THE STATE OF NEW HAMPSHIRE
BEFORE THE
PUBLIC UTILITIES COMMISSION

Unitil Energy Systems, Inc.

RELIABILITY PROGRAM AND VEGETATION MANAGEMENT PROGRAM ANNUAL REPORT – FISCAL YEAR 2019

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 2019 ("FY 2019"), report the period, January 1, 2019 – December 31, 2019.

The Settlement Agreement provides that 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 report will be reconciled along with the revenue requirements associated with the actual and planned capital additions and expenses. This report includes the following information:

(A) A description of Unitil's VMP;
(B) A comparison of FY2019 actual to budgeted spending on O&M activities related to the VMP
(C) Detail on the O&M spending related to the FY2019 VMP estimated expenditures and work to be completed;
(D) A summary of the Vegetation Management Storm Hardening Program results;
(E) Detail on the O&M spending related to Enhanced Tree Trimming;
(F) Detail on the reliability capital spending for 2019 and 2020 budget; and
(G) Reliability performance of the UES Capital and UES Seacoast systems.

2. Vegetation Management Plan

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

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.

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

[2] A copy of the ECI reliability report, 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.

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. 2019 Actual Expenditures and Work Completed

Table 1 depicts the 2019 VMP expenditures by activity in relation to the anticipated budget expenditures. As the program progressed in 2019 there were some deviations in the anticipated expenditures. In the VMP spending, the Cycle Pruning and the Hazard Tree Mitigation work activities had the most deviation in spending relative to anticipated costs. Cycle Pruning had spending above anticipated levels by $468,033 due to increased cost of labor, equipment, and vendor overheads such as insurance and health care. Hazard Tree Mitigation has seen an increase due to forest health decline, especially the presence of Emerald Ash Borer infestations in the service territory. As a result of these overages in budget projections, the mid-cycle work was kept at a minimum ($100,845 underspend) with only high priority work being done and a plan of monitoring of other concern areas into the growing season of 2020. The work spending for the SRP was $188,777 above the anticipated level. This was due to additional hazard tree removals identified on the E7X2 circuit, and a high density of risk-trees on the E18X1 circuit, requiring more trees per mile removal than previous averages. As shown in the table below, total spending for all VMP and SRP components was above the budget by $692,604.

Table 1

2019 VMP O&M Activities		
VM Activity	**2019 Cost Proposal**	**2019 Actual Cost**
Cycle Prune	$ 1,163,894	$ 1,631,927
Hazard Tree Mitigation	$ 800,000	$ 912,401
Forestry Reliability Work	$ 24,857	$ 19,273
Mid-Cycle Review	$ 112,000	$ 11,155
Police / Flagger	$ 557,000	$ 447,877
Core Work	$ 150,000	$ 180,872
VMP Planning	$ -	$ -
Distribution Total	**$ 2,807,751**	**$ 3,203,506**
Sub-T	$ 623,090	$ 690,645
Substation Spraying	$ 10,700	$ 10,804
VM Staff	$ 322,876	$ 363,290
Program Total	**$ 3,764,417**	**$ 4,268,244**
Storm Resiliency Program	$ 1,690,556	$ 1,879,333
Grand Total	**$ 5,454,973**	**$ 6,147,577**

The following tables detail the 2019 VMP work completed by activity. Table 2 details the cycle pruning work. A total of 225 miles of cycle pruning was completed in 2019.

Table 2

2019 VMP Planned Cycle Pruning Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C13W1	33.6	33.6	33.6
Capital	C22W1	4.4	4.4	4.4
Capital	C22W2	0.9	0.9	0.9
Capital	C38	8.3	8.3	8.3
Capital	C4W4	14.3	14.3	14.3
Capital	C4X1	24.0	24.0	24.0
Capital	C7W4	7.4	7.4	7.4
Capital	C8H1	1.2	1.2	1.2
Capital	C8H2	4.6	4.6	4.6
Capital	C8X5	7.4	7.4	7.4
Seacoast	E13W1	18.5	18.5	18.5
Seacoast	E18X1	18.4	14.7	14.7
Seacoast	E19H1	4.7	4.7	4.7
Seacoast	E21W1	29.7	29.7	29.7
Seacoast	E21W2	21.6	21.6	21.6
Seacoast	E47X1	14.7	14.7	14.7
Seacoast	E7X2	19.3	15.0	15.0
Total			**225**	**225**

Table 3 details the hazard tree mitigation work. A total of 94.6 miles of line across 22 circuits were mitigated for hazard tree risk. Unitil had estimated approximately 2,225 hazard tree removals in the budget. The actual results indicate 2,659 total hazard trees were removed on these circuits and various other circuits as found through the course of work over the year.

Table 3

2019 VMP Completed Hazard Tree Mitigation Details

District	Feeder	Overhead Miles	Scheduled Miles	Completed Miles	# of Removals
Capital	C24H1	2.0	0.7	0.7	8
Capital	C24H2	2.0	1.3	1.3	4
Capital	C18W2	34.0	5.0	5.0	277
Capital	C6X3	15.2	4.7	4.7	190
Capital	C37X1	6.8	1.2	0	0
Capital	C4W3	18.6	7.5	7.5	6
Capital	C13W1	33.6	6.2	6.2	388
Capital	C4W4	14.3	4.0	4.0	61
Capital	C4X1	24.0	7.9	7.9	155
Capital	Various				631
Seacoast	E6W2	19.2	2.2	2.2	38
Seacoast	E13W2	29.0	3.0	3.0	73
Seacoast	E56X2	2.4	1.6	1.6	4
Seacoast	E58X1	31.0	6.3	6.3	108
Seacoast	E15X1	9.7	5.8	5.8	18
Seacoast	E17X1	8.9	3.5	3.5	26
Seacoast	E17W2	4.8	1.5	1.5	18
Seacoast	E2H1	2.3	1.4	1.4	5
Seacoast	E19X3	38.7	16.0	16.0	330
Seacoast	E43X1	30.8	7.8	3.9	19*
Seacoast	E51X1	30.1	10.3	5.2	6*
Seacoast	E59X1	15.4	7.3	0	0
Seacoast	E13W1	18.5	4.7	1.0	1*
Seacoast	E21W1	29.7	9.9	4.9	4
Seacoast	E21W2	21.6	8.5	1.0	3
Seacoast	Various				286
Total			**128.3**	**94.6**	**2,659**

* All hazard trees identified, marked, and approved for removal but not yet completed in the field – removals to carry over to 2020

Tables 4 and 5 detail the forestry reliability work and mid-cycle work respectively. A total of 7.4 miles of line underwent forestry reliability work and 27.6 miles of line were completed for mid-cycle work.

Table 4

2019 VMP Completed Reliability Analysis Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C22W3	40.1	2.7	2.7
Capital	C8X3	105.8	4.7	4.7
Total			**7.4**	**7.4**

Table 5

2019 VMP Completed Mid-Cycle Review Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C18W2	34.0	5.0	2.0*
Capital	C37X1	6.8	1.2	0
Capital	C4W3	18.6	7.5	0
Capital	C6X3	15.2	4.7	4.7
Seacoast	E19X3	38.7	16.0	16.0
Seacoast	E43X1	30.8	7.8	3.9*
Seacoast	E51X1	30.1	10.3	0
Seacoast	E59X1	15.4	7.3	0
Total			**59.8**	**27.6**

* All work identified, marked, and approved but not yet completed in the field – some work to carry over to 2020

Table 6 details the sub-transmission right-of-way clearing work. A total of 18.1 linear miles of right-of-way floor were cleared.

Table 6

2019 Sub Transmission Clearing Details			
District	**Feeder**	**Scheduled Miles**	**Completed Miles**
Capital	37	4.1	4.1
Capital	34/36	2.2	2.2
Seacoast	3359	7.5	7.5
Seacoast	3348/3350	4.3	4.3
Total		**18.1**	**18.1**

Additionally the sub-transmission right-of-way that was cleared in both Capital and Seacoast in 2018 underwent the integrated vegetation management (IVM) program's low-volume foliar herbicide application work in 2019. A total of approximately 177 acres were managed with IVM chemical control.

2.3. 2020 VMP Estimated Expenditures and Work To Be Completed

Table 7 depicts the 2020 VMP expenditures by activity and the proposed VMP activity details. Unitil proposes to spend $4,023,205 on VMP activities and another $1,423,000 on vegetation storm resiliency, explained in more detail below, for a total of $5,446,205. This amount includes the required work to complete the minor effort carried over from 2019.

Table 7

2020 VMP O&M Activities Cost Proposal		
VM Activity		**2020 Cost Proposal**
Cycle Prune	$	1,490,000
Hazard Tree Mitigation	$	800,000
Forestry Reliability Work	$	24,857
Mid-Cycle Review	$	112,000
Brush Control	$	-
Police / Flagger	$	529,500
Core Work	$	150,000
Distribution Total	**$**	**2,780,251**
Sub-T	$	528,000
Substation Spraying	$	11,021
VM Staff	$	377,827
Program Total	**$**	**4,023,205**
Storm Resiliency Program (SRP)	$	1,423,000
Grand Total	**$**	**5,446,205**

Tables 8 through 12 provide more detail on each of the VMP activities planned for 2020. The activities include 212.9 miles of cycle pruning (Table 8), 107.4 miles of hazard tree mitigation (Table 9) which estimates 2,242 hazard tree removals, 6.7 miles of forestry reliability work (Table 10), 62.2 miles of mid-cycle pruning (Table 11), and 13.7 miles of sub-transmission clearing (Table 12).

Table 8

2020 VMP Planned Cycle Pruning Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C14H1	1.1	1.1
Capital	C14H2	3.8	3.8
Capital	C14X3	0.3	0.3
Capital	C15W1	16.8	16.8
Capital	C15W2	5.8	2.2
Capital	C1H1	0.6	0.6
Capital	C1H2	0.6	0.6
Capital	C1H3	2.3	2.3
Capital	C1H4	1.6	1.6
Capital	C1H5	0.8	0.8
Capital	C1H6	1.6	1.6
Capital	C22W3	40.2	40.2
Capital	C3H1	2.5	2.5
Capital	C3H2	2.4	2.4
Capital	C3H3	1.0	1.0
Capital	C7W3	23.2	23.2
Capital	C7X1	2.6	2.6
Seacoast	E1H3	1.6	1.6
Seacoast	E1H4	3.2	3.2
Seacoast	E22X1	37.6	37.6
Seacoast	E22X2	4.9	4.9
Seacoast	E23X1	24.0	21.4
Seacoast	E6W1	27.0	22.8
Seacoast	E6W2	20.2	17.9
Total			**212.9**

Table 9

2020 VMP Planned Hazard Tree Mitigation Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C8X3	105.9	27.1
Capital	C22W3	40.2	11.3
Seacoast	E43X1	30.8	3.9*
Seacoast	E51X1	30.1	5.2*
Seacoast	E13W1	18.5	3.7*
Seacoast	E21W1	29.7	5.0*
Seacoast	E21W2	21.6	7.5*
Seacoast	E54X1	21.9	4.9
Seacoast	E54X2	22.1	5.6
Seacoast	E56X1	16.9	4.7
Seacoast	E11X2	11.9	6.6
Seacoast	E2X2	19.8	12.7
Seacoast	E22X1	37.6	9.2
Total			**107.4**

***Carry-over from 2019**

Table 10

2020 VMP Planned Reliability Analysis Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C4W3	18.5	0.5
Capital	C13W3	82.9	3.8
Capital	C18W2	34.0	0.6
Seacoast	C17W2	4.6	0.7
Seacoast	C2X3	13.7	1.1
Total			**6.7**

Table 11

2020 VMP Planned Mid-Cycle Review Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C18W2	34.0	2.0*
Capital	C8X3	105.9	27.1
Seacoast	E43X1	30.8	3.9*
Seacoast	E11X2	11.9	6.6
Seacoast	E19X2	2.8	1.8
Seacoast	E20H1	4.5	2.2
Seacoast	E28X1	10.2	5.1
Seacoast	E2X3	13.7	7.1
Seacoast	E2X2	19.8	7.2
Seacoast	E46X1	2.3	1.2
Total			**62.2**

*carry over from 2019

Table 12

2020 Sub Transmission Planned Clearing Details		
District	**Feeder**	**Scheduled Miles**
Capital	34	1.7
Capital	374	2.7
Capital	375	1.5
Seacoast	3342/3353	3.7
Seacoast	3346	2.0
Seacoast	3341/3352	2.1
Total		**13.7**

2.4. 2019 Vegetation Management Storm Resiliency Program Results

In 2019, Unitil continued the SRP, targeting the resiliency efforts in communities in the Seacoast area. This program, now through its eighth year, has been very successful. Unitil is experiencing less damage during storm events resulting in a quicker restoration and the ability to send line and tree crews to our neighboring utilities to assist with their restoration. As in previous program years, the 2019 circuits were selected through analysis of tree related reliability performance. The 2019 circuits are shown below in Table 13. In 2019, 40 miles of critical three phase line were worked planned for hazard tree removals and ground-to-sky pruning. A total of 3,412 hazard trees were removed along these portions of line.

Table 13

2019 Storm Program Work Details			
Circuit	**Scheduled Miles**	**Completed Miles**	**# of Removals**
E27X1	2.4	2.4*	205
E7X2	6.6	6.6*	690
E23X1	10.1	10.1	595
E59X1	7.3	7.3	508
E11X1	4.3	4.3	56
E18X1	9.3	9.3	1,358
Total	**40.0**	**40.0**	**3,412**

* carried-over from 2018

As table 13 shows, all carry over work from 2018 plus planned work in 2019 was completed. The company was able to bring in additional vendors from the extended region to combat the work force issue. Using this additional work force and a new request for pricing release schedule allowed for a large volume of work to be completed.

Again in 2019, 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 growth 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] 896 trees along the 2019 SRP corridor were treated with the tree growth regulator.

Due to the varying nature of storm resiliency work and traffic control, as well as the lack of workforce availability, 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 Company did experience an elevated number of major storms again in 2019, compared to the absence of major storms seen in 2016. The largest tree related event was the October 17th nor'easter wind event. The Company believes that the SRP program contributed significantly to the swift restoration times and shortened duration of the event, with all customers restored in just over 24 hours. It is evident

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

from these most recent results, and results from previous events during the duration of the SRP program, like the October 2017 wind event, the 2015 Plaistow microburst, the 2014 Thanksgiving storm, and favorable results of the 2012 and 2013 storm resiliency pilot circuits over the last eight 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.

In order to more thoroughly assess the program's results and provide future recommendations, the Company has brought industry expert consultants on board. In 2020 the Company will be using an assessment tool providing data analytics using the SRP work location data, customer restriction of work data, Outage Manage System data, Customer Information System data, Geographical Information System data, and storm duration and cost data. Using this assessment tool, a third party consultant will be performing a full assessment of the program. The analysis is expected to be completed by May 2020.

2.5. 2020 Vegetation Management Storm Resiliency Program Planned

For 2020, storm resiliency work on 34.7 miles of line in the Capital service area is proposed, at a total cost of $1,423,000. These planned circuits, shown in Table 14, were chosen for their recent historic reliability performance, number of customers served, field conditions, and location.

Table 14

2020 SRP Planned Work Details		
Circuit	**Overhead Miles**	**Scheduled Miles**
C15W2	5.8	4.3
C2H2	8.8	5.3
C13W2	18.0	5.0
C37X1	6.8	1.2
C4W4	14.2	4.0
C8X5	7.4	7.2
C16H1	3.2	2.1
C16H3	4.5	1.8
C16X4	6.6	3.8
Total		**34.7**

3. Reliability Planning and Performance

The Company approved total spending of $2,640,791 in the 2020 annual budget on capital reliability projects and $300,000 in reliability O&M expenditures. The capital budget includes costs that are carried over from reliability projects that were initiated in 2019 and are expected to be completed 2020.

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 inspections of tree growth and health and enhanced trimming in targeted areas on the system.

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 recommend 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 perform a detailed review on 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 loading analysis; 5) fault current and protection device coordination analysis. Engineering work requests are initiated for any apparent miscoordination identified during this analysis. Projects are entered into the capital budget for projects that require replacement or installation of equipment.

In addition to the fuse coordination completed as part of circuit analysis, the Company reviews trouble interruption reliability reports 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 report on 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 report also 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 1 and Attachment 2 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 for enhanced tree trimming. The Enhanced Tree Trimming funding is intended to target “problem” areas identified through engineering analysis.

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 2019, Distribution Engineering recommended a thorough review of sub-transmission lines. Work was done on UES Capital circuits C38, 34, 37, 375, 374, 33 and 396X1. In total, $361,587 was spent on Enhanced Tree Trimming and 768 hazard tree removals were completed along with sideline clearing on selected portions.

For 2020, Distribution Engineering is recommending the continuation of enhanced tree trimming/ hazard tree removal on a the 38 Line emanating from one of the system supply substations as well as continuing thorough inspection of the trees along the sub-transmission lines that experienced a tree related outages in the UES Seacoast area. The work is budgeted not to exceed $300,000.

3.3. Reliability Capital Expenditures

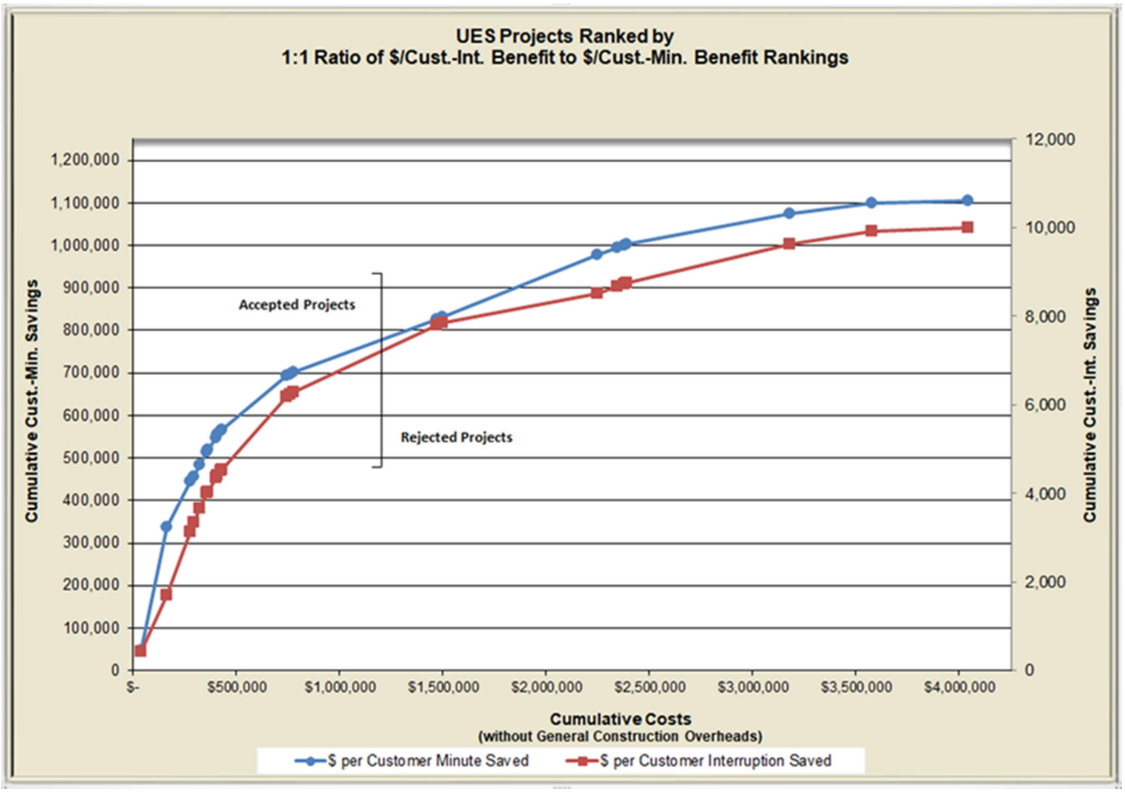
As described in section 3.1.2 above, in addition to the annual pole inspection and replacement program, each year Unitil completes annual reliability studies for each of its operating areas. The recommendations provided in the study are focused on improving the worst performing circuits, as well as the 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 1 below. This chart displays the cumulative project cost compared to the anticipated reliability benefits of all projects. Each data point pair represents 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 1



The reliability projects for 2020 presented in Table 15 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 2019 annual reliability studies for the UES system which have been accepted into the 2019 Capital Budget. This project-listing details the overall project ranking, scope, cost, and anticipated reliability benefits.

Table 15

Project Ranking	Budget No.	Description	Project Cost	Cumulative Cost	Customer Interruptions Saved Annually	Customer Minutes Saved Annually
1	DRBC08	Replace Hydaulic Recloser on Main St, Chichester - 8X3	$37,815	$37,815	439	46,125
2	DRBE02	3343 and 3354 Lines – Install Reclosers	$123,388	$161,203	1,250	290,000
3	DRBCF1	N. Main St Boscawen	$15,454	$176,657	195	13,095
4	DRBC10	Install Recloser on Pleasant St - 6X3	$32,706	$209,363	334	27,774
5	DRBC07	Install Recloser on Mountain Rd - 15W1	$33,670	$243,033	335	27,838
6	DRBCF4	Knox Rd, Bow	$5,720	$248,753	30	5,720
7	DRBC09	Install Recloser on Regional Dr - 8X5	$36,331	$285,084	330	27,429
8	DRBCF2	New Orchard Rd Epsom	$9,447	$294,531	31	10,111
9	DRBCF3	Stickney Hill Rd, Hopkinton	$15,454	$309,985	120	7,565
10	DRBCF9	Borough Rd Caterbury	$7,915	$317,900	20	4,200
11	DRBE01	Circuit 43X1 – Install Reclosers and Implement Distribution Automation	$312,497	$630,397	1,650	125,000
PROPOSED NH RELIABILITY PROJECTS			**$630,397**		**4,734**	**584,857**

Recommended 2020 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 2020 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. 2019 Actual Reliability Expenditures

The capital expenditures of reliability project construction for the Company in 2019, totaled $2,534,863[4]. This total includes the planned annual pole replacement projects in addition to the projects recommended as part of the 2018 annual reliability analysis.

Attachment 3 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] Refer to Attachment 3 for reliability project spending

4. 2019 Reliability Performance

4.1. Historical Performance (2015-2019)

The historical reliability performance for the UES system for the time period from 2015-2019 is outlined in Charts 2-4 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 2

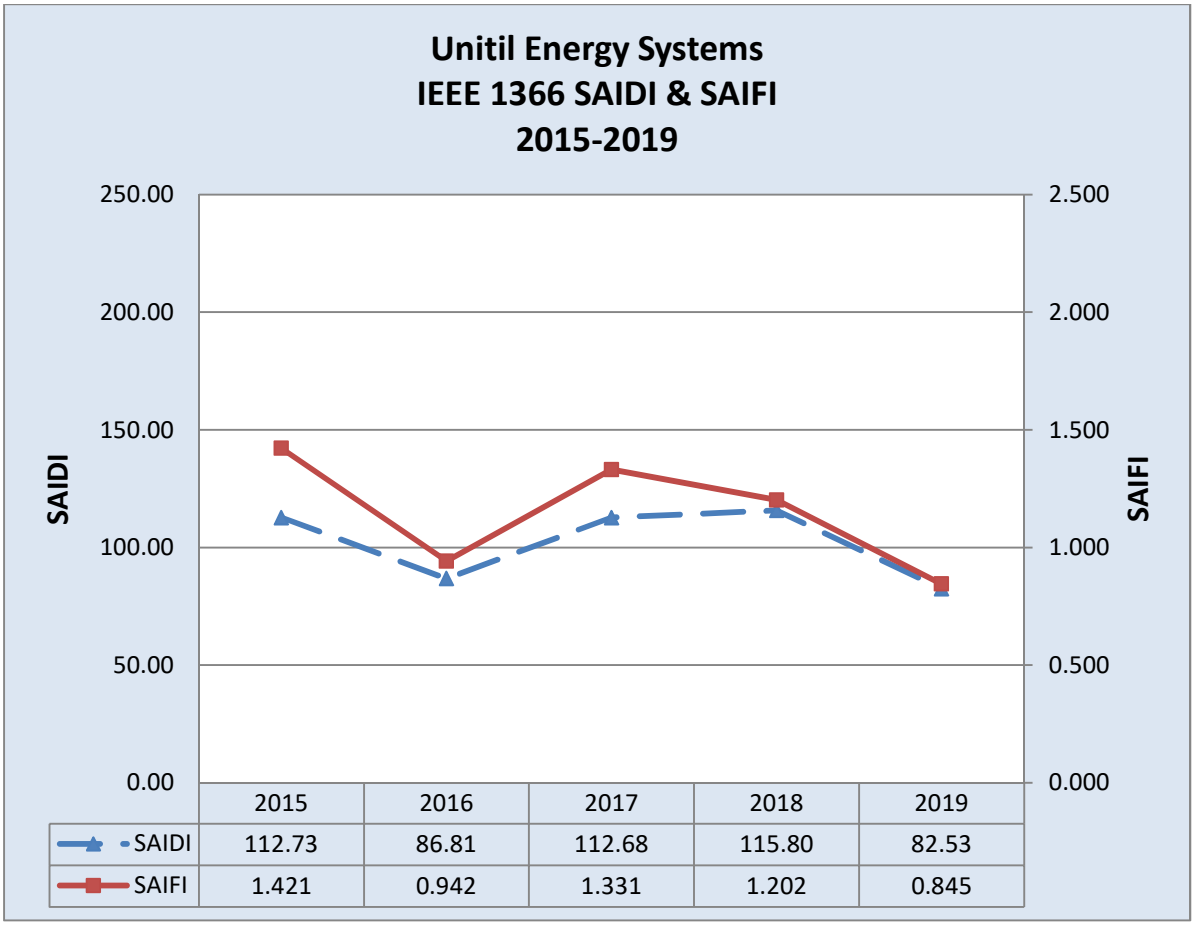


Chart 3

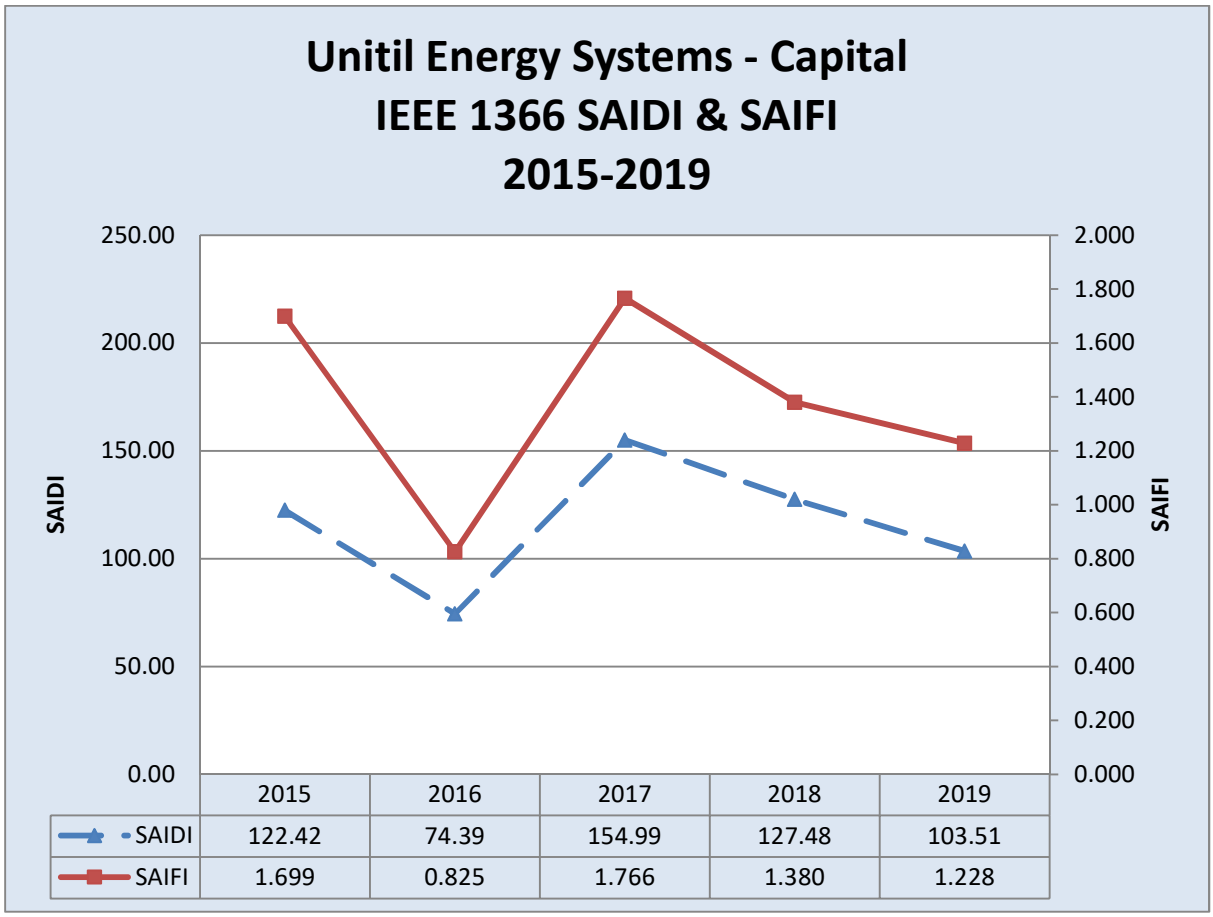
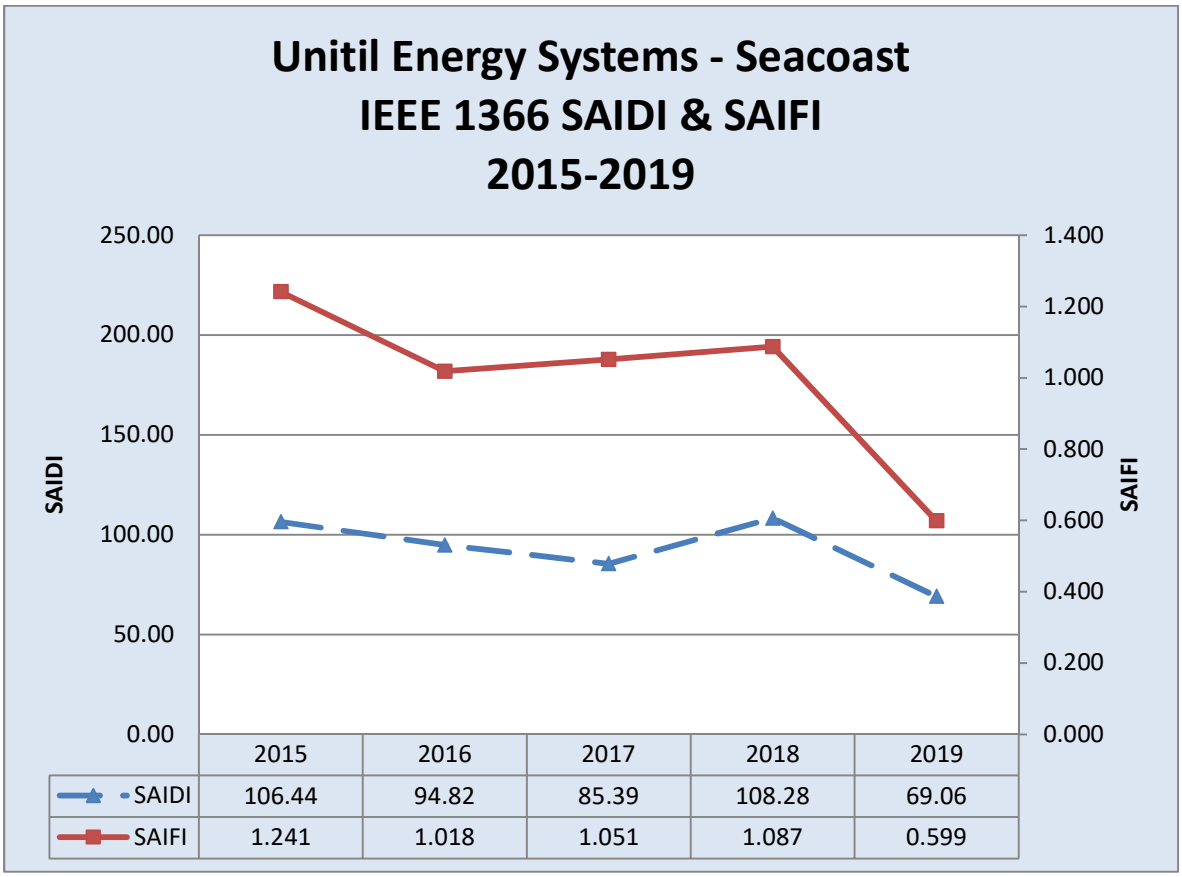

Unitil Energy Systems - Capital
IEEE 1366 SAIDI & SAIFI
2015-2019
SAIDI
SAIFI
250.00
200.00
150.00
100.00
50.00
0.00
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
2015 2016 2017 2018 2019
SAIDI 122.42 74.39 154.99 127.48 103.51
SAIFI 1.699 0.825 1.766 1.380 1.228

Chart 4



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 2019 Performance

The reported reliability performance of the UES systems in 2019 (based on IEEE-1366) was the best performance in the last five years in terms of SAIDI. The combined UES system SAIDI of 82.53 minutes is approximately 20% lower than the 5 year average of 102.11 minutes. The UES combined

system SAIFI for 2019 was 0.845 interruptions which was the best performance in the last five years. The system SAIFI is approximately 26% lower than the 5 year average of 1.148. The total number of interruption events recorded in 2019 was 838.

In 2019, there were two 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:

- June 30th – Wind Event (Capital Region
- October 17th – Wind Event (Capital and Seacoast Region)

Table 16 below shows a breakdown of the reliability performance of the UES system by individual cause codes.

Table 16

Cause of Outage	No of Troubles	Cust Int	Cust Hrs	SAIDI	% Total (SAIDI)	SAIFI	% Total (SAIFI)
Action by Others	12	919	1,985	1.53	1.9%	0.012	1.4%
Animal - Other	3	44	71	0.05	0.1%	0.001	0.1%
Bird	26	2,251	1,926	1.48	1.8%	0.029	3.4%
Civil Emergency (fire,flood,etc.)	3	18	9	0.01	0.0%	-	0.0%
Equipment Failure Company	137	9,217	10,185	7.84	9.5%	0.118	13.9%
Equipment Failure Customer	4	11	48	0.04	0.0%	-	0.0%
Lightning Strike	6	160	285	0.22	0.3%	0.002	0.2%
Loose/Failed Connection	15	615	1,120	0.86	1.0%	0.008	0.9%
Operator Error/System Malfunction	1	1	1	-	0.0%	-	0.0%
Other	9	763	1,808	1.39	1.7%	0.010	1.2%
Overload	8	138	243	0.19	0.2%	0.002	0.2%
Patrolled, Nothing Found	74	4,915	6,734	5.18	6.3%	0.063	7.4%
Scheduled, Planned Work	109	5,287	4,830	3.72	4.5%	0.068	8.0%
Squirrel	49	1,160	1,340	1.03	1.2%	0.015	1.8%
Tree/Limb Contact - Broken Limb	161	11,126	16,622	12.79	15.5%	0.143	16.9%
Tree/Limb Contact - Broken Trunk	137	19,065	43,432	33.43	40.5%	0.245	28.9%
Tree/Limb Contact - Growth into Line	14	555	808	0.62	0.8%	0.007	0.8%
Tree/Limb Contact - Uprooted Tree	32	4,345	4,384	3.37	4.1%	0.056	6.6%
Tree/Limb Contact - Vines	9	744	773	0.59	0.7%	0.010	1.2%
Vehicle Accident	29	4,528	10,631	8.18	9.9%	0.058	6.8%

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 2019. Tables 17 and 18 below shows how the top three causes during 2019 have trended over the last three years[5].

Table 17

	SAIDI (% Total)		
Cause	**2019**	**2018**	**2017**
Tree Related	51%	65%	54%
Vehicle Accident	10%	7%	7%
Equipment Failure	10%	20%	18%

Table 18

	SAIFI (% Total)		
Cause	**2019**	**2018**	**2017**
Tree Related	59%	62%	48%
Equipment Failure	15%	17%	19%
Patrolled, Nothing Found	8%	10%	5%

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