TEXAS RE

NERC IBR Reports and Activities

ERCOT Technical Advisory Committee
NOGRR245 Meeting
May 10, 2024

Texas Reliability Entity, Inc.
Mark Henry, David Penney, and Joseph Younger

Time Horizons for Electric Grid Operation

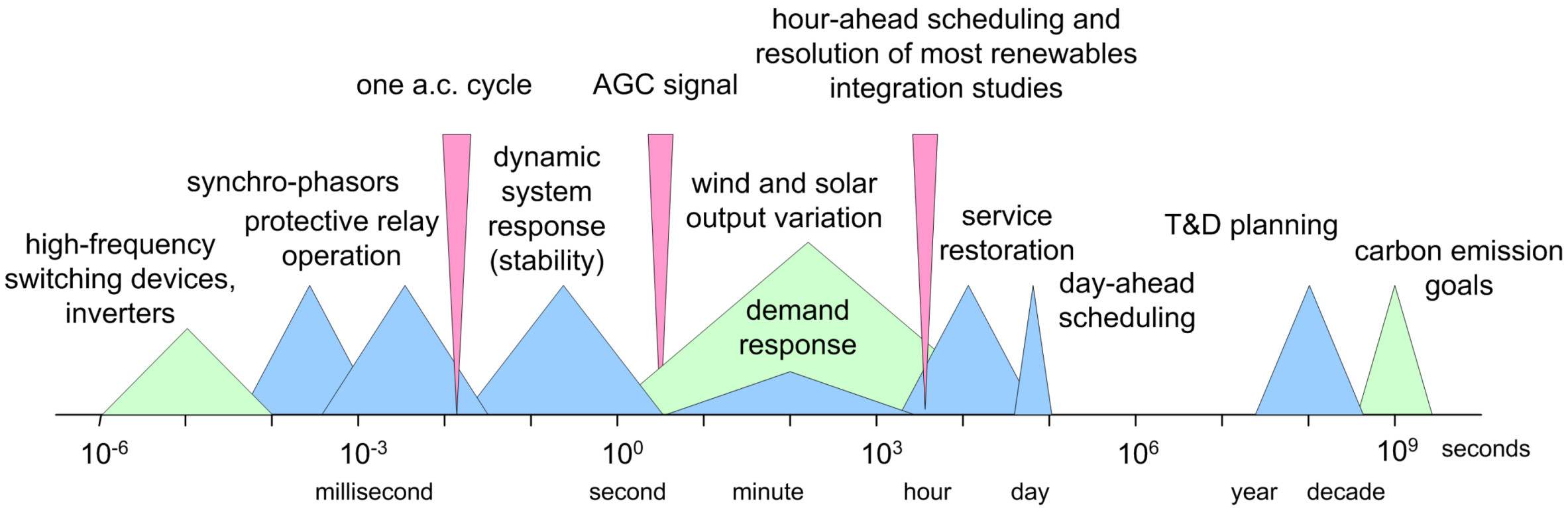
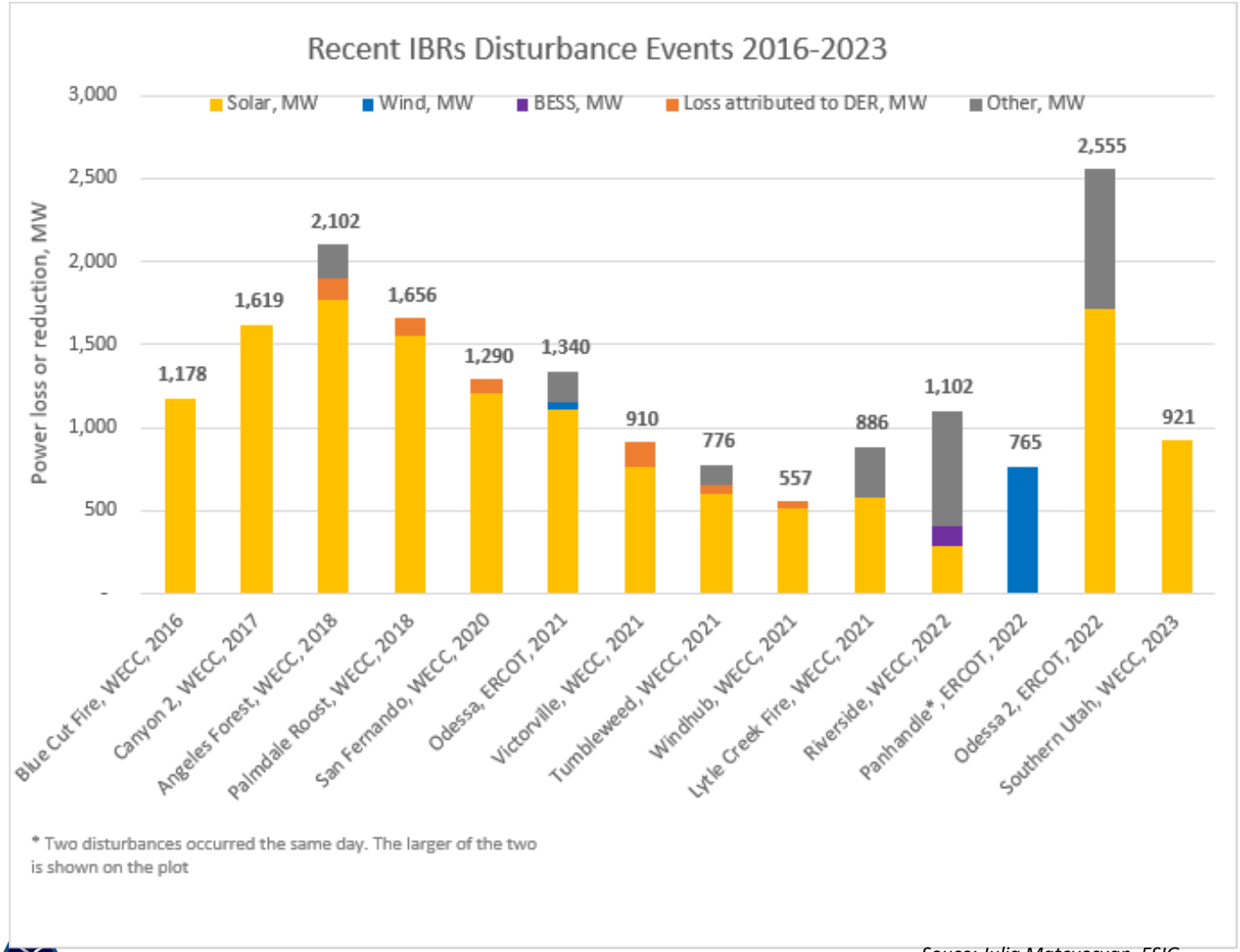


Figure 1. Time scales in electric grid operation.

Source: Integration of Renewable Generation in California, Dr.Alexandra von Meier, CIEE, 2011

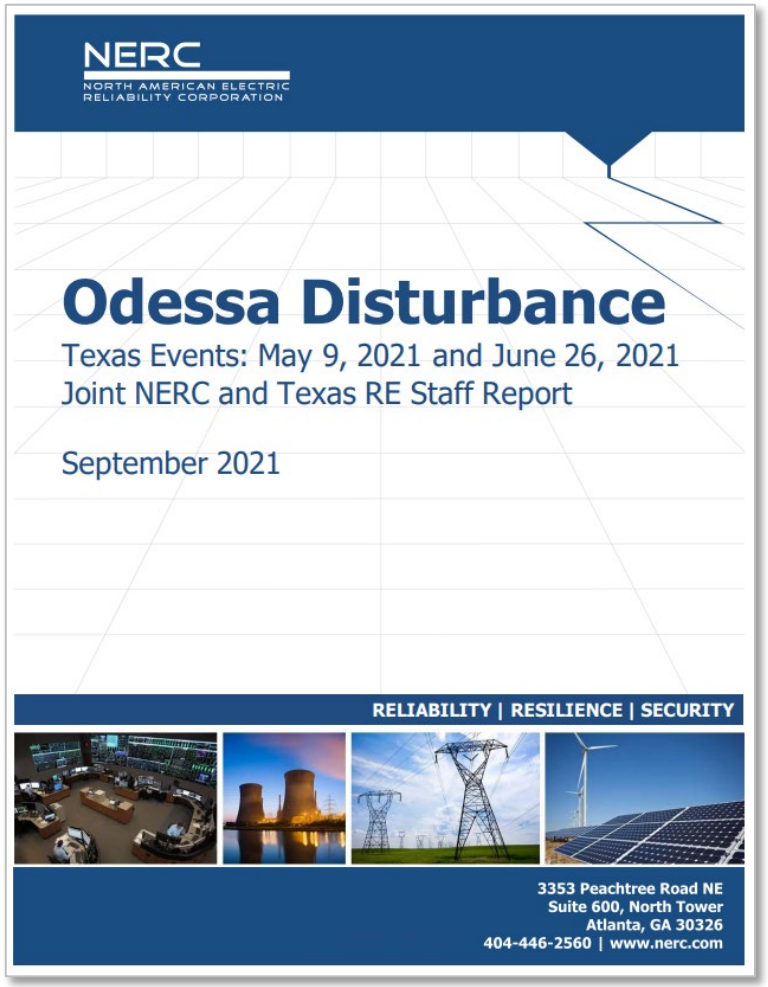
NERC Disturbance Reports

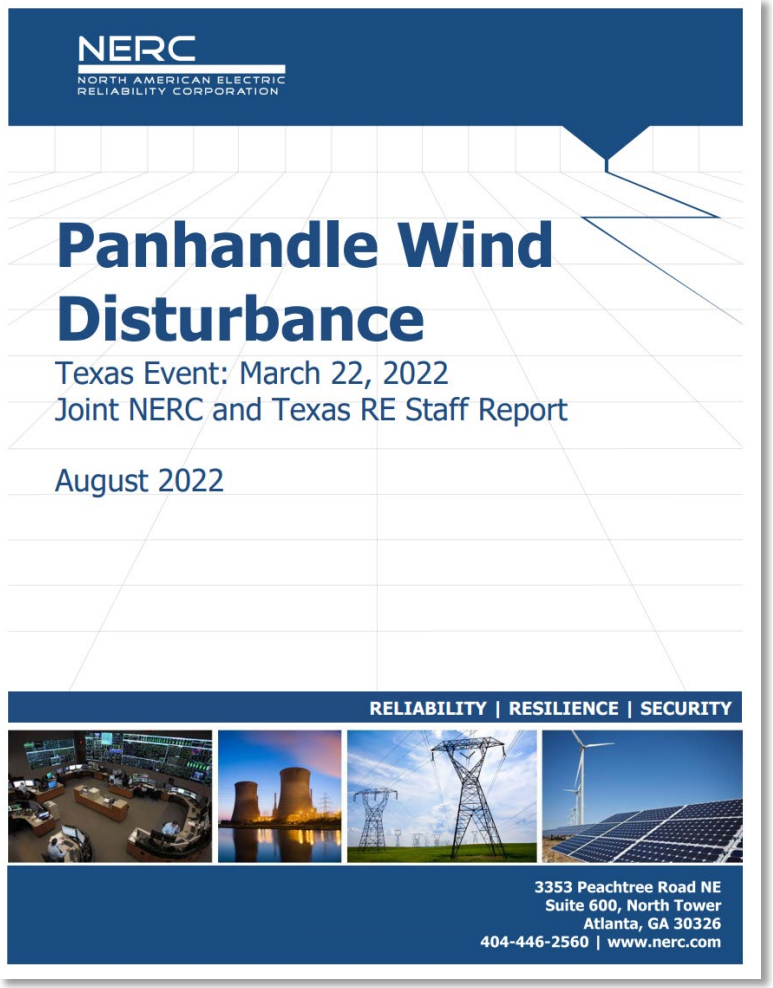


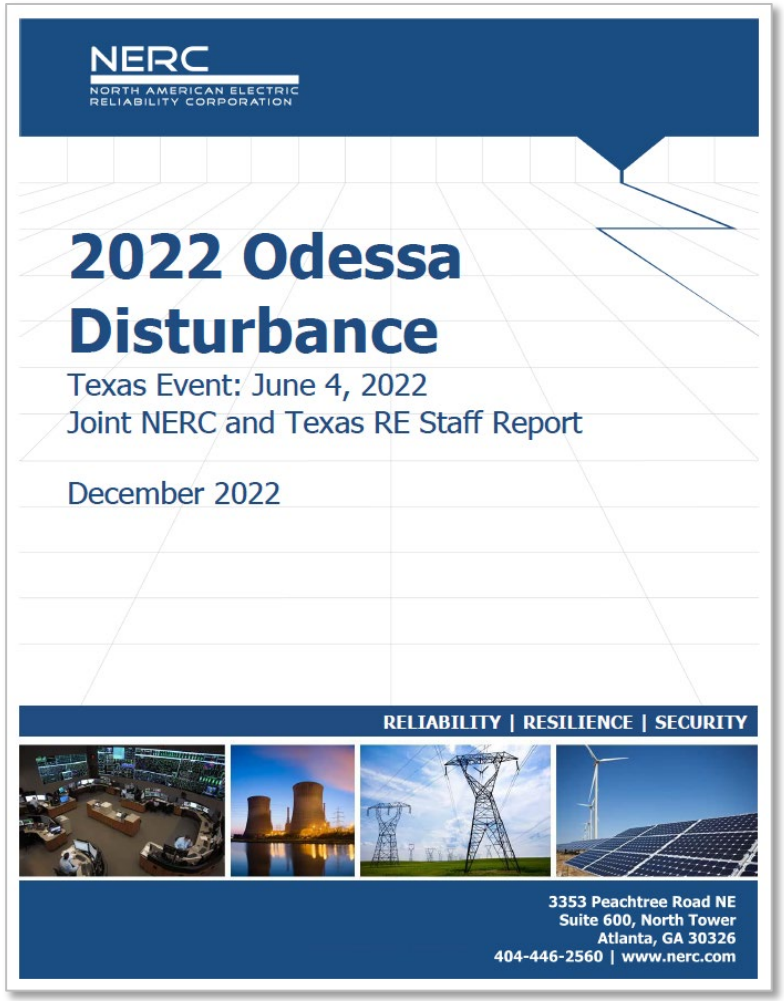
Souce: Julia Matevosyan, ESIG

- NERC established a 500 MW reporting threshold during this period for basic event analysis
- WECC indicates a second event in Southern Utah under review
- CAISO indicates two other events under review
- Other smaller disturbances involving IBR did not lead to NERC event analyses or NERC reports

NERC Disturbance Reports in ERCOT







Overview of Event: Odessa 2 - June 4, 2022

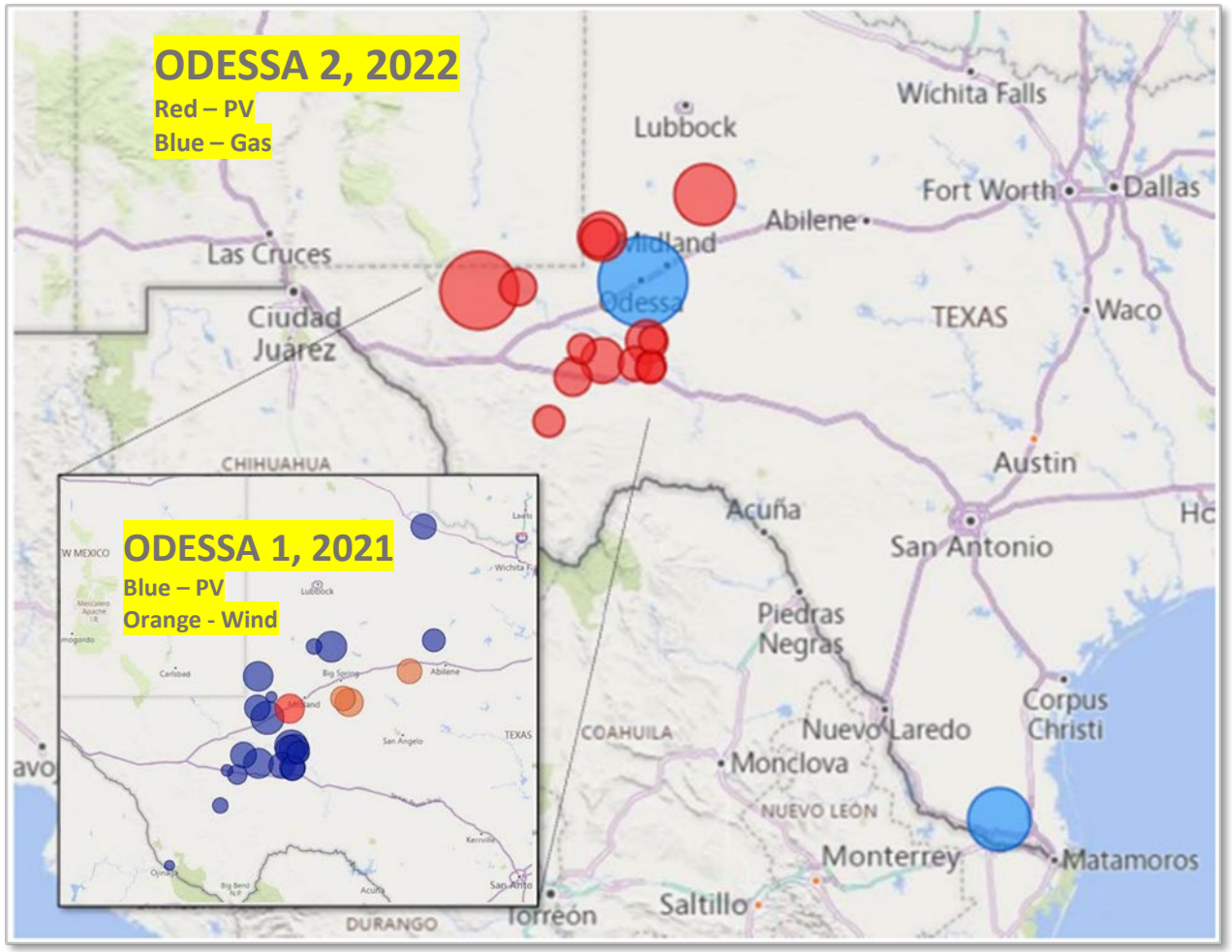
345 kV single-line-to-ground fault at 12:59 PM CT, cleared normally in 3 cycles

2,555 MW generation loss (Category 3a event)

- 844 MW loss of synchronous generation
- 1,711 MW loss of BPS solar PV generation

Solar at Time of Event: 8,740 MW

- 8,660 MW installed capacity
- 3,010 MW in commissioning



Odessa 2 Causes of Solar PV Reduction

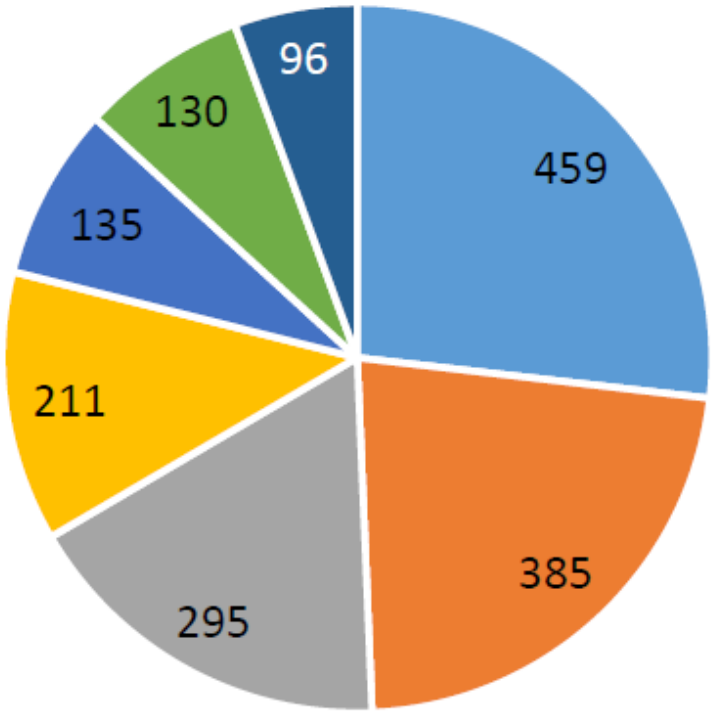


Table 1.1: Causes of Solar PV Active Power Reductions

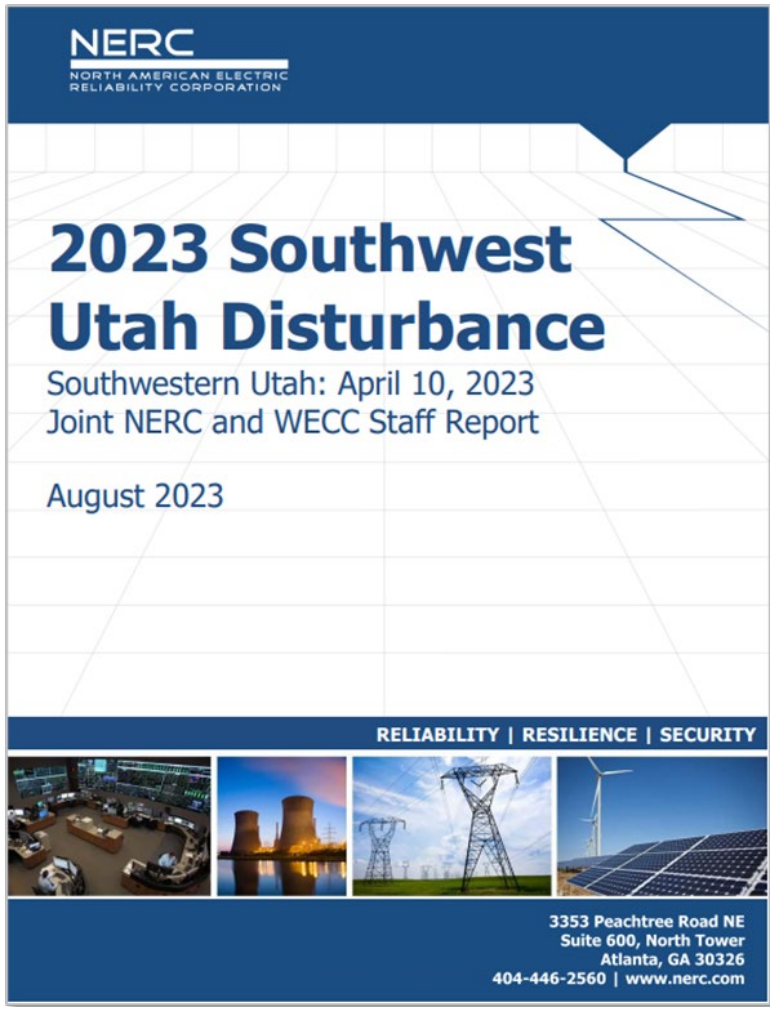
Cause of Reduction	Odessa 2021 Reduction [MW]	Odessa 2022 Reduction [MW]	
Inverter Instantaneous AC Overcurrent	–	459	✗
Passive Anti-Islanding (Phase Jump)	–	385	✗
Inverter Instantaneous AC Overvoltage	269	295	
Inverter DC Bus Voltage Unbalance	–	211	✗
Feeder Underfrequency	21	148*	
Unknown/Misc.	51	96	
Incorrect Ride-Through Configuration	–	135	✗
Plant Controller Interactions	–	146	✗
Momentary Cessation	153	130**	
Inverter Overfrequency	–	–	
PLL Loss of Synchronism	389	–	✓
Feeder AC Overvoltage	147	–	✓
Inverter Underfrequency	48	–	✓
Not Analyzed	34	–	

* In addition to inverter-level tripping (not included in total tripping calculation.)
** Power supply failure

Odessa 2 Event Recommendations

- **Reiteration of need for Reliability Standards enhancements to address performance and modeling/studies gaps**
- **NERC Alerts for additional data on IBR performance and model quality**
- **Industry-wide enhancement of model quality and validation, adoption of NERC reliability guidelines and improvement of (FERC) interconnection process**
- **ERCOT specific:**
  - Improve interconnection process to close model quality gaps and commissioning discrepancies
  - Adopt reliability guidelines and other resources' (ie, IEEE 2800-2022) content
  - Follow-up with affected facility owners
  - Conduct detailed model quality review and validation

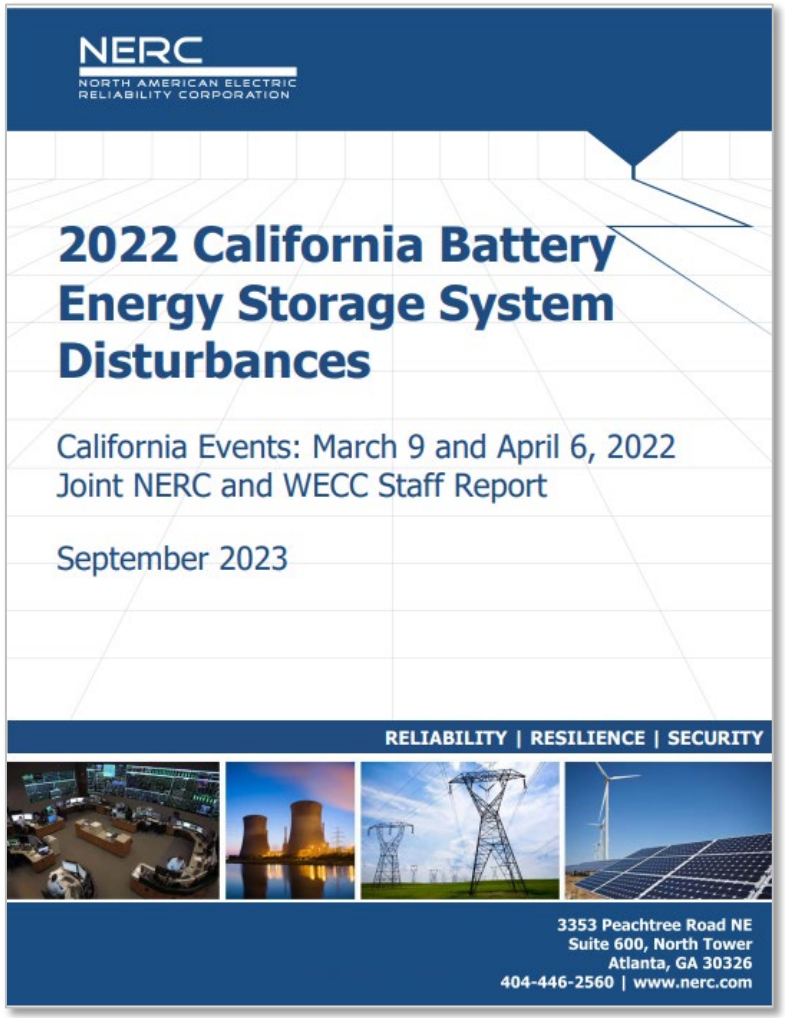
Recent Disturbance Reports Outside ERCOT



Observations:

- Systemic inverter performance issues with legacy and recent facilities
- Inadequate modeling, studies, and commissioning
  - Ride-through assessments lacking
- Bad or missing event data hindering review

Latent risks that threaten Bulk Power System (BPS) reliability



NERC IBR Performance Alert Summary

NERC Level 2 Alert - March 14, 2023

- Issued in response to multiple disturbance events
- Registered Bulk Electric System (BES)-connected solar resources (>75 MVA, connected at >100kV)
- Did not include wind or storage facilities
- Gathered data to understand need for additional actions to mitigate possible BPS performance risks
- Data collection included specific settings for inverter and plant level controls

Third Level 2 NERC Alert on IBR performance since 2017

NERC-wide data collection included responses from:

- 521 generation facilities
- Over 53,500 MW (10,703 MW ERCOT Solar)
- 15 different OEMs

NERC Alert Frequency/Voltage Settings vs Inverter Capability (ERCOT-specific)

Is the setting based on the maximum capability of the inverter?

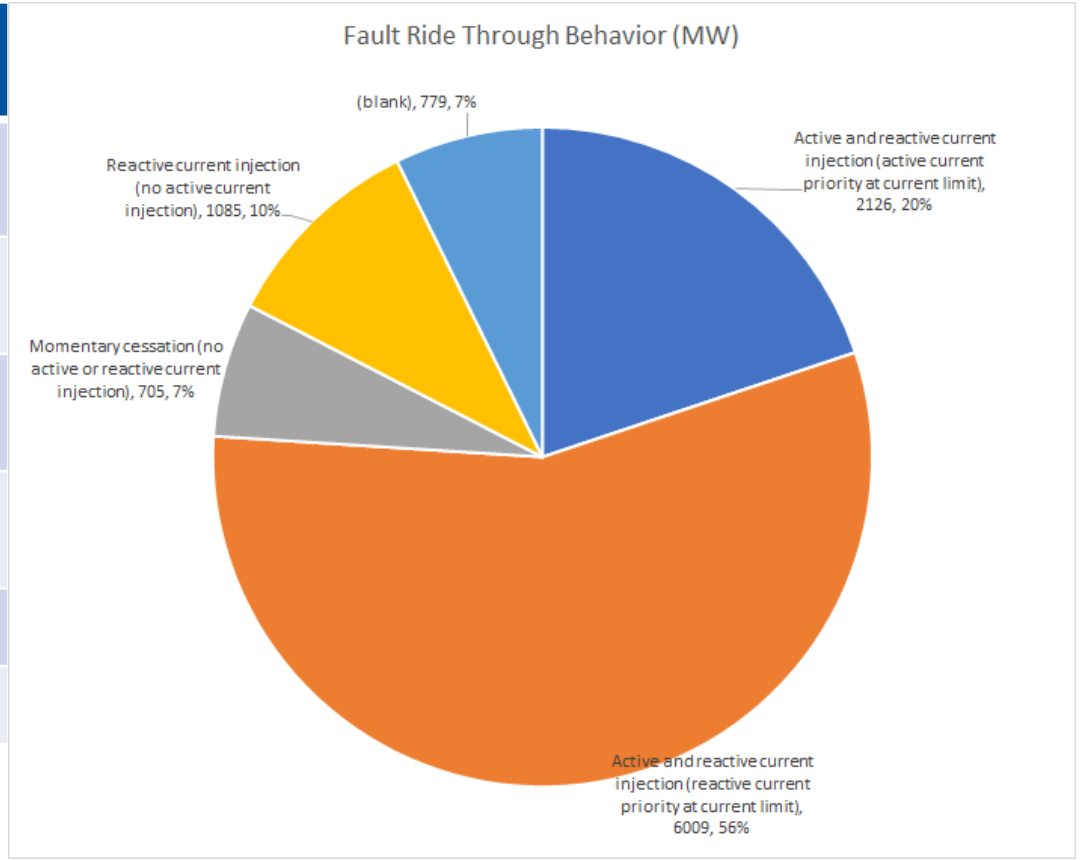
	HVRT			LVRT			HFRT			LFRT		
Manufacturer	Yes	No	Pct % Yes	Yes	No	Pct	Yes	No	Pct	Yes	No	Pct
General Electric	8	0	100%	8	2	80%	2	0	100%	3	0	100%
KACO	11	7	61%	9	13	41%	6	11	35%	4	11	27%
Other	0	8	0%	0	8	0%	0	6	0%	0	8	0%
Power Electronics	6	40	13%	6	44	12%	1	34	3%	1	34	3%
Schneider Electric	0	5	0%	0	5	0%	0	2	0%	0	4	0%
SMA	0	8	0%	0	4	0%	0	4	0%	0	4	0%
Sungrow	1	29	3%	0	22	0%	1	18	5%	1	20	5%
TMEIC	26	40	39%	40	27	60%	22	33	40%	18	30	38%
Total	**52**	**137**	**28%**	**63**	**125**	**34%**	**32**	**108**	**23%**	**27**	**111**	**20%**

Key Takeaways:

- **Frequency and voltage ride-through settings should reflect maximum inverter equipment capability.**
- **PRC-024 curves are intended for the point of interconnection and not at the inverter terminals.**
- **Use of instantaneous unfiltered measurements prone to inadvertent tripping**

IBR Fault Ride-Through Behavior (ERCOT-specific)

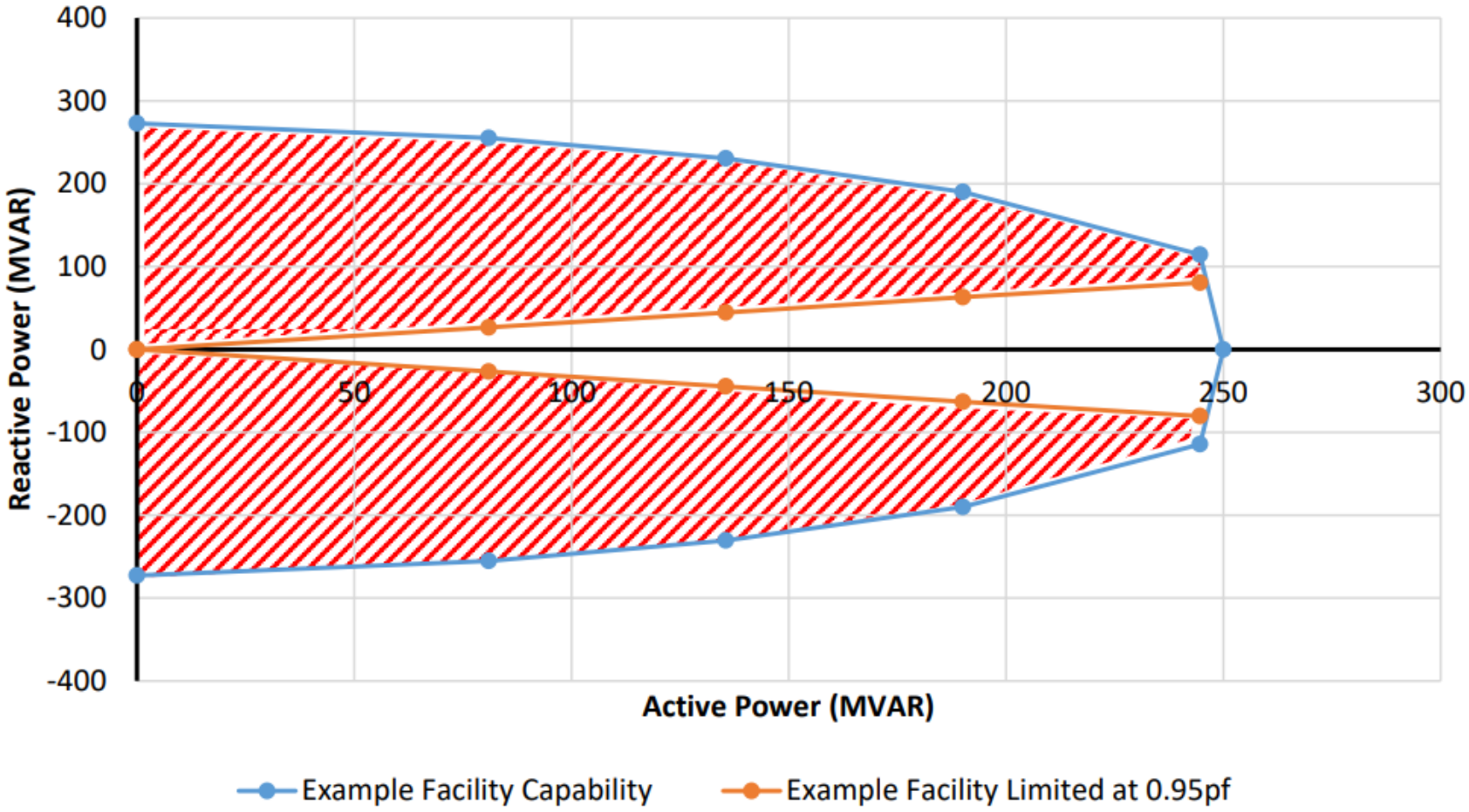
Fault ride-through behavior enabled at the facility	# Facilities	Nameplate MW Sum
Active and reactive current injection (active current priority at current limit)	9	2,126
Active and reactive current injection (reactive current priority at current limit)	32	6,009
Momentary cessation (no active or reactive current injection)	5	705
Reactive current injection (no active current injection)	5	1,085
No response	4	779
Grand Total	55	10,703



Key Takeaways:

- **Momentary cessation is undesired (two plants affected during 2022 Odessa event).**
- **Reducing active power to provide reactive also goes against the recent FERC order.**
- **Reactive current priority at current limit is the desired response for low voltage conditions.**

NERC IBR Alert Key Findings (NERC-wide)



Key Takeaways

- ~35% of resources have the "triangle" shaped capability curve, potentially leaving significant reactive power capability unused
- Reactive capability artificially limited by plant controller settings
- Steady-state and dynamic reactive capability should be at least 0.95 power factor at maximum power output

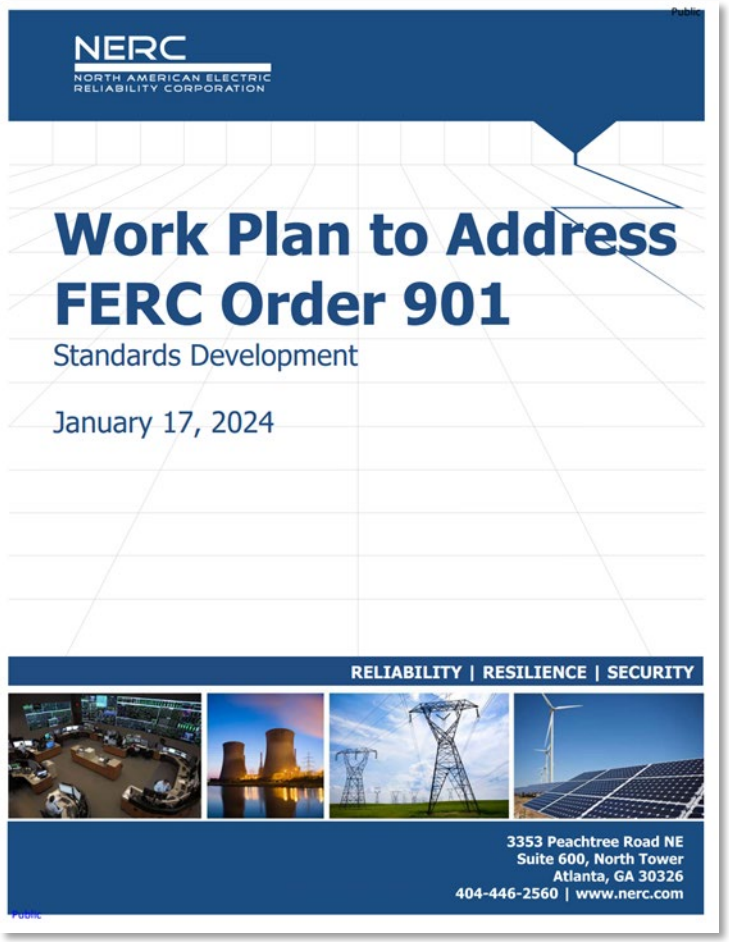
FERC Order 901

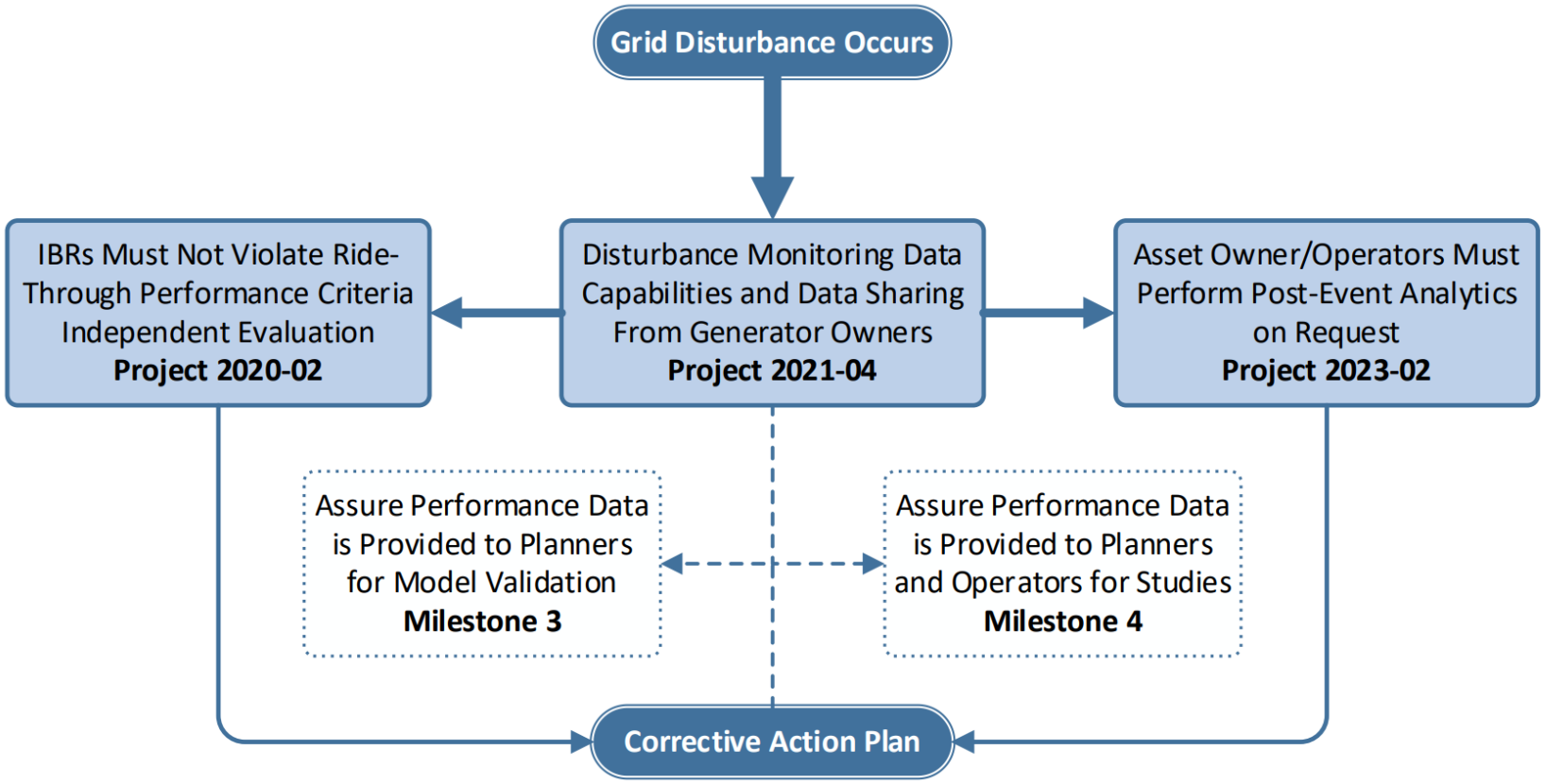
Issued October 19, 2023

Directed NERC to submit a detailed standards development plan to address IBR reliability gaps in four areas

- Data sharing
- Model validation
- Planning and operational studies
- Performance requirements

FERC Order 901 Follow-up






Questions?
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TEXAS RE
Ensuring electric reliability for Texans