
Performance Indicators and Texas RE 2018 Assessment of Reliability Performance

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Objectives

Review Performance Indicators

Outline Observations

- **North American Electric Reliability Corporation (NERC) State of Reliability report**

Overview Activities and Emerging Issues

Data Sources

- **Transmission Availability Data Systems (TADS)**
- **Generation Availability Data Systems (GADS)**
- **Misoperation Information Data Analysis System (MIDAS)**
- **Electric Reliability Council of Texas (ERCOT) PI System**
- **ERCOT Market Information System (MIS) historical data**

Focus Areas

Resource Adequacy and Performance

System Resilience

Changing Resource Mix

Human Performance

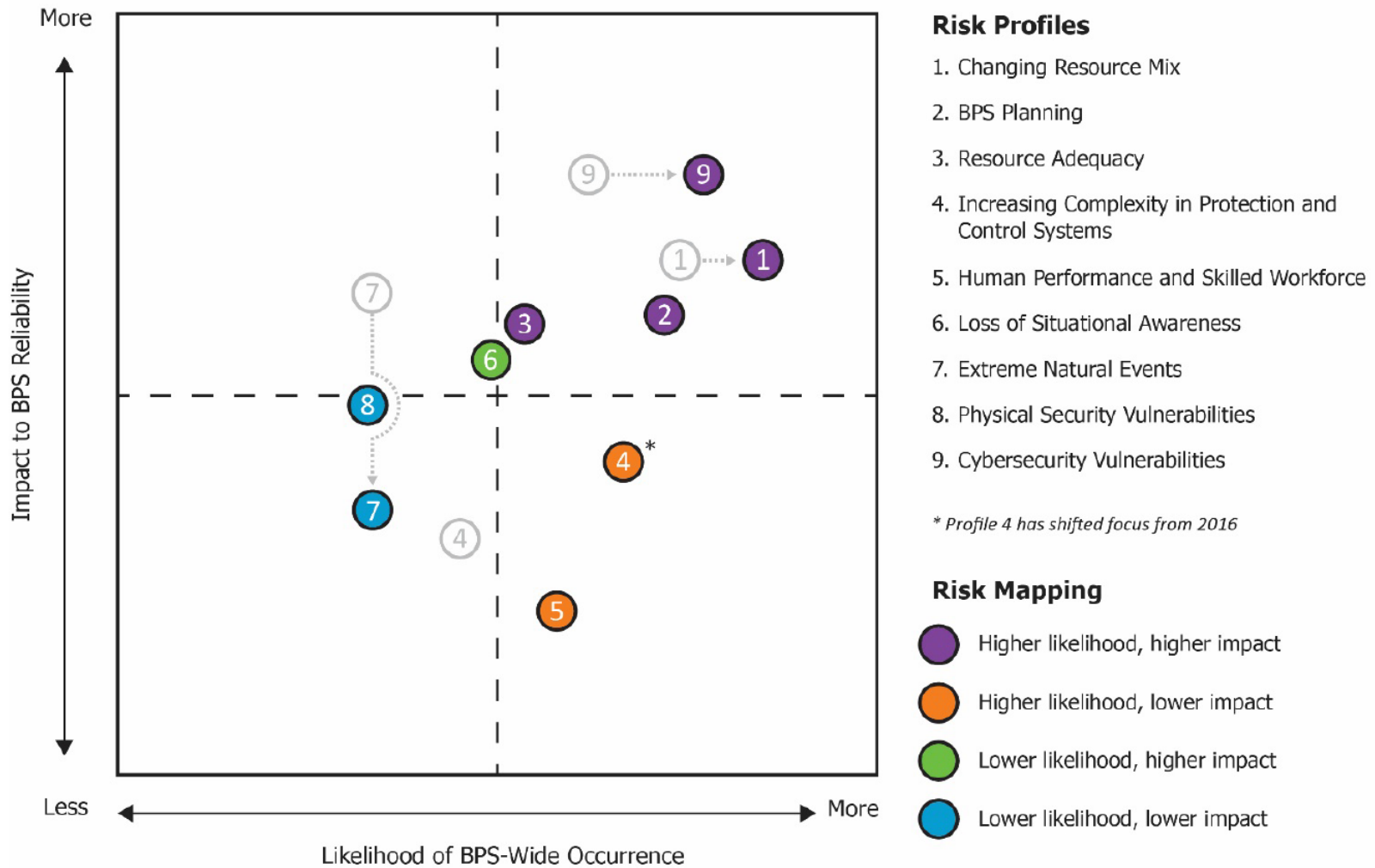
Bulk Power System Planning

Loss of Situational Awareness

Protection and Control Systems

Physical and Cyber Security

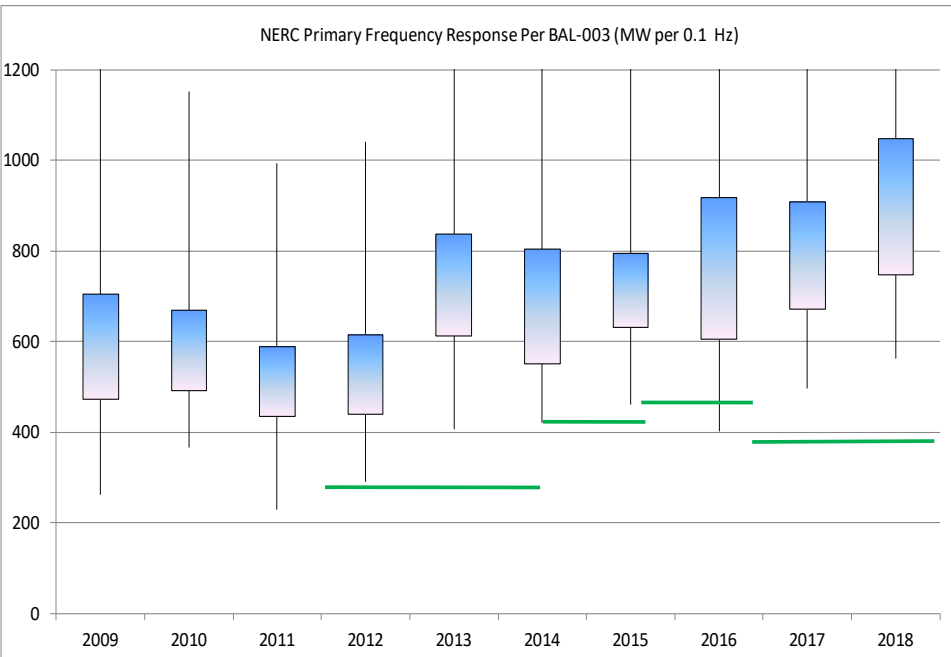
NERC's Inherent Risk Mapping 2018-19



Key Performance Trends for 2014 through 2018

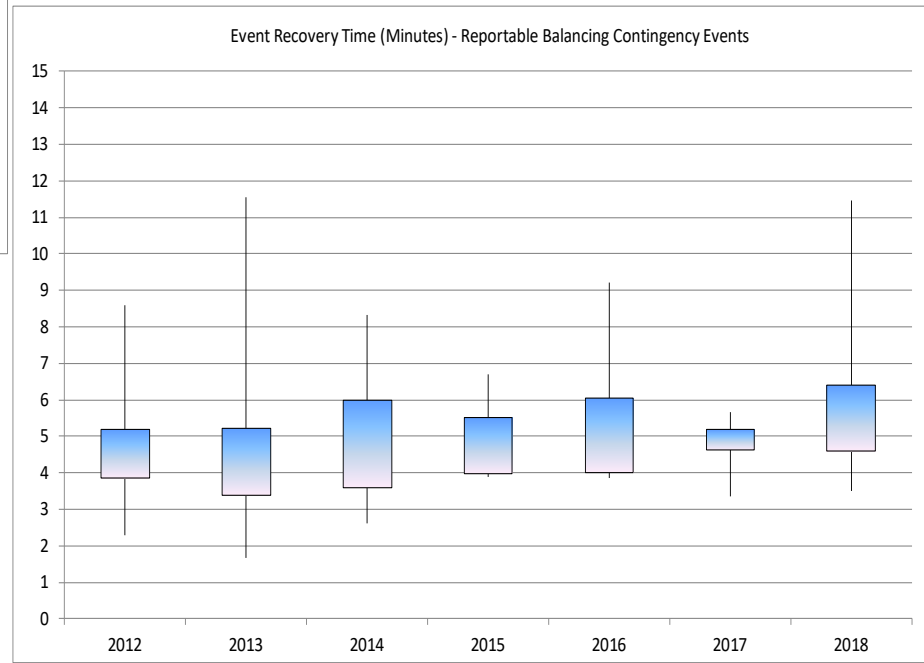
Key Performance Indicator	Negative Trend *	Stable Trend *	Positive Trend *
Resource Adequacy	Planning reserve margin Natural gas curtailments	Sufficient operating reserves maintained during summer and winter peaks	
Transmission Performance		Outage rates per circuit & per 100 miles 0 IROL exceedances	
Resource Performance	Inverter generation low voltage ride-through	EFOR rates No Balancing Contingency event failures	Primary frequency response
System Inertia	Negative inertia trend during minimum load hours	Stable trend during other hours	
Misoperation Rate	Increased rate in 2018	5-year overall stable trend	
Human Performance		Stable trend in generation HP errors	Improving trend in transmission and misoperation HP errors
Situational Awareness	7 Loss of EMS events in 2018	State Estimator convergence rate	

Resource Adequacy

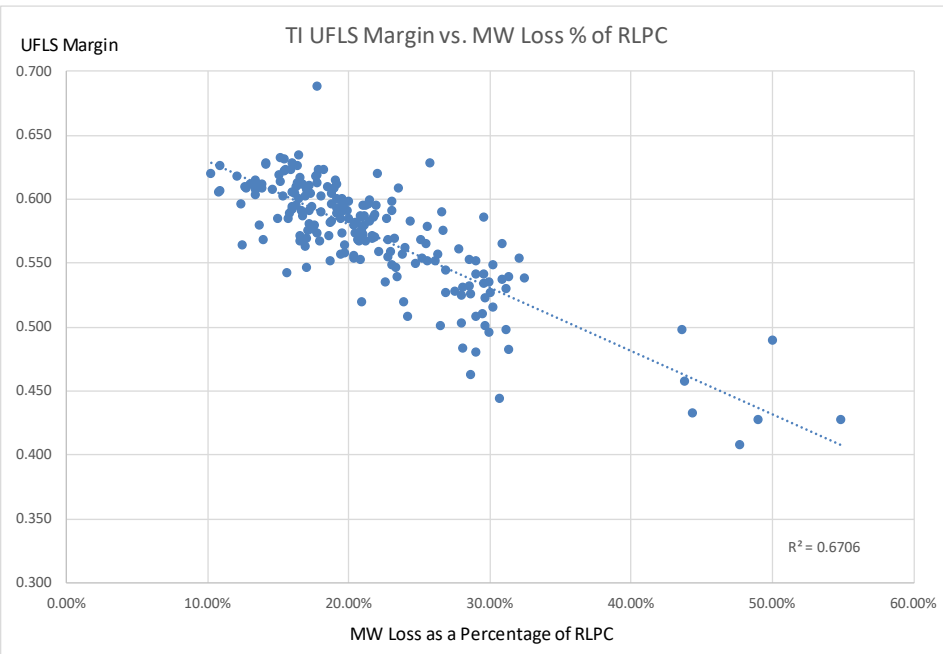


← Primary frequency response metrics continue to be maintained at high levels.

Average recovery time from generation loss events was 6.2 minutes in 2018 versus 5.4 minutes for calendar year 2017. The average event recovery time is showing a long-term gradual increase since 2012, but is still well within NERC requirements.

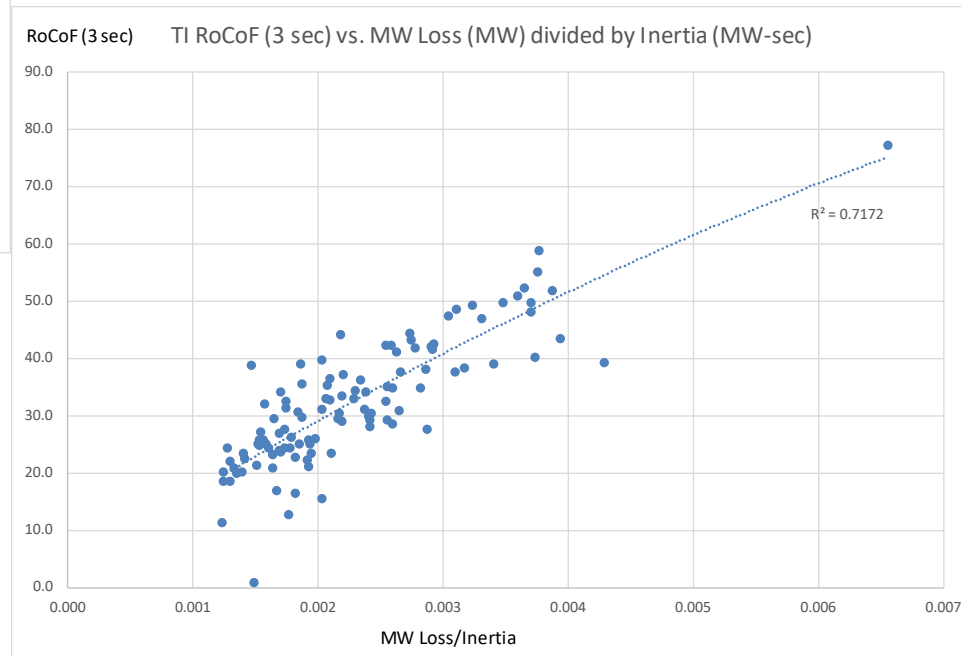


Resource Adequacy



- The impact of a generator loss is becoming more predictable based on system conditions.

- The relationships between inertia, rate-of-change of frequency, and the MW loss during frequency events are well understood.

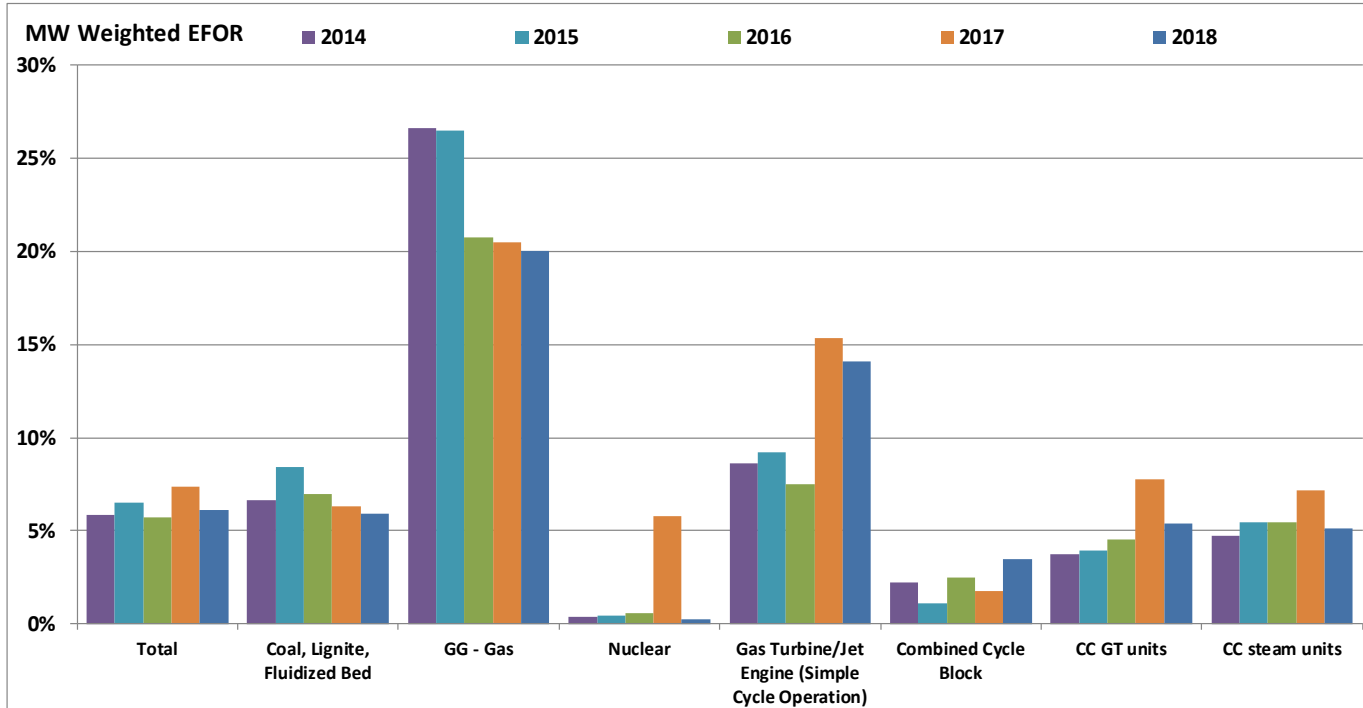


Resource Adequacy

Fossil Performance Metrics

In 2018, 2,026 immediate forced outage events, totaling 120,037 hours, were reported in GADS.

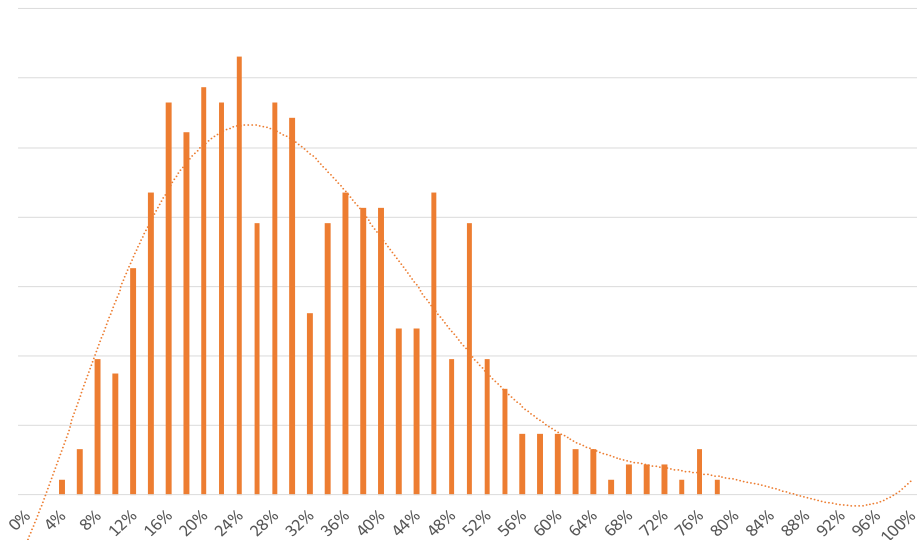
The majority of the immediate forced outage events were due to boiler control or other control system issues, blade path temperature spreads, fuel piping, human error, and vibration issues.



2018 Fossil Unit Forced Outages Major System	Number of Forced Outage Events	Total Duration (hours)	Total Capacity (MW)	Median Duration per Event (hours)	Median Capacity per Event (MW)	Average Duration per Event (hours)	Average Capacity per Event (MW)
Boiler System	199	9,941.8	72,873.2	8.8	300.0	49.9	366.2
Balance of Plant	399	12,481.1	84,564.3	4.9	170.0	31.3	211.9
Steam Turbine/Generator	1,091	35,929.3	178,597.3	3.6	157.5	32.9	163.7
Heat Recovery Steam Generator	92	5,647.6	18,962.9	21.8	185.0	61.4	206.1
Pollution Control Equipment	31	938.0	4,431.0	5.3	57.0	30.3	142.9
External	114	54,371.7	18,432.9	15.3	102.7	476.9	161.7
Regulatory, Safety, Environmental	14	182.8	1,471.6	13.9	85.0	13.1	105.1
Personnel/Procedure Errors	78	376.6	19,627.7	2.3	182.0	4.8	251.6
Other	8	168.0	247.0	1.8	46.8	21.0	30.9

Resource Adequacy

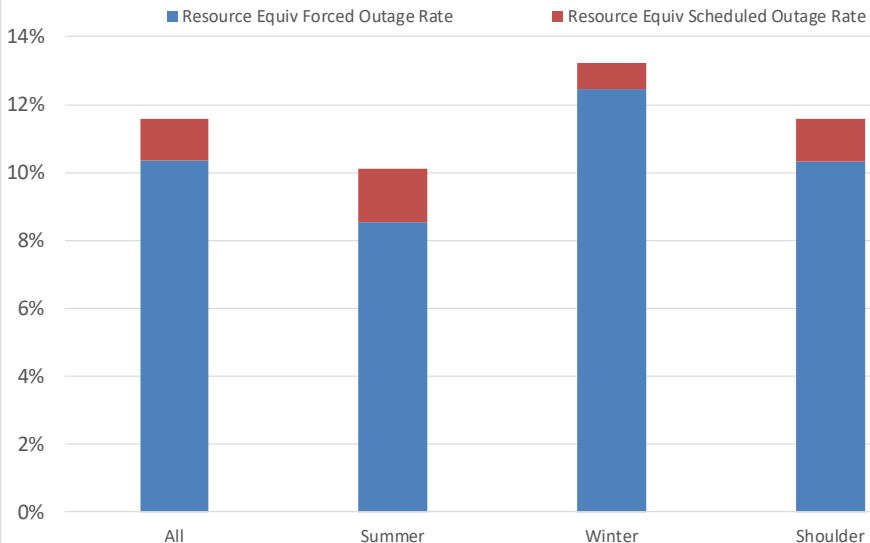
Wind Capacity Factor, Jun-Aug 2018, HE1500-1900



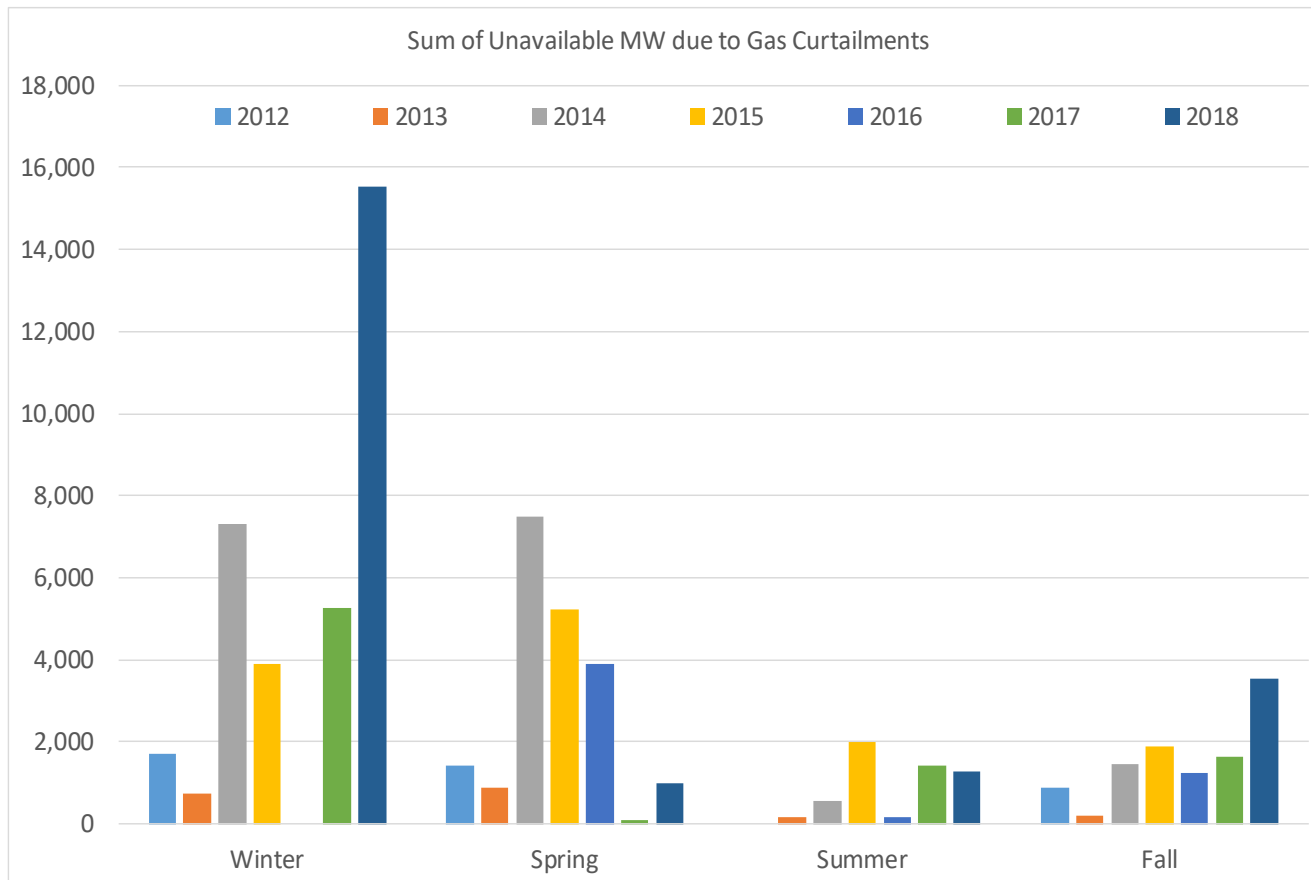
- WindGADS provides similar metrics to GADS (EFOR, EAF, NCF, etc.)
- In 2019, mandatory reporting begins for wind units > 100 MW

- 2018 was the first full year of mandatory reporting for wind generators > 200 MW in WindGADS
- In 2018, 81 ERCOT wind facilities submitted a total of 795 unit-months of data

Wind Generation

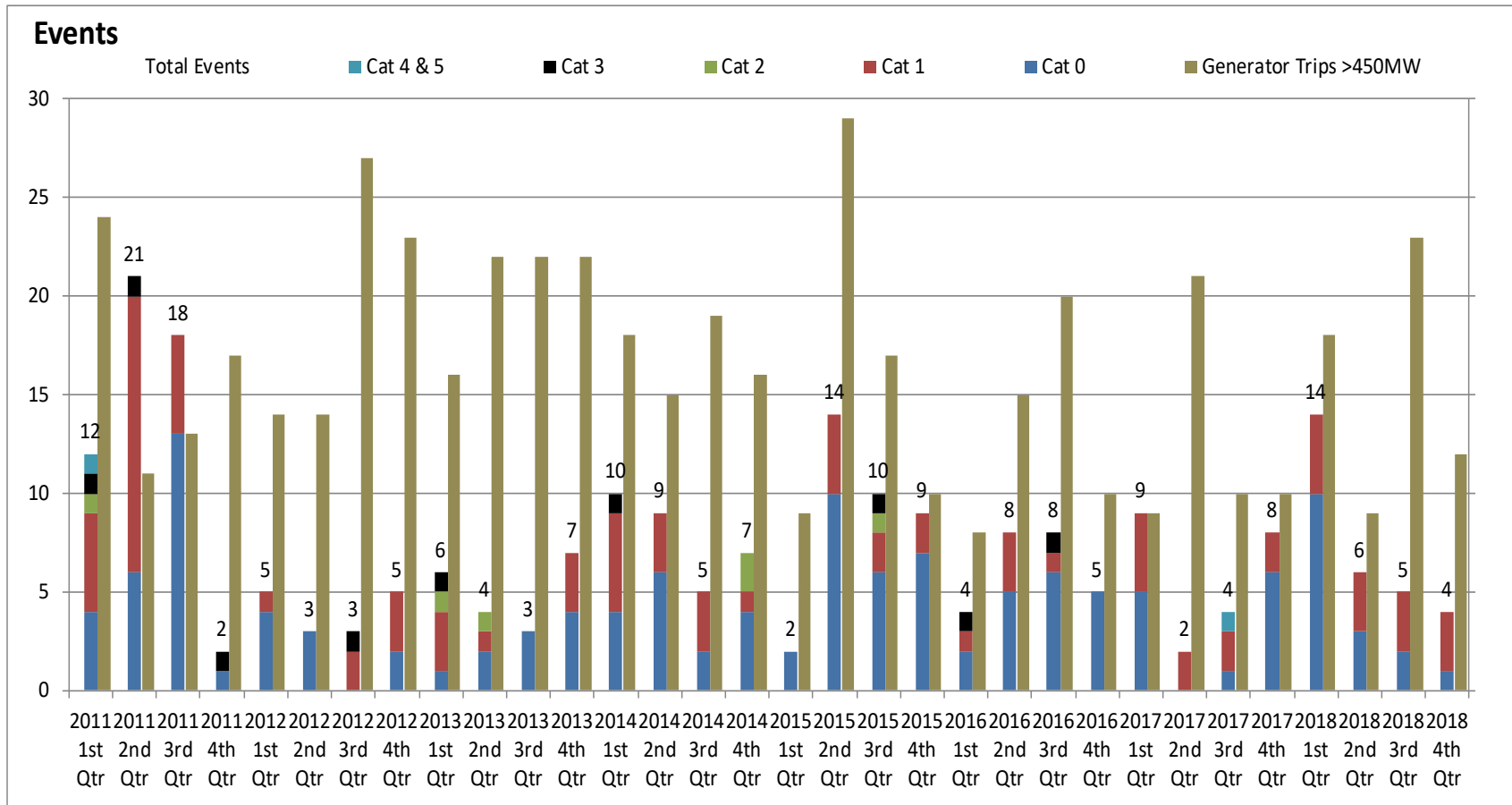


Resource Adequacy



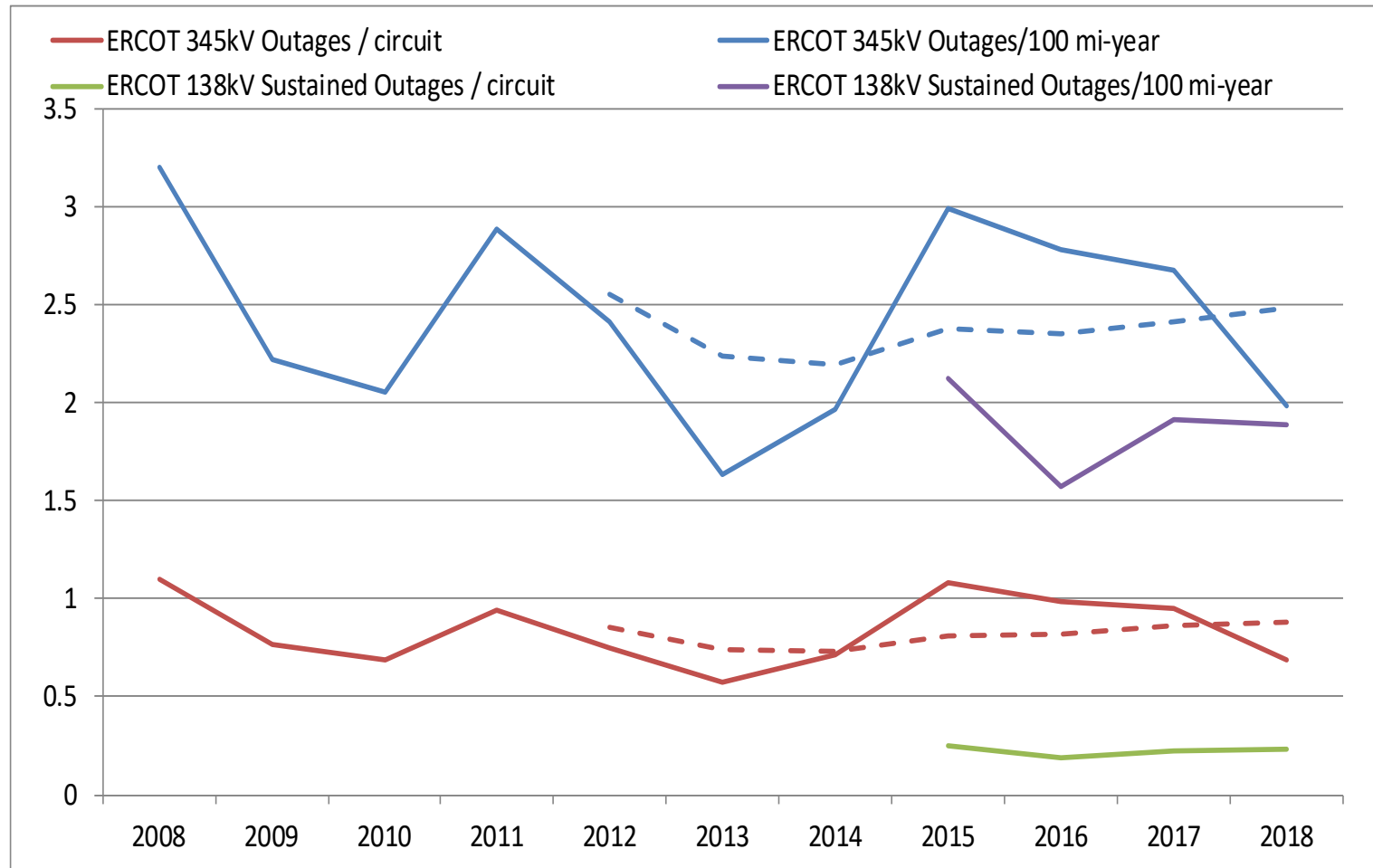
- Significant increase in the unavailable generation capacity due to natural gas fuel curtailments in 2018.
- Most curtailments occurred in January 2018 during two extreme cold events that month.

System Resilience



- There were no Category 2 or higher events in 2018.
- During one system event, the voltage collapsed in a local area following a transmission line fault, resulting in the loss of fourteen 138 kV and 69 kV lines and 140 MW of load.

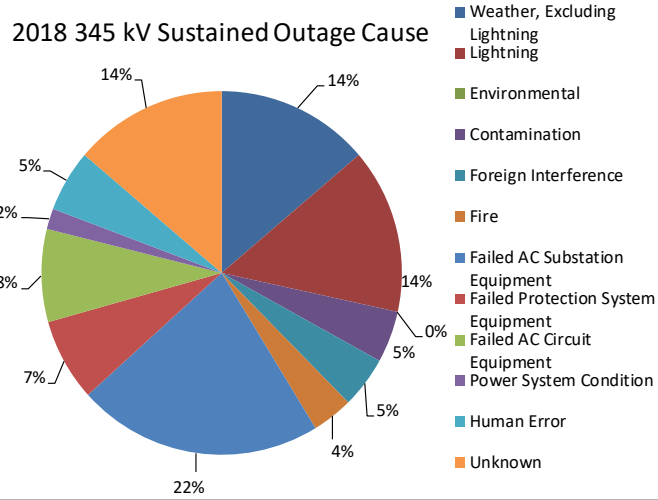
System Resilience



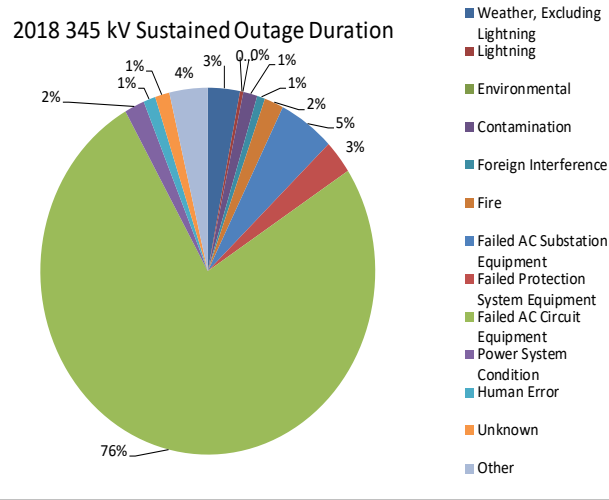
- 345kV and 138kV transmission outage rates remained stable.

System Resilience

2018 345 kV Sustained Outage Cause



2018 345 kV Sustained Outage Duration

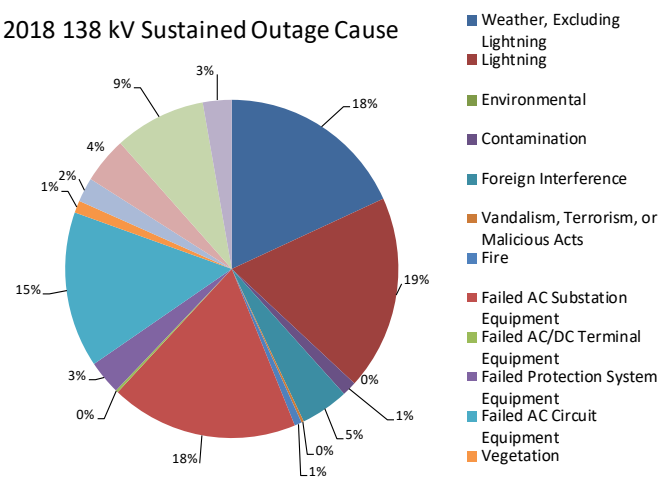


345 kV circuits
111 sustained outages
3,447 outage hours

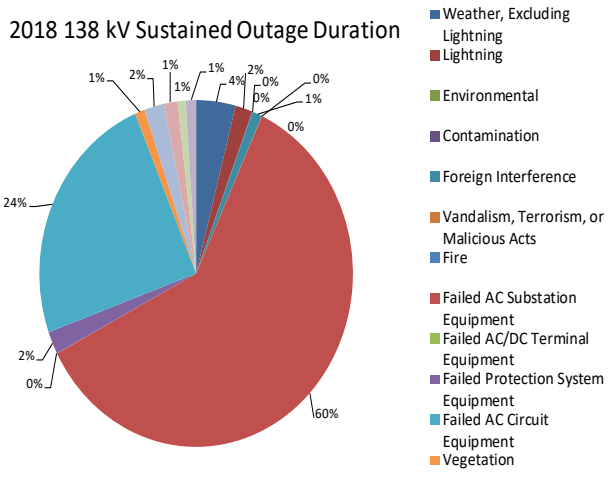
345 kV transformers
28 sustained outages
19,172 outage hours

138 kV circuits
429 sustained outages
7,514 outage hours

2018 138 kV Sustained Outage Cause



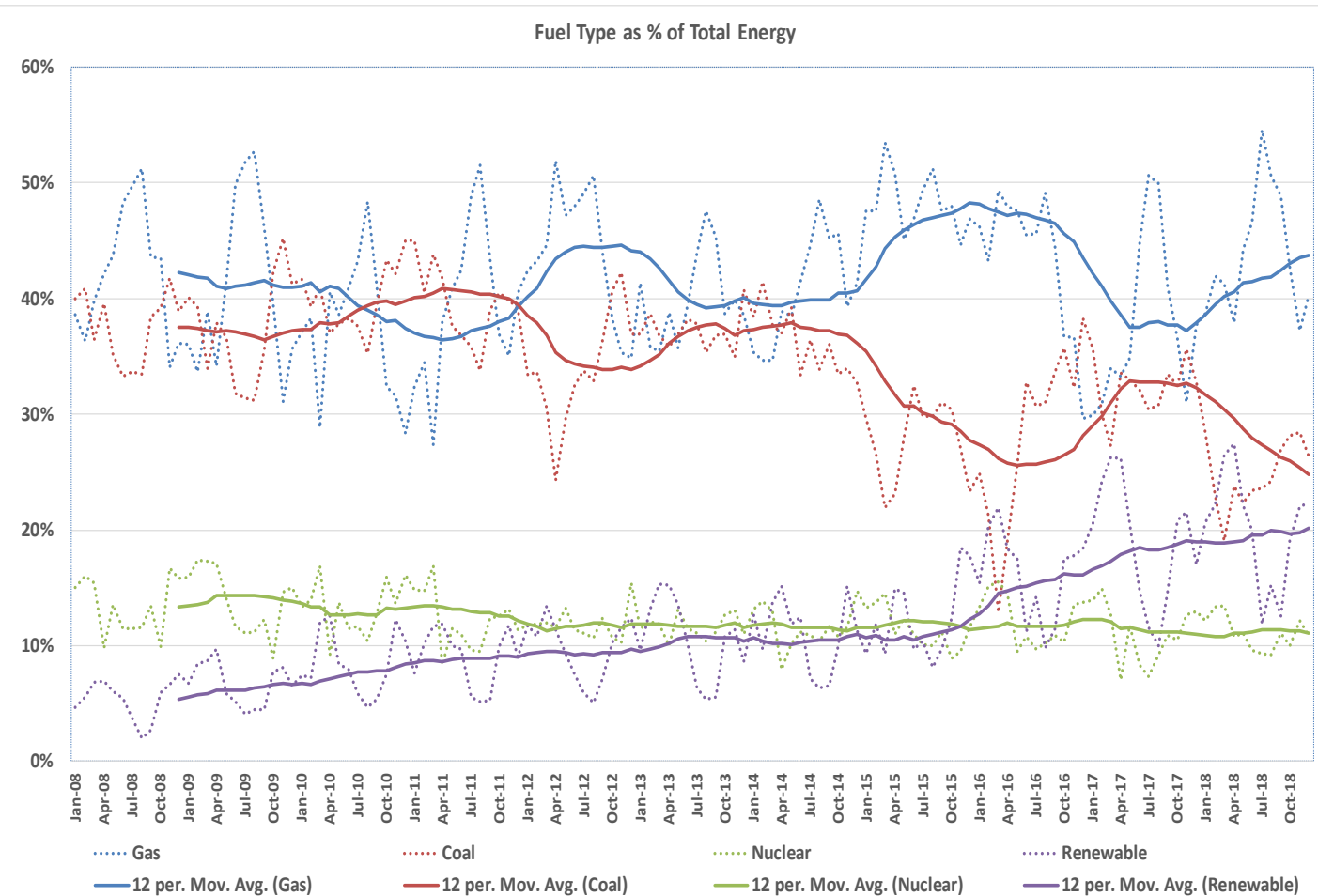
2018 138 kV Sustained Outage Duration



For 345 kV transmission circuits, failed transmission circuit equipment accounted for 8% of cause and 76% of duration.

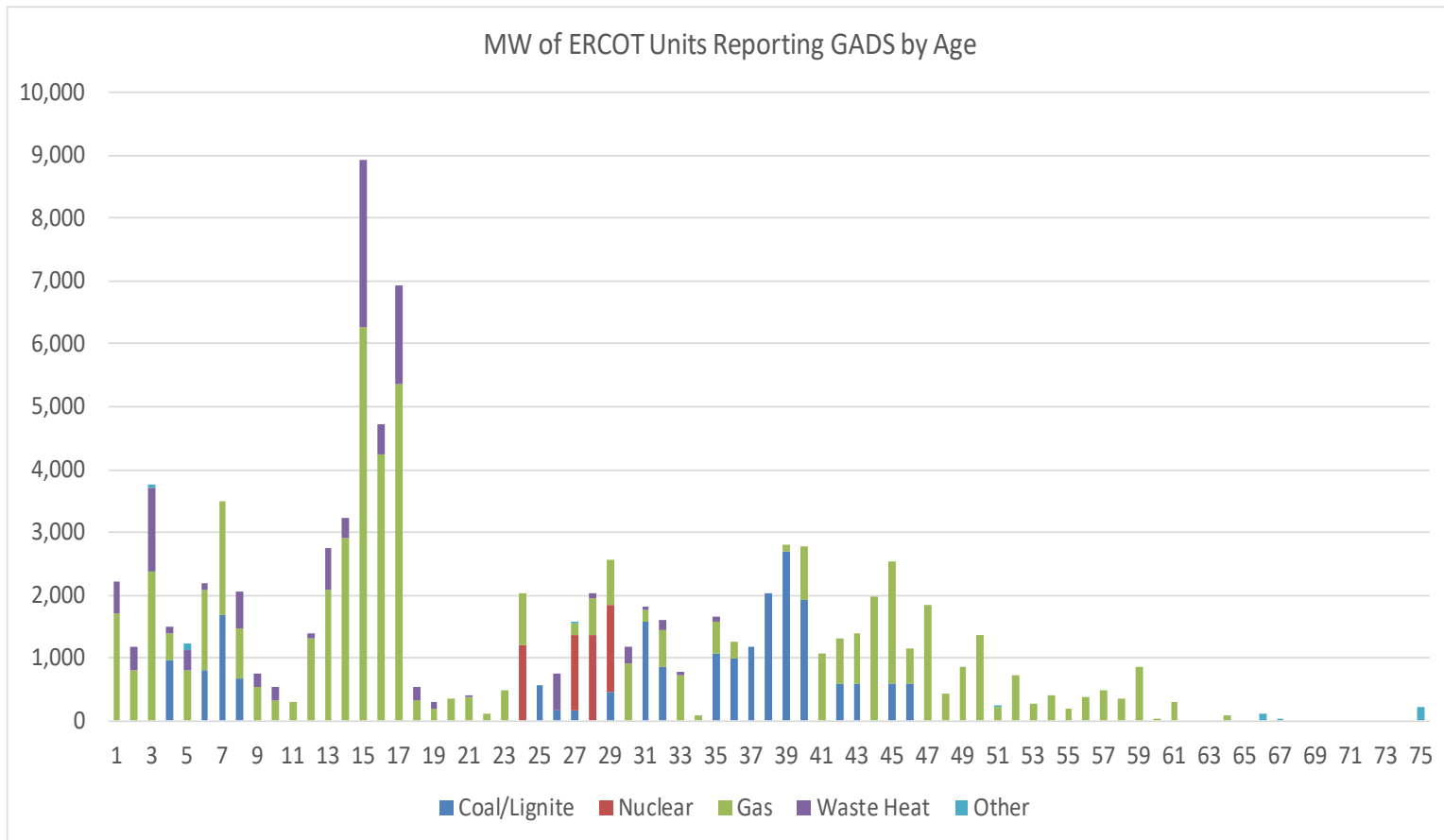
For 138 kV transmission circuits, failed substation and transmission circuit equipment accounted for 33% of cause and 85% of duration.

Changing Resource Mix



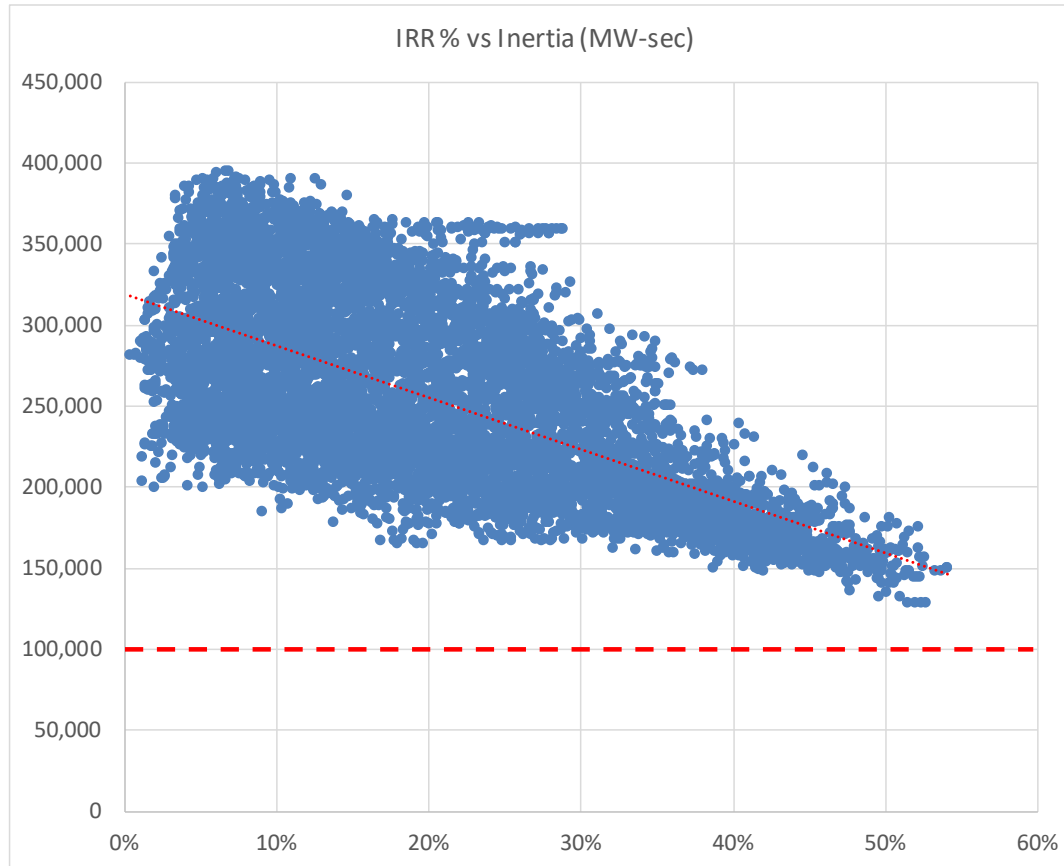
- The portion of total energy supplied by natural gas increased in 2018, up from 38% in 2017 to 44% in 2018 due to retirement of multiple coal units.
- Coal's portion of total energy decreased from 32% in 2017 to 25% in 2018.

Changing Resource Mix



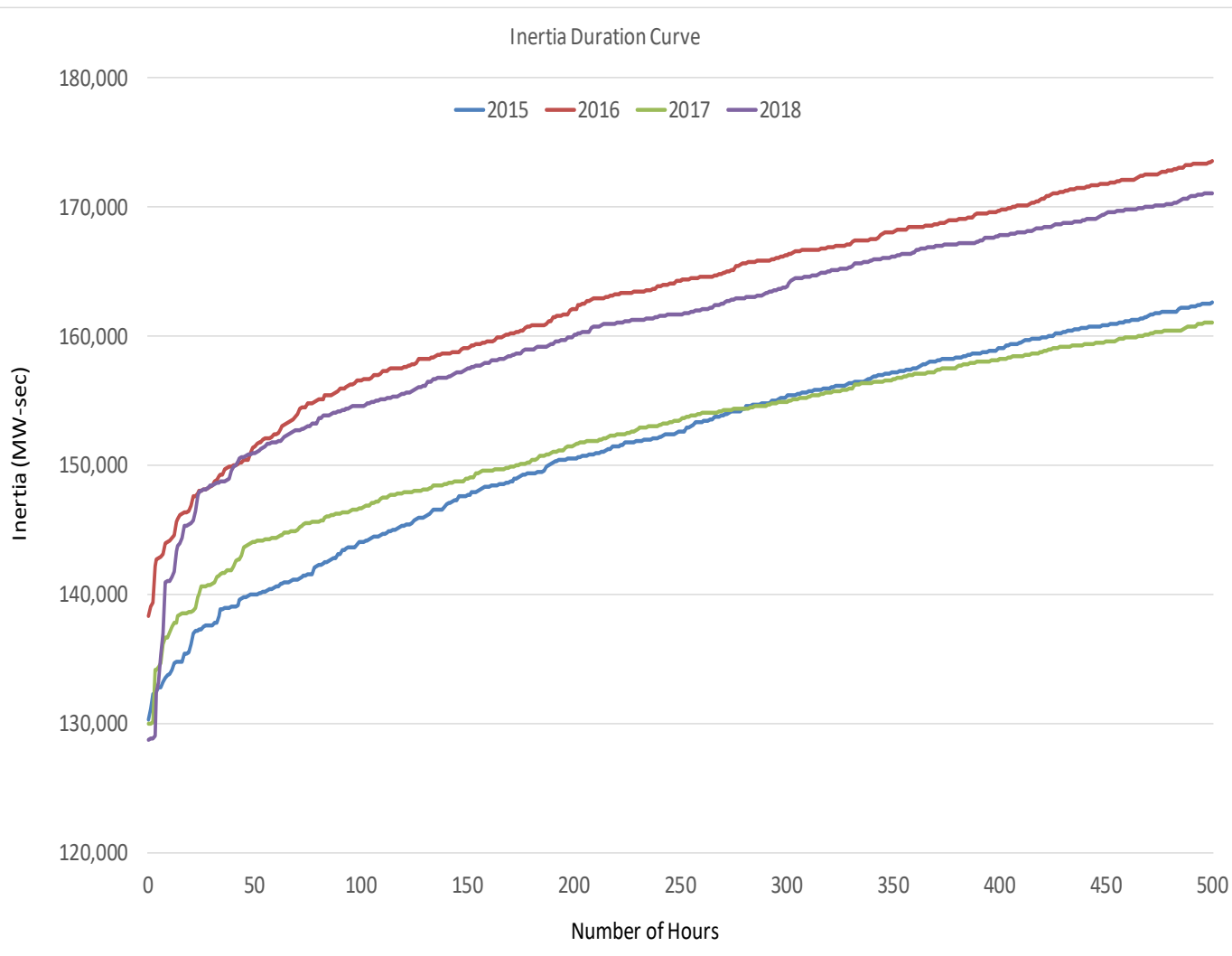
- There is an age bubble around 35–39 years which is driven by coal and some gas units.
- Another age bubble around occurs at 12–17 years comprised almost exclusively of combined cycle units.

Changing Resource Mix



Year	Minimum Inertia (GW-s)	Load (MW)	Net Load (MW)	IRR %
2015	130.3	27,798	20,569	26.1%
2016	138.4	26,839	14,797	44.9%
2017	130.0	28,443	13,178	53.7%
2018	128.8	28,412	13,452	52.7%

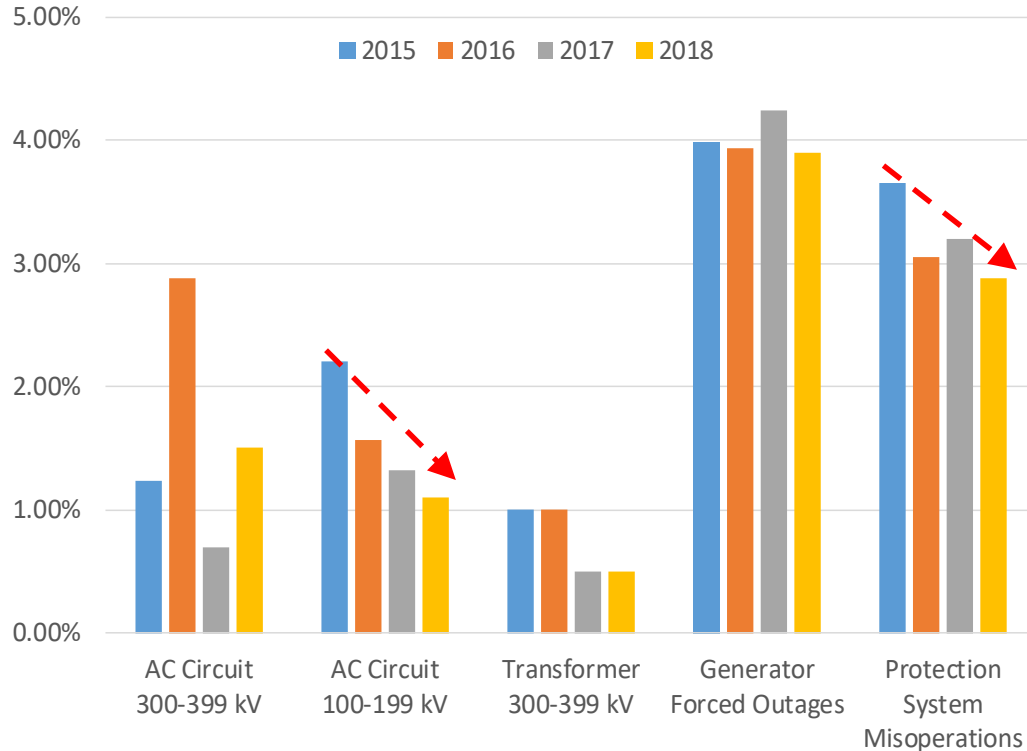
Changing Resource Mix



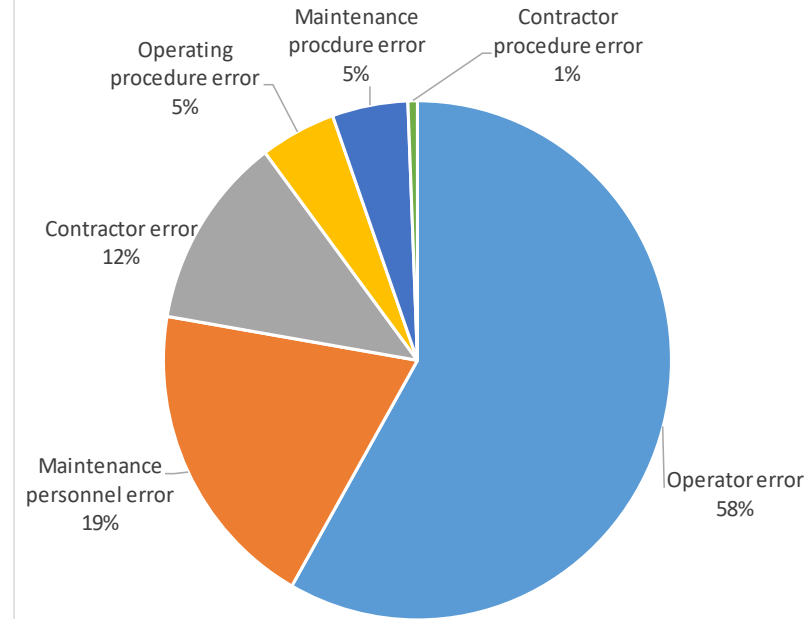
- Average inertia increased across most operating hours in 2018, but decreased during minimum net load conditions.

Human Error Performance

Outages Rates Initiated by Human Error



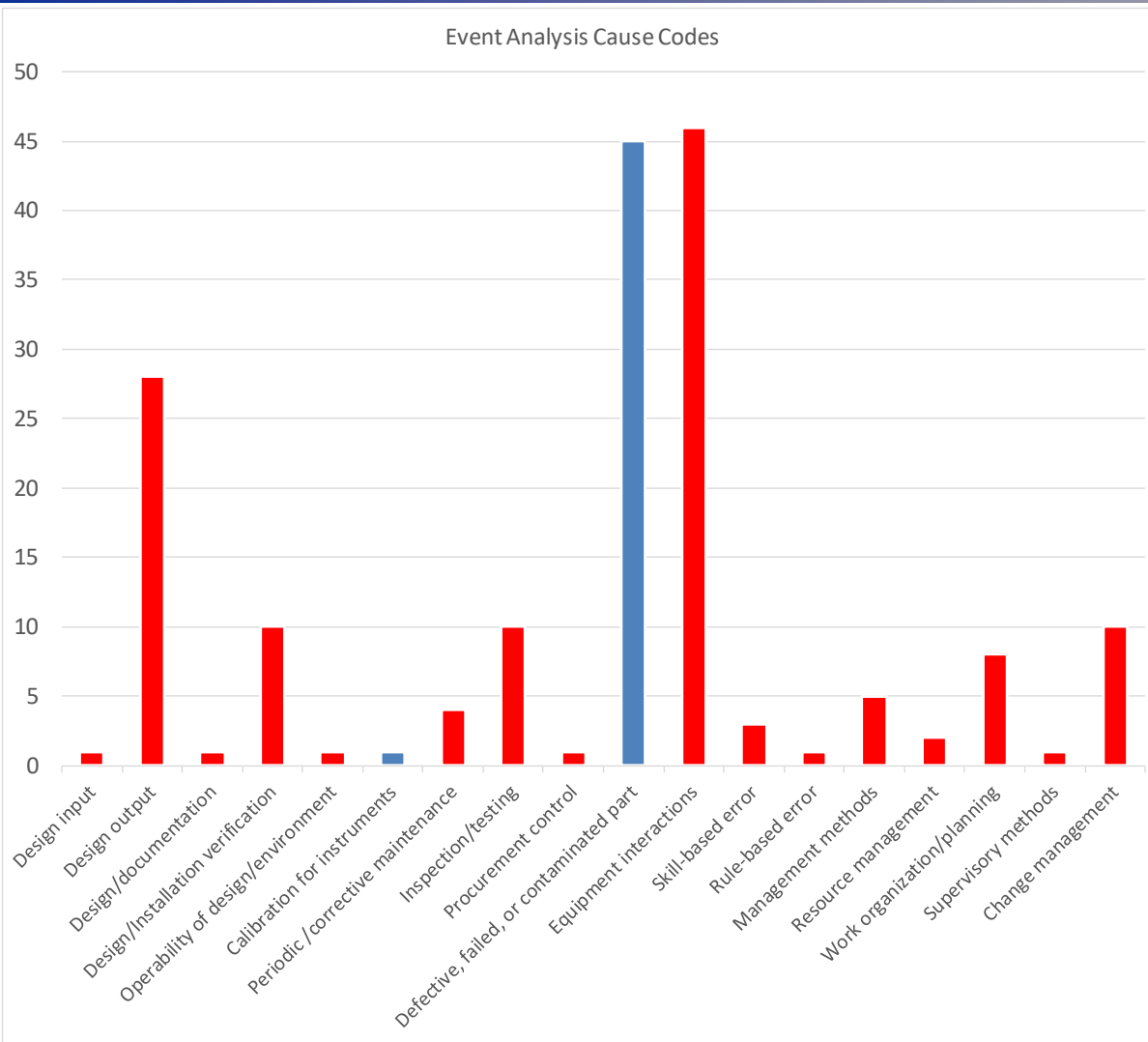
Generator Human Error - by Cause



- 138 kV circuit outage rates caused by human error are showing an improving trend. Generator outage rates caused by human error remain stable.

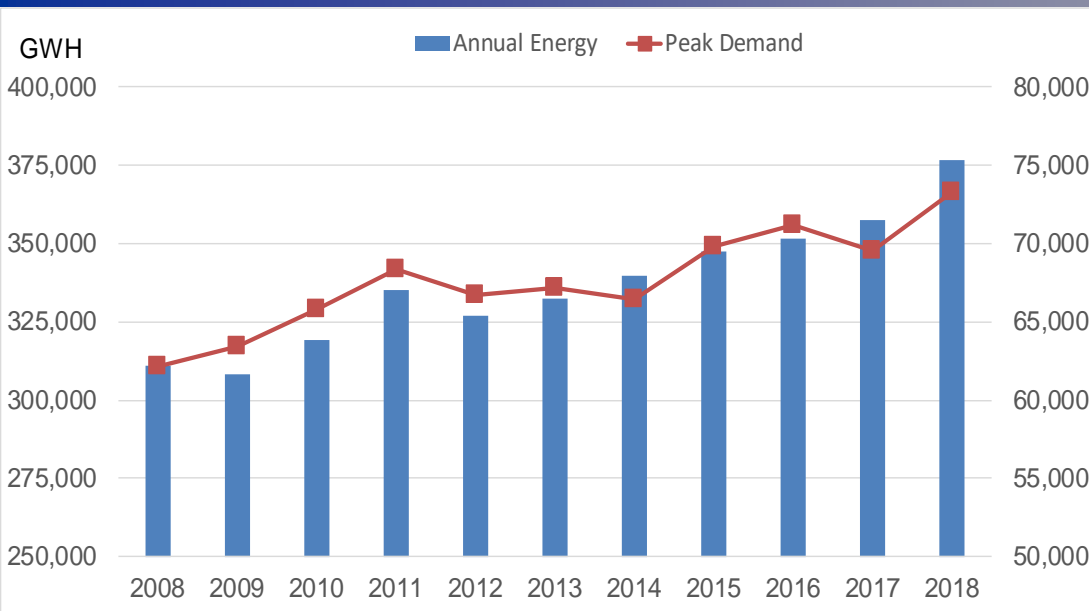
- Since 2014, there have been 498 generator immediate forced outages caused by human error.

Human Error Performance



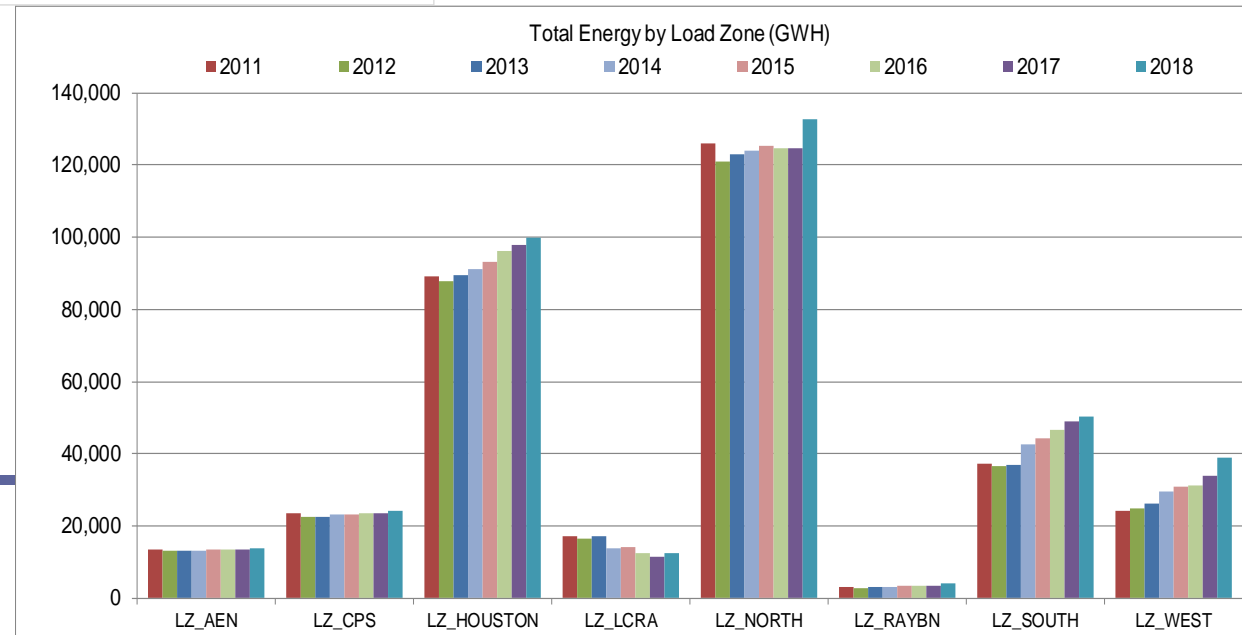
- Cause coding for system events continues to yield outstanding data.
- 47% of root cause and contributing causes for system events are related to potential human performance issues.

Bulk Power System Planning

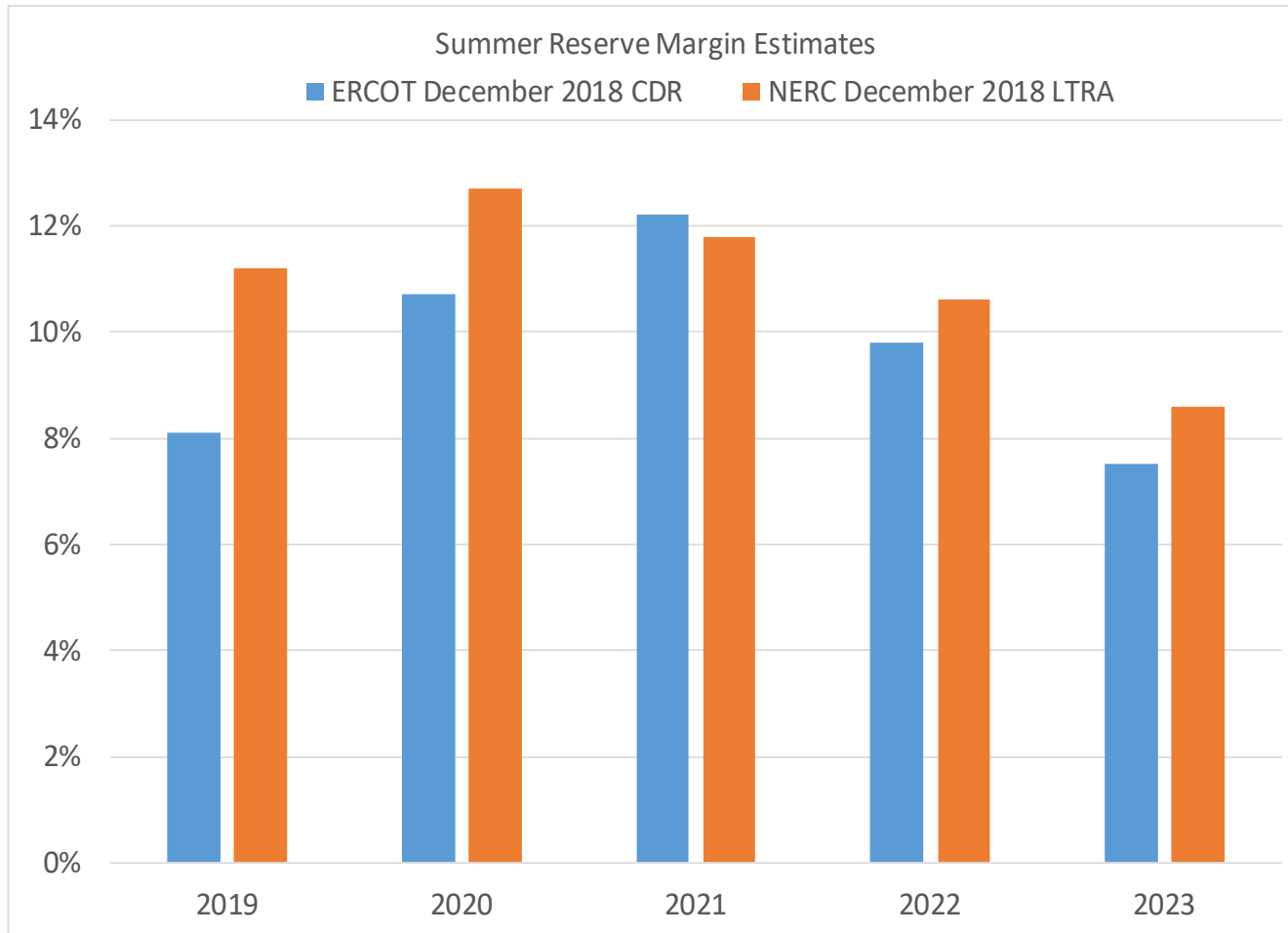


- Total annual energy usage was 376.8 GWH, an increase of 5.4% over 2017.

- Load zones with the largest percentage energy increases are the West load zone followed by the North load zone.

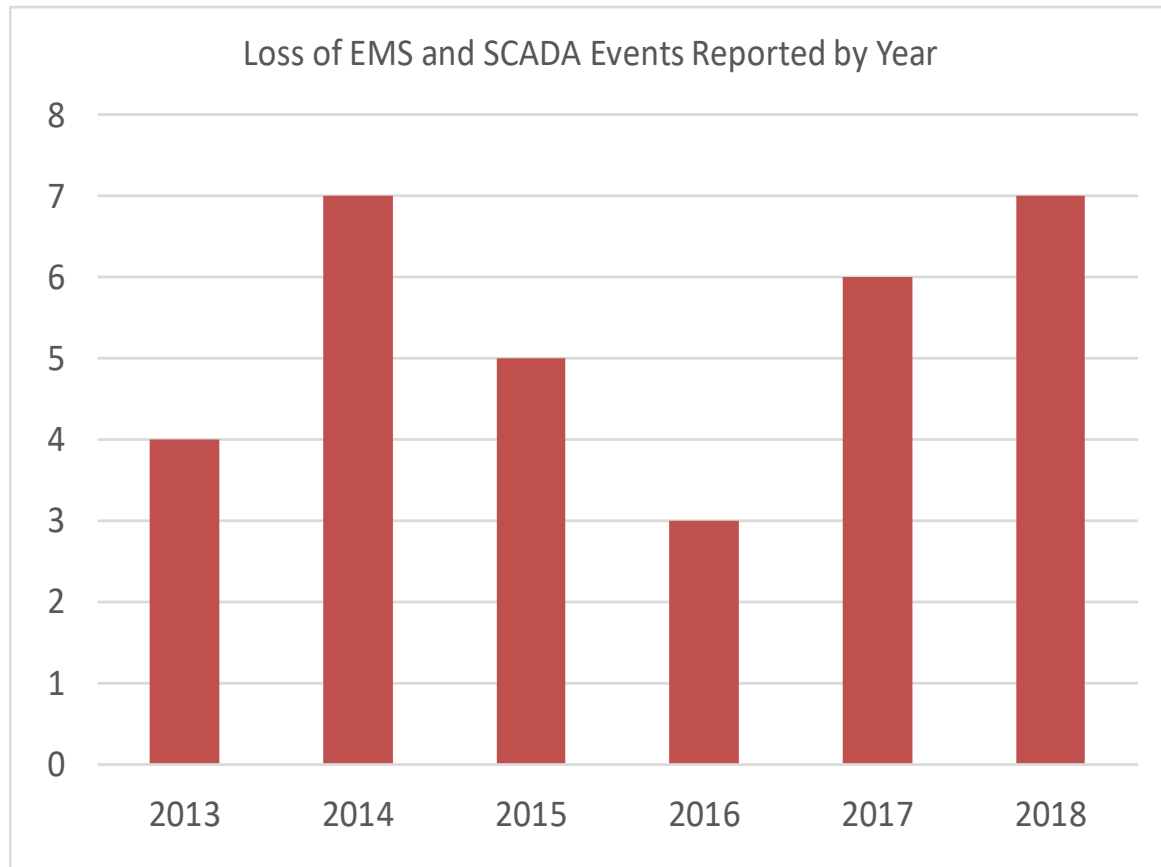


Bulk Power System Planning



- Reference planning reserve margin is 13.75%, based on a 1 event in 10 year loss of load probability.

Loss of Situational Awareness

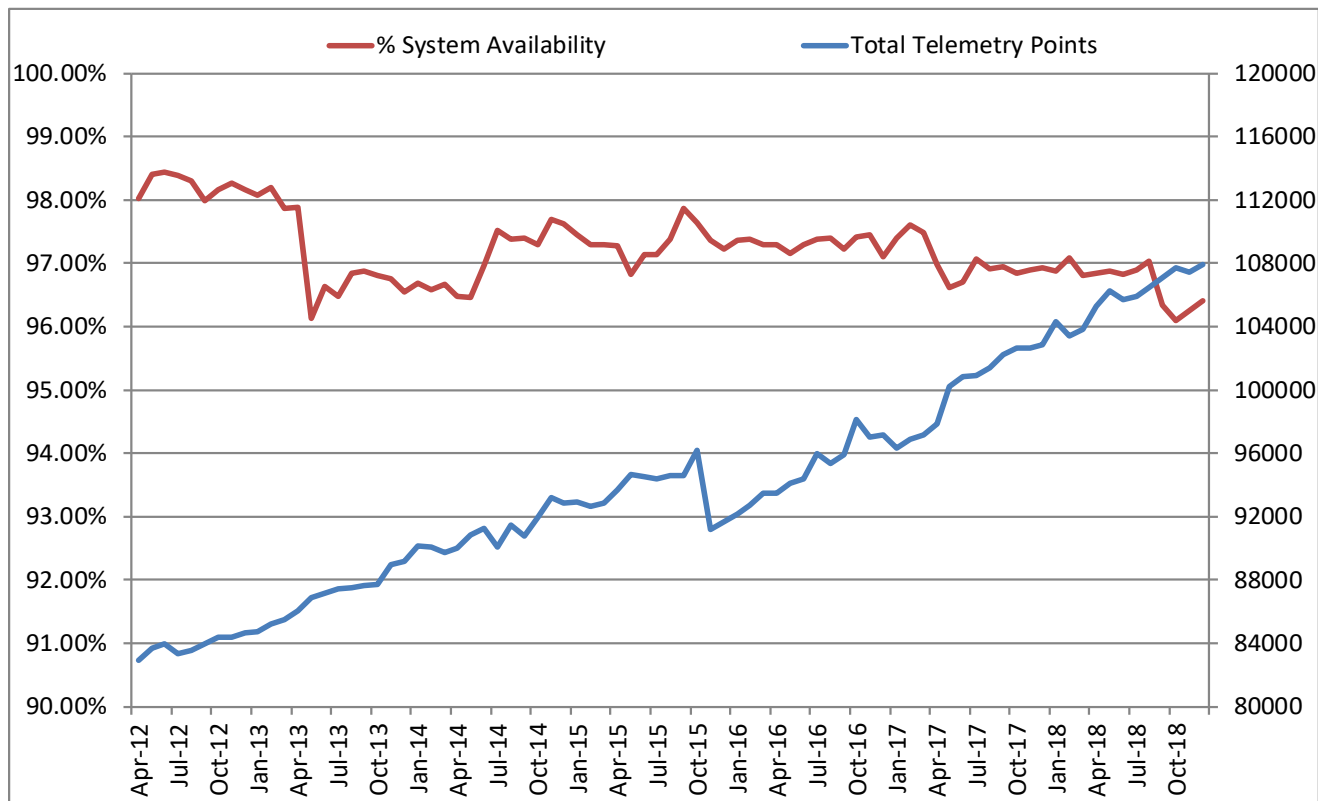


EMS/SCADA events are a focus point at NERC and federal levels.

Category 1 events include:

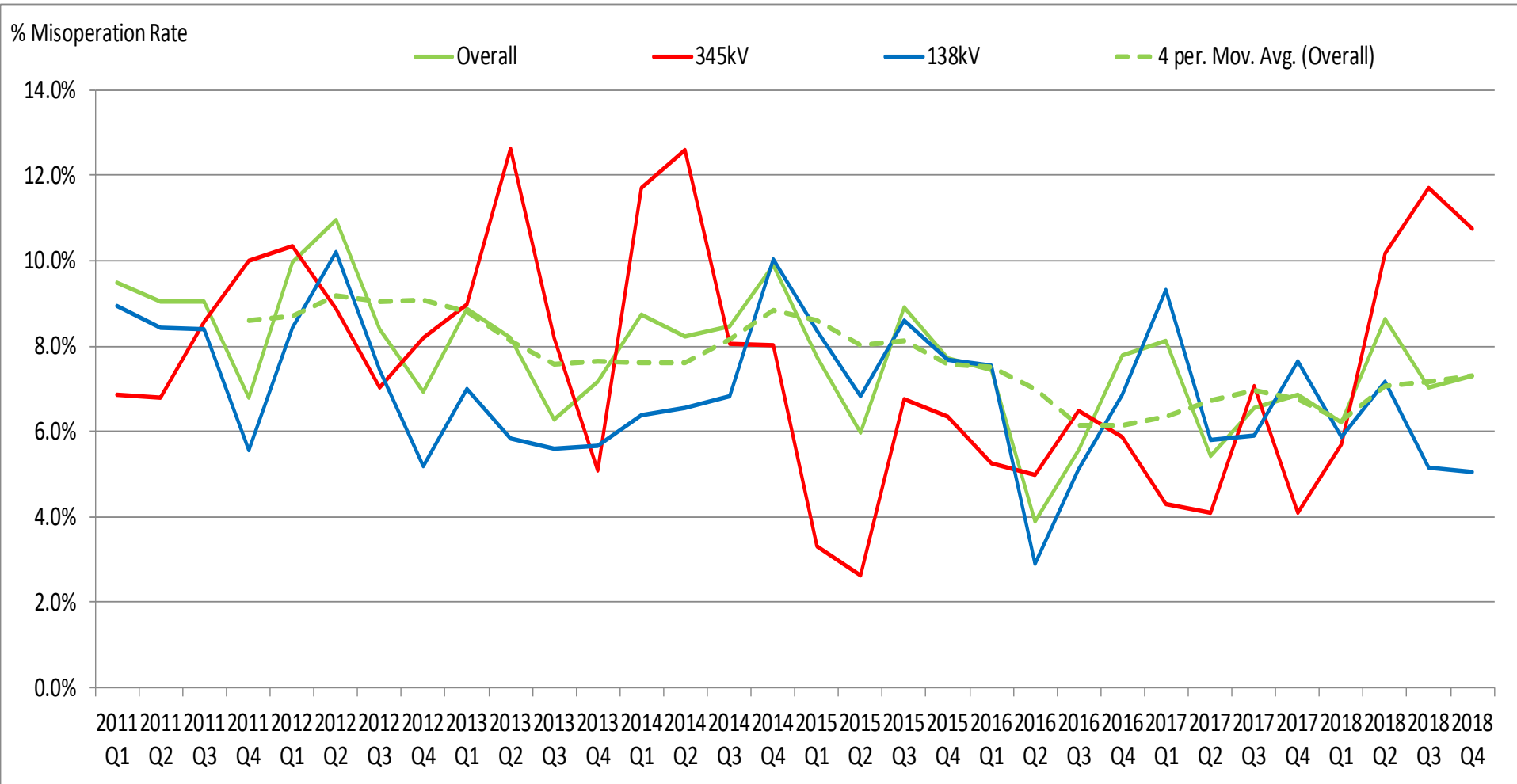
- Loss of operator ability to remotely monitor, control BES elements,
- Loss of communications from SCADA Remote Terminal Units (RTU),
- Unavailability of Inter-Control Center Communications Protocol (ICCP) links,
- Loss of the ability to remotely monitor and control generating units via Automatic Generation Control (AGC), and
- Unacceptable State Estimator or Contingency Analysis solutions for more than 30 minutes.

Loss of Situational Awareness

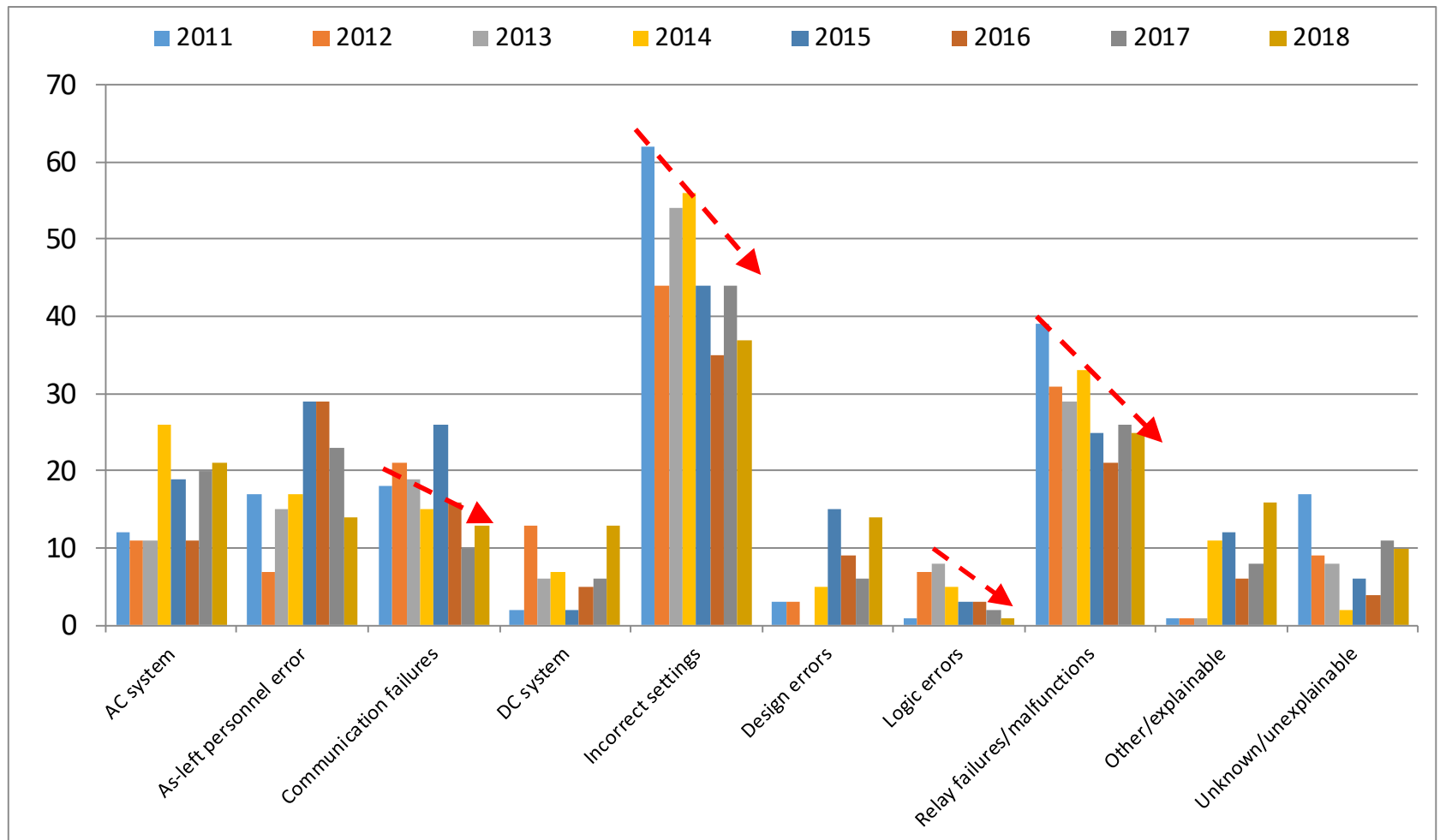


- ERCOT telemetry performance criteria states that 92% of all telemetry provided to ERCOT must achieve a quarterly availability of 80%. For 2018, the average number of telemetry points failing this metric was approximately 4,011 each month, or 3.8% of the total system telemetry points.

Protection and Control System Performance



Protection and Control System Performance



Questions?

