THE STATE OF NEW HAMPSHIRE
BEFORE THE
PUBLIC UTILITIES COMMISSION

Unitil Energy Systems, Inc.

RELIABILITY PROGRAM AND VEGETATION MANAGEMENT PROGRAM ANNUAL REPORT – FISCAL YEAR 2017

1. Introduction

Pursuant to the Settlement Agreement approved by the New Hampshire Public Utilities Commission ("Commission") in Docket No. DE 10-055[1] , Unitil Energy Systems, Inc. ("UES" or "Company") is submitting the results of the Reliability Enhancement Plan ("REP") and Vegetation Management Plan ("VMP") for Fiscal Year 2016 ("FY 2016"), report the period, January 1, 2016 – December 31, 2016.

The Settlement Agreement provides that on or before the last day of February of each year following approval, Unitil will provide an annual report to the Commission, Staff and OCA showing actual REP and VMP activities and costs for the previous calendar year, and its planned activities and costs for the current calendar year. Actual and planned REP and VMP costs shown in the reportwill be reconciled along with the revenue requirements associated with the actual and planned capital additions and expenses. This reportincludes the following information:

(A) A description of Unitil's VMP;
(B) A comparison of FY2016 actual to budgeted spending on O&M activities related to the VMP
(C) Detail on the O&M spending related to the FY2017 VMP estimated expenditures and work to be completed;
(D) A summary of the reliability performance tracking for pruning, hazard tree and storm pilot program components;
(E) A summary of the Vegetation Management Storm Hardening Pilot Program results;
(F) Detail on the O&M spending related to Exacter Inspection survey;
(G) Detail on the O&M spending related to Enhanced Tree Trimming;
(H) Detail on the reliability capital spending for 2016 and 2017 budget; and
(I) Reliability performance of the UES Capital and UES Seacoast systems.

[1] Order 25,214 dated April 26, 2011

2. Vegetation Management Plan

The VMP is based upon the recommended program provided in the report of Unitil's consultant Environmental Consultants, Inc. ("ECI")[2], modified to incorporate a 5-year prune cycle with 10-foot side and 15-foot top prune zones.

2.1. Plan Description

Unitil's VMP is comprised of five components; 1) circuit pruning; 2) hazard tree mitigation; 3) mid-cycle review; 4) forestry reliability assessment; and 5) storm resiliency work. This program is designed to support favorable reliability performance, reduce damage to lines and equipment, as well as provide a measure of public safety. The main benefits and risks addressed by these programs are reliability, regulatory, efficiency, safety and customer satisfaction.

2.1.1. Circuit Pruning

Vegetation maintenance pruning is done on a cyclical schedule by circuit. The optimal cycle length was calculated by balancing five important aspects: 1) clearance to be created at time of pruning; 2) growth rates of predominant species; 3) risk to system performance; 4) aesthetics / public acceptance of pruning; and 5) cost to implement. For New Hampshire, this optimal cycle length was calculated as 5 years for all lines.

2.1.2. Hazard Tree Mitigation

The Hazard Tree Mitigation program ("HTM") consolidates tree removal activities into a formalized program with risk tree assessment. This program is aimed at developing a more resistant electrical system that is more resilient under the impacts of typical wind, rain and snow events. The intention is to accomplish this through minimizing the incidence and resulting damage of large tree and limb failures from above and alongside the conductors through removal of biologically unhealthy or structurally unstable trees and limbs.

[2] A copy of the ECI reliabilityort, originally provided in response to data request Staff 1-29 (Confidential), was made part of the record in DE 10-055, UES's 2010 base rate case, as a Confidential Exhibit, accompanied by a public redacted version, during the hearing before the Commission.

HTM circuits are identified and prioritized through reliability assessment risk ranking, identification as a worst performing circuit, field problem identification, and time since last worked. Once circuits are identified they are scheduled in two ways: 1) while the circuit is undergoing cycle pruning; or 2) scheduled independently of cycle pruning. In New Hampshire, HTM circuit selection corresponds closely with cycle pruning, as both pruning and HTM are on a 5 year cycle.

In order to produce the greatest reliability impact quickly and cost effectively, HTM circuit hazard tree assessment and removal is focused primarily on the three phase only, with most emphasis on the portion of the circuit from the substation to the first protection device. In circuits that have undergone storm resiliency work, the HTM focus also includes single phase circuitry.

2.1.3. Mid-Cycle Review

The mid-cycle review program targets circuits for inspection and pruning based on time since last circuit pruning and forecasted next circuit pruning. The aim of this program is to address the fastest growing tree species that will grow into the conductors prior to the next cyclic pruning, potentially causing reliability, restoration and safety issues. As the first full circuit pruning cycle is underway, mid-cycle review will be used to address only 13.8kV and above, three-phase portions of selected circuits. Circuit selection is based on number of years since last prune and field assessment.

2.1.4. Forestry Reliability Assessment

The Forestry Reliability Assessment program targets circuits for inspection, pruning, and hazard tree removal based on recent historic reliability performance. The goal of this program is to allow reactive flexibly to address immediate reliability issues not addressed by the scheduled maintenance programs. Using recent historic interruption data, poor performing circuits are selected for analysis of tree related interruptions. Circuits or portions of circuits showing a high number of tree related events per mile, customers interrupted per event, and/or customer minutes interrupted per event are selected for field assessment. After field assessment, suitable circuits are scheduled and a forestry work prescription is written for selected circuits or areas.

2.1.5. Storm Resiliency Work

The SRP targets critical sections of circuits for tree exposure reduction by removing all overhanging vegetation or pruning "ground to sky", as well as performing intensive hazard tree review and removal along these critical sections and the remaining three phase of the circuit. The goal of this program is to reduce tree related incidents and resulting customers interrupted along these portions in minor and major weather events. In turn, the aim is to reduce the overall cost of storm preparation and response, and improve restoration.

2.2. 2017 Actual Expenditures and Work Completed

Table 1 depicts the 2017 VMP expenditures by activity in relation to the anticipated budget expenditures. As the program progressed in 2017 there were some deviations in the anticipated expenditures. In the VMP spending, the Hazard Tree Mitigation and the Police/Flagging work activities had the most deviation in spending relative to anticipated costs. Both were less than anticipated. An additional cost for VMP Planning was also incurred for a new viewer to current software which more efficiently and effectively schedules, manages, implements and monitors the VMP components and the SRP work. As shown in the table below, the program total was $606,560 under budget, with only minor work carryover (in hazard tree, mid-cycle and sub-transmission) into 2018 due to vendor delays from nationwide and regional storm impact. The work spending for the SRP was well above the anticipated level. This was due to encountering a higher than anticipated level of risk trees on the identified circuits. As shown in the table below, total spending for all VMP and SRP components was above the budget by $210,887.

Table 1

2017 VMP O&M Activities		
VM Activity	**2017 Cost Proposal**	**2017 Actual Cost**
Cycle Prune	$ 1,163,894	$ 1,150,079
Hazard Tree Mitigation	$ 800,000	$ 622,537
Forestry Reliability Work	$ 24,857	$ 6,983
Mid-Cycle Review	$ 112,000	$ 27,745
Police / Flagger	$ 616,852	$ 363,349
Core Work	$ 150,000	$ 149,367
VMP Planning	$ -	$ 10,000
Distribution Total	**$ 2,867,603**	**$ 2,330,060**
Sub-T	$ 484,543	$ 409,398
VM Staff	$ 304,757	$ 310,885
Program Total	**$ 3,656,903**	**$ 3,050343**
Storm Resiliency Program	$ 1,423,000	$ 2,240,447
Grand Total	**$ 5,079,903**	**$ 5,290,790**

The following tables detail the 2017 VMP work completed by activity. Table 2 details the cycle pruning work. A total of 224 miles of cycle pruning was completed in 2017.

Table 2

2017 VMP Completed Cycle Pruning Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C8X3	105.5	105.5	105.5
Seacoast	E11X1	11.9	11.9	11.9
Seacoast	E11X2	11.9	11.9	11.9
Seacoast	E19X2	2.8	2.8	2.8
Seacoast	E20H1	4.5	4.5	4.5
Seacoast	E28X1	10.2	10.2	10.2
Seacoast	E2X3	13.2	13.2	13.2
Seacoast	E2X2	20.1	20.1	20.1
Seacoast	E46X1	3.8	3.8	3.8
Seacoast	E54X1	21.5	17.5	17.5
Seacoast	E54X2	8.7	7.0	7.0
Seacoast	E56X1	17.0	15.6	15.6
Total			**224**	**224**

Table 3 details the hazard tree mitigation work. A total of 136.8 miles of line across 19 circuits were mitigated for hazard tree risk. Unitil had estimated approximately 2,228 hazard tree removals in the budget. The actual results indicate 1,566 total hazard trees were removed on these circuits and various other circuits as found through the course of work over the year.

Table 3

2017 VMP Completed Hazard Tree Mitigation Details					
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**	**# of Removals**
Capital	C4W3	18.6	3.0	3.0	36
Capital	C18W2	33.7	4.0	4.0	25
Capital	C13W1	33.7	6.2	6.2	267
Capital	C13W2	17.9	3.7	3.7	67
Capital	C4X1	23.7	16.1	0	0*
Capital	C4W4	14.2	4.0	4.0	8
Capital	C8X3	105.5	42.5	21.0	20*
Capital	*Various*				62
Seacoast	E13W2	29.0	2.0	2.0	79
Seacoast	E21W1	29.7	9.9	9.9	298
Seacoast	E21W2	21.6	8.5	8.5	139
Seacoast	E7X2	19.2	6.6	6.6	33
Seacoast	E18X1	17.9	8.5	8.5	39
Seacoast	E19X2	2.8	1.7	1.7	8
Seacoast	E2X3	13.2	7.2	7.2	20
Seacoast	E2X2	201.	12.9	12.9	41
Seacoast	E54X1	21.5	16.2	14.2	7*
Seacoast	E54X2	8.7	4.6	4.6	19
Seacoast	E56X1	17.0	11.8	11.8	3
Seacoast	E11X1	11.9	0	4.3	60
Seacoast	E11X2	11.9	0	2.7	34
Seacoast	*Various*				301
Total			**198.1**	**202.0**	**1,566**

* All hazard trees identified, marked, and approved for removal but not yet completed in the field – removals to carry over to 2018

Tables 4 and 5 detail the forestry reliability work and mid-cycle work respectively. A total of 2.3 miles of line underwent forestry reliability work and 64.7 miles of line were completed for mid-cycle work. Four circuits had work identified in the field, but work was not completed by year end and will carry over into 2018.

Table 4

2017 VMP Completed Reliability Analysis Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Seacoast	E58X1	31.1	2.3	2.3
Total			**2.3**	**2.3**

Table 5

2017 VMP Completed Mid-Cycle Review Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C13W1	33.7	6.2	6.2
Capital	C13W2	17.9	3.7	3.7
Capital	C4X1	23.7	7.6	0
Capital	C4W4	14.2	4.0	4.0
Capital	C22W1	4.4	3.1	3.1
Capital	C22W2	0.9	0.9	0.9
Capital	C7W4	7.4	4.2	0
Capital	C8H1	1.2	1.2	1.2
Capital	C8H2	4.6	2.8	0
Capital	C8X5	7.4	6.8	0
Capital	C38E	4.1	2.3	2.3
Capital	C38W	3.7	3.1	3.1
Seacoast	E21W1	29.7	9.9	9.9
Seacoast	E21W2	21.6	8.5	8.5
Seacoast	E7X2	19.2	6.6	6.6
Seacoast	E18X1	17.9	8.5	8.5
Seacoast	E17W1	8.9	3.5	3.5
Seacoast	E19H1	4.7	3.3	3.3
Total			**86.1**	**64.7**

Table 6 details the sub-transmission right-of-way clearing work. A total of 16.4 linear miles of right-of-way floor were cleared. A small portion of line 3358 along the RR will carry over into 2018 due to railroad flagger restrtictions and delays.

Table 6

2017 Sub Transmission Clearing Details			
District	**Feeder**	**Scheduled Miles**	**Completed Miles**
Capital	396	3.3	3.3
Capital	375	3.2	3.2
Capital	374	1.6	1.6
Seacoast	3358	1.2	0.1
Seacoast	3345/3356	4.5	4.5
Seacoast	3343/3354	3.7	3.7
Total		**17.5**	**16.4**

Additionally the sub-transmission right-of-way that was cleared in both Capital and Seacoast in 2016 underwent the integrated vegetation management (IVM) program's low-volume foliar herbicide application work in 2017. A total of approximately 222 acres were managed with IVM chemical control.

2.3. 2018 VMP Estimated Expenditures and Work To Be Completed

Table 7 depicts the 2018 VMP expenditures by activity and the proposed VMP activity details. Unitil proposes to spend $3,776,139 on VMP activities and another $1,897,333 on vegetation storm resiliency, explained in more detail below, for a total of $5,673,472.

Table 7

2018 VMP O&M Activities Cost Proposal		
VM Activity		**2018 Cost Proposal**
Cycle Prune	$	1,163,000
Hazard Tree Mitigation	$	800,000
Forestry Reliability Work	$	24,857
Mid-Cycle Review	$	112,000
Brush Control	$	-
Police / Flagger	$	573,600
Core Work	$	150,000
Distribution Total	**$**	**2,824,351**
Sub-T	$	626,521
Substation Spraying	$	10,700
VM Staff	$	314,567
Program Total	**$**	**3,776,139**
Storm Resiliency Program (SRP)	$	1,423,000
SRP Acceleration	$	474,333
Grand Total	**$**	**5,673,472**

Tables 8 through 12 provide more detail on each of the VMP activities planned for 2018. The activities include 216.4 miles of cycle pruning (Table 8), 86.2 miles of hazard tree mitigation (Table 9) which estimates 2,229 hazard tree removals, 7.7 miles of forestry reliability work (Table 10), 65.6 miles of mid-cycle pruning (Table 11), and 17.7 miles of sub-transmission clearing.

Table 8

2018 VMP Planned Cycle Pruning Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C13W2	18.0	18.0
Capital	C13W3	82.7	69.3
Capital	C24H1	2	2
Capital	C24H2	2	2
Capital	C33X4	2	2
Capital	C34X4	0.2	0.2
Seacoast	E13W2	29.0	29.0
Seacoast	E13X3	3.9	3.9
Seacoast	E56X2	2.4	2.4
Seacoast	E58X1	31.0	31.0
Seacoast	E5H1	2.4	2.4
Seacoast	E5H2	4.9	4.9
Seacoast	E5X3	2.2	2.2
Seacoast	E15X1	9.7	9.7
Seacoast	E17X1	8.9	8.9
Seacoast	E17W2	4.8	4.8
Seacoast	E2H1	2.3	2.3
Seacoast	E27X1	16.1	14.1
Seacoast	E27X2	8.7	7.3
Total			**216.4**

Table 9

2018 VMP Planned Hazard Tree Mitigation Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C4X1	23.7	16.1*
Capital	C8X3	105.5	8.9*
Capital	C15W1	16.8	8.2
Capital	C15W2	5.8	4.4
Capital	C7W3	23.2	14.8
Capital	C13W2	18.0	3.7
Capital	C24H2	2.0	1.6
Capital	C33X4	2.0	0.1
Seacoast	E54X1	21.5	3.0*
Seacoast	E22X1	51.1	11.9
Seacoast	E23X1	23.8	6.9
Seacoast	E6W1	27.0	10.7
Seacoast	E6W2	19.2	7.2
Seacoast	E13W2	29.0	10.7
Seacoast	E13X3	3.9	2.5
Seacoast	E56X2	2.4	2.1
Seacoast	E58X1	31.0	7.8
Seacoast	E5H1	2.4	1.7
Seacoast	E5H2	4.9	2.6

Seacoast	E5X3	2.2	0.6
Seacoast	E15X1	9.7	6.3
Seacoast	E17X1	8.9	3.5
Seacoast	E17W2	4.8	2.0
Seacoast	E2H1	2.3	1.4
Total			**86.2**

*carry-over

Table 10

2018 VMP Planned Reliability Analysis Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C15W1	16.8	3.6
Capital	C13W1	33.6	1.3
Capital	C4W4	13.3	1.1
Capital	C4W3	18.6	1.7
Total			**7.7**

Table 11

2018 VMP Planned Mid-Cycle Review Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C4X1	23.7	7.6*
Capital	C7W4	7.4	4.2*
Capital	C8H2	4.6	2.8*
Capital	C8X5	7.4	6.8*
Capital	C15W2	5.8	4.4
Capital	C7W3	23.2	14.8
Seacoast	E22X1	51.1	25.0
Total			**65.6**

*carry-over

Table 12

2018 Sub Transmission Planned Clearing Details		
District	**Feeder**	**Scheduled Miles**
Capital	35	4.4
Capital	34	2.3
Seacoast	3358	1.1
Seacoast	3343/3354	9.9

Total	**17.7**

2.4. Vegetation Management Storm Resiliency Program Results

In 2017, Unitil continued the SRP, targeting the resiliency efforts in communities in the Capital area. As in previous program years, the 2017 circuits were selected through analysis of tree related reliability performance. The 2017 circuits are shown below in Table 13. In 2017, 34.2 miles of critical three phase line were mitigated and 4,209 hazard trees were removed along this portion of line.

Table 13

2017 Storm Program Work Details			
Circuit	**Scheduled Miles**	**Completed Miles**	**# of Removals**
C15W1	5.0	5.0	130
C13W3	17.9	17.9	2,899
C22W3	11.3	11.3	1,180
Total	**34.2**	**34.2**	**4,209**

This program, now through it's sixth year, has been very successful. All program work in 2017 was completed, however the total expenses were above the estimated budget, with final expenditures totaling $2,240,447, which is $817,447 over the $1,423,000 budget estimate. The overspending was due to the higher number of identified hazard trees, most prominently seen on the C13W3 circuit. In the past 5 previous years, the average number of removals per mile was approximately 66 trees per mile, ranging from 115 trees per mile down to 18 trees per mile. With the C13W3 having 2,899 removals identified over 17.9 miles, the number of removals identified was exceedingly high at 162 trees per mile. The C22W3 was also on higher range at 104 identified risk tree removals per mile. This anomaly, perhaps due to the circuit location and adjacent tree density, was noticed during the work planning phase. Even with the higher number of trees removed on these sections of circuits, it is important to note that the risk was still mitigated.

Again in 2017, Unitil continued tree growth regulator application, an additional measure to improve the health of the adjacent trees along the overhead electric line corridor. Trees remaining and being pruned were treated with the tree growh regulator chemical in order to reduce the resulting tree growth after pruning and positively affect the tree's health. The Cambistat tree growth regulator treatment creates other plant growth effects that are beneficial for tree health including increased root density,

improved drought and heat resistance, and higher tolerance to insects and diseases.[3] 1,080 trees along the 2017 SRP corridor were treated with the tree growth regulator.

Due to the varying nature of storm resiliency work and traffic control, the Company expects costs may continue to experience minor variances, with final annual costs being slightly above or below the estimated budget. Even with yearly fluctuations, the average cost for the SRP program has remained close to the original estimate. The average cost over the last five years is $1,418,588 and the last three years is $1,438,597. The Company believes that the annual program funding level of $1,423,000 remains an appropriate and reasonable estimate of the Company's targeted spending for its SRP.

The Company did experience an increase in major storms in 2017, from the absence of major storms the year previously. The largest tree related event was the October 29th and 30th wind event. The Company believes that the SRP program contributed significantly to the swift restoration times and shortened duration of the event. More analysis of this storm in relation to past major storms can be seen in the report Storm Resiliency Analysis and Acceleration Proposal, Attachment 1. It is evident from these most recent results, the results of the Plaistow microburst, the 2014 Thanksgiving storm, and favorable results of the 2012 and 2013 storm resiliency pilot circuits over the last six years, that the Storm Resiliency work has the ability to and was successful at preventing tree related failures and subsequent electric incidents. This reduction in incidents reduces damage to the electric infrastructure and the need for crews to respond, which reduces the overall storm costs and expedites the restoration.

[3] 2014 Rainbow Treecare Scientific Advancements, Cambistat Customer Literature

2.5. Vegetation Management Storm Resiliency Program Recommendation

For 2018, storm resiliency work on 33.5 miles of line in the Seacoast service area is proposed, at a total cost of $1,423,000. These circuits, shown in Table 14 (a), were chosen for their recent historic reliability performance, number of customers served, field conditions, and location.

Table 14 (a)

2018 SRP Planned Work Details		
Circuit	**Overhead Miles**	**Scheduled Miles**
E6W1	27.0	5.8
E6W2	19.2	4.9
E23X1	23.8	10.1
E27X1	16.1	4.7
E27X2	8.7	1.4
E7X2	19.2	6.6
Total		**33.5**

Beginning in 2018, the Company is proposing additional storm resiliency work to accelerate the storm resiliency program and shorten the program by one year. An additional one-third of the normal SRP work is being proposed, see Table 14 (b). These additional 13.6 miles of line would bring the total SRP work to 47.1 miles of line in the Seacoast service area.

Table 14 (b)

2018 SRP Acceleration Planned Work Details		
Circuit	**Overhead Miles**	**Scheduled Miles**
E15X1	9.7	6.3
E59X1	15.4	7.3
Total		**13.6**

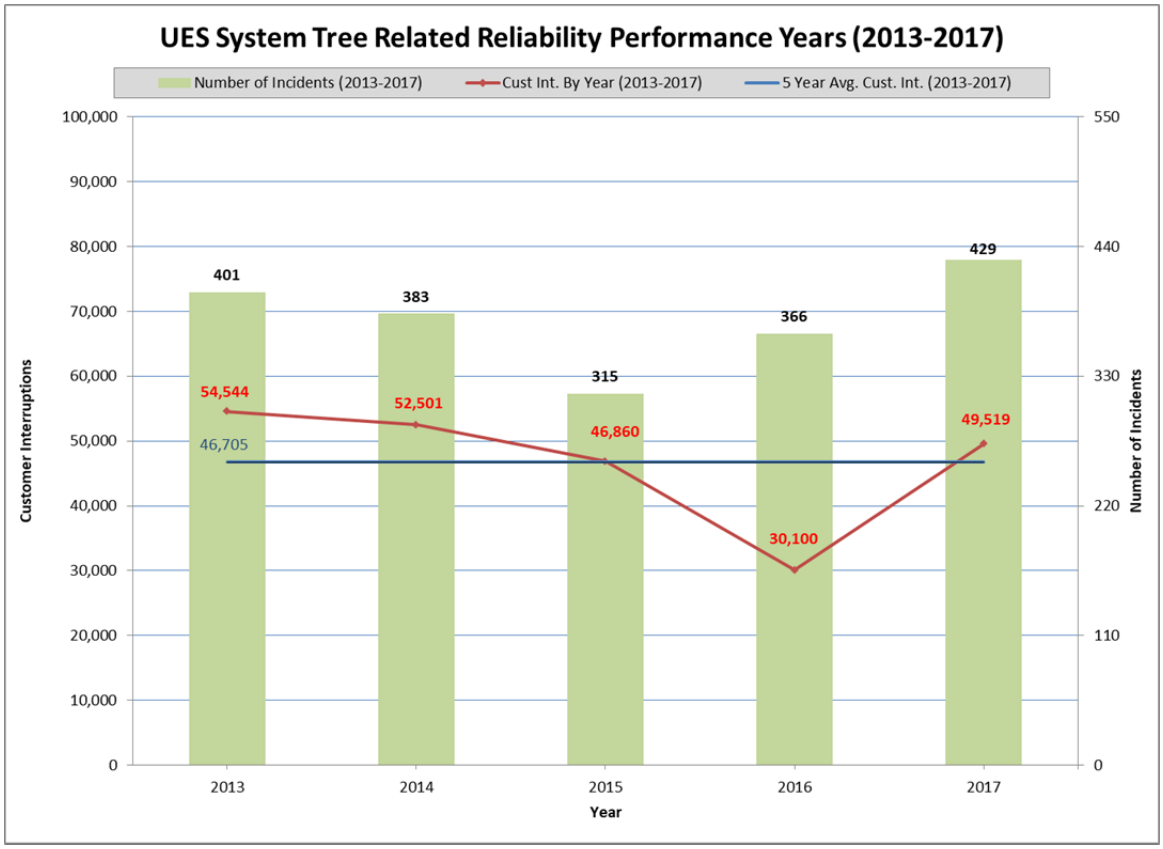
The Company is confident in the positive results of the SRP and propsing to accelerate the program in order to realize full program implementation benefits a year ahead of schedule. For the accelerated circuits only, a total estimated reduction of 6 outages could be realized, equating to a customer impact of 7,638 customer interruptions and 687,624 customer minutes of interruption avoided years in advance. The avoidance of outages and the ability to return to normal service conditions more quickly after storm events while minimizing the economic impact that storm events have on customer's lives is a real benefit. Accelerating the SRP program will bring that benefit to more customers immediately. For the full Storm Resiliency Analysis and Acceleration Proposal, please see Attachment 1.

2.6. Vegetation Management Reliability Performance Tracking

As the VMP progresses through its second five-year prune and hazard tree cycle, the effects of these programs on reliability have been shown over the last few years. The overall New Hampshire system tree related reliability performance was reviewed. Chart 1, shown below, displays the number of tree related incidents per year as well as the number of customers interrupted from tree related incidents from 2013 to 2017 against the 5 year average of tree related incidents during the same time period. The data used for this comparison excludes all major storm events identified by the NH PUC definition of a major storm in effect prior to 2015. The data for 2015 through 2017 uses IEEE 1366 methodology for identifying major event days. There were no major event days during 2015 and 2016 that excluded tree related interruptions. In 2017 there were 6 events that met the criteria for a major event day. They can be seen in more detail in Section 4.2 “Summary of 2017 Performance”.

Similar to the obvious declining trend in tree related outages demonstrated in the past three years, Chart 1 shows a slight declining trend in customers interrupted from 2013 through 2017, with the five year average declining from 54,236 in 2016 to 46,705 in 2017. The fluctuation in number of outages can be attributed to the increase in weather events in 2017. While trees are dynamic and susceptible to damage, drought, disease and an other sources of decline, tree related outages will always fluctuate on the system. The VM program has the largest influence on the effect of tree related outages on the system, show in the relationship between the number of tree related events and the customers interrupted. The fact that the number of incidients rose to its highest level in five years, but the number of customers interrupted stayed near the five year average indicates that the VM program is producing positive results.

Chart 1


UES System Tree Related Reliability Performance Years (2013-2017)
Number of Incidents (2013-2017)
Cust Int. By Year (2013-2017)
5 Year Avg. Cust. Int. (2013-2017)
Customer Interruptions
Number of Incidents
Year
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
550
440
330
220
110
0
401
383
315
366
429
54,544
52,501
46,860
30,100
49,519
46,705
2013
2014
2015
2016
2017

3. Reliability Planning and Performance

The Company approved total spending of $2,186,517 in the 2017 annual budget on capital reliability projects and $300,000 in reliability O&M expenditures.

The Reliability Program covers capital and O&M activities and projects intended to maintain or improve the reliability of the electric system including: (1) system hardening measures, i.e., equipment upgrades; installation of additional fuses, sectionalizers and reclosers; SCADA and automation projects; improvements to lightning protection; installation of animal guards; and other activities to mitigate the specific causes of outages; and (2) reliability-based inspections and maintenance, which will include enhanced inspection methods to detect and mitigate outage causes before they occur, including surveys using new or improved technology such as thermography (IR) and radiofrequency (RF) sensor technology to identify and mitigate failing electrical equipment, as well as software applications to better manage inspection, maintenance, and reliability programs and data.

3.1. Annual Studies

Each year the Company completes an annual distribution planning study and reliability study in each of the operation areas. Both of these studies incorporate analysis to improved system reliability.

3.1.1. Distribution Planning Study

The Company conducts distribution planning studies on an annual basis. The purpose of this study is to identify when system load growth is likely to cause main elements of the distribution system to reach their operating limits, and to preliabilityare plans for the most cost-effective system improvements.

Circuit analysis provides the basis for the distribution planning study. Circuit analysis is completed on a three year rotating cycle with the objective to review one-third of the entire system each year. The Milsoft WindMil software application is used to perform circuit analysis to identify potential problem areas and to evaluate available alternatives for system improvements. Circuit analysis includes the following: 1) update of circuit model from GIS; 2) circuit diagnostics; 3) load allocation; 4) voltage drop and overload analysis; 5) fault current and protection device coordination analysis. Engineering work requests are initiated for any apparent miscoordination identified during this analysis.

In addition to the fuse coordination completed as part of circuit analysis, the Company reviews trouble interruption reliabilityorts on a daily basis. Any outage in which the fuse did not appear to operate correctly is further analyzed to determine the cause. Engineering Work Requests are issued to

implement upgrades or changes on the system identified by the circuit analysis or an evaluation of an outage.

3.1.2. Reliability Studies

Each year, Unitil completes annual reliability studies for each of its operating areas. The purpose of these studies is to reporton the overall reliability performance of the electric systems from January 1 through December 31 of the previous year (12 months total). The scope of this reportalso evaluates substation, subtransmission (34.5kV system generally off road and serving one or more substations or circuit taps) and individual circuit reliability performance over the same time period. The analysis also identifies common trends or themes based upon type of outage (i.e. tree, equipment failure, etc.). The Annual Reliability Analysis and Recommendations report for the UES Capital Operating Area and UES Seacoast Operating Area are attached to this report as Attachment 2 and Attachment 3 respectively.

The recommendations provided in the study are focused on improving the worst performing circuits as well as the overall system reliability. These recommendations are provided for budget consideration and will be further developed with the intention of incorporation into the capital budget development process.

There are several common solutions which can improve reliability depending upon the circumstance: 1) installation of reclosers or sectionalizers; 2) addition of fusing locations; 3) tree trimming; 4) installation of tree wire or spacer cable; and 5) implementation of automatic restoration schemes. These solutions are recommended most commonly; however, other solutions are also recommended for specific situations.

3.2. Reliability O&M Expenditures

The Company has allocated $300,000 to Reliability O&M expenditures, split between reliability centered maintenance and inspection and enhanced tree trimming. The Enhanced Tree Trimming funding of $80,000 is intended to target “problem” areas identified through engineering analysis, while $220,000 is allocated to the Exacter® inspection program.

Table 15 below lists the amount of operation and maintenance expenditures budgeted for 2018 and past five years on Enhanced Tree Trimming and reliability centered inspection and maintenance programs.

Table 15

Reliability O&M Category	Budgeted Spending Amounts					
	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Enhanced Tree Trimming	$200,000	$200,000	$80,000	$80,000	$80,000	$80,000
Reliability Inspection and Maintenance	$ 100,000	$100,000	$220,000	$220,000	$220,000	$220,000
Totals	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000

3.2.1. Enhanced Tree Trimming

Each year, the Company completes reliability analysis on the distribution and subtransmission system. The reliability analysis identifies areas of the system which have experienced an abnormal or increasing amount of tree related outages in the previous year. Distribution Engineering provides the System Arborist a prioritized list of recommended subtransmission lines and/or distribution circuits which would benefit the most from enhanced tree trimming.

In 2017, Distribution Engineering recommended the sub-transmission 396 Line in the UES Capital area to receive enhanced tree trimming. In total, $71,143 was spent on Enhanced Tree Trimming and 256 hazard tree removals were completed along with sideline clearing on selected portions.

For 2019, Distribution Engineering is recommending enhanced tree trimming/ hazard tree removal be performed on the 3346 and 3347 Lines in the UES – Seacoast. The work on this line will be prioritized and is budgeted not to exceed $80,000 in 2019.

3.2.2. Reliability Inspection and Maintenance

In 2017, Unitil continued to inspect our distribution facilities utilizing Exacter® technology as described in the Unitil Energy Systems, Inc. Reliability Enhancement Program and Vegetation Management Report 2013. The scope of the 2017 program included Davey Resource Group performing field survey work and analysis, and providing the company with a report of their findings. In 2017, the Company spent $220,000 in O&M expenditures and $140,044 in capital dollars to replace equipment identified by the survey as possibly failing in the near future.

Unitil has budgeted $220,000 again in 2018 for Reliability Inspection and maintenance.

3.2.2.1. Exacter Overview

As explained in our initial 2013 reliability report, Exacter® technology is deployed by electric utilities to locate overhead distribution equipment showing signs of degradation and possible failure, thereby increasing overall system reliability by preventing failures before they occur. As a result of the successful pilot, Unitil continued the program in 2017.

3.2.2.2. Project Overview and Results

Unitil continued the inspection and survey program and completed a survey of all our overhead, three-phase circuitry, or a total of 419 pole miles of line. We believe this methodology provides the greatest impact to customers as a failure of equipment along these circuits would affect the greatest amount of customers and therefore have the greatest impact on system reliability, i.e. SAIDI.

The circuit survey performed in 2017 identified 76 pieces of equipment that displayed the immanent failure signature and required reliabilityair or reliabilitylacement. As was the case in prior years, the types of facilities identified included transformers, insulators, lightning arrestors, bushings, and cutouts.

Utilizing Unitil's Outage Management System (OMS) which details customer counts and protective devices, we are able to develop potential system reliability impacts. The 2017 program identified a reliability repair every 5.5 miles, and an average of 642 customers impacted by each failure event if it occurred. The estimated number of customers impacted by potential failures of all identified locations is 48,783. The estimated customer minutes of interruption would be 3,845,516, calculated using 2017 customer counts. The total opportunity for avoided system SAIDI is 49.7 minutes, which represents 33.6% of UES' most recent 10-year average annual SAIDI of 147.98 minutes.

We continue to believe the program has significant benefits to our customers, and the Company plans to continue with the program for the foreseeable future.

3.2.2.3. 2018 Plan Proposal

Unitil is continuing the Exacter® preventative maintenance program in 2018. We will continue to perform an annual survey of all three-phase circuit miles of the UES distribution system, as failures of this equipment has the greatest impact on customer interruptions. The estimated cost to perform the annual survey and provide the analytics is $220,000, and the cost to replace the identified equipment is expected to be approximately $100,000 annually. Given the potential impact on system SAIDI, the company believes these expenditures are prudent and beneficial to customers.

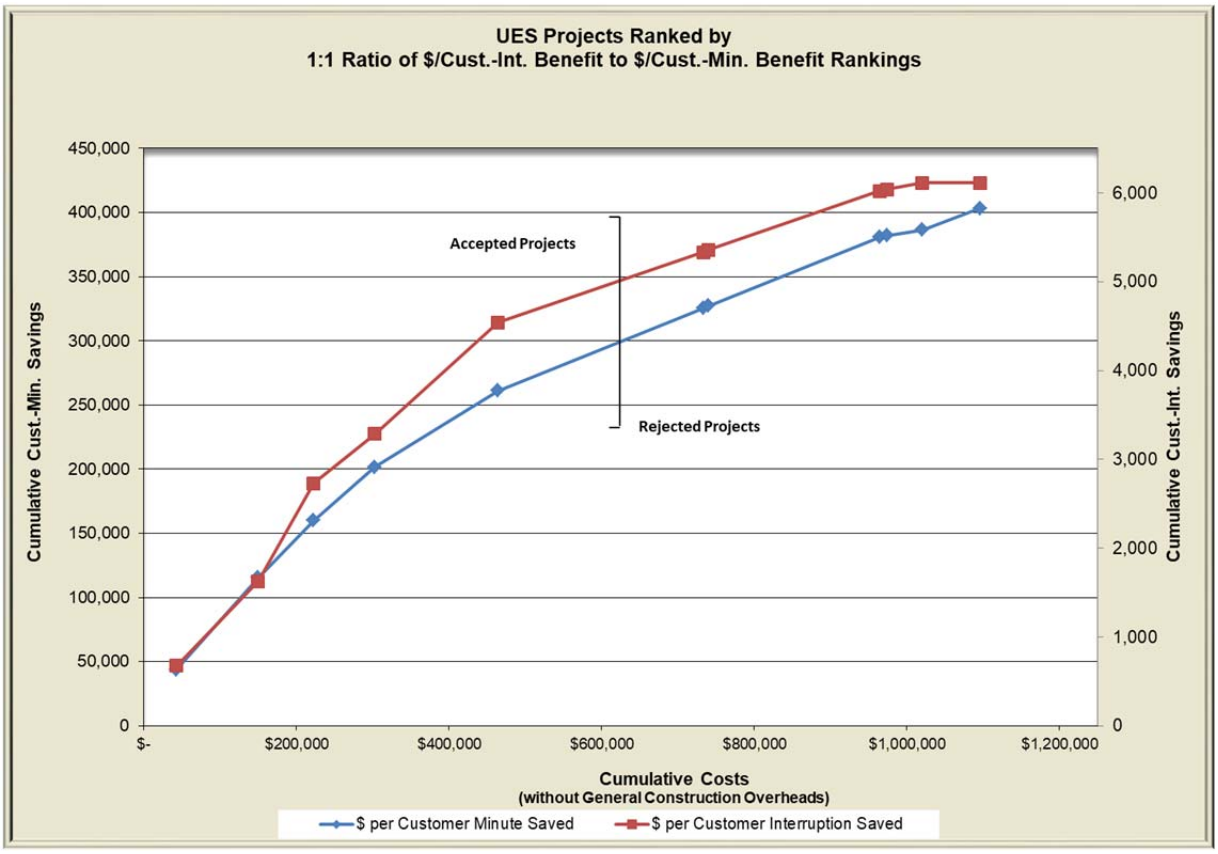
3.3. Reliability Capital Expenditures

As described in section 3.1.2 above, in addition to the annual pole inspection and replacement program, each year Unitil completes annual reliability studies for each of its operating areas. The recommendations provided in the study are focused on improving the worst performing circuits, as well as the overall system reliability. These reliability projects count for the majority or all of the "System Hardening/Reliability" spending for each year.

The reliability projects recommended for the budget include a project scope, construction cost estimate and estimated reliability improvements (annualized saved customer minutes and saved customer interruptions). All of the recommended projects are ranked against each other based upon two cost benefit comparisons (cost per saved customer minute and cost per saved customer interruption).

An overall project rank is derived from the sum of these two cost benefit rankings. In general, projects with low construction cost and high saved customer minutes or high saved customer interruptions are ranked highest on the list while those projects with high construction cost and low saved customer minutes or saved customer interruptions are ranked low on the list. Another way these projects are analyzed by Distribution Engineering is shown in Chart 2 below. This chart displays the cumulative project cost compared to the anticipated reliability benefits of all projects. Each data point pair reliabilityresents a specific project and its associated reliability benefits (saved customer minutes and saved customer interruptions). This chart is used to compare the relative return of reliability benefits associated with project cost between all projects. The projects to the left of the cutoff line are those that are entered into the annual Capital Budget for approval. Those to the right have been rejected.

Chart 2



The reliability projects for 2018 presented in Table 16 below provide an illustration of the process used to identify reliability projects. Table 16 is a listing of reliability projects recommended by Distribution Engineering as part of the 2017 annual reliability studies for the UES system which have been accepted into the 2018 Capital Budget. This project-listing details the overall project ranking, scope, cost, and anticipated reliability benefits.

Table 16

Project Ranking	Budget No.	Description	Project Cost	Cumulative Cost	Customer Interruptions Saved Annually	Customer Minutes Saved Annually
1	DRBC01	Circuit 18W2 – Install Recloser in North Direction out of Bow Bog	$42,490	$42,490	674	43,804
2	DRBE06	Guinea Switching – Reliability Enhancements	$107,321	$149,811	954	71,568
3	DRBE03	Circuit 43X1 – Install Recloser Exeter Road	$72,462	$222,273	1,102	44,649
4	DRBC06	Bridge Street S/S – Reliability Enhancements	$80,376	$302,649	557	41,759
5	DRBE04	3346 Line – Automatic Restoration Schemem (Year 1 of 2)	$161,586[4]	$464,236	1,253	59,528
PROPOSED NH RELIABILITY PROJECTS			$464,236		4,540	261,308

Recommended 2018 Reliability Based Projects

Note the project list in the table above has been sorted by project rank in ascending order beginning with the project having the best composite cost benefit ranking. This list is used by Distribution Engineering as a guide for recommending projects to be included in the Capital Budget as reliability projects. The projects listed above are those projects that were accepted into the 2018 capital budget. However, it should be noted other projects were identified in the annual reliability analysis and were not accepted in the Capital Budget as providing adequate reliability compared to the cost. The Capital Budget process approves the amount of spending for reliability projects and allows for changes of projects, if it is later determined that there are better or more practical projects.

3.3.1. 2017 Actual Reliability Expenditures

The capital expenditures of reliability project construction for the Company in 2017, totaled $2085,429[5]. This total includes the annual pole replacement project in addition to the projects recommended as part of the 2016 annual reliability analysis. .

[4] Total Project Cost – 2018/19
[5] Refer to Attachment 3 for reliability project spending

Attachment 4 details the budgeted costs and actual expenditures of all capital reliability projects. This list includes the projects that were originally budgeted and those that were actually constructed. There were a few projects that were budgeted and then were replaced by other projects due to practicality of completing the construction.

4. 2017 Reliability Performance

4.1. Historical Performance (2013-2017)

The historical reliability performance for the UES system for the time period from 2013-2017 is outlined in Charts 3-5 below. These charts display annual SAIDI and SAIFI for the combined UES systems as well as separate charts for each of the UES-Capital and UES-Seacoast service territories.

Chart 3

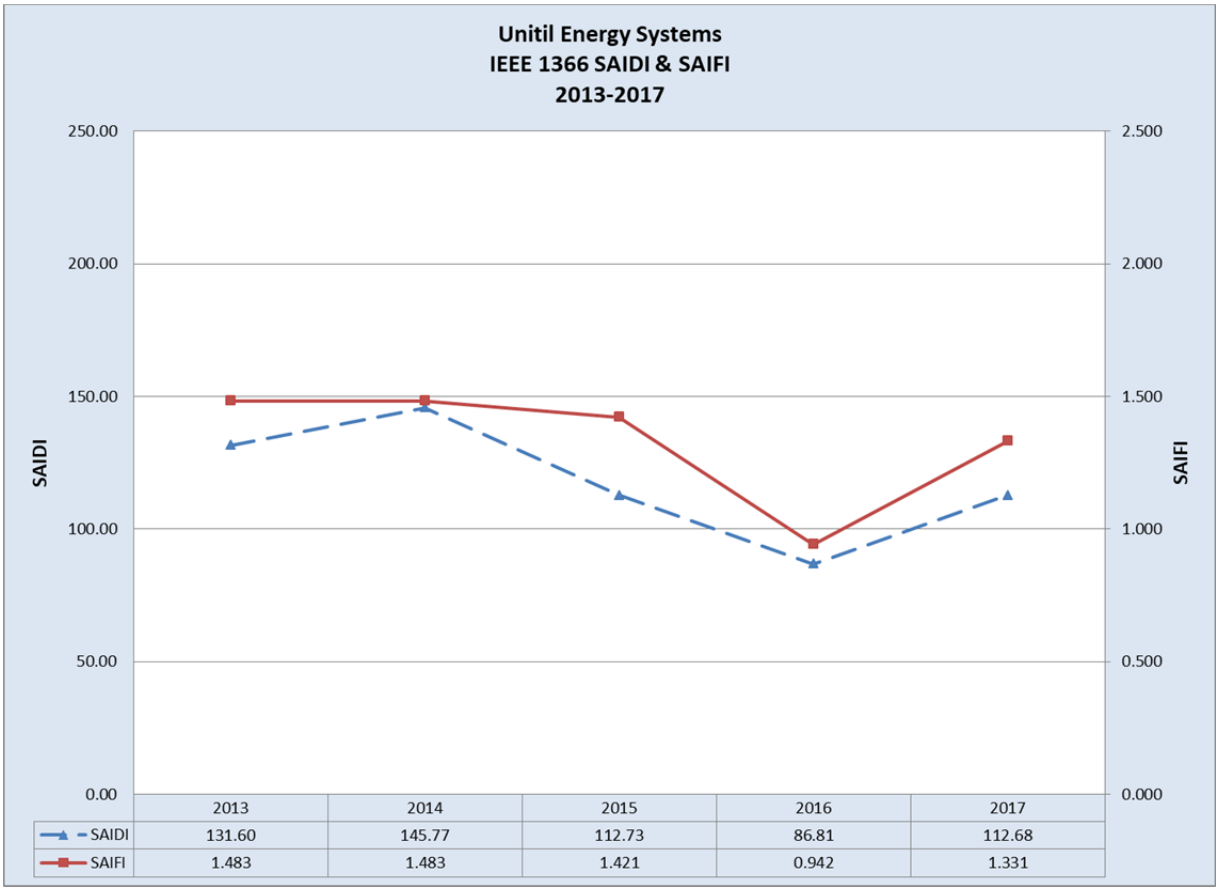


Chart 4

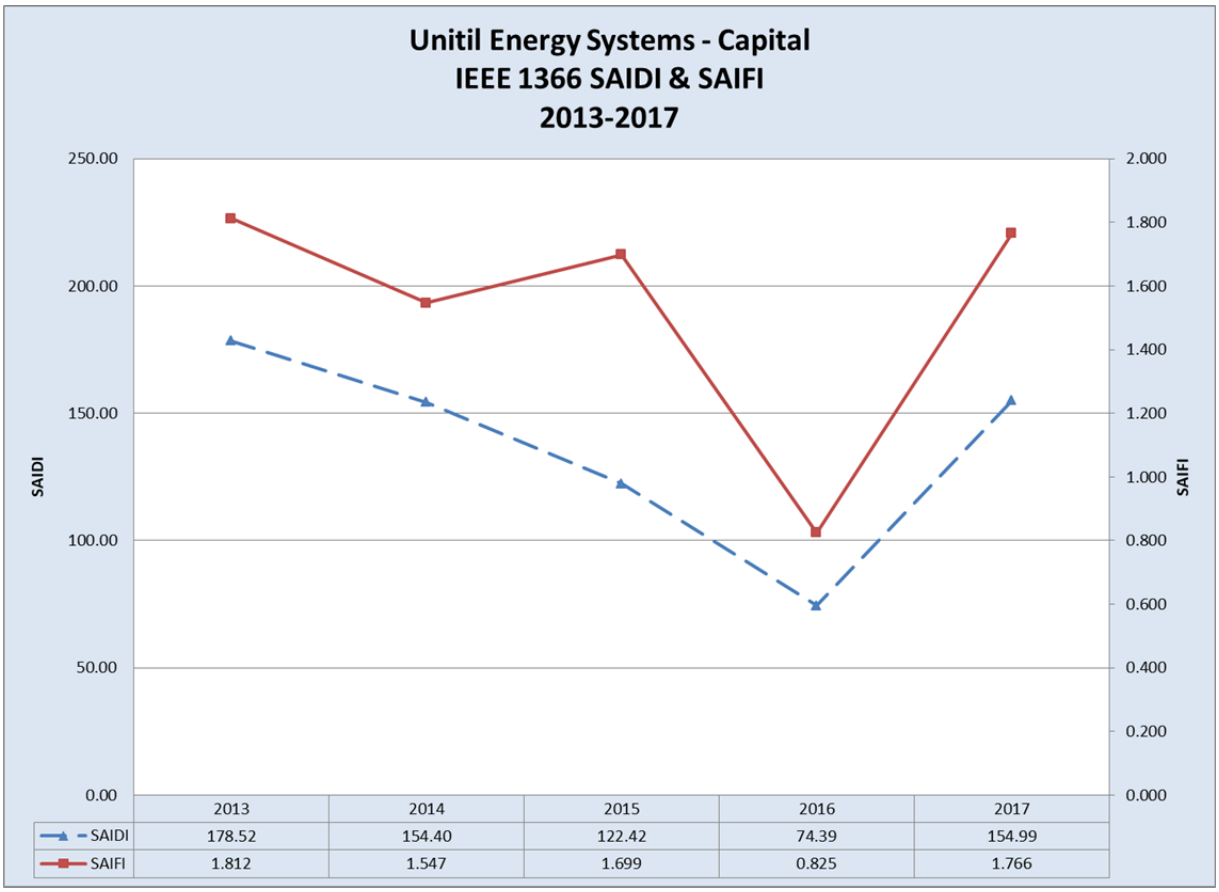
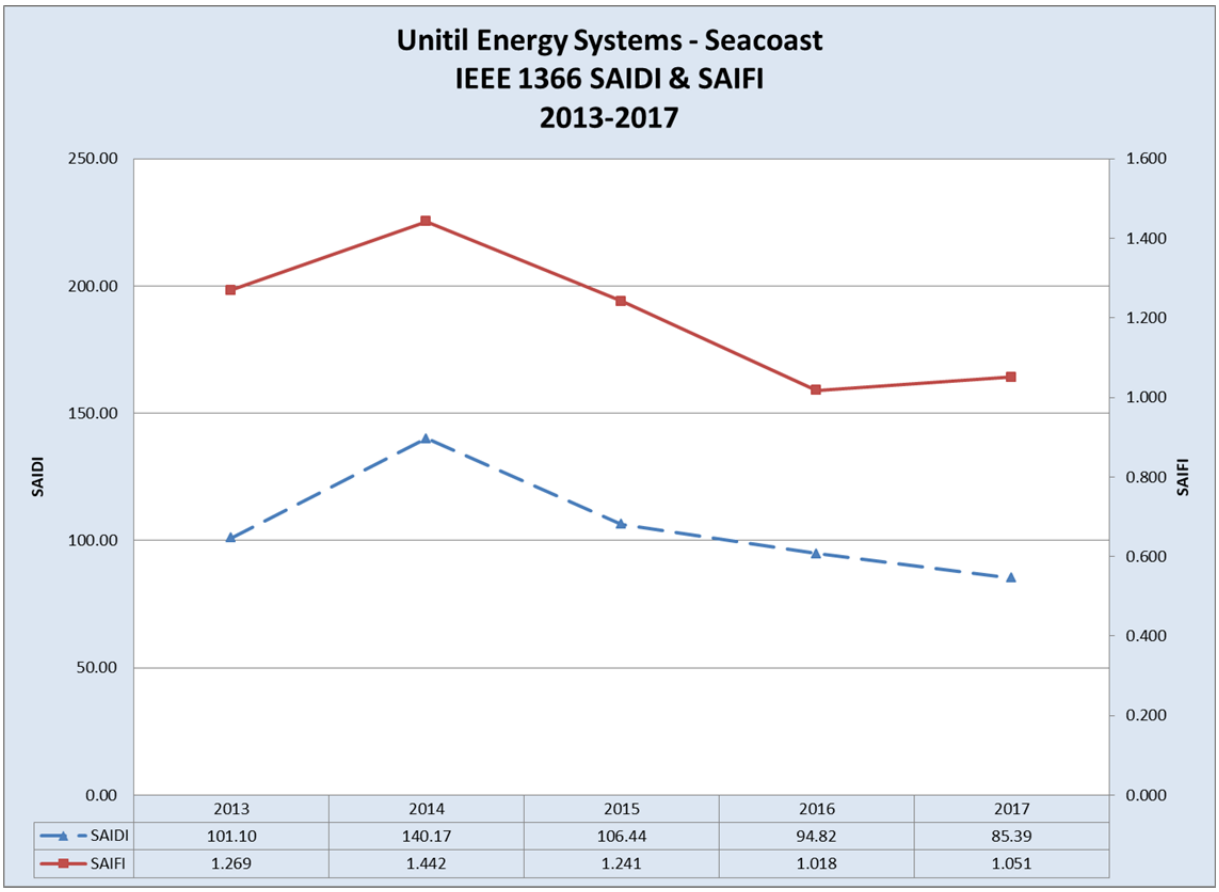

Unitil Energy Systems - Capital
IEEE 1366 SAIDI & SAIFI
2013-2017
SAIDI
SAIFI
250.00
200.00
150.00
100.00
50.00
0.00
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
2013 2014 2015 2016 2017
SAIDI 178.52 154.40 122.42 74.39 154.99
SAIFI 1.812 1.547 1.699 0.825 1.766

Chart 5



NOTE: Only those events causing an outage to 1 or more customers and lasting more than 5 minutes in duration are included in the calculation of these indices. In addition, events meeting any of the following criteria have also been excluded from these calculations:

- PUC Major Storm: All outages occurring in any day classified as an IEEE-1366 Major Event Day
- Interruptions/outages involving the failure of customer owned equipment
- Off system power supply interruptions

4.2. Summary of 2017 Performance

The reliabilityorted reliability performance of the UES systems in 2017 (based on IEEE-1366) was the second best performance in the last five years in terms of SAIDI. The combined UES system SAIDI of 112.68 minutes is roughly 4.4% lower than the 5 year average of 117.92 minutes. The UES combined system SAIFI for 2017 was 1.331 interruptions which was the second best performance in

the last five years. The system SAIFI is approximately the same as the 5 year average of 1.332. The total number of interruption events recorded in 2017 was 1,093.

In 2017, there were six events that met the IEEE -1366 criteria for a Major Event Day which were therefore not included in the calculation of UES system SAIDI and SAIFI. These Major Event Days are listed below:

- March 2nd – Wind Event (Capital Region)
- March 14th – Nor'Easter (Capital & Seacoast Regions)
- April 1st – Snow Storm (Seacoast Region)
- May 18th – Lightning & Rain Storm (Seacoast Region)
- October 29th & 30th – Wind Event (Capital & Seacoast Regions)
- December 31st – 3358B Recloser Failure (Seacoast Region)

Table 17 below shows a breakdown of the reliability performance of the UES system by individual cause codes.

Table 17

Cause of Outage	No of Troubles	Cust Int	Cust Hrs	SAIDI	% Total	SAIFI	% Total
Action by Others	16	1,831	2,225	1.73	1.5%	0.024	1.8%
Animal - Other	2	23	19	0.01	0.0%	0.000	0.0%
Bird	14	1,646	1,362	1.06	0.9%	0.021	1.6%
Civil Emergency (fire,flood,etc.)	1	23	63	0.05	0.0%	0.000	0.0%
Corrosion/Contamination/Decay	3	34	26	0.02	0.0%	0.000	0.0%
Equipment Failure Company	158	19,654	26,331	20.44	18.1%	0.254	19.1%
Lightning Strike	9	1,028	1,537	1.19	1.1%	0.013	1.0%
Loose/Failed Connection	13	301	410	0.32	0.3%	0.004	0.3%
Operator Error/System Malfunction	2	1,565	1,080	0.84	0.7%	0.020	1.5%
Other	3	36	49	0.04	0.0%	0.000	0.0%
Overload	7	31	48	0.04	0.0%	0.000	0.0%
Patrolled, Nothing Found	108	4,996	8,286	6.43	5.7%	0.065	4.9%
Scheduled, Planned Work	105	4,843	3,207	2.49	2.2%	0.063	4.7%
Squirrel	189	10,726	12,382	9.61	8.5%	0.139	10.5%
Tree/Limb Contact - Broken Limb	279	25,235	38,461	29.85	26.5%	0.326	24.5%
Tree/Limb Contact - Broken Trunk	100	22,624	36,640	28.44	25.2%	0.293	22.0%
Tree/Limb Contact - Growth into Line	25	698	914	0.71	0.6%	0.009	0.7%
Tree/Limb Contact - Uprooted Tree	20	887	1,869	1.45	1.3%	0.011	0.8%
Tree/Limb Contact - Vines	5	75	124	0.10	0.1%	0.001	0.1%
Vehicle Accident	34	6,666	10,149	7.88	7.0%	0.086	6.5%
Totals	**1,093**	**102,922**	**145,182**	**112.68**	**100.00%**	**1.331**	**100.00%**

As observed from the preceding table, tree related outages had the greatest impact on the UES system reliability in terms of both SAIDI and SAIFI performance in 2017. Tables 18 and 19 below shows how the top three causes during 2017 have trended over the last three years[6].

Table 18

	SAIDI (% Total)		
Cause	**2016**	**2015**	**2014**
Tree Related	54%	38%	44%
Equipment Failure	18%	17%	23%
Vehicle Accident	9%	13%	14%

Table 19

	SAIFI (% Total)		
Cause	**2016**	**2015**	**2014**
Tree Related	48%	42%	43%
Equipment Failure	19%	11%	14%
Vehicle Accident	11%	14%	15%

[6] Percentages based on reliability data after removing exclusionary events based on the PUC exclusionary criteria in effect for the respective year.