Business Intelligence and Outage Tracking

Nick Shumaker

Nick Shumaker

- Manager of System Engineering at Oklahoma Electric Cooperative in Norman OK
- Electrical Engineer from Texas A&M
- Serve a large variety of technical functions
  - Electric Grid Design
  - Electric and Civil Code Enforcement
  - Relay Technician
  - SCADA Administrator
  - Implementation of Intelligent Electronic Devices and their Communication
  - Oversee Renewable Portfolio
    - Includes residential and grid size projects

OEC

Your trusted energy advisor

Oklahoma Electric Cooperative

- Our office is located locally in Norman OK
- Founded 1937
- Maintains 5,522 miles of line serving 57,500 meters
- Largest Distribution Cooperative in the state
- Top 10% in size (Over 800 Distribution Coops)
- Serves most of Cleveland, Grady, and McClain Counties, and small parts of Caddo, Canadian, Oklahoma, and Pottawatomie Counties.

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Metrics of an Outage

System Hardening

Business Intelligence

Importance of Power Quality

- A fundamental attribute for a product or a service
- For electricity, product quality means both the reliability (outages) and quality (voltage variations, frequency, harmonics, flicker etc.)
- A very important contributor to member satisfaction, with monetary implications for Commercial and Industrial customers
- In the electric utility industry, product quality is becoming increasingly important due to new technologies such as DER

- Tony Thomas CEM GICSP
  Sr. Principal Engineer
  National Rural Electric Cooperative Assn.

Importance of Power Quality

Interruption Cost Estimates					
Sector	# of Customers	Cost Per Event (2016$)	Cost Per Average kW (2016$)	Cost Per Unserved kWh (2016$)	Total Cost (2016$)
Residential	52,000	$6.52	$4.11	$4.11	$474,905.20
Small C&I	4,396	$657.07	$292.18	$292.18	$4,043,866.67
Medium and Large C&I	604	$4,619.92	$45.55	$45.55	$3,906,601.30
All Customers	**57,000**	**$105.58**	**$39.17**	**$39.17**	**$8,425,373.18**

The Interruption Cost Estimate (ICE) Calculator is an electric reliability planning tool developed by Lawrence Berkeley National Laboratory and Nexant, Inc.

IEEE 1366-2012

IEEE STANDARDS ASSOCIATION IEEE

IEEE Guide for Electric Power Distribution Reliability Indices

IEEE Power & Energy Society

Sponsored by the
Transmission and Distribution Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

31 May 2012

IEEE Std 1366™-2012
(Revision of
IEEE Std 1366-2003)

Types of Outages

- **Planned interruption:** The loss of electric power to one or more customers that results from a planned outage.

- If it is possible to defer the interruption, then the interruption is a planned interruption; otherwise, the interruption is an unplanned interruption.

Types of Outages

- **Power Supplier:** Outages that occur on generation, transmission, substations, or customer facilities outside of the distribution system.

- While generally a small portion of the number of interruption events, these interruptions can affect a large number of customers and may last for a long time.

Types of Outages

- **Major Event:** Designates an event that exceeds reasonable design and or operational limits of the electric power system. A Major Event includes at least one Major Event Day.

- Any day in the next year with SAIDI > TMED is a Major Event Day.
- TMED = $e^{(\alpha + 2.5 * \beta)}$.
- Average (α) and standard deviation (β) of the natural logarithms
- **Get something that calculates this for you!**

Types of Outages

- **Forced outage:** The state of a component when it is not available to perform its intended function due to an unplanned event directly associated with that component.
- This is what we can improve.
- Examples
  - Lightning
  - Weather; Wind, Ice, Tornado
  - Member Caused, Vehicles
  - Faulty Equipment
  - Contractors, either utilities or other

Metrics

SAIDI

- **SAIDI: System Average Interruption Duration Index**
- The System Average Interruption Duration Index (SAIDI) indicates the total duration of interruption for the average customer during a predefined period of time. It is commonly measured in minutes or hours of interruption.

- SAIDI = $\frac{\sum Customer\ Mintues\ of\ Interruption}{\text{Total Number of Customers Served}}$

Metrics

SAIFI

- **SAIFI: System Average Interruption Frequency Index**
- The System Average Interruption Frequency Index (SAIFI) indicates how often the average customer experiences a sustained interruption over a predefined period of time.

- $\text{SAIFI} = \frac{\sum \text{Total Number of Customers Interrupted}}{\text{Total Number of Customers Served}}$

What is System Hardening

This program is based around replacing failed and failing equipment during normal hours. Many of these items would be replaced in an outage scenario, often at a higher labor price. This program also includes other maintenance items that would happen regardless, just on a concentrated and therefore more efficient cycle.

Great, how do we do it

- We used NISC Outage Management System for a decade
  - Great at tracking and restoring outages
  - All outage data available, but only light reporting mechanisms.
  - Data doesn’t equal action

Example Report

Description	Power Supply	Major Event	Planned	All Other	Total
2015 - TMED: 11.78476					
Number of Outages	77	1431	569	3055	5132
Number of Consumers Affected	46775	120898	4041	59638	231352
Consumer Hours	42101.4	710642.2	3087.9	79177.3	835008.9
Consumer Minutes	2526084.4	42638533.1	185276.0	4750640.4	50100533.8
Average Number of Consumers	53663	53663	53663	53663	53663
SAIDI	47.1	794.6	3.5	88.5	933.6
2016 - TMED: 10.76864					
Number of Outages	28	0	531	3000	3559
Number of Consumers Affected	44283	0	2849	59591	106723
Consumer Hours	38523.8	0.0	3361.4	76207.4	118092.5
Consumer Minutes	2311425.7	0.0	201681.3	4572444.3	7085551.3
Average Number of Consumers	54542	54542	54542	54542	54542
SAIDI	42.4	0.0	3.7	83.8	129.9
2017 - TMED: 9.07728					
Number of Outages	19	51	527	2599	3196
Number of Consumers Affected	19053	8825	3505	57382	88765
Consumer Hours	16339.2	9417.9	4576.5	61976.0	92309.6
Consumer Minutes	980351.4	565072.1	274592.9	3718562.0	5538578.3
Average Number of Consumers	55466	55466	55466	55466	55466
SAIDI	17.7	10.2	5.0	67.0	99.9
2018 - TMED: 7.91314					
Number of Outages	47	0	554	2162	2763
Number of Consumers Affected	42138	0	3602	49778	95518
Consumer Hours	32477.9	0.0	4514.9	53465.8	90458.5
Consumer Minutes	1948674.1	0.0	270892.6	3207945.4	5427512.1
Average Number of Consumers	56484	56484	56484	56484	56484
SAIDI	34.5	0.0	4.8	56.8	96.1

OEC System Hardening Project

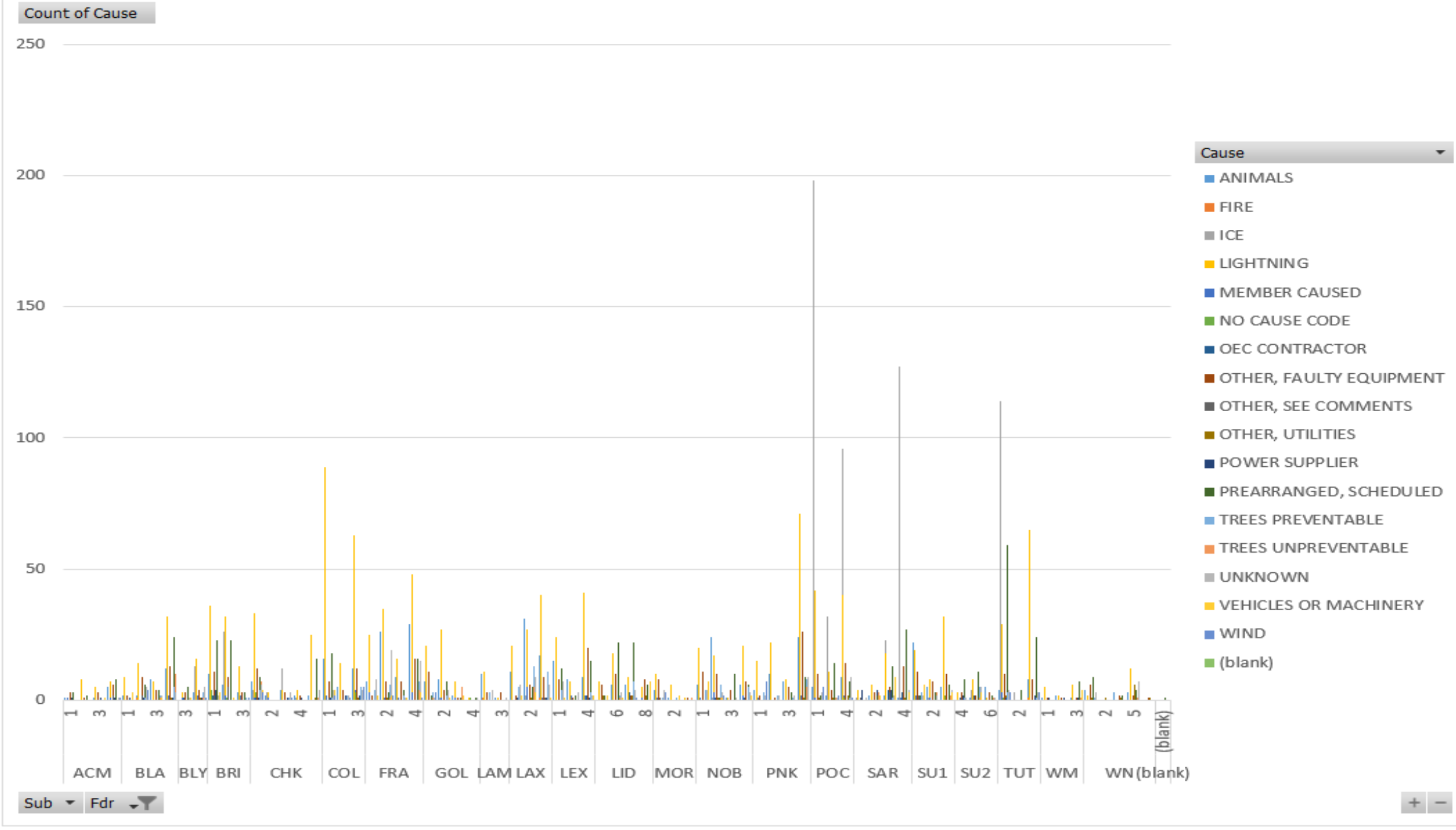
- Selecting the Worst Performing Feeders from 2016 data
- Began work mid 2017
- Currently have 4 completed Feeders
- Scope of work
  - Adding animal cover up
  - Upgrading to latest lightning protection
  - Re-coordinating entire feeder
  - Replaced rotted insulators
  - Added System Modernization Equipment

What System Hardening Isn't

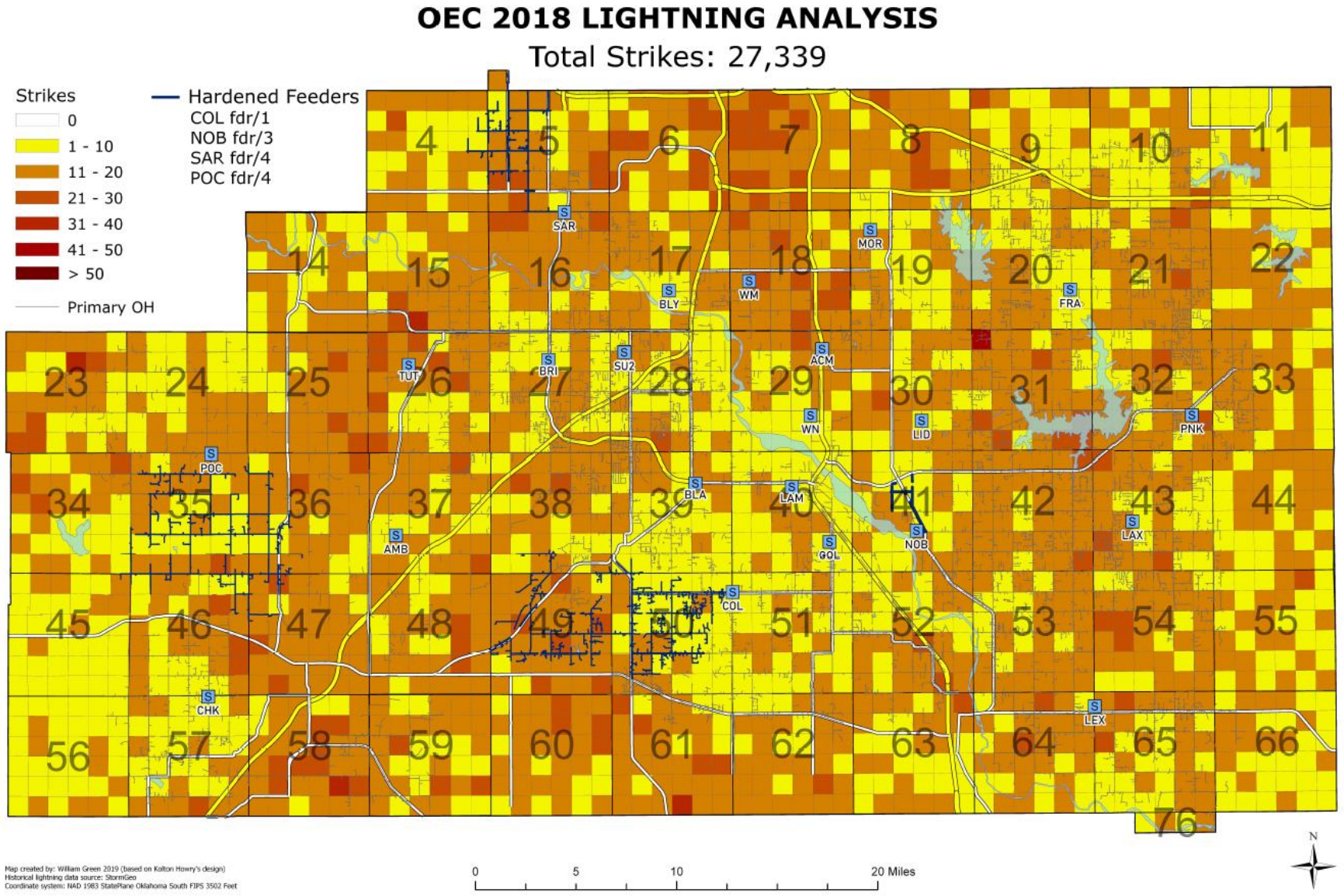
- Osmose Pole Inspection or Pole Changeouts
- Line conversion or upgrade
  - Unless its 8A mainline, but its hasn’t come up
- Setting additional Poles
- Upgrading Poles

Manual Reports

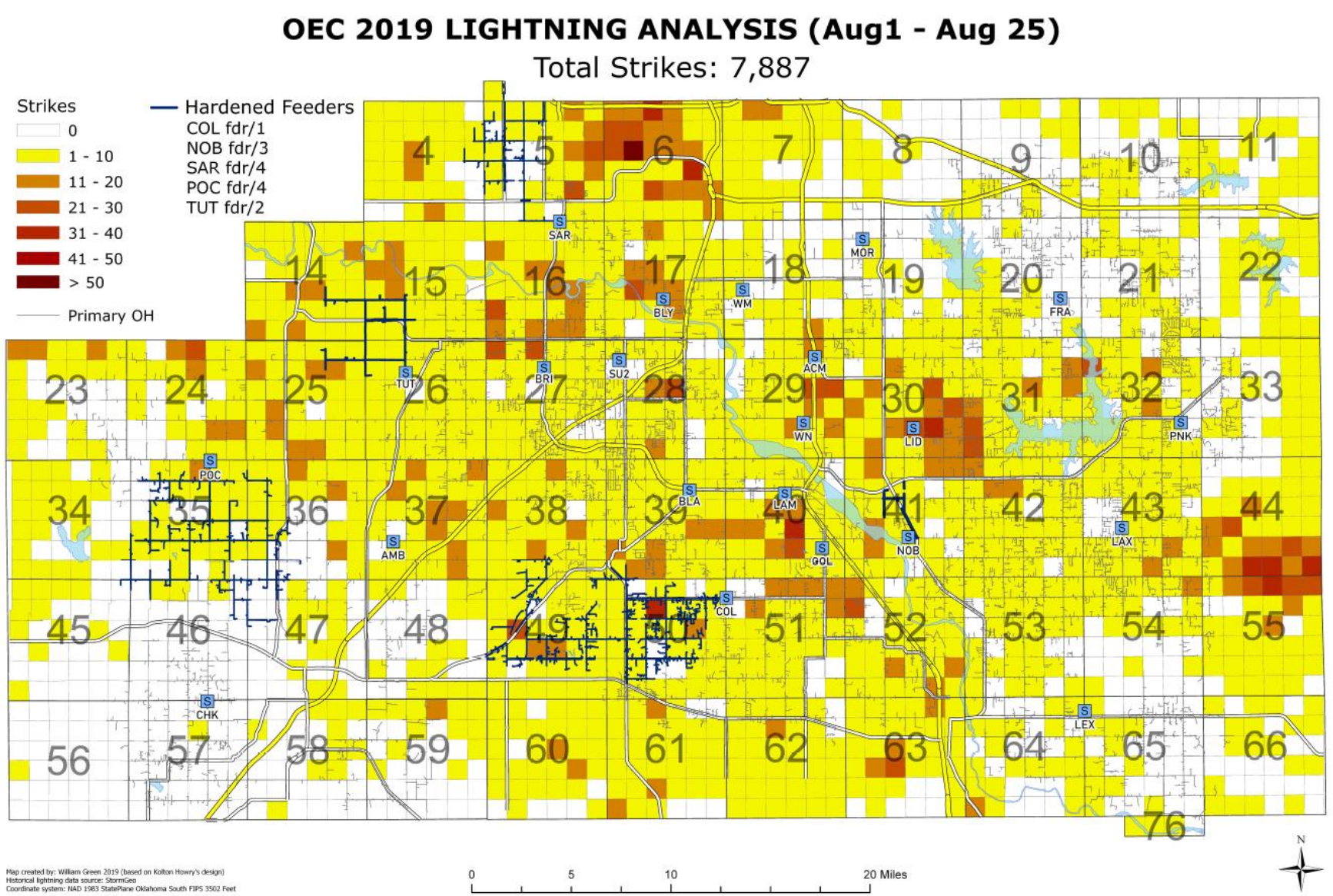
- NISC native reports don’t give enough insight to drive the decisions we wanted to make
- Export raw data to Excel
  - Lots of Pivot Tables
  - Lots of Time
  - Lots good data discoveries
- GIS Lightning heat maps
- Lack of technology available or database expertise


Count of Cause
250
200
150
100
50
0
1 3 1 3 3 1 3 2 4 1 3 2 4 2 4 3 2 1 4 6 8 2 1 3 1 3 1 4 2 4 2 4 6 2 1 3 2 5
ACM BLA BLY BRI CHK COL FRA GOL LAM LAX LEX LID MOR NOB PNK POC SAR SU1 SU2 TUT WM WN (blank)
Cause
ANIMALS
FIRE
ICE
LIGHTNING
MEMBER CAUSED
NO CAUSE CODE
OEC CONTRACTOR
OTHER, FAULTY EQUIPMENT
OTHER, SEE COMMENTS
OTHER, UTILITIES
POWER SUPPLIER
PREARRANGED, SCHEDULED
TREES PREVENTABLE
TREES UNPREVENTABLE
UNKNOWN
VEHICLES OR MACHINERY
WIND
(blank)
Sub
Fdr

Lightning Data



Individual Storm Data



SAIDI Average Outage Time per Year

Feeder	2016	2017	2018
COL/1	283	137.433	44.702
NOB/3	173.001	22.605	0.272
POC/4	763.13	176.172	115.913
SAR/4	228.701	126.28	8.766

Consumer Minutes	2016	2017	2018
COL/1	369,520	180,038	57,710
NOB/3	277,148	37,751	474
POC/4	275,490	64,655	42,540
SAR/4	200,343	115,041	8,126

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Reduction per Hardened Feeder

	2017	2018
COL/1	51.28%	**84.38%**
NOB/3	86.38%	**99.83%**
POC/4	76.53%	**84.56%**
SAR/4	42.58%	**95.94%**

OEC vs The Rest

SAIDI	2015	2016	2017
OG&E	137.2	158.4	143.9
PSO	105.5	99.6	115.91
OEC+WFEC	**135.6**	**129.9**	**84.7**
OGE%More	1.2%	21.9%	69.9%
PSO%More	-22.2%	-23.3%	36.8%

OEC

Other Great Numbers

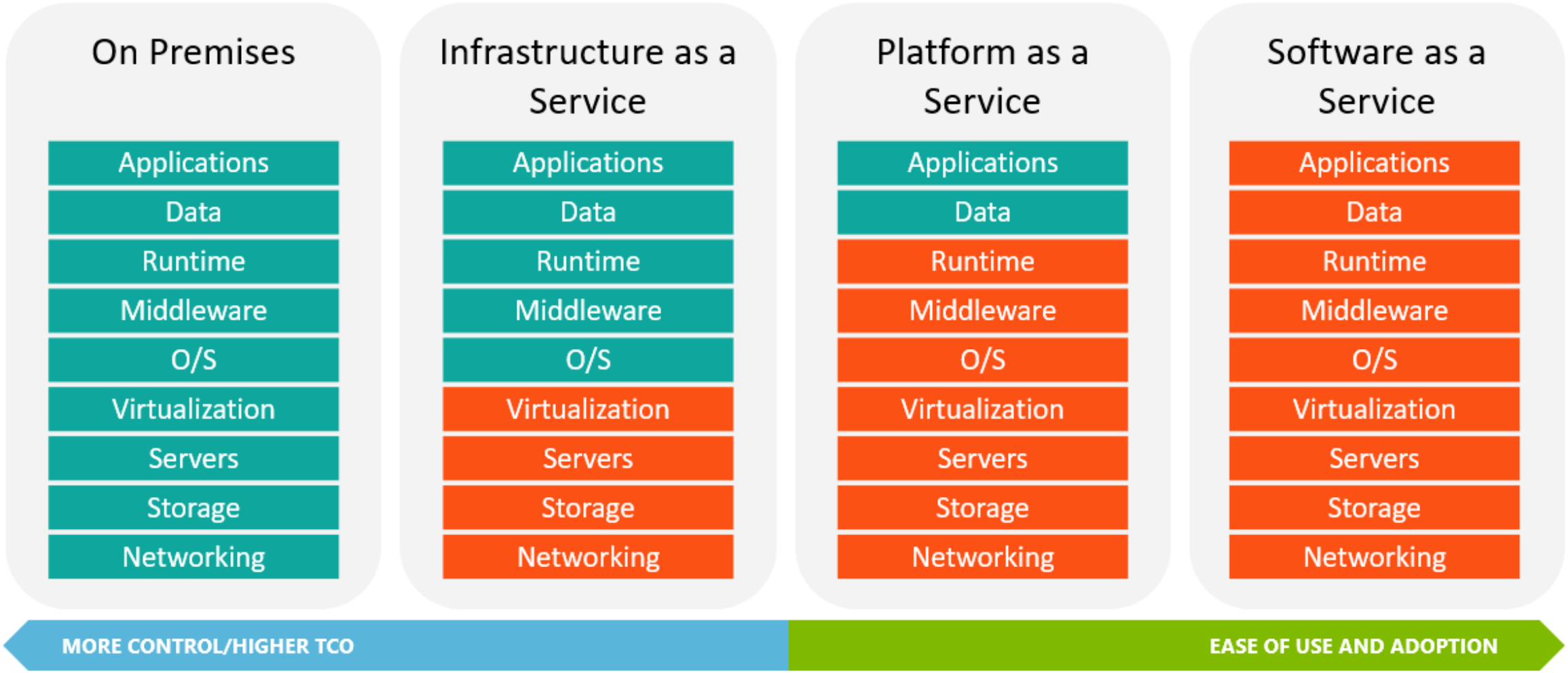
- Reduced 1.3 million minutes in 2018 vs 2016
  - 1 million of those minutes came from System Hardening Feeders (4 of 77)
- Overtime and double time pay reduced by 25%
  - Over $200,000 in savings annually
- Lightning outages reduced by 40%, while having the same number of lighting strikes

Phase 1 Takeaways

- Obviously, the data when analyzed leads to better allocation of resources
  - No Overtime for this project
  - No additional hires or contractors for this project
  - “Working Smarter Not Harder”

- How do we leverage Technology to push this forward?
  - Don’t have the inhouse resources
  - Don’t want a piece of specialty software

Comparison of management areas of on-premises and cloud services architectures



ABOUT VISUAL BI

All-in-One Partner for End-to-End BI & Analytics Needs

Visual BI Solutions is a leading All-in-One Business Intelligence (BI) enablement firm specializing in BI & Analytics services, solutions, trainings and products. We have proven expertise in enabling BI & Analytics for **100+** world's leading brands. We can help you achieve competitive advantage by effectively managing the Plan - Build - Run spectrum for BI.

Trusted by the largest companies world-wide

CONSULTING SERVICES

- Strategy
- Architecture Implementation
- Training
- Managed Services
- Visualization
- Cloud Migrations

SOFTWARE PRODUCTS

- VBI View – One Portal for All BI Content
- Product Extensions for SAP Lumira / SAP Design Studio
  - Visual BI Extensions (VBX Suite)
  - Document Management and Change Control
- Value Driver Tree (VDT) for Planning and Simulations

TRAINING

- SAP Business Objects Training
  - SAP Lumira Discovery (2 Days)
  - SAP Lumira Designer (3 Days)
  - SAP Web Intelligence (2 Days)
  - SAP Analysis for Office (2 Days)
- SAP Analytics Cloud Training
- Microsoft Power BI Training
- Tableau Training

ANALYTICS SOLUTIONS

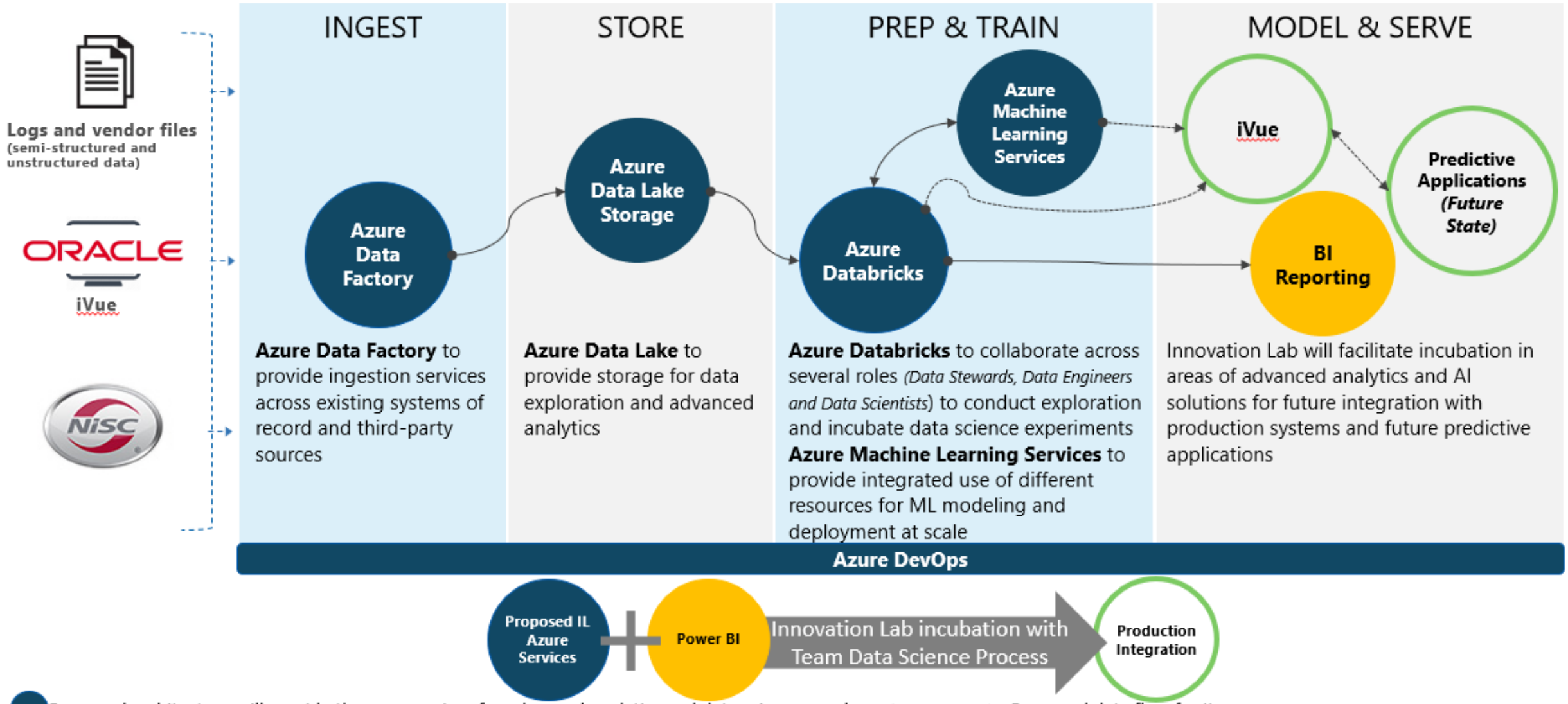
- Dashboards by LOB
- Advanced Analytics
- Big Data Solutions

Trusted by the industry

Integration and Partnership with SAP and Microsoft is our forte

ESTABLISH DATA SCIENCE INNOVATION LAB (IL)

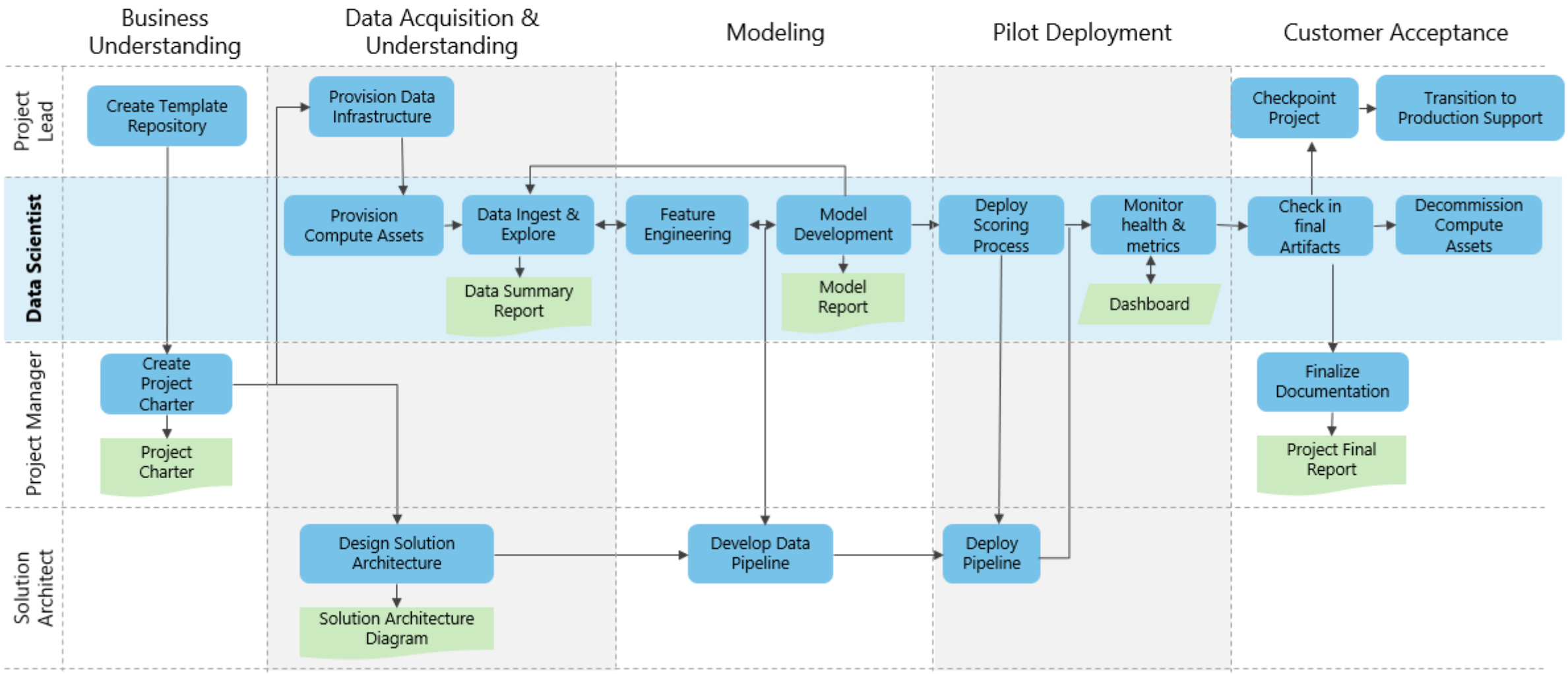
Proposed IL Azure Data Services Architecture



INNOVATION LAB

Proposed Data Science Process Lifecycle – Team Data Science Process

TDSP roles and tasks



KEY BUSINESS BENEFITS OF THE INNOVATION LAB (IL)

Benefits for OEC

Autoscaling capacity & power	Do what you need to do when you need to do it with no additional capital or resource investment
Autopause	You only pay for what you use No carry costs for idle time Minimizes investment to business-rationalized expense
Next-generation ready	Cloud services are added frequently New technology will always be available within the ecosystem Scale up and down as needed
Limited internal expertise required	Infrastructure managed by cloud provider In many instances configuration is also managed
Fast prototyping and production enablement	Get a prototype running in hours and days instead of weeks and months Predefined development and governance methodology

Last 48 Hours at a Glance

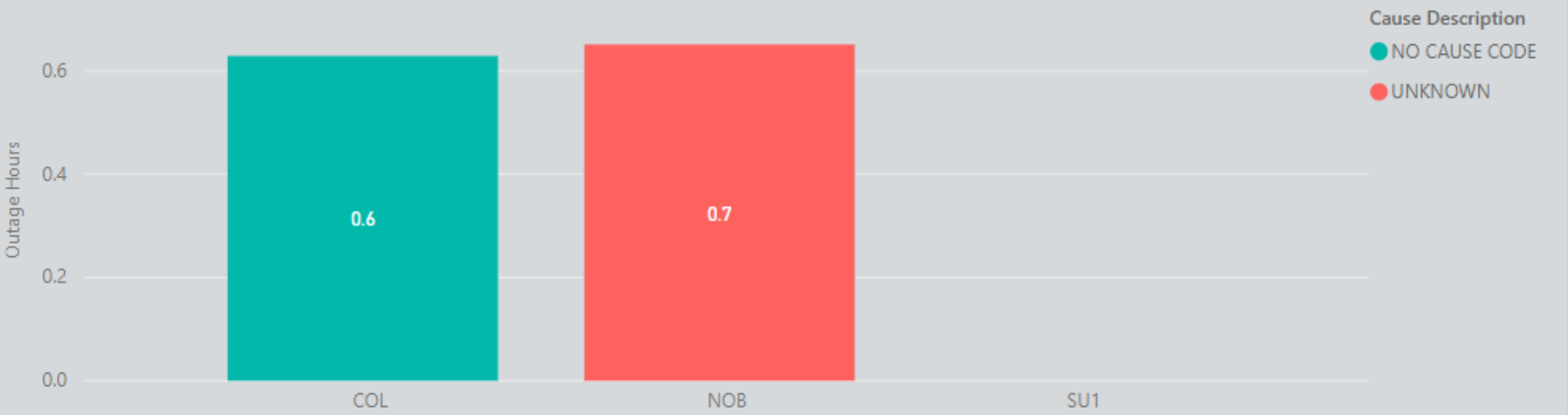
OKLAHOMA ELECTRIC COOPERATIVE

9/18/2019 7:11:42 AM
Last Refresh

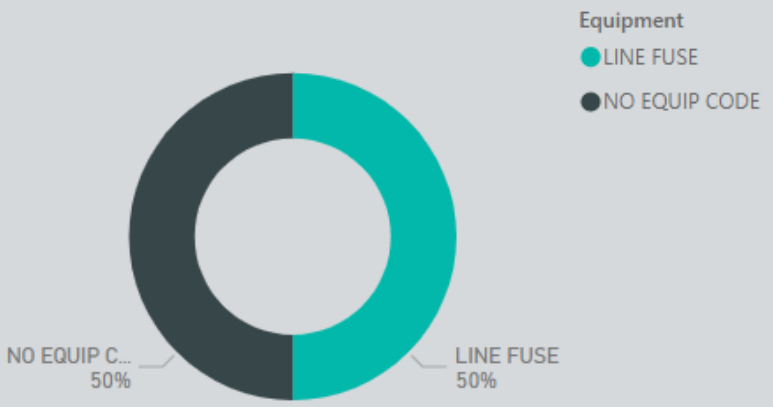
Substation: All
Equipment: All
Feeder Line: All
Cause Group: Multiple selections
Cause Description: All

4
Customers Impacted
1.3
Outage Hours

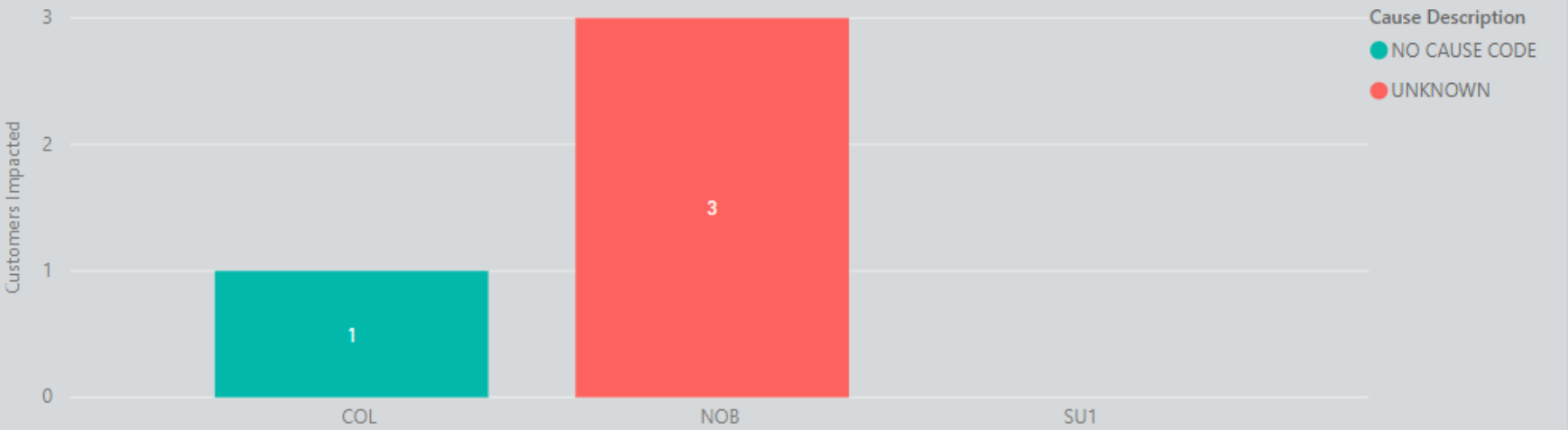
Outage Hours by Substation and Cause



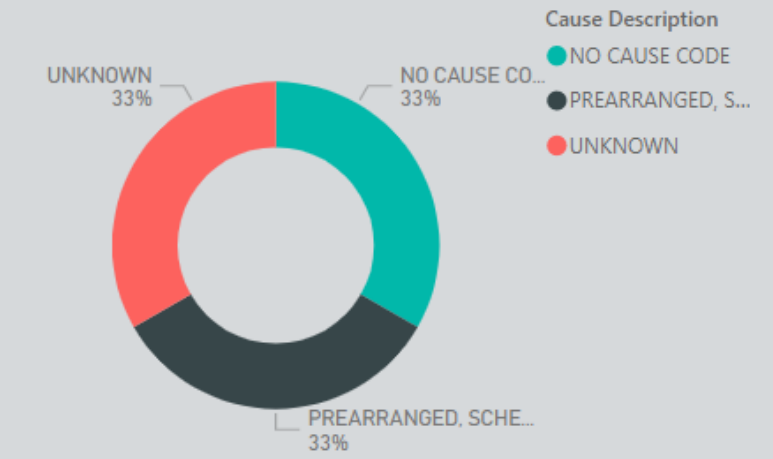
Equipment Outage Occurrence



Customers Impacted by Substation and Cause



Cause Occurrence



OEC
OKLAHOMA ELECTRIC COOPERATIVE

9/18/2019 7:11:42 AM
Last Refresh

Outage Date
This - Year
1/1/2019 - 12/31/2019

Substation
All

Feeder Line
All

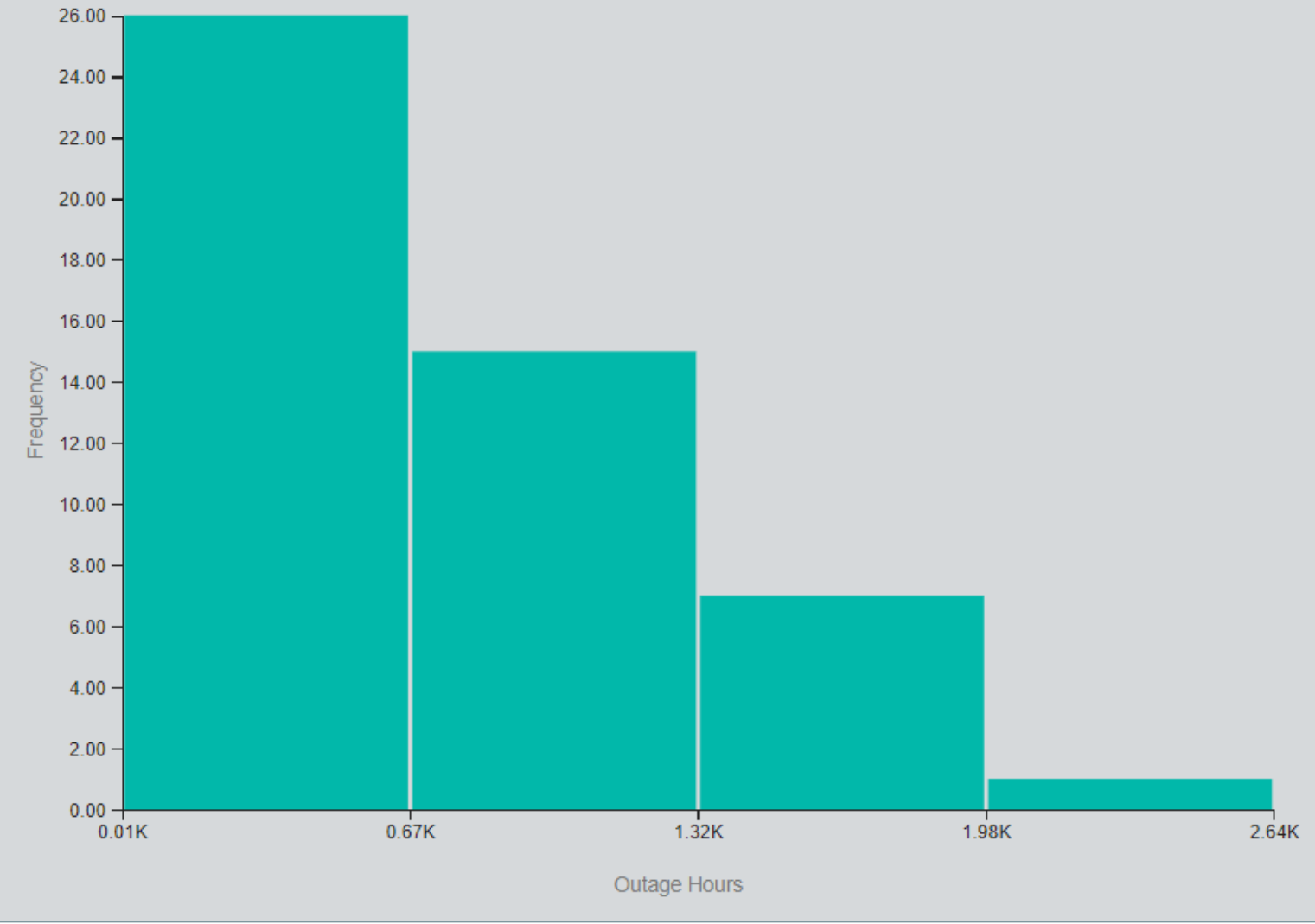
LineSection
All

Transformer
All

Meter
All

Outage Type
- Feeder
- LineSection
- Meter
- N
- SubStation

Outage Hours vs Frequency



Outage Spread across a day

OEC
OKLAHOMA ELECTRIC COOPERATIVE

9/18/2019 7:11:42 AM
Last Refresh

Outage Date
This | - | Year
1/1/2019 - 12/31/2019

Substation
NOB

Equipment
All

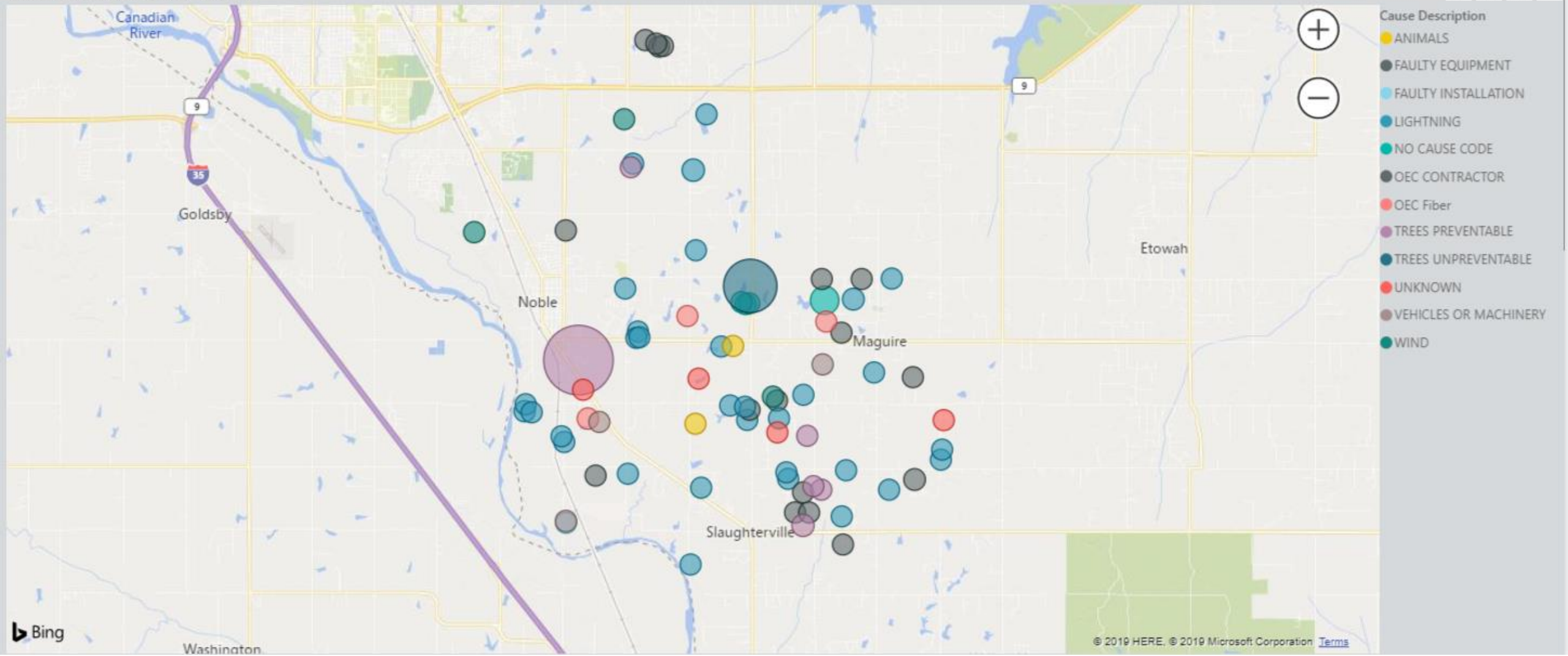
Feeder Line
All

Cause Group
Multiple selections

Cause Description
All

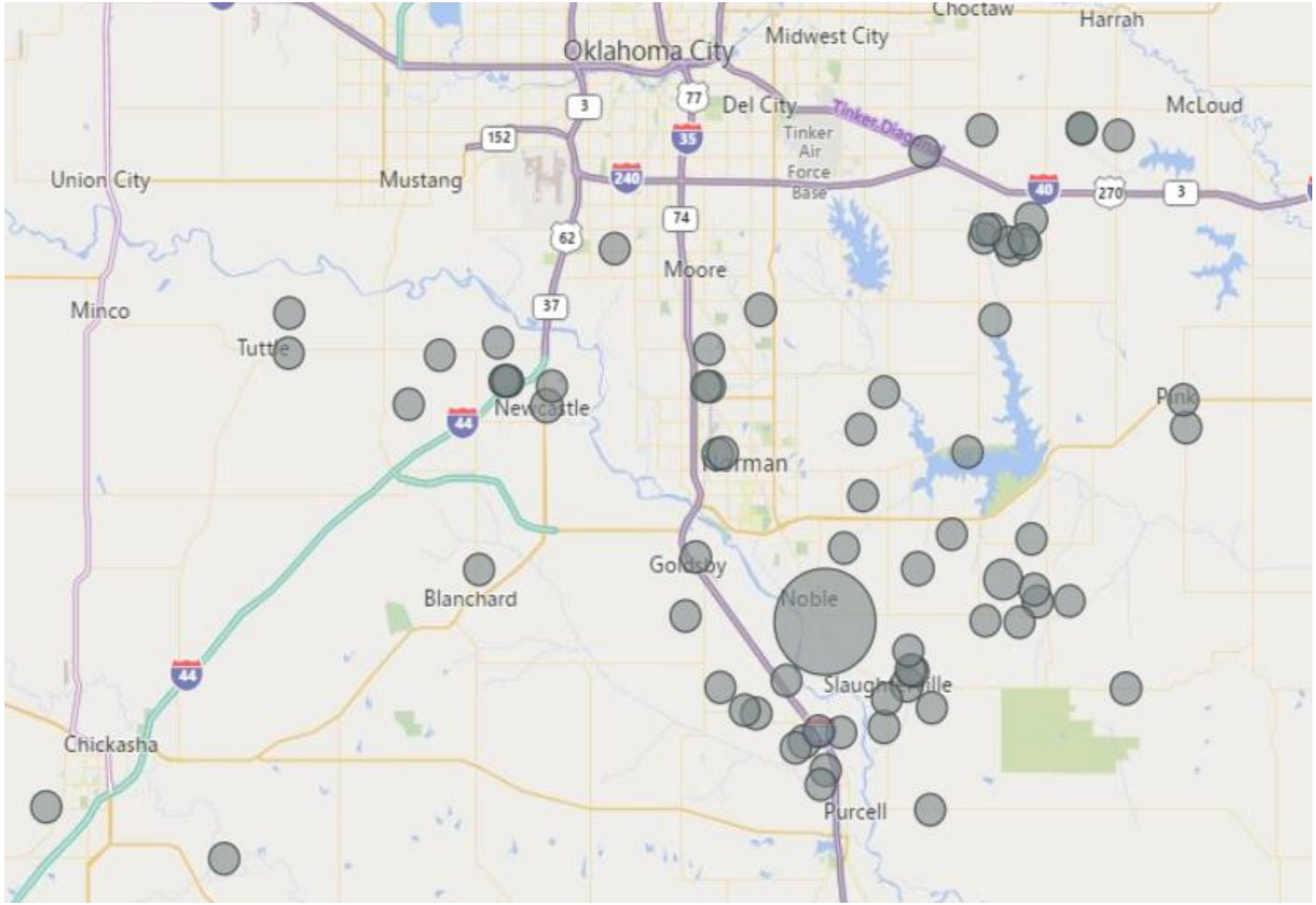
3407
Customers Impacted
141.5
Outage Hours

Customers Impacted by Cause



GIS Integration

Tree Outages



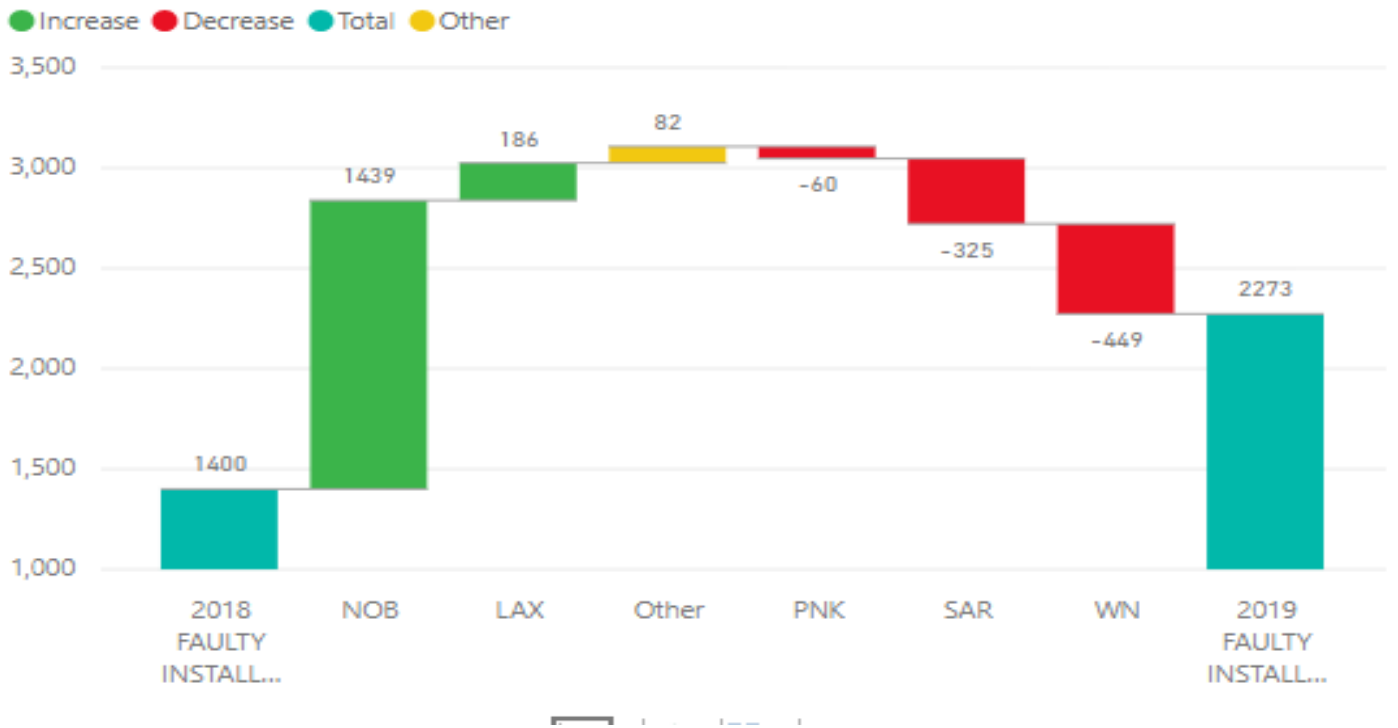
Built in Analysis

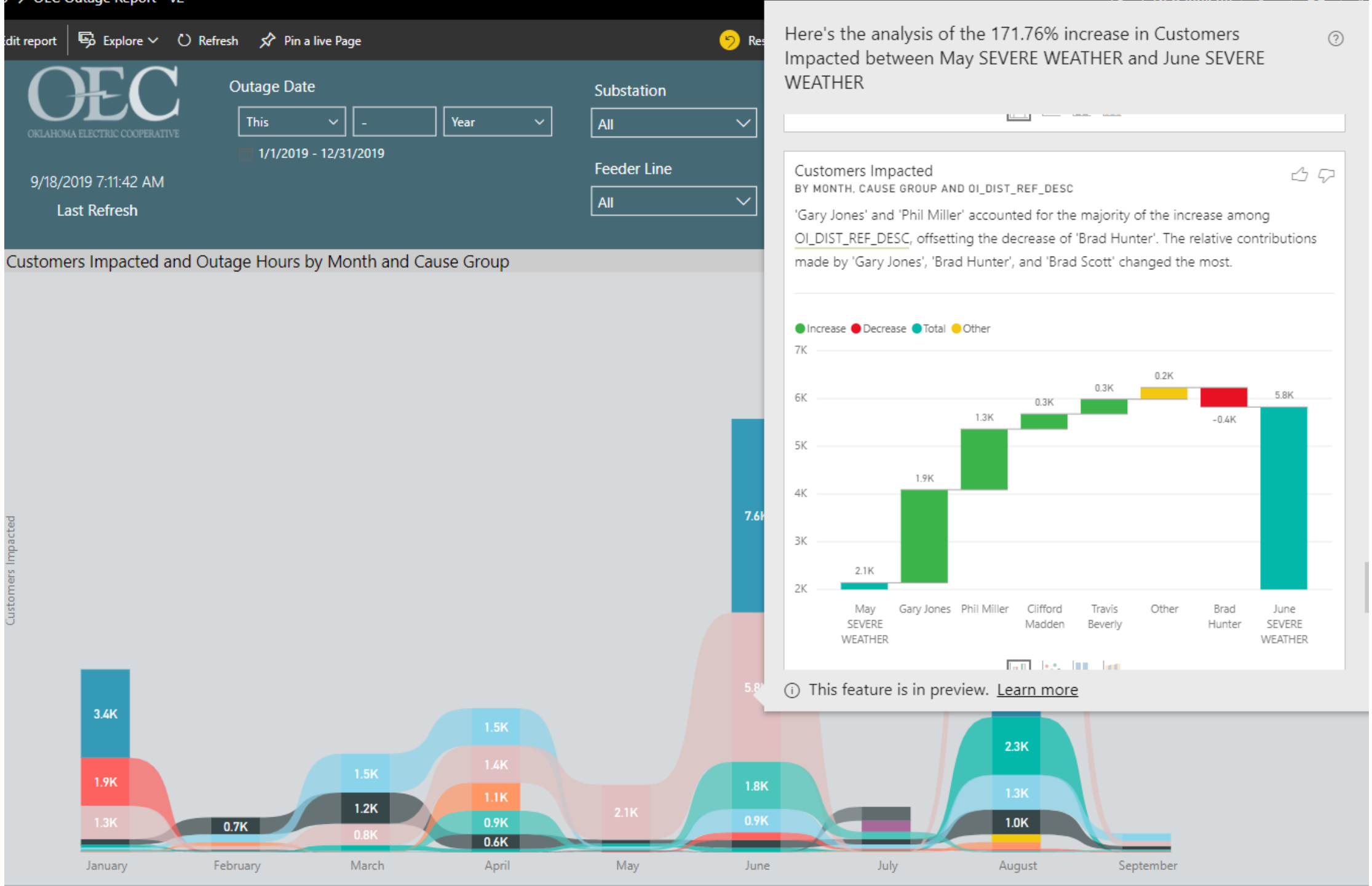
Here's the analysis of the 62.36% increase in Customers Impacted between 2018 FAULTY INSTALLATION/MAINTENANCE and 2019 FAULTY INSTALLATION/MAINTENANCE

Customers Impacted

BY YEAR, CAUSE GROUP AND OI_SUB

'NOB' accounted for the majority of the increase among OI_SUB, offsetting the decrease of 'WN'. The relative contributions made by 'NOB', 'WN', and 'SAR' changed the most.




dit report
Explore
Refresh
Pin a live Page
OEC
OKLAHOMA ELECTRIC COOPERATIVE
Outage Date
This
-
Year
1/1/2019 - 12/31/2019
9/18/2019 7:11:42 AM
Last Refresh
Substation
All
Feeder Line
All
Customers Impacted and Outage Hours by Month and Cause Group
Customers Impacted
3.4K
1.9K
1.3K
0.7K
1.5K
1.2K
0.8K
1.5K
1.4K
1.1K
0.9K
0.6K
2.1K
7.6K
1.8K
0.9K
2.3K
1.3K
1.0K
January
February
March
April
May
June
July
August
September
Here's the analysis of the 171.76% increase in Customers Impacted between May SEVERE WEATHER and June SEVERE WEATHER
Customers Impacted
BY MONTH, CAUSE GROUP AND OI_DIST_REF_DESC
'Gary Jones' and 'Phil Miller' accounted for the majority of the increase among OI_DIST_REF_DESC, offsetting the decrease of 'Brad Hunter'. The relative contributions made by 'Gary Jones', 'Brad Hunter', and 'Brad Scott' changed the most.
Increase
Decrease
Total
Other
7K
6K
5K
4K
3K
2K
2.1K
1.9K
1.3K
0.3K
0.3K
0.2K
-0.4K
5.8K
May SEVERE WEATHER
Gary Jones
Phil Miller
Clifford Madden
Travis Beverly
Other
Brad Hunter
June SEVERE WEATHER
This feature is in preview. Learn more

OEC Mission Statement

- At OEC, our purpose is to improve our members' quality of life through the safe delivery of highly reliable, reasonably priced electric service, innovative energy programs, and exceptional member service.

QUESTIONS?