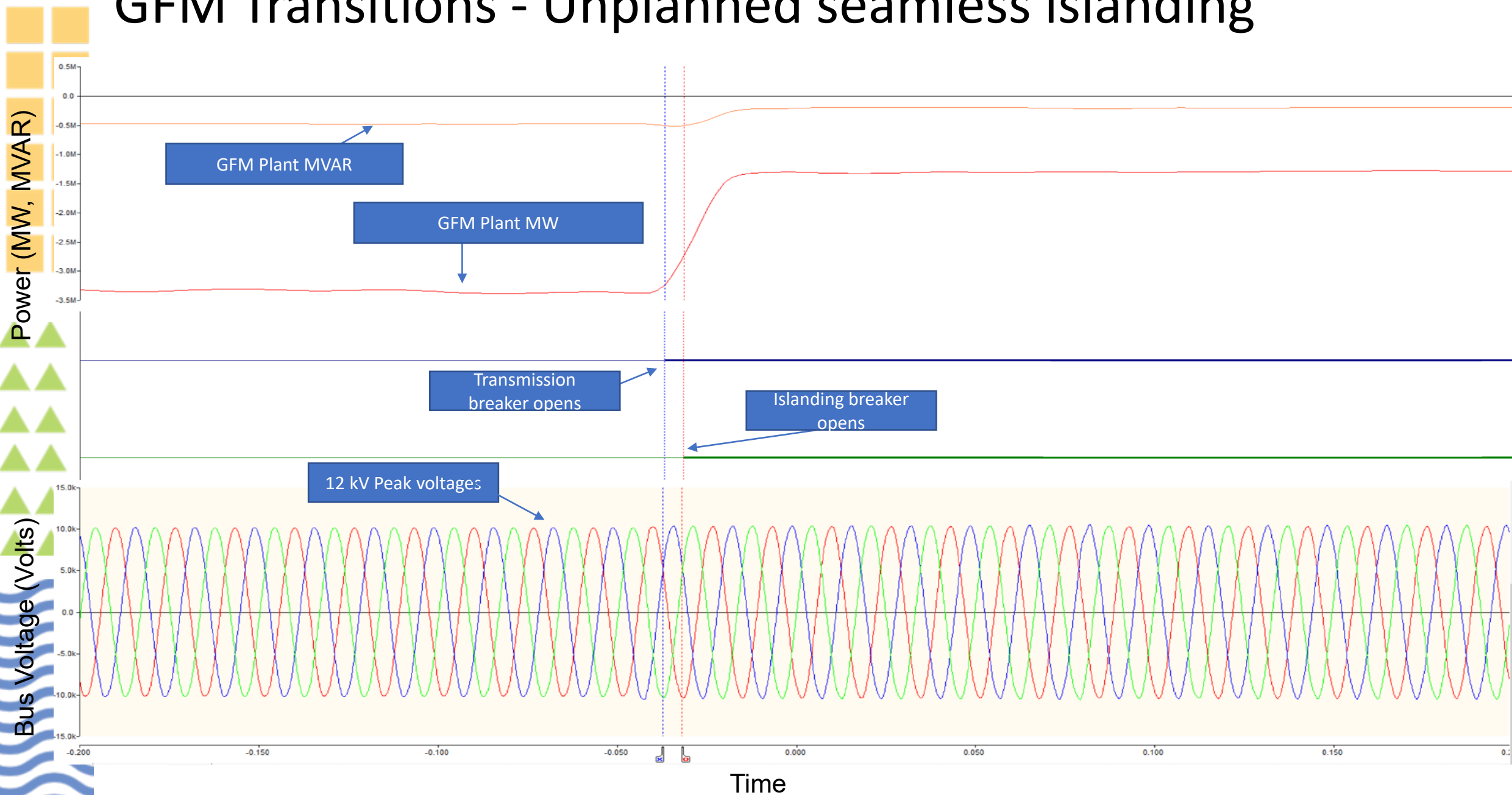
Bus Voltage (Volts)



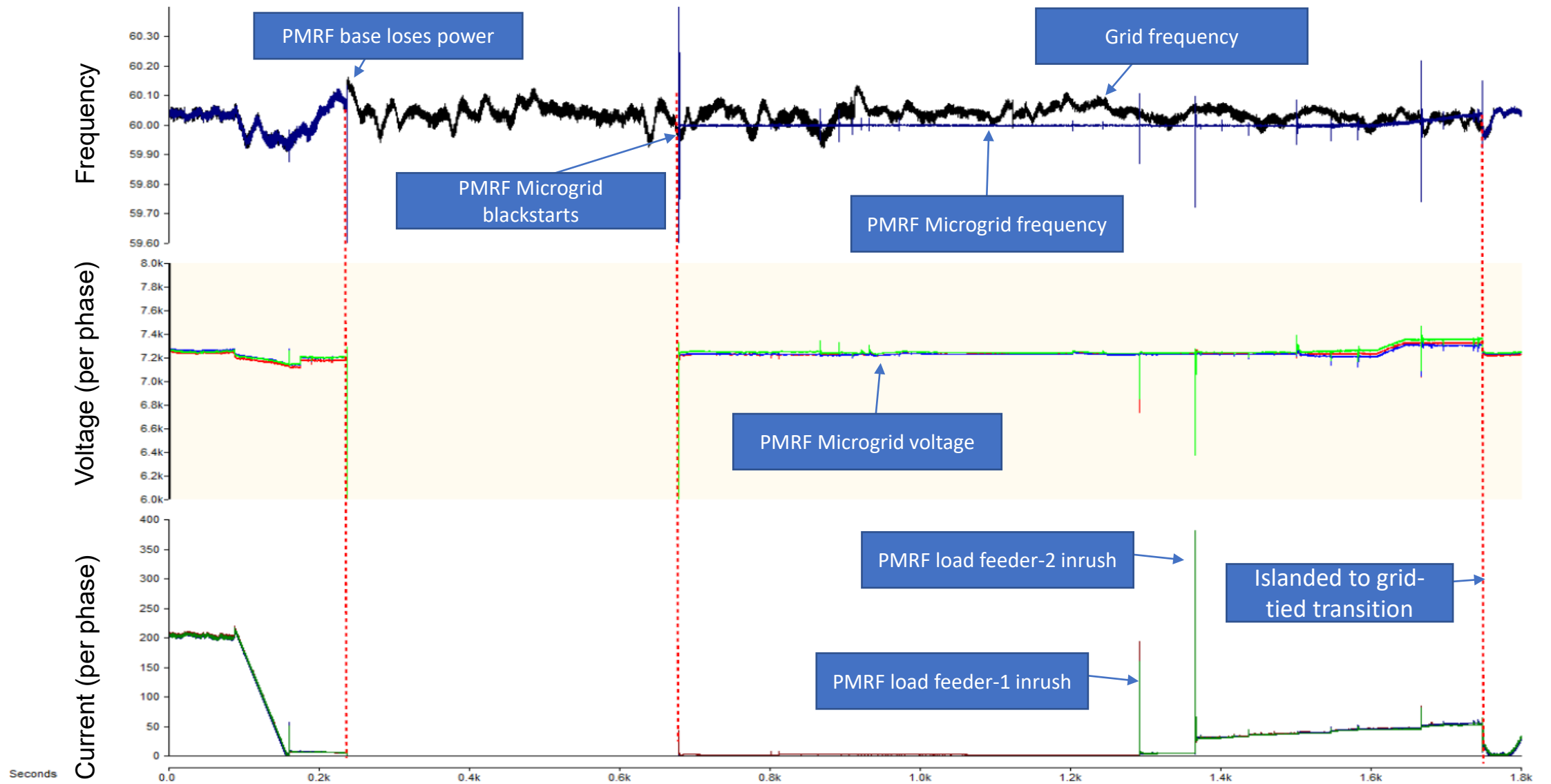
GFM Transitions - Planned Islanded to Grid-tied

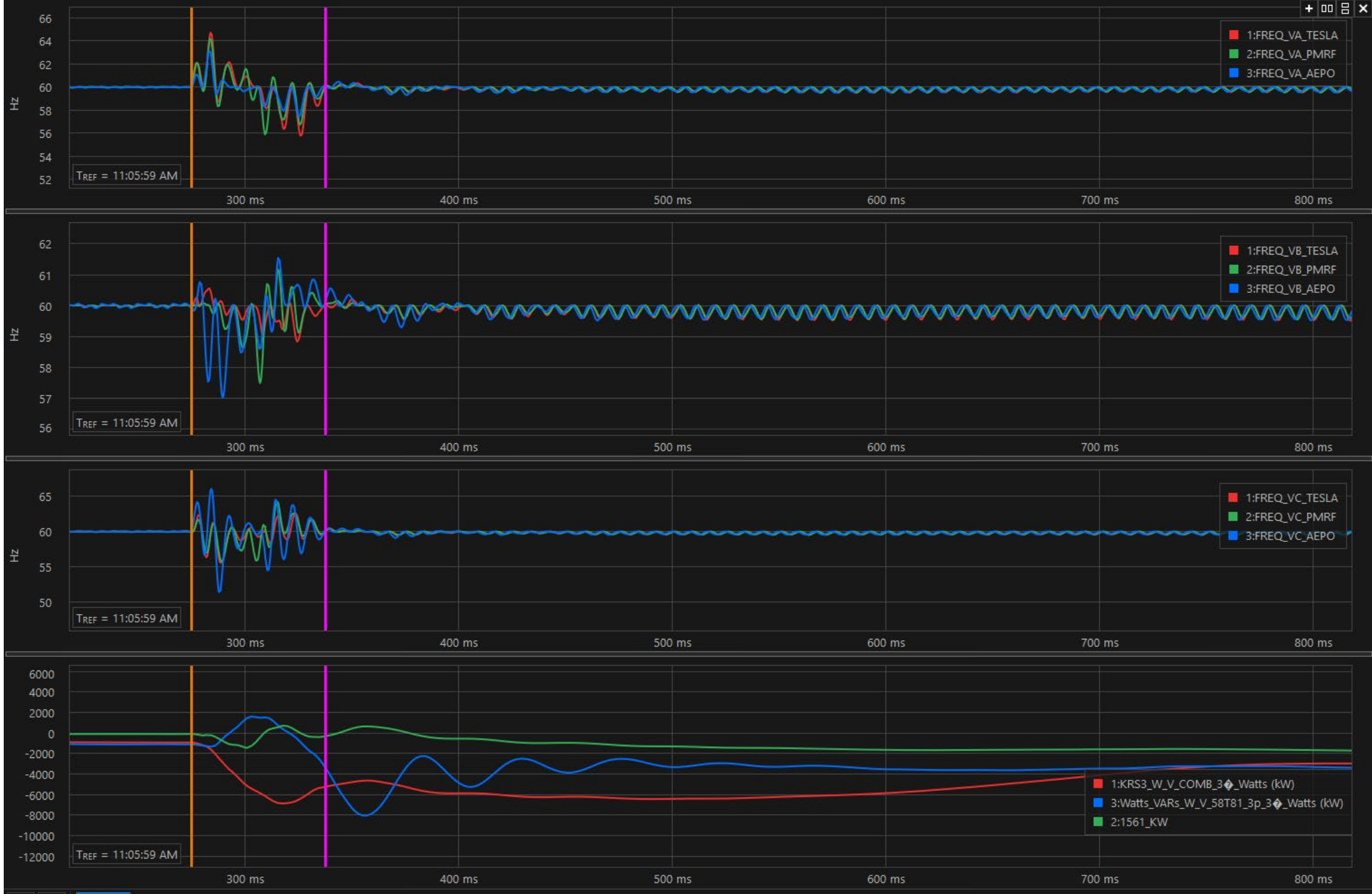


GFM Transitions - Unplanned seamless islanding



GFM Transitions - Load Blackstart







Lessons Learned so far...

- BESS energy PPA's with droop and ride through technical requirements
- Inverter Ride-Through past clearing time & power output
- UFLS scheme increased block count from 5 -> 13
- Transmission protection across the island implemented with 87L protection with backup 21 protection (z1: 0 delay, z2: 12 cycle delay, z3: 24 cycle delay), zone delays were already setup with fast clearing from KPS
- 87L direct fiber implementation allowed for unused strands to be used for large BESS dispatch
- Started implementing Traveling Wave transmission relays
- PLL error as a result of high rate of Hz/sec - Droop settings tuning
- Digital Fault Recorder's at each substation
- Synchronous Generation in parallel with Renewable Sources should be tuned to prevent steady state oscillations
- Fast Frequency Response from inverters should be tuned to prevent out of band frequency conditions



Thank you

Cameron Kruse, P.E. | Engineering and Technology Manager
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