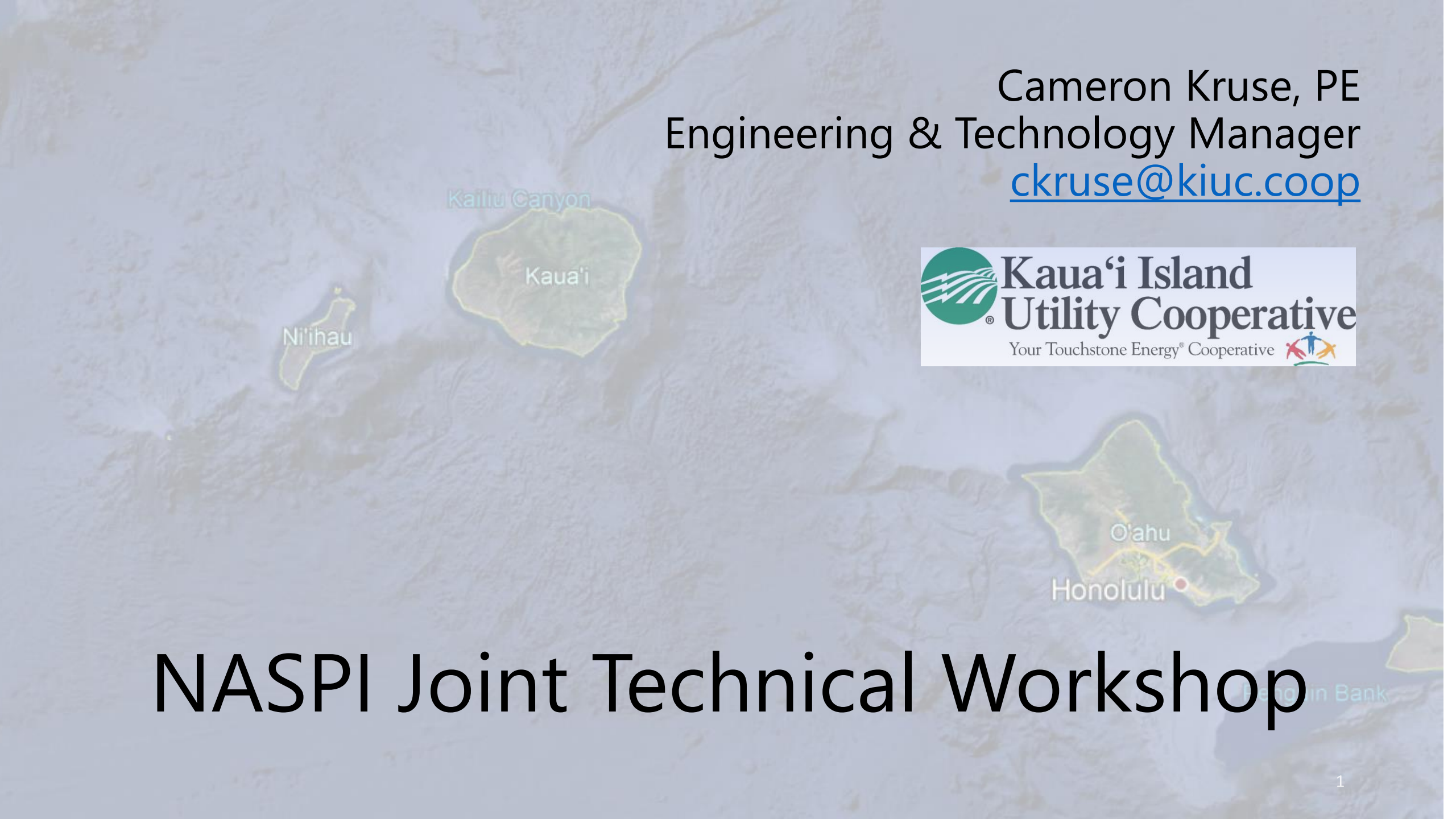
Cameron Kruse, PE
Engineering & Technology Manager
ckruse@kiuc.coop

Kaua'i Island Utility Cooperative
Your Touchstone Energy® Cooperative



NASPI Joint Technical Workshop

Kaua`i Statistics

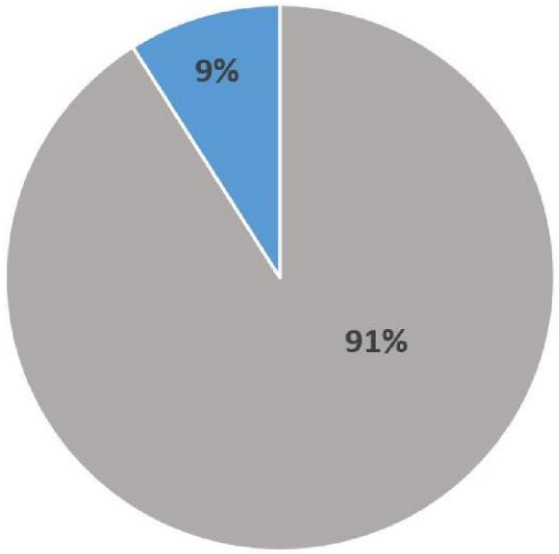
- 72,000 resident population (5% of State)
- Consistent visitor load (+28,000)
- 550 sq mi (10% of State)
- Member-owned Electric Cooperative
- High rates due to oil-dominated power supply (31-38 cents/kWh last 3 years)
- Low residential energy use due to stable climate (500 kWh per month avg)

KIUC Grid Statistics

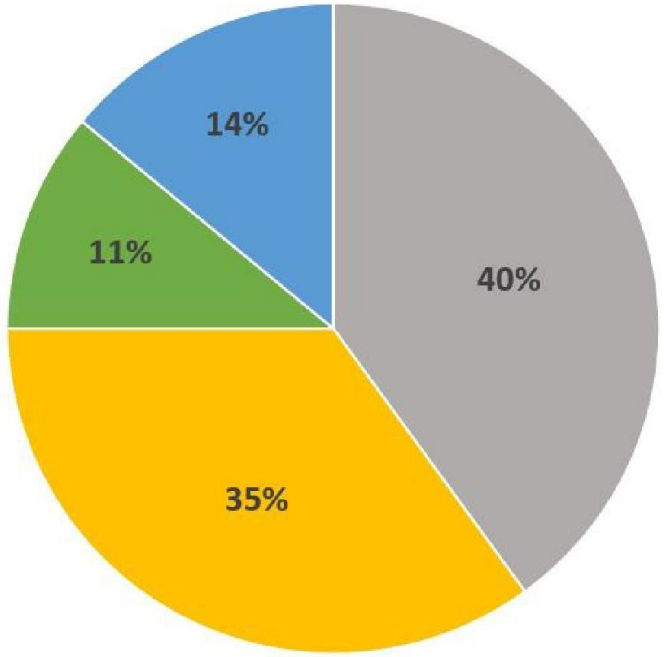
- **Completely islanded, vertically integrated**
- **171 miles 69 kV-rated transmission**
- **1,311 miles 12.47 kV distribution**
- **35-80 MW daily demand profile**
- **80 MW all-time peak (Aug 2019)**
- **117 MW oil-fired generation capacity**
- **106 MW solar (40% MW customer-owned)**
- **16 MW hydro**
- **7 MW biomass**
- **58 MW / 240 MWh Battery Energy Storage**

Background: Where Kaua`i Gets Its Power

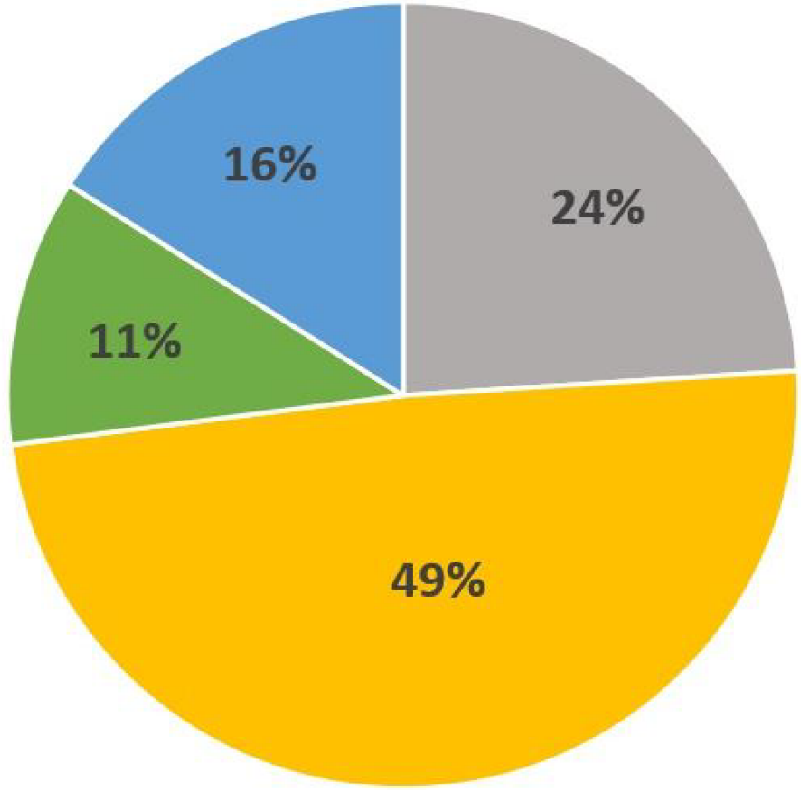
2009



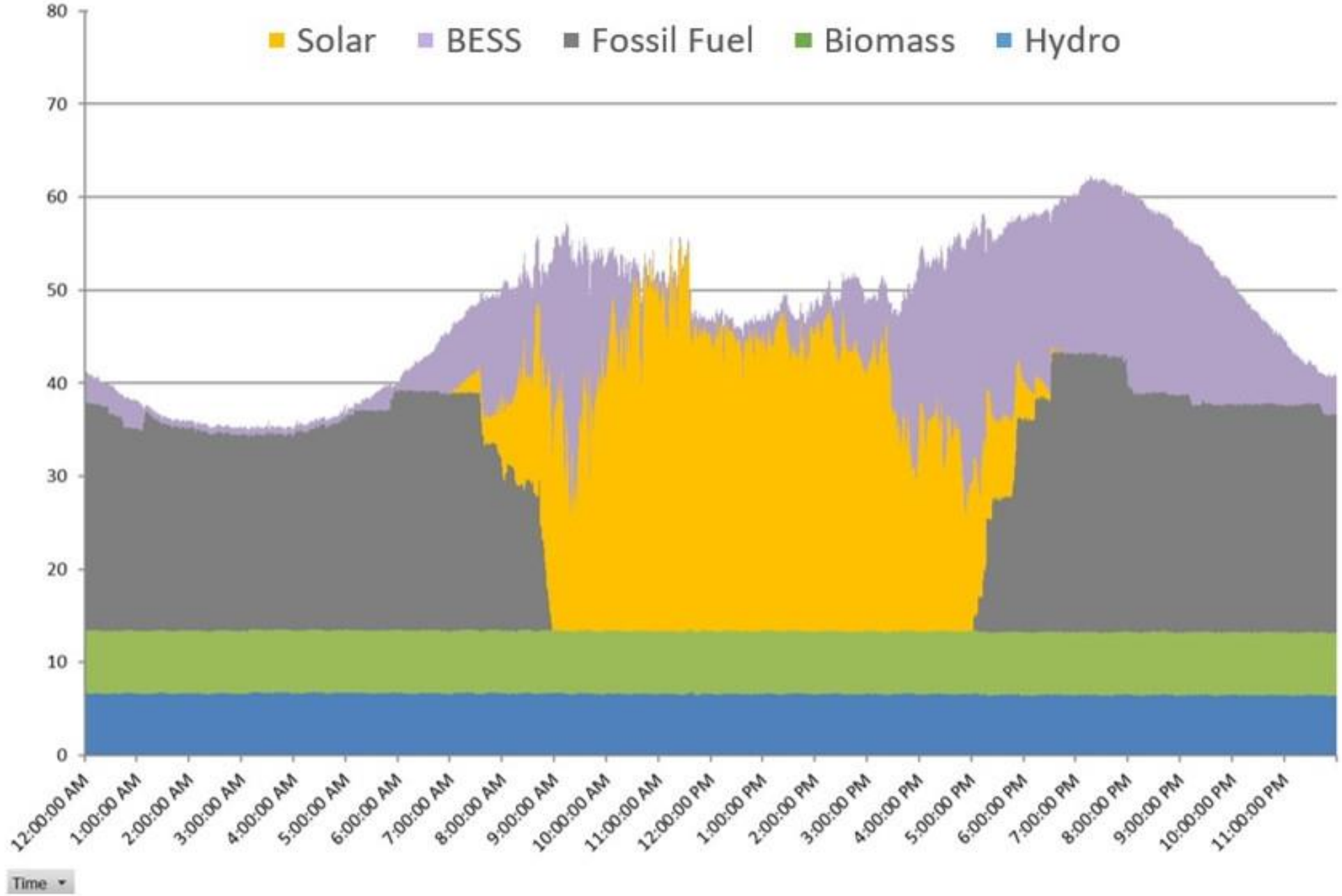
2020



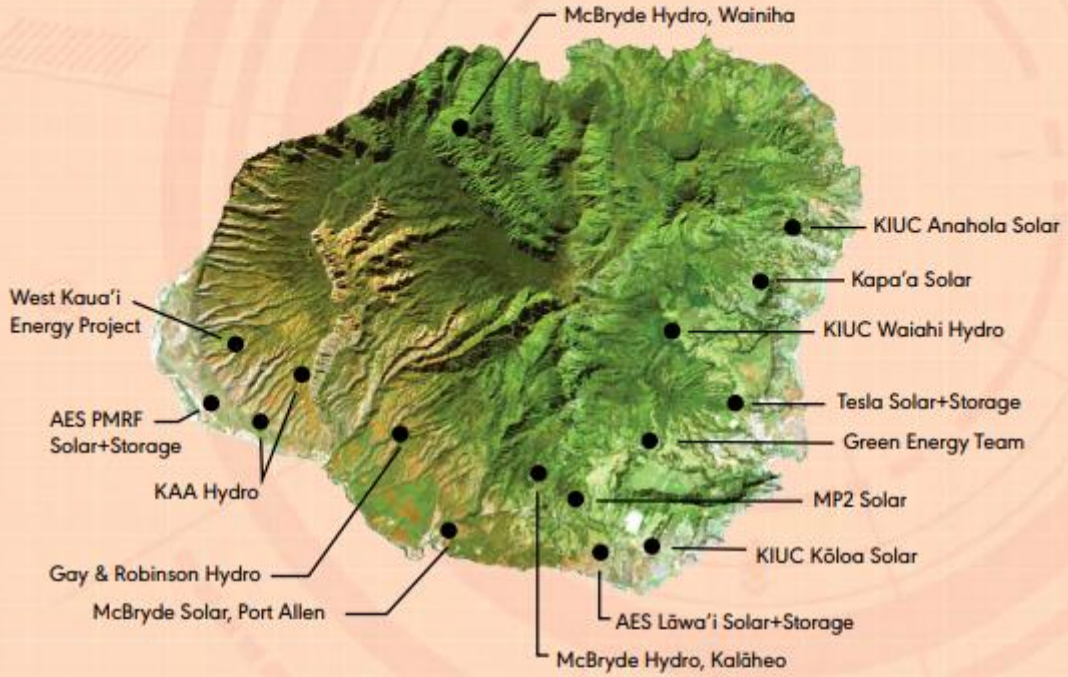
2025



Fossil Fuel Solar Biomass Hydro


Solar
BESS
Fossil Fuel
Biomass
Hydro
80
70
60
50
40
30
20
10
0
12:00:00 AM
1:00:00 AM
2:00:00 AM
3:00:00 AM
4:00:00 AM
5:00:00 AM
6:00:00 AM
7:00:00 AM
8:00:00 AM
9:00:00 AM
10:00:00 AM
11:00:00 AM
12:00:00 PM
1:00:00 PM
2:00:00 PM
3:00:00 PM
4:00:00 PM
5:00:00 PM
6:00:00 PM
7:00:00 PM
8:00:00 PM
9:00:00 PM
10:00:00 PM
11:00:00 PM
Time

KIUC Renewable Map



	Type	MW	% of Sales
Active In Use			
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/Kalaheo	Hydro	6.0	4.2
KIUC, Waiahi	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

Total Renewable Energy in Service 2022

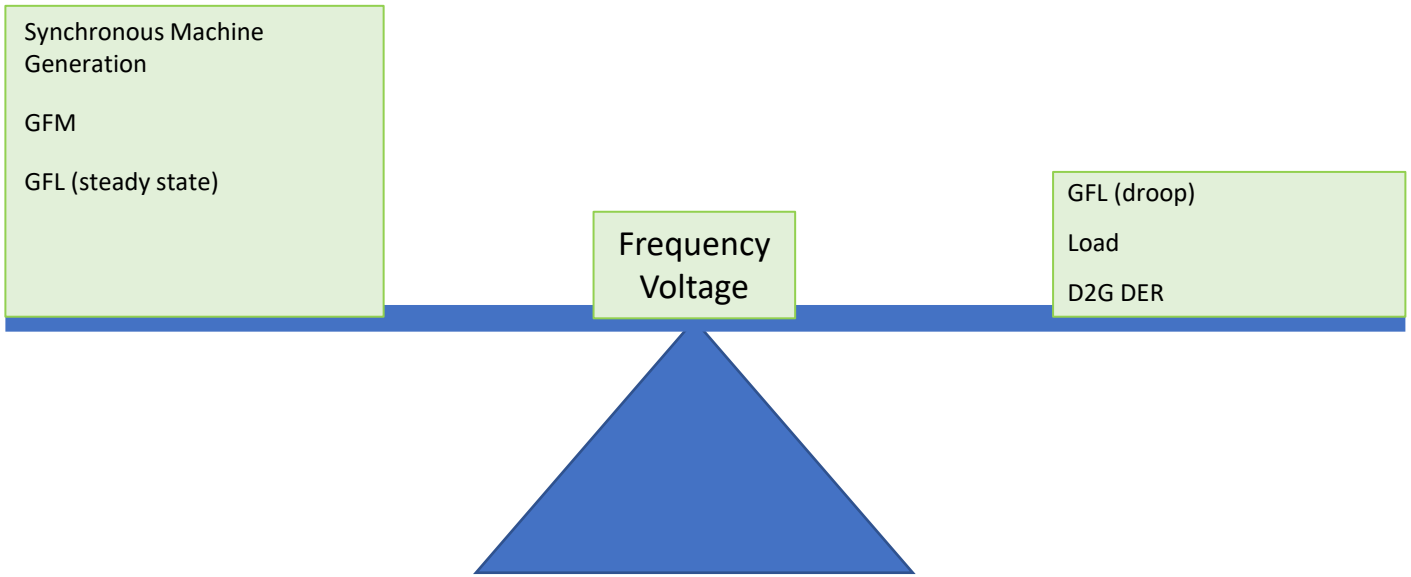
142.2 MW/67%

Potential Renewable Energy in Service 2025

166.2 MW/85%

Methods of Operation

- Steady State - Custom Island Wide Frequency Controller for dispatch
  - ~ 1 second resolution
- Transients – at most 50ms response
  - When operating in GFL, treated as negative load
  - GFM means voltage phasor (magnitude and angle) sourced from IBR
    - Implementations differ between vendors at this time



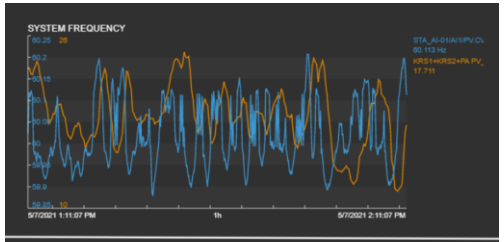
Methods of Operation - IBR's

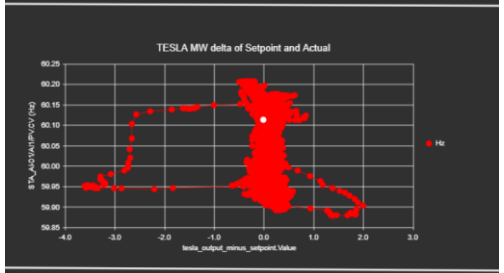
- Steady State - Custom Island Wide Frequency Controller for dispatch
  - ~ 1 second resolution
- Transients – at most 50ms response
  - When operating in GFL, treated as negative load
  - GFM means voltage phasor (magnitude and angle) sourced from IBR
    - Implementations differ between vendors at this time

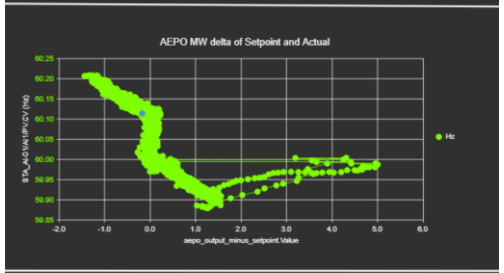
Lessons Learned

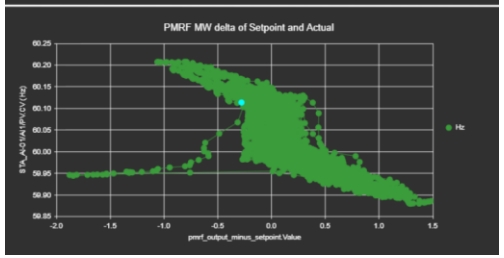
- Three Categories
  - 1) Steady State
    - when running in parallel with synchronous machines and IBR’s
  - 2) Transient periods
  - 3) Black start/microgrid

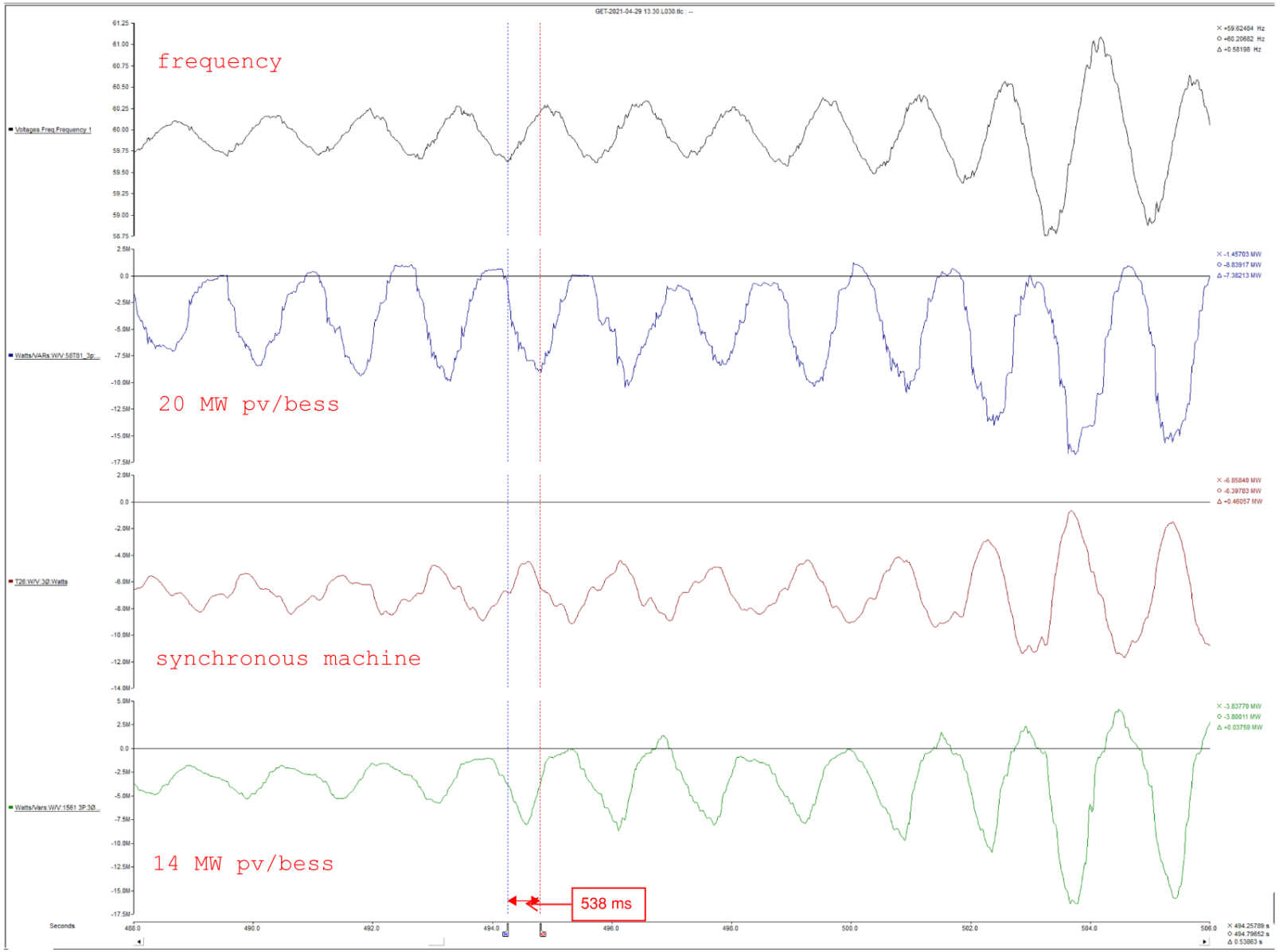
Fast Frequency Droop Response Leads to Steady State Oscillations





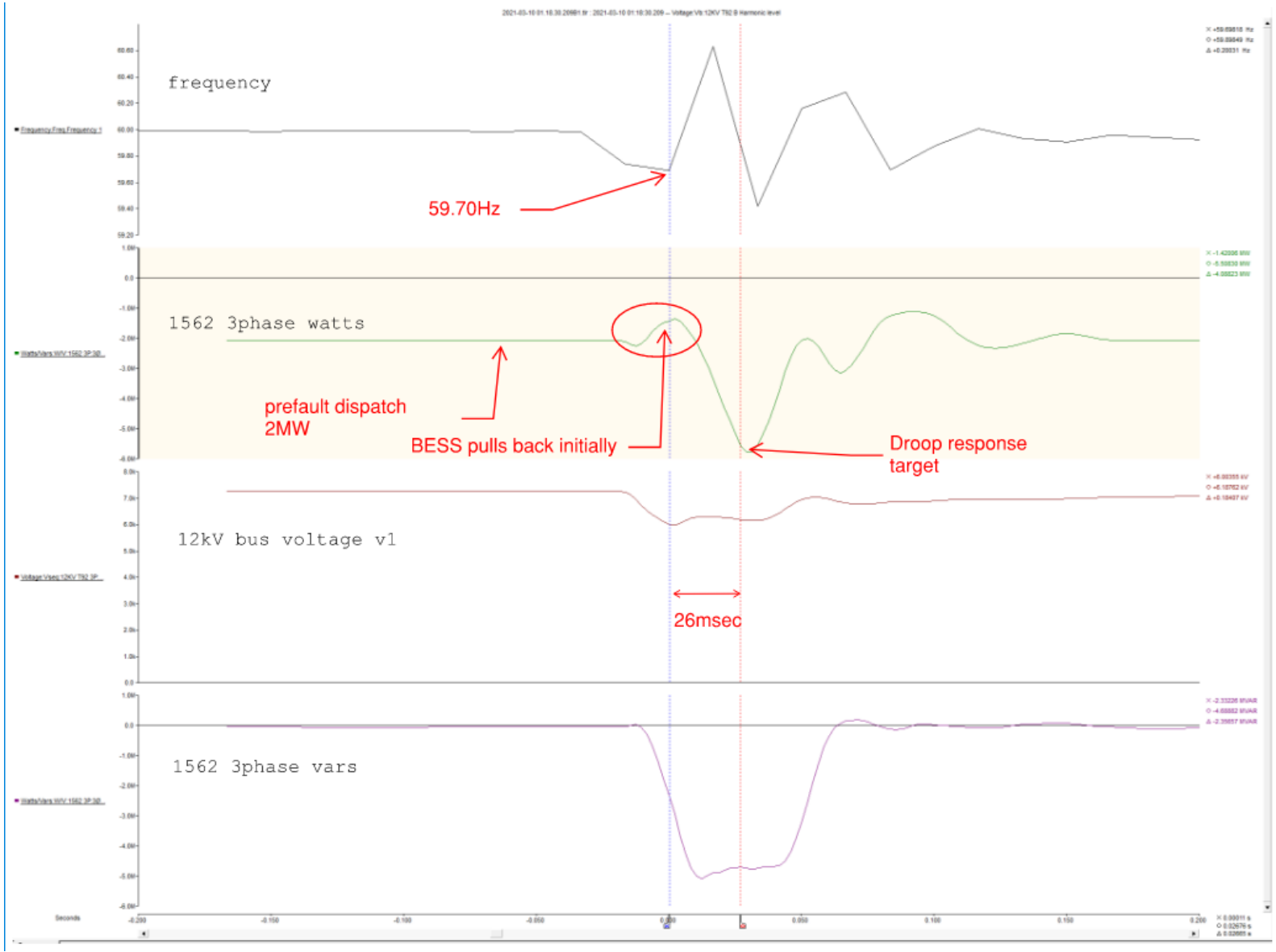





frequency
20 MW pv/bess
synchronous machine
14 MW pv/bess
538 ms
Seconds


SYSTEM FREQUENCY
df/dt (2sec calculation)
IBR% of Total Ge
TESLA MW delta of Setpoint and Actual
tesla_output_minus_setpoint.Value
Tesla Actual MW
0.027135 MW
Tesla Setpoint MW
0 %
AEPO MW delta of Setpoint and Actual
aepo_output_minus_setpoint.Value
Aepo Setpoint MW
10.438 MW
Aepo Actual MW
10.401 MW
PMRF MW delta of Setpoint and Actual
pmrf_output_minus_setpoint.Value
PMRF Actual MW
7.8076 MW
PMRF Setpoint MW
7.8816 MW

Transient Periods



Blackstart / Microgrid

Evolving Interconnection Requirements for IBR Monitoring

KIUC's Latest Large Generation Interconnection Agreement (LGIA)

- Hawaii PUC Docket 2020-0218
  - LGIA link: DocumentViewer (hawaii.gov)