2021 SYSTEM RELIABILITY

AT GRAYS HARBOR PUD

April 18, 2022

Areas of Discussion

- Reliability Review
- Reliability Statistics
- 2021 Overview
- Outage Causes
- Tree Related Outages
- Wrap Up

Reliability Review

WHAT IS RELIABILITY?

Reliability …

… is an indication of how well the system performs at delivering power to our customers.

… has to do with complete interruptions of power.

… does not cover momentary outages or power quality issues.

Factors related to reliability are …

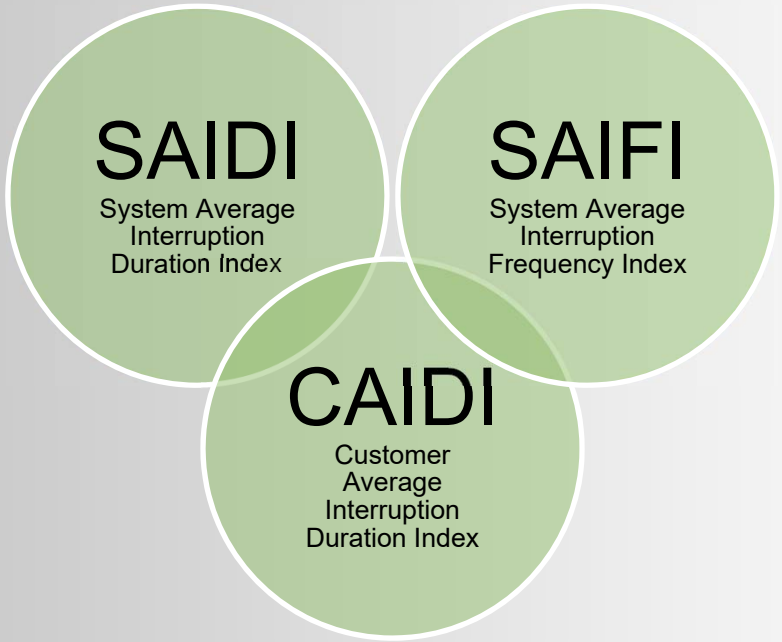
… number of customers

… duration of the interruption

… frequency of interruptions

HOW DO WE MEASURE RELIABILITY?

We track the three most common standard indices:



We also track outage counts and duration by various causes, circuits, substations, etc.

HOW DO WE IMPROVE RELIABILITY?

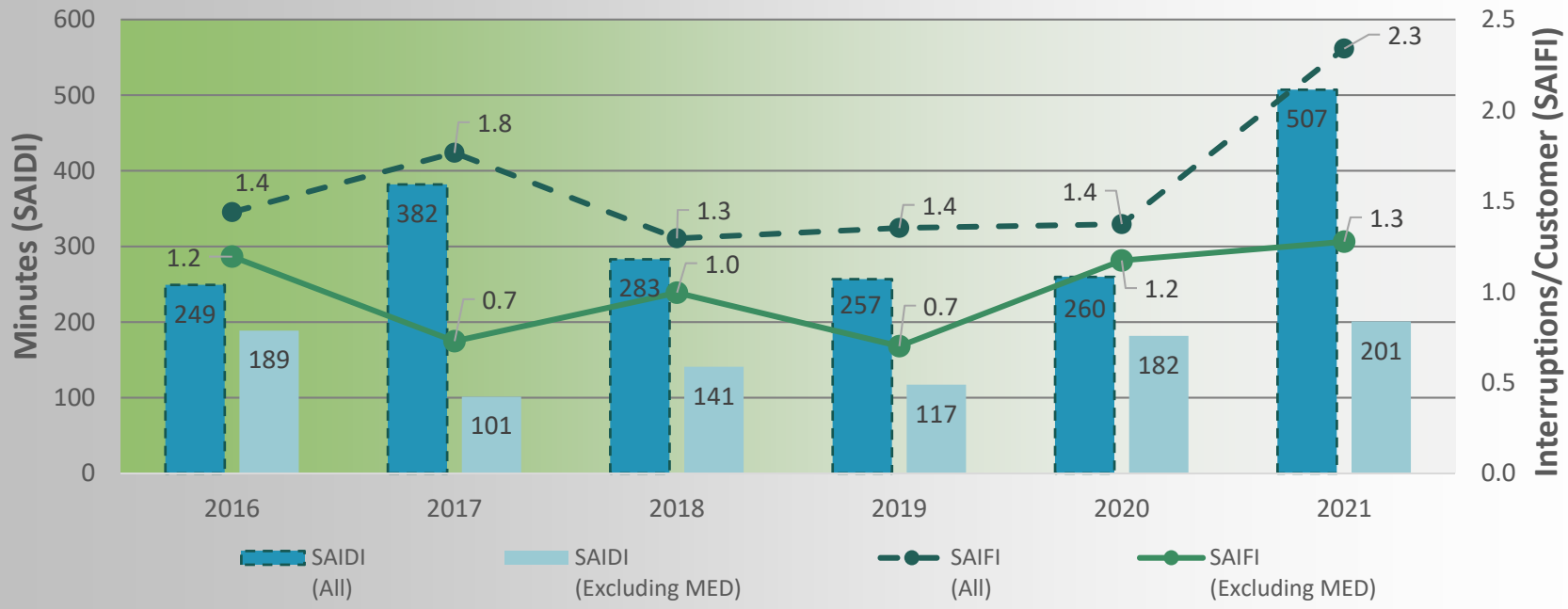
Reliability is improved by reducing outage frequency and duration through:

- Tree Trimming and Mowing
- Equipment Maintenance and Replacement
- Adding Line Reclosers and Other Protective Devices
- Feeder Configuration Change (Add More Ties and Backup Connections)
- Faster Customer Restoration

Reliability Statistics

RELIABILITY INDICES THROUGH 2021

Excluding Scheduled Outages



SAIDI - System Average Interruption Duration Index in Minutes/Customer
SAIFI - System Average Interruption Frequency Index in Interruptions/Customer

What Happened?

In 2021

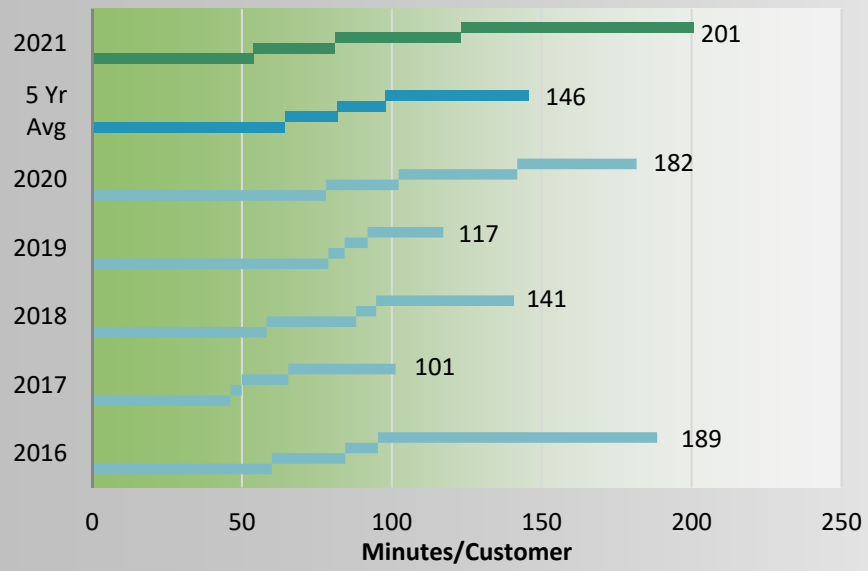
- Higher number of Major Event Days than normal
- More “large” outages than normal
- Extended outages due to snow and ice
- Multiple widespread storm events
- Multiple large scale vehicle incidents

2021 QUARTERLY RELIABILITY INDICES

Excluding Major Event Days

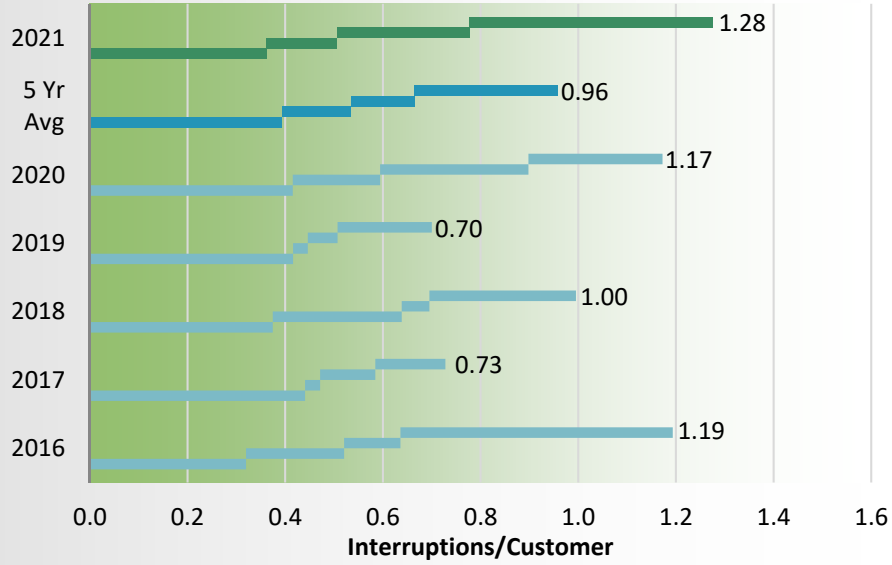
SAIDI

System Average Interruption Duration Index



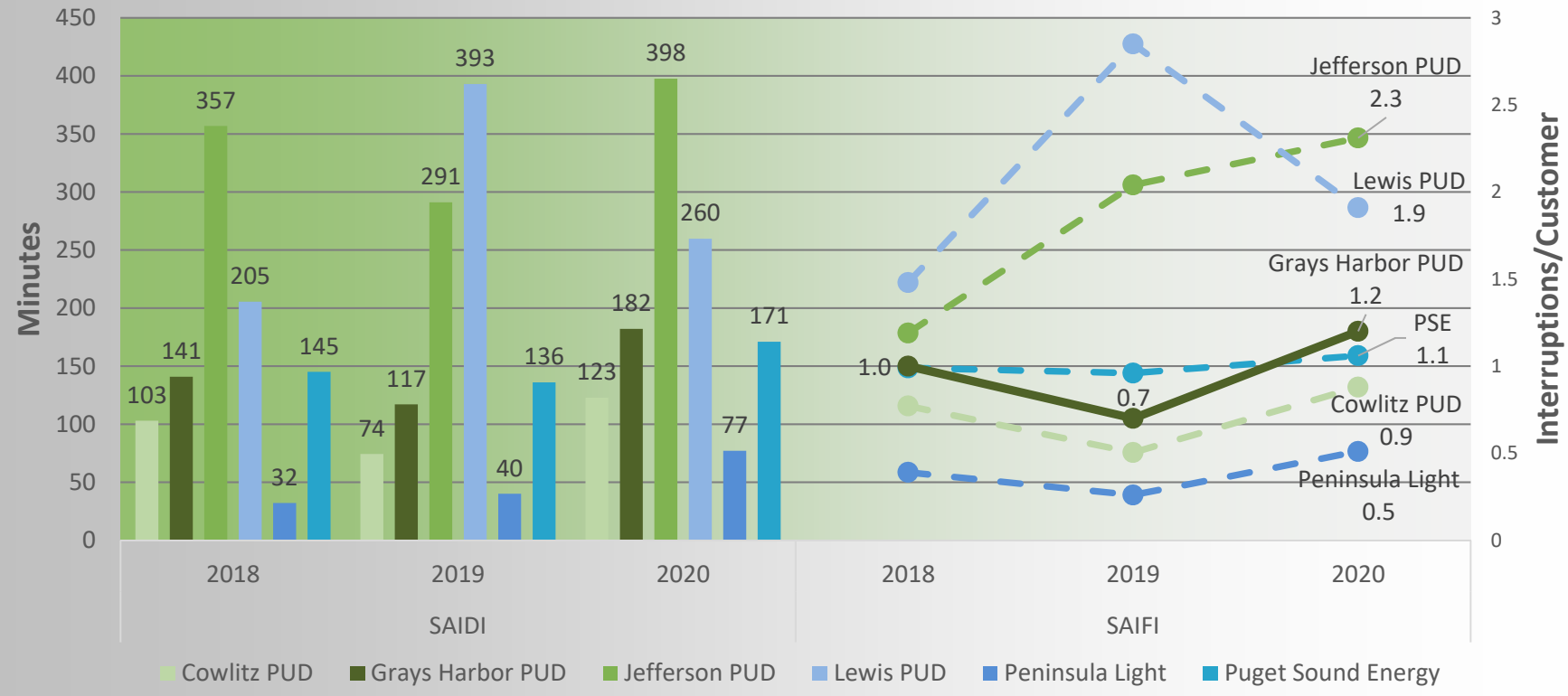
SAIFI

System Average Interruption Frequency Index



UTILITY RELIABILITY STATISTICS COMPARISON

Based on IEEE 1366 and Reported to USEIA - excluding Major Event Days



USEIA - US Energy Information Administration
SAIDI - System Average Interruption Duration Index in Minutes/Customer
SAIFI - System Average Interruption Frequency Index in Interruptions/Customer

2021 Overview

KEY OUTAGE INDICATOR COMPARISON

	Totals 2021	Totals 2020	Previous 5 Yr Avg	Change
Outages	**312**	345	323	▼ -3%
Interruptions	**102,091**	59,068	60,710	▲ 68%
Customer Hours	**368,833**	186,224	200,405	▲ 84%
SAIDI (Min / Cust)	**507**	260	286	▲ 77%
*	**201**	182	146	▲ 38%
SAIFI (Int / Cust)	**2.3**	1.4	1.4	▲ 62%
*	**1.3**	1.2	1.0	▲ 33%

* Excluding Major Event Days

KEY OUTAGE CONTRIBUTORS

Most Affected Month

Main Cause

Most Affected System

	Most Affected Month	2021	% of Total	Main Cause	2021	% of Total	Most Affected System	2021	% of Total
Outages	December	49	16%	Trees - Broken or Fell	116	37%	12kV	284	91%
Interruptions	June	18,319	18%	Trees - Broken or Fell	41,732	41%	69kV	62,866	62%
Customer Hours	October	79,183	21%	Trees - Broken or Fell	133,281	36%	69kV	249,426	68%

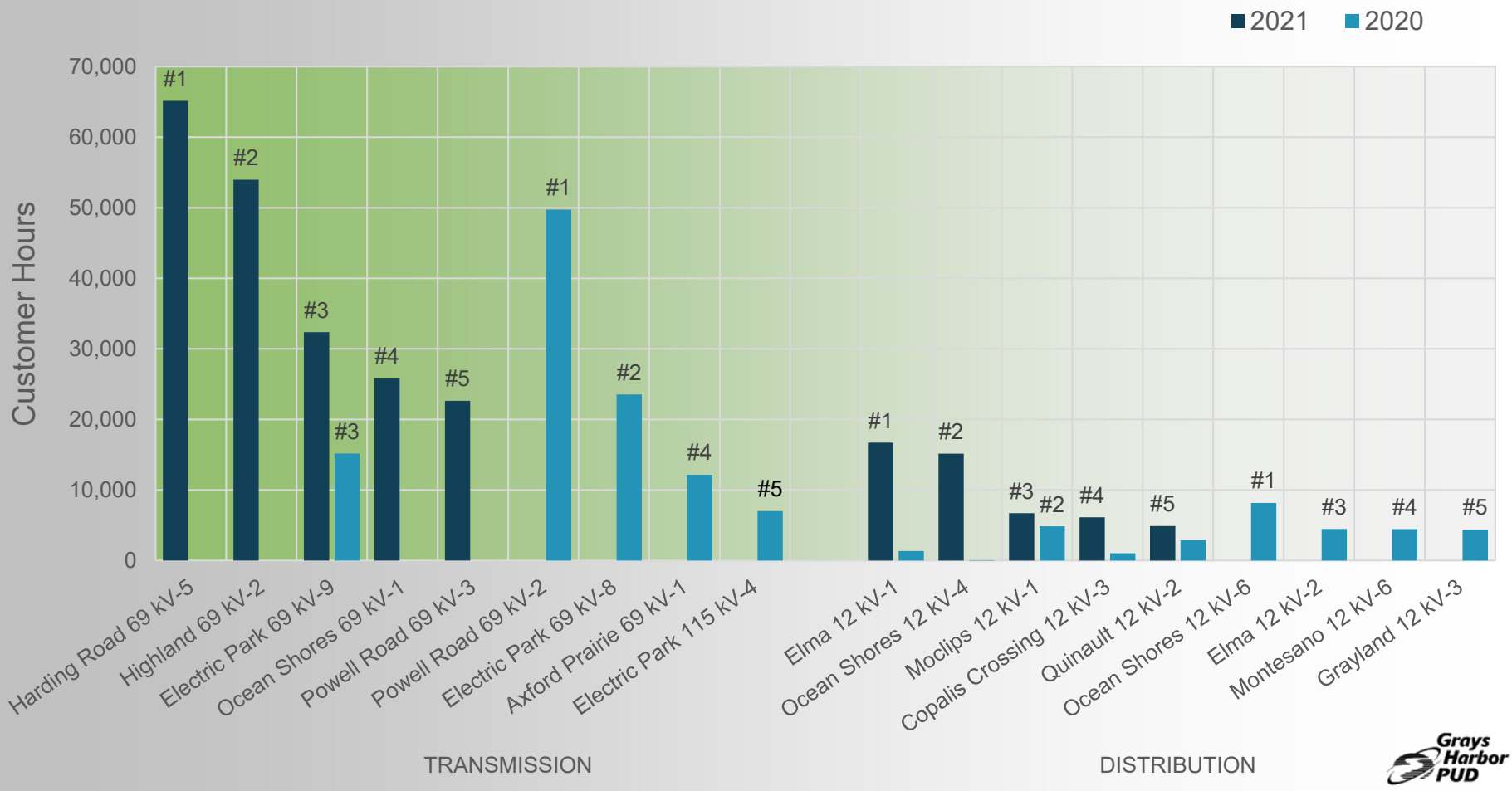
LARGE OUTAGES

More Than 3,000 Customer Hours

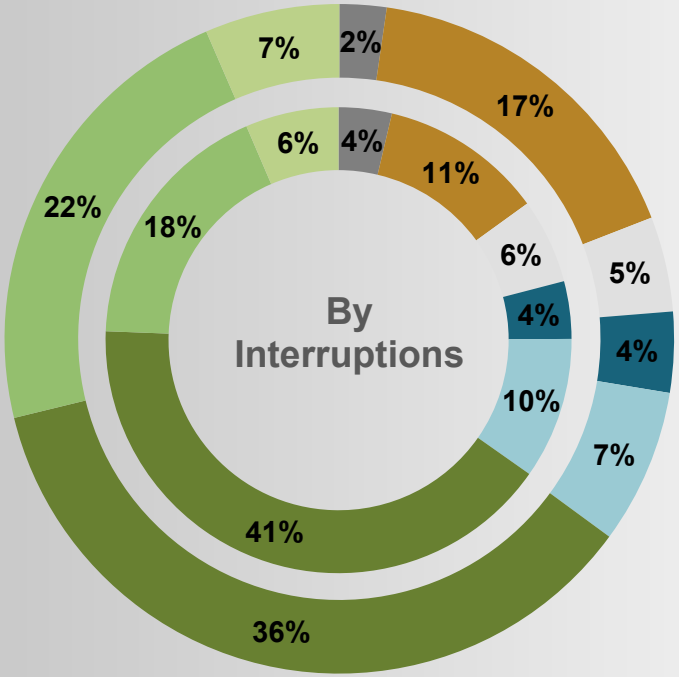
Outage No.	Date	Circuit	Cause	Equipment Involved	Customers Affected	Customer Hours
114837	10/25/2021	Harding Road 69 kV-5	Storm Related	Circuit Breaker	5,153	32,747
114743	6/17/2021	Harding Road 69 kV-5	Motor Vehicle	Circuit Breaker	5,111	32,397
114833	10/24/2021	Ocean Shores 69 kV-1	Trees - Broken or Fell	Circuit Breaker	7,546	25,782
114746	6/26/2021	Powell Road 69 kV-3	Trees - Broken or Fell	Aluminum Wire	8,590	22,620
114685	2/26/2021	Highland 69 kV-2	Wind	Circuit Breaker	5,931	21,606
114767	8/1/2021	Highland 69 kV-2	Overload	Circuit Breaker	5,945	16,409
114901	12/11/2021	Highland 69 kV-2	Storm Related	Circuit Breaker	5,155	15,959
114652	2/12/2021	Ocean Shores 12 kV-4	Electrical Failure	Copper Wire	200	14,087
114628	1/12/2021	Elma 12 kV-1	Trees - Broken or Fell	Aluminum Wire	1,375	13,223
114629	1/12/2021	South Elma 115 kV-2	Trees - Broken or Fell	Aluminum Wire	1,609	11,812
114627	1/12/2021	Electric Park 69 kV-9	Trees - Broken or Fell	Aluminum Wire	1,817	10,741
114844	10/30/2021	Westport 69 kV-1	Motor Vehicle	Poles	1,087	10,290
114920	12/26/2021	Electric Park 69 kV-9	Trees - Broken or Fell	Conductor	1,814	9,308
114848	11/3/2021	Electric Park 69 kV-8	Trees - Broken or Fell	Circuit Breaker	2,564	8,263
114691	3/4/2021	Powell Road 69 kV-1	Motor Vehicle	Conductor	2,261	7,885
114748	6/27/2021	Electric Park 69 kV-9	District's Equipt	Circuit Breaker	1,814	7,528
114674	2/14/2021	Westport 69 kV-1	Motor Vehicle	Poles	1,746	6,984
114654	2/12/2021	Copalis Crossing 12 kV-3	Storm Related	Aluminum Wire	91	6,077
114620	1/3/2021	Quinault 69 kV-1	Trees - Broken or Fell	Circuit Breaker	857	5,542
114747	6/27/2021	Electric Park 69 kV-9	Electrical Failure	Circuit Breaker	1,814	4,784
114903	12/11/2021	Axford Prairie 69 kV-1	Storm Related	Aluminum Wire	862	4,628
114891	12/1/2021	Elma 12 kV-3	District's Equipt	Circuit Breaker	1,166	4,275
114838	10/25/2021	Moclips 12 kV-1	Storm Related	Circuit Breaker	1,270	4,170
114753	7/2/2021	Electric Park 12 kV-7	Electrical Failure	Connector/Splice/Jumper	2,098	3,673
Totals	**24**				**67,876**	**300,790**
Overall Totals	**312**				**102,091**	**368,833**
% of Overall Totals	**8%**				**66%**	**82%**

Grays Harbor PUD

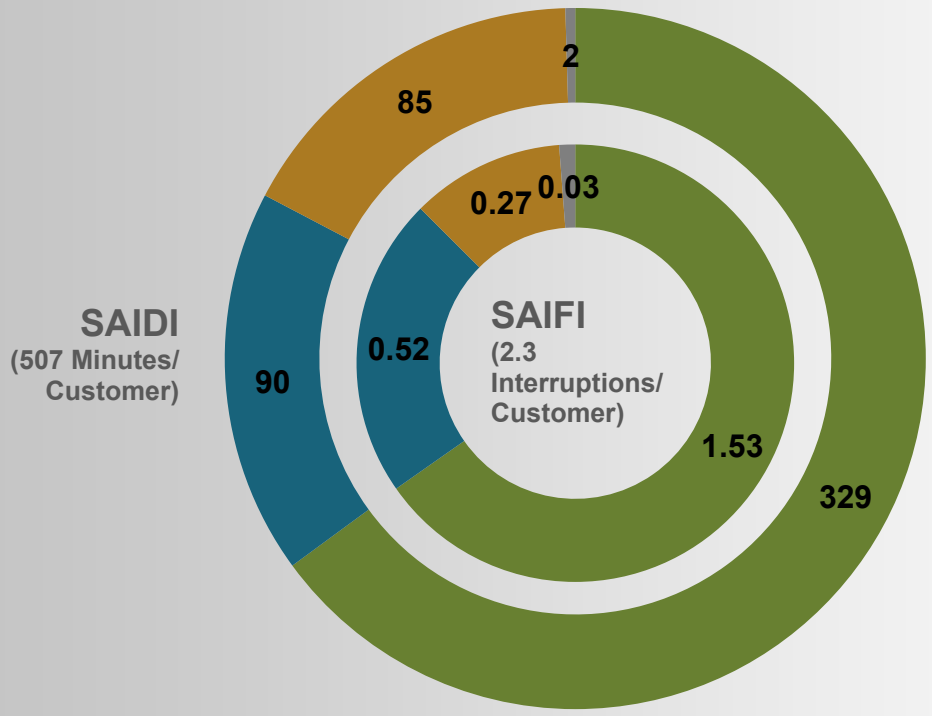
MOST AFFECTED CIRCUITS FOR 2021



2021 Outage Causes

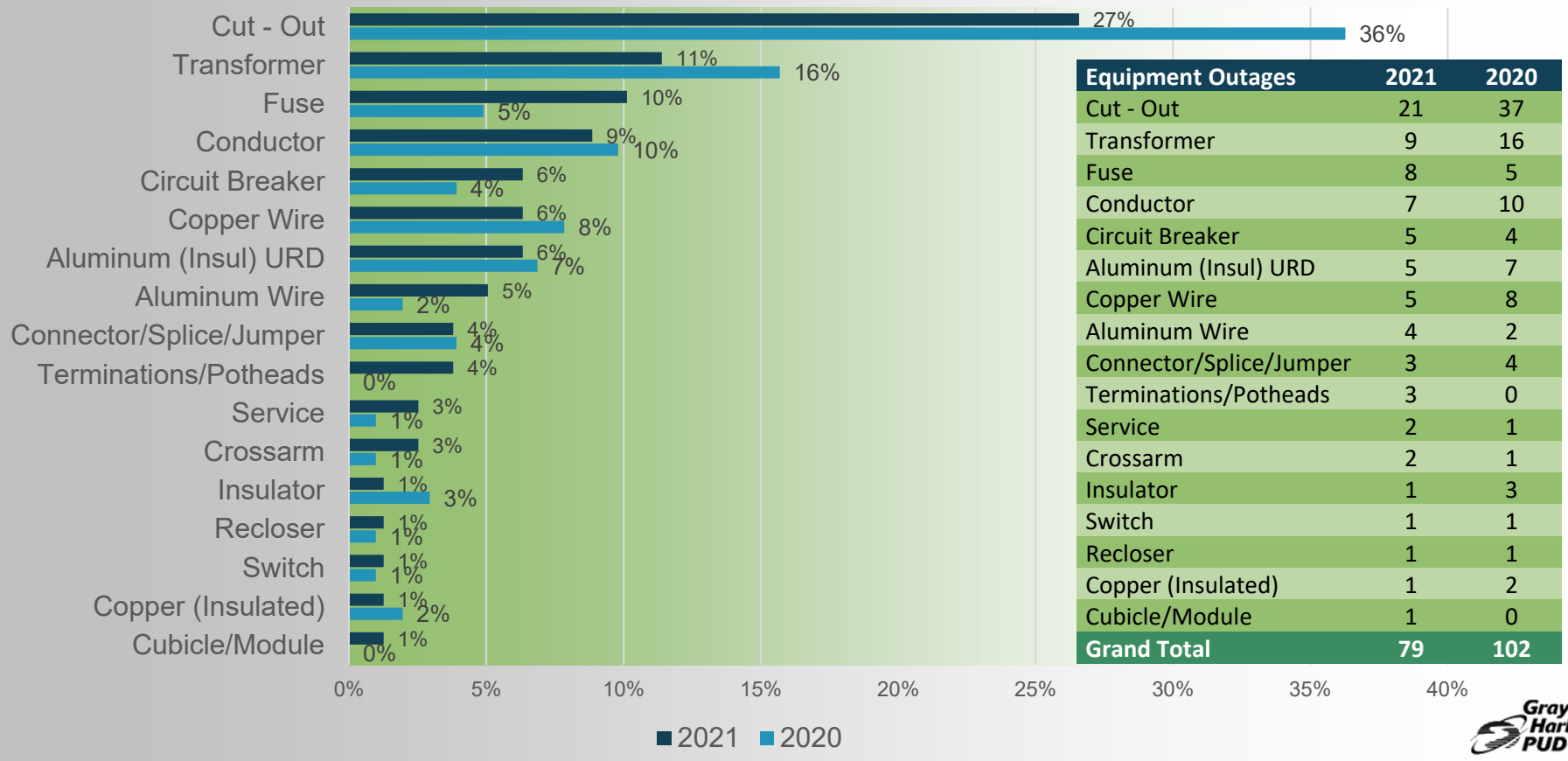


CAUSES RELATED TO INDICES



EQUIPMENT FAILURES

By % of Total Failures



Equipment Outages	2021	2020
Cut - Out	21	37
Transformer	9	16
Fuse	8	5
Conductor	7	10
Circuit Breaker	5	4
Aluminum (Insul) URD	5	7
Copper Wire	5	8
Aluminum Wire	4	2
Connector/Splice/Jumper	3	4
Terminations/Potheads	3	0
Service	2	1
Crossarm	2	1
Insulator	1	3
Switch	1	1
Recloser	1	1
Copper (Insulated)	1	2
Cubicle/Module	1	0
Grand Total	**79**	**102**

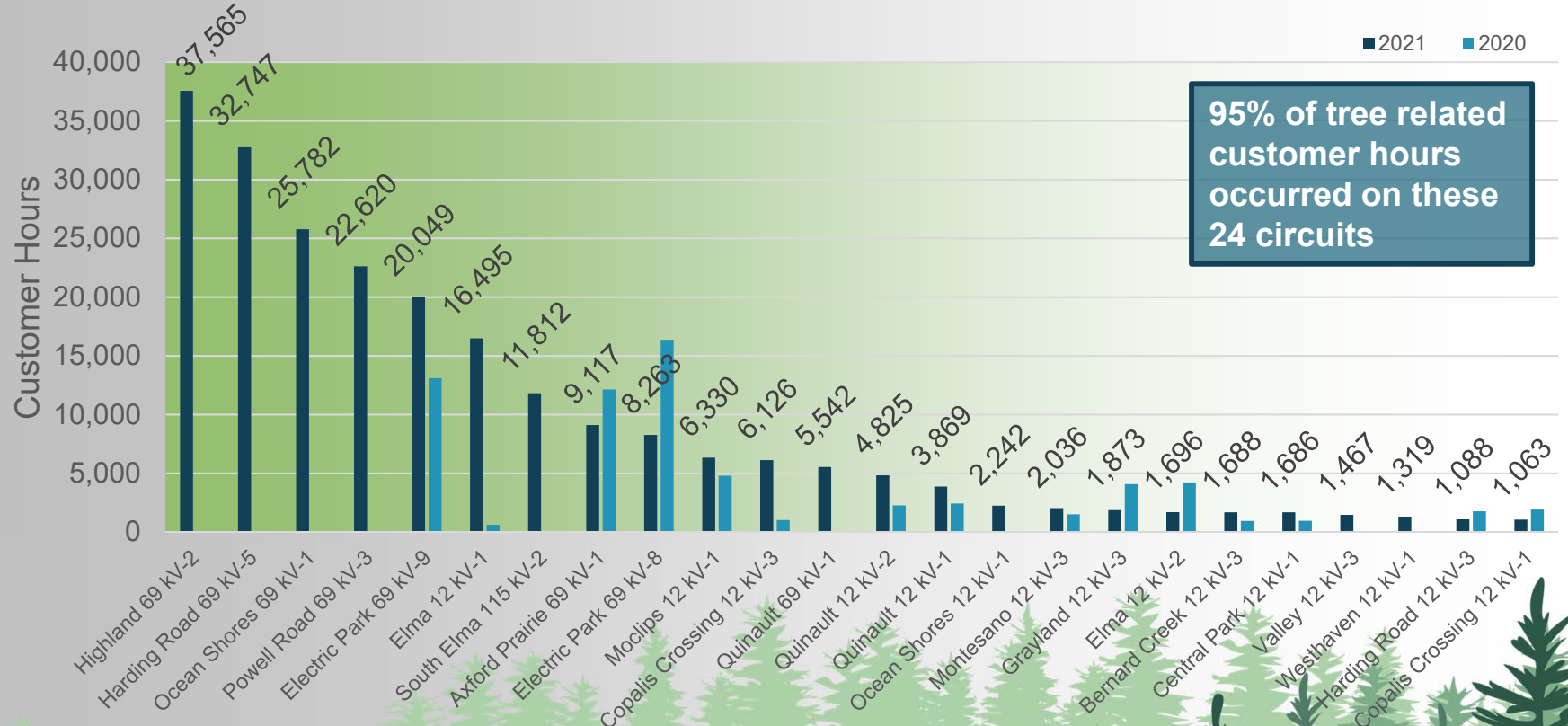
Tree Related Outages

ANALYSIS

- Typically, trees cause the majority of our outages
- To more closely reflect the effect that trees have on system outages, we have combined Storm Related, Trees – Broken or Fell, and Wind for analysis
- With these combined causes we looked at the outages by substation and by circuit

Grays Harbor PUD

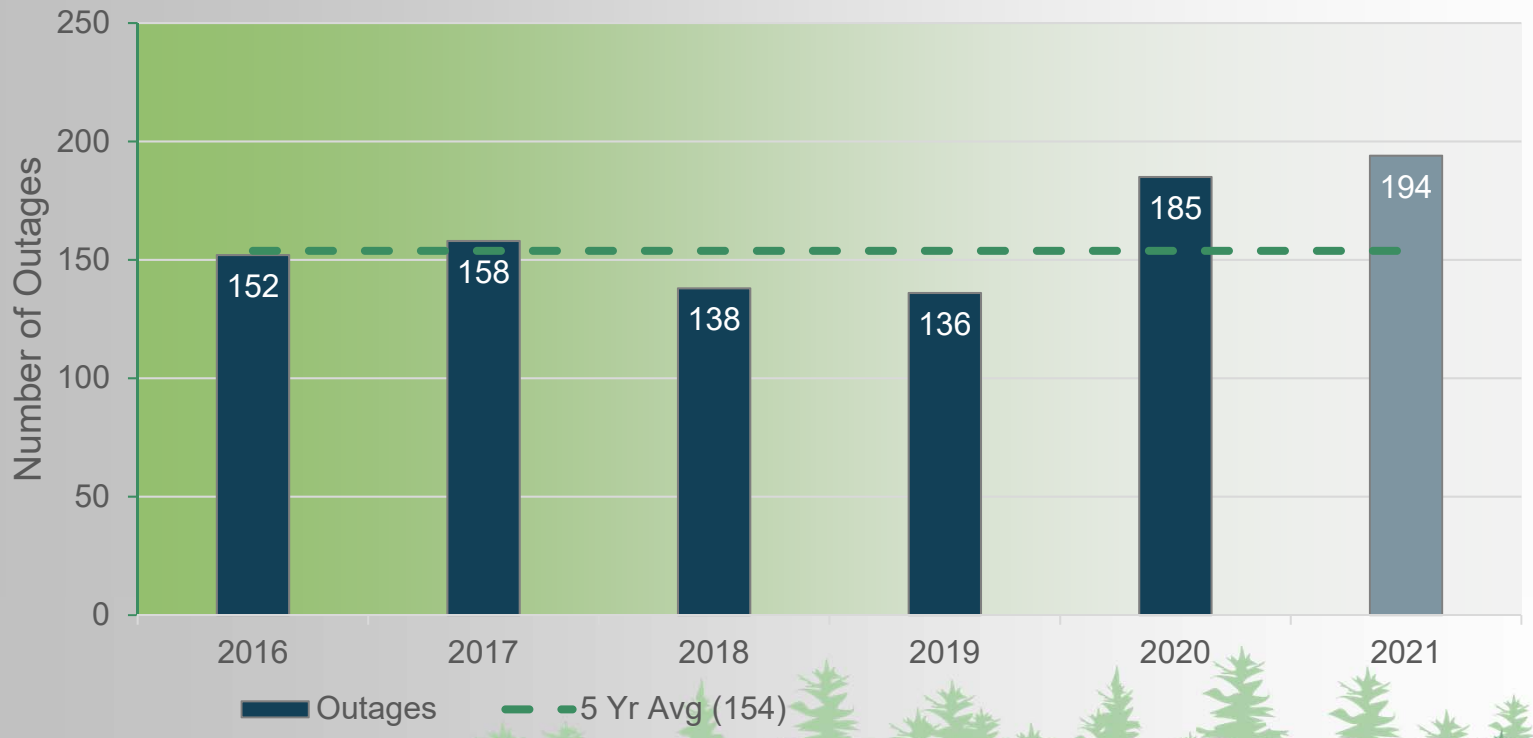
TREE RELATED OUTAGES BY CIRCUIT



95% of tree related customer hours occurred on these 24 circuits

More Than 1,000 Customer Hours

TREE RELATED OUTAGES BY YEAR



POSSIBLE AREAS OF FOCUS

Looking at locations with three or more outages we should take a closer look at these areas:

Area	Outages	Customer Hours	Customers Affected
Cloquallum Rd / South Union Rd	5	13,634	1,597
South Shore Rd	12	3,824	756
North Shore Rd	10	3,302	806
Ocean Beach Rd	5	1,688	632
East Wiskah Rd	4	1,436	424
Kindred Ave	4	1,187	240
Malone Hill Rd	3	909	107
Pacific Ave	4	673	130
North River Rd	3	545	41
Geissler Rd	4	349	165
Aberdeen Gardens Rd	3	192	100
Abbott Rd	3	172	40
Upper Falls Crk Rd	5	103	75
Hurd Rd	3	99	40

Wrap Up

CONCLUSION

Overall

Almost all key indicators were up compared to the previous year and the 5 year average.

SAIDI and SAIFI

Removing Major Event Days did have a sizable positive effect on SAIDI and SAIFI.

Trees

Tree related outages were up compared to the previous year and the 5 year average.

Continued Focus

Stay focused on vegetation management overall and focus on improvements in high outage areas.

Future

Review / update sectionalizing to improve exposure.

Questions?

Grays Harbor PUD