



Odessa Disturbance 2: June 4th, 2022

IBRTF Meeting

July 8th, 2022

Odessa Disturbance 2: Event Summary

- Event initiated by lightning arrester fault on 345 kV level in Odessa area
- Fault occurred on June 4th at 12:59:25 PM
- Estimated loss of 2,560 MW of thermal and IRR generation
 - 1,709 MW of IRR generation loss from 14 solar facilities
 - 851 MW of thermal generation loss
- System Frequency declined to 59.700 Hz and recovered to 60 Hz in 1 min 20 sec
- 1,227 MW of RRS deployed
- 1,116 MW of Load Resources deployed
- Categorized as NERC Cat 3a event (gen loss > 2000 MW)

Real Time PMU Voltage

- Lowest recorded voltage of 0.714pu from PMU in Odessa area on 345 kV line
- Highest recorded voltage of 1.102pu from PMU in Del Rio area on 138 kV line
- Attempted reclose ~10 seconds later
- Faults cleared in ~3 cycles
- Within VRT “No Tripping” zone in NOG 2.9.1



Real Time PMU Frequency

- Most PMUs lowest freq. of 59.7 Hz after LOG
- Single PMU near Laredo had lowest freq. of 59.62 Hz
- Couple other PMUs in South dipped below 59.7 Hz
- Local transient freq. seen as low 58.83 Hz and high as 60.26 Hz in Far West
- Protection settings should not be set on transient freq.



Thermal Generation Loss

- Loss of 3 CC units within 2 different facilities
- 1st facility near Odessa where lightning arrestor fault occurred had 2 CC trains trip/reduce output
 - First CC generating ~333 MW tripped off with line to POI
 - Second CC dropped ~209 MW immediately and ran back remaining ~287 MW over next 13 minutes
 - Root cause of 2nd CC loss not clearly identified in RFI response (isolated from fault from breakers at 1st CC)
- 2nd facility near Rio Grande Valley
 - Tripped ~309 MW
 - CT tripped on loss of excitation; ST tripped due to CT trip (no steam)
 - Root cause of loss of excitation still under investigation

Solar Generation Loss

- 14 solar generation sites consisting of 19 units lost >10 MW
 - Total estimated generation loss of 1,709 MW vs. 1,112 MW in Odessa event 2021
 - Does not include generation that came back within 1 sec of fault clearing
- 9 of the 14 sites lost generation in Odessa event May 2021
 - 8 of the 9 sites were identified in NERC Odessa Disturbance report (10 total facilities identified in report)
 - Remaining 5 either in commissioning, offline, or rode through

Solar Generation Loss

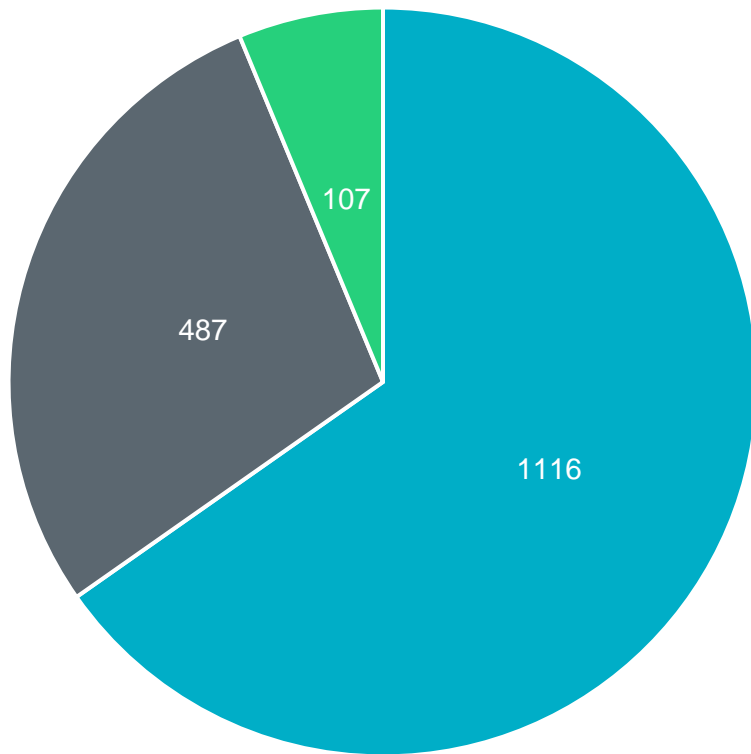
Facility	Inverter OEM	MW Loss 2021	MW Loss 2022	Recovery time 2022	Recovery MW 2022
Plant A	OEM3	28	N/A	N/A	N/A
Plant B	OEM1	150	133	8 min	Full
Plant C/D	OEM1	64	56	5 min	Full
Plant E*	OEM1	21	295	1 min	65%
Plant F	OEM3	48	47	6 min	90%
Plant G/H	OEM1	239	N/A	N/A	N/A
Plant I/J	OEM1	205	196	13 min	Full
Plant K/L	OEM2	153	131	2 min	Full
Plant M	OEM2	147	147	1 min	Full
Plant N/O	OEM3	23	50	30 min	Full
Plant P	OEM1	N/A	259	2 min	90%
Plant Q	OEM2	N/A	94	8 min	30%
Plant R	OEM1	N/A	176	6 min	74%
Plant S	OEM2	N/A	104	Offline till Next Day	0%
Plant T	OEM2	N/A	12	5 min	Full
Plant U	OEM3	9	10	5 min	Full

*Plant E has additional unit from 2021



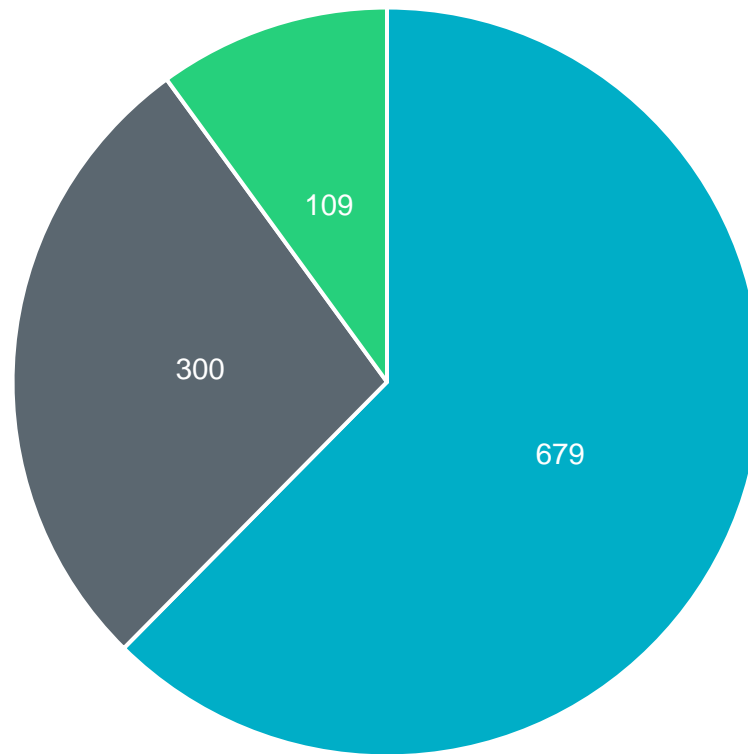
MW Loss per Inverter Type

2022



■ OEM1 ■ OEM2 ■ OEM3

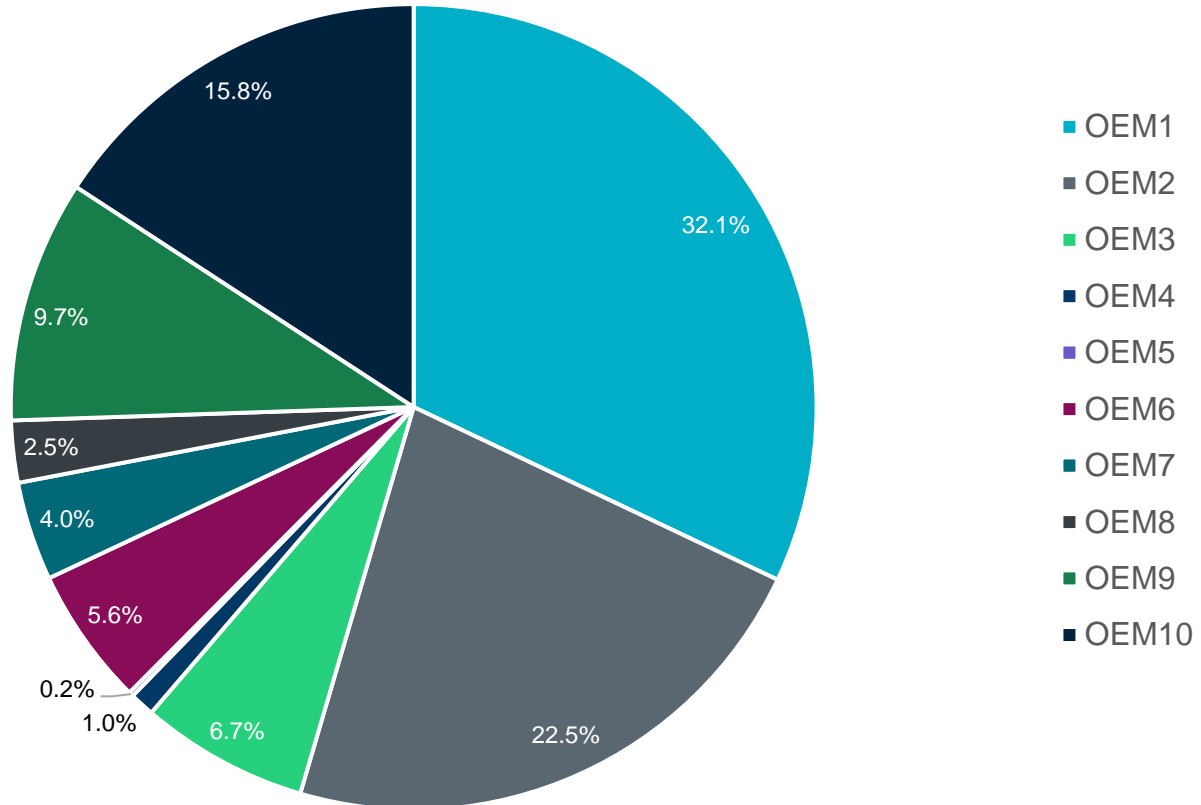
2021



■ OEM1 ■ OEM2 ■ OEM3

Total OEM Capacity

% Solar Capacity

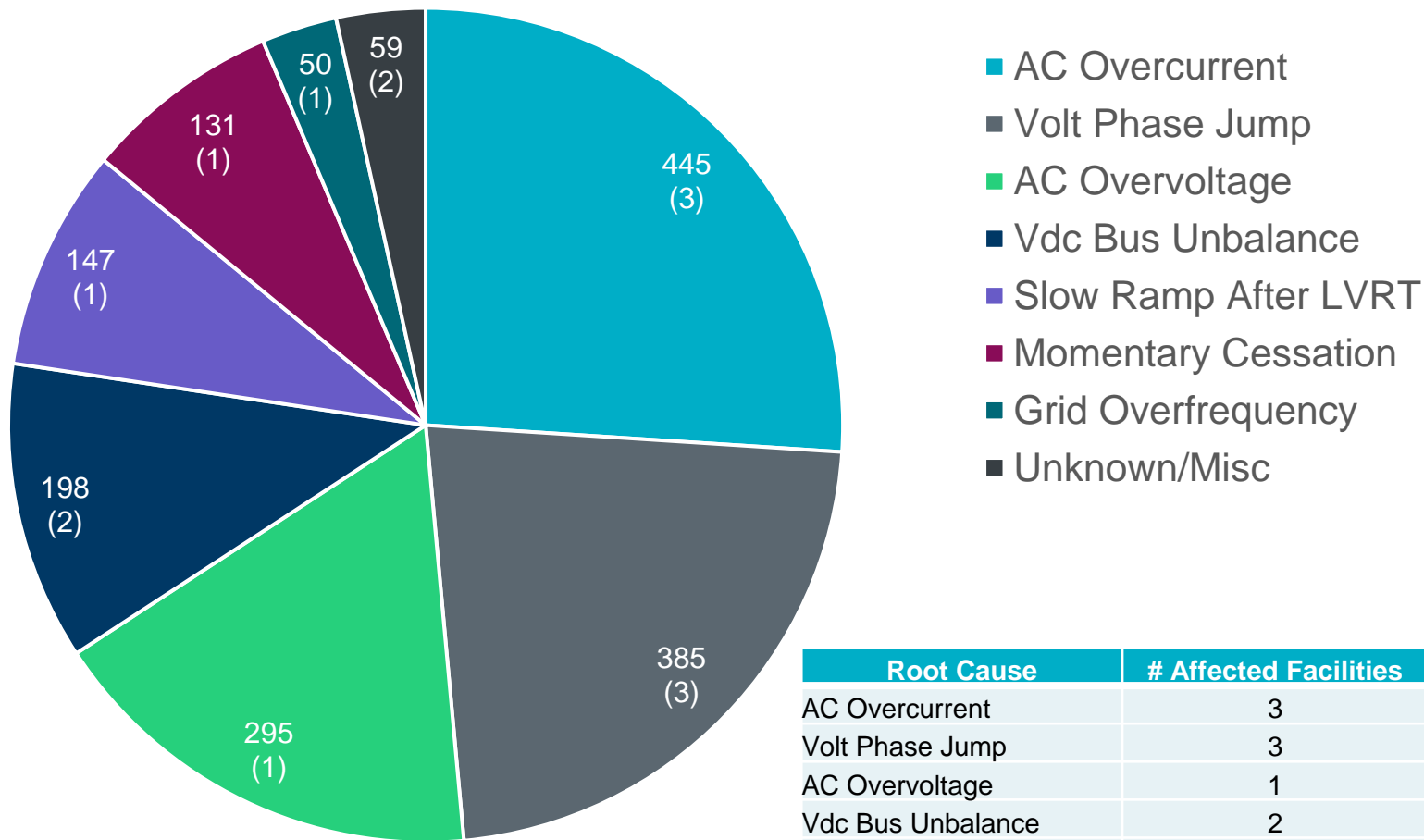


PMU/High Resolution Relay Data Availability

- Only 7 of the 14 plants provided the required PMU data
- Most provided some high-resolution relay data, but time consuming going through to determine what is usable (correct time and both voltage/current components for power calculations)
- Received large data dumps with dozens of files without timestamps or file descriptions
- ERCOT able to retrieve PMU data for 5 of the 7 plants that did not provide data from TO of plant POI
- ERCOT will follow up with all entities that did not provide PMU to provide new sample data for verification
- Entities are out of compliance with NOG 6.1.3
- ERCOT to begin working on improving requirements

Root Causes for Solar Generation Loss 2022

MW Loss by Root Cause



Root Cause	# Affected Facilities	MW Loss
AC Overcurrent	3	445
Volt Phase Jump	3	385
AC Overvoltage	1	295
Vdc Bus Unbalance	2	198
Slow Ramp After LVRT	1	147
Momentary Cessation	1	131
Grid Overfrequency	1	50
Unknown/Misc	2	59

AC Overcurrent Protection

- 3 total plants with combined loss of 445 MW
- 2 plants (Plants P & R) with OEM1 inverters (435 MW loss)
 - Most/All inverters tripped on following fault codes
 - Minor Fault Instant AC Overcurrent Low - 140% rated current with automatic restart
 - Major Fault Instant AC Overcurrent High - 150% of rated current with manual restart
 - Neither plant identified root cause of overcurrent in RFI response nor any corrective actions for overcurrent
- 1 plant (Plant U) with OEM3 inverters (10 MW loss)
 - Insulated-Gate Bipolar Transistor Overcurrent protection
 - No correlation identified to grid frequency/voltage disturbance
 - Only 7 out of 79 inverters tripped
 - Plant still working with OEM to investigate further

Volt Phase Jump Protection

- 3 plants (Plants B, C/D, I/J) with combined loss of 385 MW
- All 3 plants have OEM1 inverters
- Plants had all inverters trip on Fault Code 221: Volt Phase Jump – occurs when expected phase angle deviates > 15 degrees
- Plant B stated they are working with OEM to determine if settings can be modified or if necessary for inverter protection
- Plants C/D and I/J claimed protections worked as designed and identified no corrective actions nor ongoing investigation

AC Overvoltage

- Plant E with OEM1 inverters and 295 MW loss
- All inverters tripped on Instant AC Overvoltage in which inverter trip occurs in 1-3 ms when voltage exceeds 1.25pu
- Inverter terminal voltage reached 1.3pu during event, but high side of MPT only reached 1.056pu per PMU data provided by RE
- 2 feeder breakers also opened during event due to underfrequency, resulting in longer return to pre-disturbance output
- Plant in process of adjusting feeder relay settings to ride-through frequency event
- No corrective actions identified to correct overvoltage tripping

Vdc Bus Unbalance

- 2 plants (Plants Q & S) with OEM2 inverters and combined 198 MW loss
- Fault Code for Vdc Unbalance occurs when DC-side positive and negative bus voltage difference > 200 V for 1 ms
- Plants and OEM claim protection operated correctly and required for equipment protection
- Software update currently in field validation to improve DC regulation response time and ride-through capabilities
- Can be implemented in August if successful
- Plant Q also had 10 inverters trip to unknown reason and still investigating with OEM

Slow Ramp After LVRT

- Plant M with OEM2 inverters and 147 MW loss
- Provides 100% reactive current during LVRT and does not recover quickly (~10 sec) upon fault clearing
- Issue identified during Odessa 2021 event analysis
- Plant in process of adjusting settings to:
 - Change LVRT/HVRT mode to provide consistent active power as well as required reactive power
 - Change LVRT/HVRT mode settings from 0.9pu to 0.5pu for LVRT and from 1.1pu to 1.2pu for HVRT
 - Change fast overvoltage protection trip settings to 1.35pu with 0.5 sec delay
- Work scheduled to be completed in July 2022
- Follow up on issues with slow return (possibly PPC interaction) and active power oscillations

Momentary Cessation

- Plant K/L with OEM2 inverters and 131 MW loss
- Legacy inverters with momentary cessation (active and reactive current to zero during LVRT) that cannot be disabled
- ERCOT aware of MC of plant from 2021 Odessa Event – required plant to return as quickly as possible (should be < 1 sec)
- New PPC installed since 2021 event – still not recovering quickly (took 1.5 min to recover in 2022 event)
- RFI response states plant continues to investigate potential PPC updates to improve performance

Grid Over-frequency

- Plant N/O with OEM3 inverters and 50 MW loss
- All inverters tripped on Grid Over-frequency Fault Code
- Plant acknowledged that conditions for over-frequency trip of 60.6 Hz for 600 sec were not met
- Investigations ongoing with OEM
- OEM to verify if parameter settings are installed and operating correctly

Unknown / Miscellaneous

- Plant F with OEM3 inverters and 47 MW loss
 - 25/26 inverters went into standby mode and restart after 6 minute timeout
 - Inverter fault codes overwritten so root cause unknown
 - Inverters tripped during 2021 event for grid under-frequency
 - Protection settings for under-frequency have been updated since the June 4th, 2022 event
 - Unclear if settings update will improve performance
 - Plant needs to improve logging capabilities and install high-resolution recording devices
- Plant T with OEM2 inverters and 12 MW loss
 - 3 inverters reduce active power due to high internal temperature
 - 2 inverters trip due to AC overcurrent protection
 - Plant reduced to 0 MW output during LVRT and recovered to 95% pre-disturbance output within 1 sec
 - Similar response to 2021 event
 - Working with OEM to investigate real power drop of all inverters and root causes for inverter trips

Next Steps

- NERC Brief Report to be submitted to TRE on Monday, 7/11
- Begin scheduling follow up discussions with all resource entities beginning August to discuss investigation results / corrective action plans
- Review unit responses for rest of solar farms that submitted data to estimate losses during LVRT
- ERCOT will require sample PMU data to be submitted from all entities that did not provide data
- Run studies to determine reliability concerns of large losses during LVRT

Questions?