STRATEGIES FOR COMPLEX ORGANIZATIONS

Final Report

Connecticut Light and Power's Emergency Preparedness and Response to Storm Irene and the October Nor'easter

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1. Executive Summary

In 2011, two storms struck Northeast Utilities' (NU) Connecticut Light and Power Company (CL&P) service territory, causing widespread outages for more than 2.4 million customers, and requiring 20 total restoration days. On August 28, 2011, Tropical Storm Irene made landfall in Stamford, Connecticut, causing outages to peak at 671,789 late on that same day. This was, at that point, the most significant outage event in CL&P's long history. The restoration effort lasted nine days.

Two months later, on October 29, 2011, an unprecedented Nor'easter struck the east coast. The storm left between eight and 16 inches of heavy wet snow across the western and central portions of Connecticut with lesser amounts along the shoreline and in southeastern towns. Deciduous trees in the region still carried most of their foliage, causing more downed trees and limbs than during typical winter storms and contributing significantly to customer outages, which peaked at 807,228 on October 30. This restoration effort required 11 days.

1.1. Approach Overview

As a result of the large number of outages, the extended restoration times in both events, and an increased focus by external stakeholders (i.e., customers, elected officials, media, and regulators) on CL&P's performance, NU hired Davies Consulting to evaluate the effectiveness of CL&P's response to the events and to provide recommendations on how to improve performance – from both an emergency response and utility operations perspective. The approach undertaken by Davies Consulting, after mobilizing the project, included the following steps:

- ***Assess the Impact of the Storms on the CL&P System*** **-** The purpose of this step was to understand the effect of the events on CL&P's system and compare damage to similar events through the use of a confidential database that Davies Consulting created in 2003 and has updated continuously, which allowed Davies Consulting to examine, using key metrics, how CL&P's performance compared to the industry norm. Davies Consulting submitted a request for more than 90 different pieces of data and then began reviewing and comparing that data and the data submitted by NU and CL&P in response to the multiple other external reviews being conducted. During this step, Davies Consulting also developed a simulation that illustrates the relationship between weather and customer outages and visually depicts how CL&P managed and deployed line and vegetation resources.
- ***Conduct Preparedness and Response Analysis*** **-** During this task, Davies Consulting used data gathered in the previous step to identify focus areas and develop interview questionnaires for key CL&P staff involved in the restoration.
- ***Assess CL&P Construction Standards and Maintenance Programs*** **-** In this step, Davies Consulting conducted a high-level review of CL&P's construction and engineering standards relative to extreme weather guidelines for the region and

assessed pole replacement and vegetation management programs to determine whether CL&P adequately funded these programs over the past several years.

- ***Develop Summary Findings Report*** **-** Throughout the course of the engagement, Davies Consulting documented findings and consolidated them into this summary report highlighting findings and, most importantly, recommended improvement opportunities that, if implemented, would enable CL&P to achieve best industry practices.

1.2. Evaluation Areas

Davies Consulting identified the following key areas to support the team in evaluating CL&P's emergency planning, preparedness and response practices:

- ***Emergency Planning and Preparedness*** – Is there a vision of what leadership wants to accomplish before, during, and after major emergencies and a set of guiding principles that define the response strategy? Is there a comprehensive Incident Command System (ICS)-based plan in place that has been tested at least annually in both table top and functional exercises? Are the senior management team roles well defined? Is there a commitment to storm roles?
- ***Resource Acquisition and Mutual Aid*** – How quickly is the company able to determine needs, secure adequate off-system support and pre-position necessary resources? Is there an effective on-boarding process?
- ***Crisis Communication and Estimated Times of Restoration (ETRs)***– Have processes been put in place to ensure "one voice" communication during major events and are these processes followed? Is there a process for creating and managing ETRs that are sufficiently granular to meet the needs of stakeholders?
- ***Planning and Damage Assessment*** – How well is the damage assessment process defined and executed? How is the damage information captured and used? Is planning done to optimize crew productivity?
- ***Restoration Execution***– How effectively did the company allocate, manage, and track resources? Was the restoration coordinated with local and state governments efficiently? Were there any delays in restoration?
- ***Information Systems and Technology*** – Is technology seen as an integral part of the restoration effort and is it tested at least annually to ensure it meets requirements and supports both customers' and internal/foreign crew needs?
- ***Logistics*** – Was logistics support adequate to ensure effective restoration? Were lodging and food secured in a timely manner? Was material available to make necessary repairs without delay?
- ***Call Center Performance*** – Is there a proactive plan for addressing the increased volume of calls from customers? Are there pre-event Interactive Voice Response (IVR) messages scripted and were the plans implemented?
- ***Maintenance and Vegetation Management*** – Did the company suffer an undue amount of damage because of inadequate vegetation management or equipment maintenance execution or funding?

- ***Transmission*** – How did the company restore its transmission system? Did transmission outages cause delays in the customer restorations? How is transmission response integrated into the overall company's restoration effort?

This report includes 75 findings and 66 recommendations related to these evaluation areas, providing concrete steps that CL&P and NU can take to improve future performance in order to achieve industry best practices.

1.3. Findings and Recommendations Summary

The findings and recommendations in this report are based on: observations made by Davies Consulting staff during a visit in November 2011 while the Nor'easter restoration was ongoing; interviews conducted from December 2011 through January 2012; and review and analysis of data included both in Davies Consulting's data requests to CL&P and also data submitted by CL&P in response to other ongoing investigations; and comparisons of CL&P's responses to Irene and the Nor'easter to industry data.

Specifically, when Davies Consulting examined CL&P's responses to Irene and the Nor'easter, it primarily compared CL&P's performance to industry norms. However, based on the State of Connecticut's, NU's and CL&P's desire, going forward, to attempt to implement an emergency preparedness program for CL&P that is among the best in the industry, the recommendations contained in this report describe the steps NU and CL&P can implement in order to achieve best industry practices.

When Davies Consulting compared CL&P's performance to industry norms, it concluded that, in both restorations, CL&P restored all of its customers within a reasonable timeframe in comparison to similar events (number of outages, amount of damage, etc.) without any serious injuries to the public or company workers (including mutual aid resources). CL&P also performed extremely well from the call center perspective, being able to handle a record number of calls leveraging new systems and available technologies. In addition, CL&P's early adoption of ICS and comprehensive emergency response plans helped provide a framework for managing the restoration, including the logistics for the record numbers of off-system resources. Moreover, overall, logistics functions (both from a lodging and food perspective and stores perspective) performed well during both storms.

However, these unprecedented events also exposed numerous opportunities to improve CL&P's existing storm restoration response so that, if these recommendations are implemented, they would enable CL&P to achieve best industry practices. Opportunities for improvement include: the ability to scale its response to the size of the event, establishing better situational awareness of the incident early in the process, ensuring consistent and accurate communication throughout the restoration, and obtaining adequate off-system resources quickly, and effectively managing a large number of crews. Although CL&P has conducted the following table top exercises: four district-level in 2010, an incident command-level in March 2011, and a walk-though in anticipation of Irene, CL&P has not conducted a system-wide functional exercise since at

least 2007. In addition, even though NU and CL&P continue to invest in enterprise information systems, in order to facilitate restoration efforts, they should fully integrate the key systems that support the restoration efforts, such as the Outage Management System (OMS), GIS (Geospatial/Geographic Information Systems), and SCADA (Supervisory Control and Data Acquisition).

When compared with other utilities in the region, CL&P appears to be spending more on its distribution system per customer. In addition, CL&P has implemented a robust pole inspection and replacement system in its fifth year of implementation and the company's vegetation management program follows industry standards. However, the current state-authorized funding for vegetation management does not provide for sufficient clearances around lines in order to achieve a four-year cycle, does not adequately address "danger" or "risk" trees, and results in a preventive maintenance cycle that does not adequately address vegetation density, vegetation growth cycles in the region, and customer expectations for service levels. Finally, while the transmission system outages and subsequent restoration did not appear to delay any customers from being restored, a number of restoration processes were developed and implemented in real-time.

As indicated previously, this report describes 66 recommendations that would enable CL&P to achieve industry best practices. These recommendations are separated into the key evaluation areas described above. Many of the recommendations address the following opportunities: improving training, processes, and functional exercises; clarifying roles and responsibilities; integrating information technology systems; and collaborating with stakeholders more effectively, while ensuring that restoration efforts are not detrimentally affected or delayed. Key recommendations across all evaluation areas include:

- Establish a clear vision and guiding principles for CL&P emergency response;
- Define restoration strategies, including the type of strategy to be used depending on event size and type;
- Define more completely event roles and responsibilities of all NU/CL&P staff, including officers;
- Refine NU's/CL&P's emergency response structure;
- Create a structured certification, training, and exercise program;
- Define an end-to-end mutual aid process with fully qualified staffing;
- Explore opportunities to join additional regional mutual aid organizations;
- Implement a resource tracking system;
- Adopt a "one voice" approach to all external stakeholders and coordinate all externally-facing staff under a single communications umbrella;
- Re-vamp the Town Liaison program to focus on a broader geographic area and incorporate liaisons into the communications group during an event;
- Enhance ETR development, release, and monitoring processes;
- Develop and implement a robust training and field certification program for all damage assessors/patrollers;

- Implement a forensic analysis process for major events;
- Develop, in collaboration with external stakeholders, critical facility/customer lists and prioritize feeders/circuits;
- Deploy mobile data terminals (MDTs);
- Integrate key IT systems to store and manage situational awareness information;
- Centralize food and lodging functions;
- Seek additional funding and changes to applicable state law in order to implement a more aggressive vegetation management program;
- Develop a more comprehensive hazard tree removal program and work with the appropriate stakeholders to secure adequate access and approvals;
- Develop, approve and implement a transmission Emergency Response Plan, including damage assessment process; and
- Review, adjust and formalize the transmission line restoration prioritization approach.

Since the Nor'easter, CL&P has begun to take steps to improve its preparedness for major events. With the creation of the emergency preparedness organization, CL&P has started to identify key improvements and establish a cross-functional team to drive the change throughout the organization. Based on Davies Consulting's experience with other utilities that have improved emergency preparedness, a strong sustained commitment by leadership is critical to implement changes in a way that will create ownership across the organization and ensure sustainability in the longer-term. While there are certain improvements that can be made over the next few months and in time for the next storm season, other improvements will take several years to fully implement.

2. Introduction

In 2011, NU and CL&P were affected by two unprecedented major storms within two months, resulting in more than 2.4 million combined customer outages. On August 28, 2011, Storm Irene made landfall in Stamford, Connecticut and, with customer outages peaking at 671,789 late on that same day, CL&P experienced what was, at that point, the most significant outage event in its long history. Although CL&P restored approximately 200,000 customers within 24 hours, the restoration lasted an additional eight days. Nearly two months later, CL&P was struck by an even more severe weather event. On October 29, 2011, an unprecedented October Nor'easter began affecting all of Connecticut – by the next day, the storm had left between 8 and 16 inches of heavy wet snow across the western and central portions of the state with lesser amounts along the shoreline and southeastern Connecticut. Customer outages peaked on October 30 with 807,228 customers without power. All customers who had lost power during the Nor'easter were restored eleven (11) days after the event (by November 10, 2011). In total, CL&P would restore 1,438,797 customers following the Nor'easter and 1,024,032 customers following Irene.

2.1. Purpose and Scope

As a result of the large number of outages and extended restoration times in both events, NU hired Davies Consulting to conduct an independent evaluation of the effectiveness of CL&P's response to the events and to provide recommendations as to how to improve performance – from both an emergency response and utility operations perspective. The purpose of the evaluation and this report is to identify the processes, technologies, and metrics that will improve future CL&P restoration efforts.

The assessment of the CL&P response focused on the five key aspects of the emergency management cycle depicted in Figure 1 below, and specifically included a review of key aspects of the restoration effort, such as : Emergency Planning and Preparedness; Resource Acquisition and Mutual Aid; Crisis Communication and ETRs; Planning and Damage Assessment; Restoration Execution; Information Systems and Technology; Logistics; Call Center Performance; Maintenance and Vegetation Management; and Transmission.

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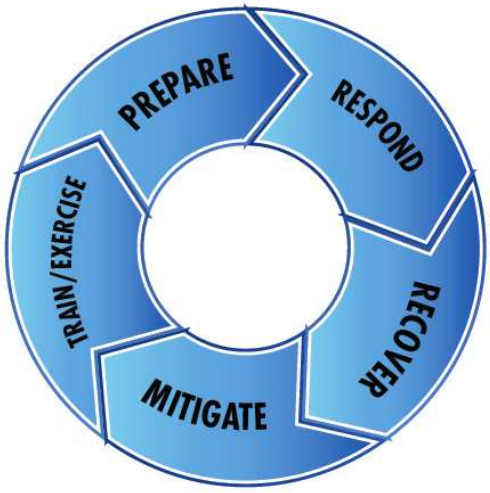
Figure 1: Emergency Management Cycle



In addition, Davies Consulting reviewed key programs, such as pole maintenance and vegetation management, which external stakeholders had pointed to as contributing factors to the damage experienced by CL&P. Finally, Davies Consulting created a simulation of the response and conducted a benchmark evaluation of the response against other similar events and utilities.

2.2. Key Evaluation Areas

Davies Consulting identified the following key areas to support the team in evaluating CL&P's emergency planning, preparedness and response practices:

- ***Emergency Planning and Preparedness*** – Is there a vision of what leadership wants to accomplish before, during, and after major emergencies and a set of guiding principles that define the response strategy? Is there a comprehensive Incident Command System (ICS)-based plan in place that has been tested at least annually in both table top and functional exercises? Are the senior management team roles well defined? Is there a commitment to storm roles?
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- ***Planning and Damage Assessment*** – How well is the damage assessment process defined and executed? How is the damage information captured and used? Is planning done to optimize crew productivity?

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- ***Restoration Execution*** – How effectively did the company allocate, manage, and track resources? Was the restoration coordinated with local and state governments efficiently? Were there any delays in restoration?
- ***Information Systems and Technology*** – Is technology seen as an integral part of the restoration effort and is it tested at least annually to ensure it meets requirements and supports both customers' and internal/foreign crew needs?
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- ***Maintenance and Vegetation Management*** – Did the company suffer an undue amount of damage because of inadequate vegetation management or equipment maintenance execution or funding?
- ***Transmission*** – How did the company restore its transmission system? Did transmission outages cause delays in the customer restorations? How is transmission response integrated into the overall company's restoration effort?

2.3. The Benchmark Database

Davies Consulting began to develop its confidential and proprietary Storm Benchmark Database in 2003 after it sent a survey to 14 utilities that had experienced major weather events during the previous ten years. The data included in the benchmark database is derived from a standard survey that includes approximately 90 questions. The questions provide numerous points of data relevant to the utility, its service territory, and the restoration of service following the weather event(s) in question. The database currently contains key statistics from more than 70 major event responses by over 32 major electric utilities across North America and allows different comparisons of response effectiveness and includes information on all different facets of restoration and preparedness. While each event is unique and the comparisons among utilities have to be carefully evaluated, benchmarking can be valuable in identifying areas where potential improvement opportunities exist. For example, certain metrics (e.g., poles replaced per 1,000 customers out of power at peak) can be used to understand the magnitude of damage a utility has experienced, while other metrics, such as the number of personnel utilized per pole replaced, can be used to evaluate the level of resource deployment.

2.4. The Response Simulation

Davies Consulting developed a visual representation of CL&P's response to Irene and the Nor'easter using Microsoft PowerPoint. The simulation captured the following

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information on a day-to-day basis for the periods for Irene (August 27, 2011 until September 6, 2011) and the Nor'easter (October 29, 2011 until November 9, 2011):

- Storm path;
- Wind speed and direction;
- Precipitation amounts;
- Percentage of customers out of power by district and the duration of those outages; and
- Number of resources deployed to specific districts of CL&P's service areas to assist with restoration.

The resources represented in the presentation include on system and mutual aid/contractor vegetation and line resources. Logistics support personnel and construction support personnel are not represented in the simulation.

Inputs to these simulations include data provided by NU and CL&P concerning (1) the extent of customer interruptions by day by district, (2) on and off-system line resources utilized by district, and (3) vegetation resources.[1] The resource numbers include CL&P's own line personnel, line resources obtained from affiliated NU companies, mutual-aid companies, and contractors. In addition, data on wind speeds and wind directions recorded by the National Oceanic and Atmospheric Administration (NOAA) and other research institutions monitoring stations in the area are represented in the simulation.

The presentation depicts the temporal development of the effect of the storms from the perspective of the customers out of service, together with the deployment of resources in response to the damage. The presentation is a useful tool for evaluating how CL&P responded and managed its resources throughout the restoration efforts and allows CL&P leadership to review critical decision points (such as resource acquisition, allocation and release decisions) and understand where opportunities exist for improvement or where processes and procedures may require closer evaluation.

[1] The term "resources" refers to workers or individual persons and is interchangeable with terms such as "workers" or "personnel."

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3. Northeast Utilities and Connecticut Light and Power Background

NU was formed in 1966 when CL&P, Western Massachusetts Electric Company (WMECO), and The Hartford Electric Light Company (HELCO) affiliated as subsidiaries of a single corporate entity. HELCO would be incorporated into CL&P in the 1980s. The NU system was the first new multistate public utility holding company system created since the enactment of the Public Utility Holding Company Act of 1935. In 1967, the Holyoke Water Power Company joined NU and in 1992, Public Service Company of New Hampshire (PSNH) was acquired. In 2000, Yankee Gas, which had separated from NU in 1989, rejoined the NU system.

As Connecticut's largest electric utility, CL&P has delivered electric service to homes, neighborhoods, and businesses for nearly 100 years. With approximately 2,000 employees, CL&P serves more than 1.2 million customers in 149 Connecticut cities and towns, in a 4,400 square mile service territory. This equates to 87 percent of the total area in Connecticut, including large urban centers, suburban and rural settings with heavily-treed areas, shoreline areas, and hilly terrain. Key 2010 system statistics for CL&P are shown below, in Table 1:

Table 1: 2010 CL&P System Statistics

Transmission Lines	
Overhead miles	1,638
Underground miles	135
Distribution Lines	
Overhead miles	16,974
Underground miles	6,290
Transformers	288,413
Poles	733,111
Substations	244
Meters	1,237,000
Peak Load (August 3, 2006)	7,479 MW

The CL&P electric transmission system consists of approximately 1,638 circuit miles of overhead transmission and 135 miles of underground transmission. CL&P has 19 transmission substations and 97 distribution substations supplied from its transmission system, with another 128 substations supplied from its distribution system. CL&P's distribution system consists of approximately 16,974 circuit miles of overhead and 6,290 circuit miles of underground primary construction, including both direct-buried and

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underground duct and manhole. Primary distribution voltages range from 4.16kV to 34.5kV with the majority of circuits operated at 4.8kV, 13.2kV, 13.8kV and 23kV. CL&P uses over 285,000 distribution transformers to supply its customers.

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4. History of the Events

As noted previously, in late August and then again in late October, CL&P experienced the two worst outage events in its history. Prior to Irene, the last event that had caused the most damage to the company in its history had been Hurricane Gloria, in 1985, when 535,000 customers lost power and the restoration took approximately 10 days. The table depicted in Figure 3, below, provides an overview of the level of damage that CL&P experienced in comparison to other major events (i.e., events that caused more than 100,000 total customer interruptions) over the last ten years.

Figure 2: Event Comparison

Storm Name	Est. Peak # Customers Affected	Customers Restored	Circuits Affected	Feeder Lockouts	Trouble Spots	Poles Replaced	Transformers Replaced	Cross Arms	CL&P Crews	Off-System Line Crews	VM Crews
Nor'easter (October 2011)	807,228	1,438,797	841	368	25,475	1,655	1,964	5,590	172	1,631	870
Storm Irene (August 2011)	671,789	1,024,032	822	258	16,101	1,297	1,748	3,204	204	1,130	555
T'storm (June 2011)	141,068	209,045	531	43	2,603	95	332	438	130	283	148
Tornadoes (July 2010)	63,840	108,305	358	44	1,337	29	122	181	120	132	54
Rain/Wind (March 2010)	102,601	168,554	416	66	3,743	472	615	980	149	222	164
TS Ernesto (September 2006)	59,503	116,768	327	38	1,484	33	132	152	110	89	62
Heat/ T'storm (August 2006)	59,618	146,801	477	19	1,785	115	275	634	114	60	56
Ice Storm (November 2002)	131,600	224,912	308	N/A	5,872	83	377	617	147	251	125
Wind Storm (September 2002)	120,118	182,388	569	38	3,016	124	245	N/A	210	129	111

As is clear from the above, the damage caused by Irene and then by the October Nor'easter only two months later was extreme. The storms are described in greater detail below.

4.1. Storm Irene

Irene first became a tropical storm on August 20, 2011 between the African coast and the Lesser Antilles and became a hurricane two days later, while passing over Puerto Rico. On August 24, Irene hit the Bahamas as a category 3 hurricane (as defined by the Saffir-Simpson Hurricane Wind Scale). On August 27, after gradually weakening, Irene made landfall in North Carolina as a category 1 hurricane and moved north-northeastward, making another landfall near Atlantic City, New Jersey on August 28, bringing significant precipitation and wind from the Mid-Atlantic through New England. At the time of landfall in New Jersey, Irene had peak winds of approximately 69 miles

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per hour. Storm surges of between 4' and 6' were reported from New Jersey north. The figure below, which details wind speeds and storm surges experienced in Connecticut, is courtesy of the National Hurricane Center's Tropical Cyclone Report for Hurricane Irene.

Figure 3: NHC Irene Storm Details

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Connecticut								
ICAO Sites								
Bridgeport (KBDR)	28/1412	975.6	28/0831	40	55			3.50
Groton (KGON)	28/1258	983.1	28/1257	40	50			
New Haven (KHVN)	28/1540	977.7	28/1336	37	58			3.34
Windsor Locks (KBDL)	28/1751	977.1	29/0151	26	44			5.23
Danbury (KDXR)	28/1454	973.2	28/1012	27	41			6.72
Marine Observations								
Bridgeport (BRHC3)	28/1500	975.4	28/1436	37	45	4.44	12.08	
New Haven (NWHC3)	28/1630	977.0	28/1554	35	45	4.65	11.57	
New London (NLNC3)	28/1748	983.5	28/1442	37	47	3.49	6.55	

When Irene passed over Connecticut, the state was exposed to the northeast quadrant of the storm, which had sustained winds of 35 to 40 mph and gusts to 66 mph. Rain accumulation of 6 to 8 inches was measured in the western half of the state, with lesser amounts in the southeast region of Connecticut. The storm became extra-tropical while near the New Hampshire/Vermont border on August 28.

4.1.1. Event Timeline and Response Description

Irene's wind began to affect the CL&P service territory late on August 27, 2011, with the system making landfall in Stamford at approximately 10:00 A.M. on August 28. Several days before the storm actually struck Connecticut, however, forecasts had predicted that the storm would have a significant impact on the state and Telvent, CL&P's weather monitoring service, indicated that there would be "flooding rains, damaging winds, and coastal flooding," which would be a major concern. Based on Telvent and National Weather Service/National Hurricane Center alerts, CL&P began making preparations for Irene's arrival on August 23, 2011 – five days prior to the projected impact date. More specifically, CL&P began participating in daily National Weather Service conference calls/briefings on August 23; began participating in mutual aid conference calls on August 24; opened the company's Emergency Operations Center and conducted a table top exercise on August 26; and had more than 150 off-system line crews positioned on the CL&P service territory before the storm arrived.

Outages peaked at 671,789 on August 28 at approximately 9:00 P.M. Within 24 hours, CL&P had 239 off-system line crews, 250 tree crews on system and had restored more than 160,000 customers, or twenty-four percent (24%) of customers out at peak. Forty-

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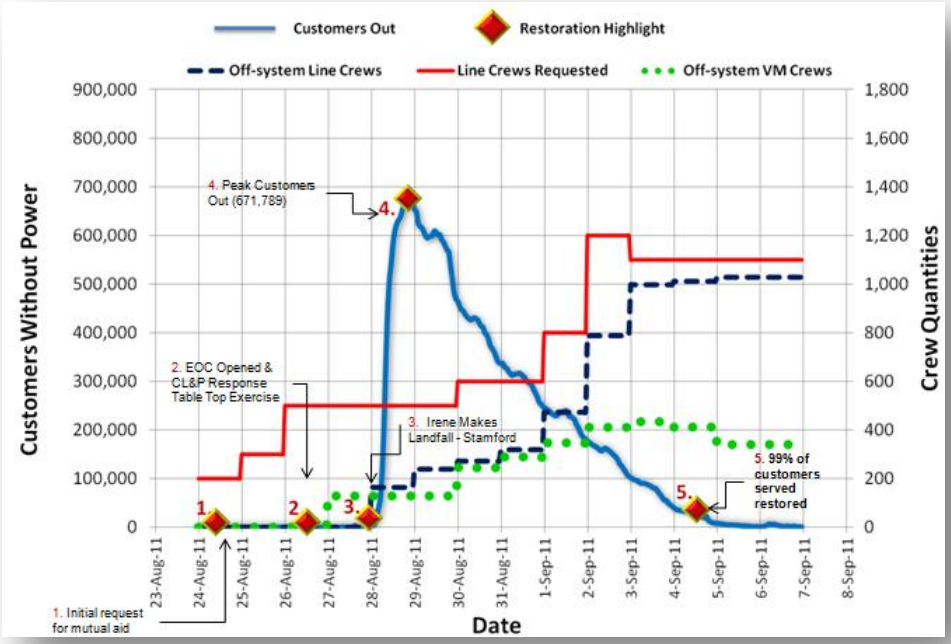
eight hours after peak, CL&P had restored nearly 50% of those out at peak and had 272 off-system line crews and 366 tree crews on system. CL&P had restored 90% of those out at peak by 4:00 P.M. on September 3 – approximately five days after the storm had exited the CL&P service territory. Early on September 5, CL&P had restored 99% of customers out a peak. Mutual aid/contractor line crews on system peaked at 1,029 on September 5 and tree crews peaked at 556 on September 3.

During the event (from August 28 until September 6), a total of approximately 1.03 million customer calls were answered. The IVR system processed approximately 74% of customer calls. The average speed of answer of all calls received during the storm event was 13 seconds.

The graphic in Figure 4, below, depicts: the restoration curve (solid blue); off-system line crews requested (solid red); off-system line crews that have arrived on CL&P service territory (dashed blue); total number of off-system tree trimming crews (dotted green); and some key points in the restoration (amber diamonds).

Figure 4: Irene Resource and Restoration Timeline



4.1.2. The Response Simulation Key Points

In the simulation graphics included in this section and Section 4.2.2, the following key applies:

- The shaded circles represent the location of a CL&P area work center that serves the surrounding municipalities in that region: Greenwich, Stamford, Norwalk; Madison,

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New London, Newtown; Cheshire; Waterbury; Middletown; East Hampton; New Milford; Willimantic; Hartford; Torrington; Danielson; Simsbury; Tolland; and Falls Village.

- The size of a circle reflects the number of customers served in each area in relation to the other areas. The more customers served within an area, the larger the circle.
- The percentage of customers without power within a particular areas is designated by the color of the circle – ranging from zero percent without power (gray-blue) to less than 10% without power (light blue) to more than 90% without power (black).
- The wind gusts and sustained winds are reflected by star figures with the direction of the wind represented by an arrow.
- The blue and orange cells represent the numbers of crews assigned to each area. Blue shaded cells reflect the total number of line crews, including CL&P crews, sustaining contractor and off-system line crews. Orange shaded cells represent the total number of vegetation management crews. These figures are based on the available information provided by CL&P and may be estimated.
- While the "storm phase" of the simulation provides hourly data for the storm period, the "restoration phase" has daily information, updated at 6:00 A.M.
- Certain graphics (the storm phase) include a radar depiction of the storm passing through the service territory.

The granular data used to develop the Irene simulation is based on the hourly estimate of customer outages at the district level that were captured during the restoration.

Late on August 27, the CL&P territory began to experience winds in excess of 24 miles per hour and by midnight, customers in four regions were without power (ranging from 11%-29%). By 9:00 P.M. on August 28, when peak outages occurred, six regions had more than 90% of customers out and no region had less than 31% of customers out.

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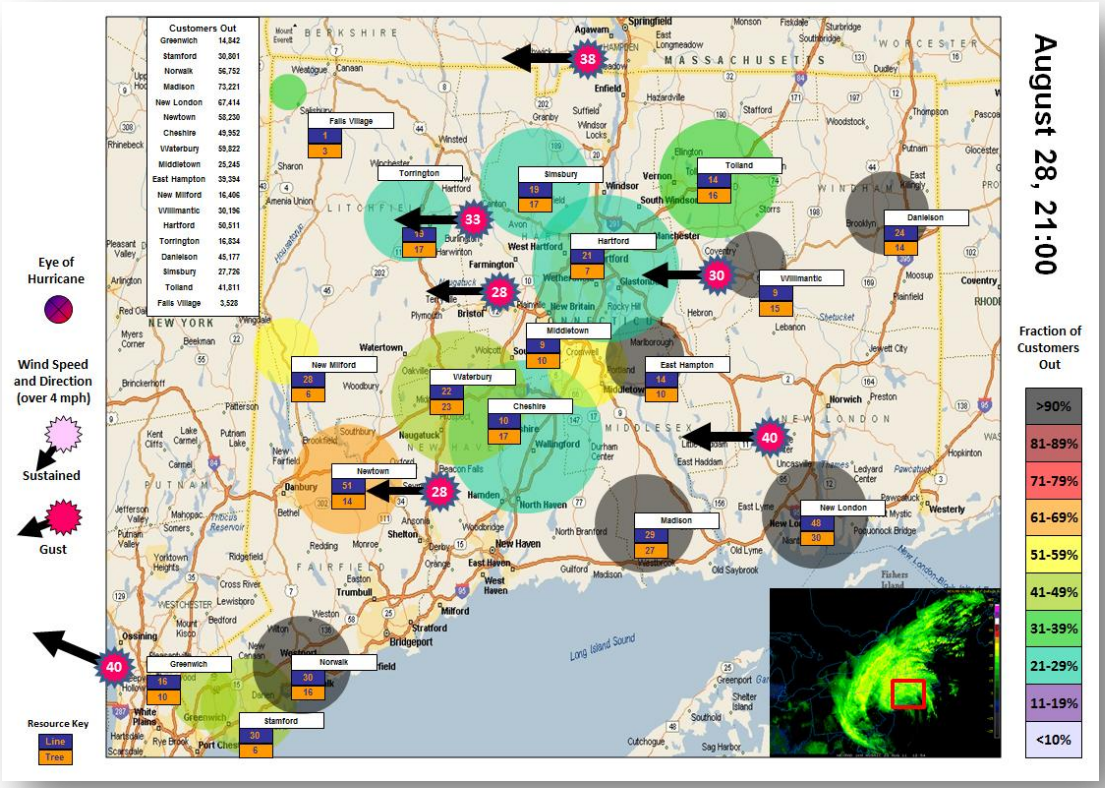
Figure 5: Irene Simulation – Peak Outage View



It should be noted that while six regions had more than 90% of customers without power, some of those regions actually had fewer total customers without power than more urban districts that may have had smaller percentages but a larger number of customers out. For example, while Willimantic had more than 90% of customers out (as shown above), the total number of customers out was 30,196 as compared to Hartford, which only had between 21%-29% of customers out but a total of 50,511. In any restoration affecting multiple districts, therefore, CL&P gives consideration not only to the percentage of customers out, but also to the number of customers out. There may be times that CL&P should focus resources on a more urban area, with a lower percentage but greater total number of customers affected, than on an area with devastation to the whole region but fewer customers out.

By 6:00 A.M. on August 29, Irene had nearly exited the service territory, and nearly 600,000 customers remained without power. At that point, however, CL&P had decreased the number customers without power in sixteen out of the eighteen regions, with the most dramatic decreases (on a number of customer basis) in Cheshire and Simsbury. With the storm off the system, resources begin to ramp up on August 29, continuing to increase for the next seven days. At 6:00 A.M. on August 30, Madison had

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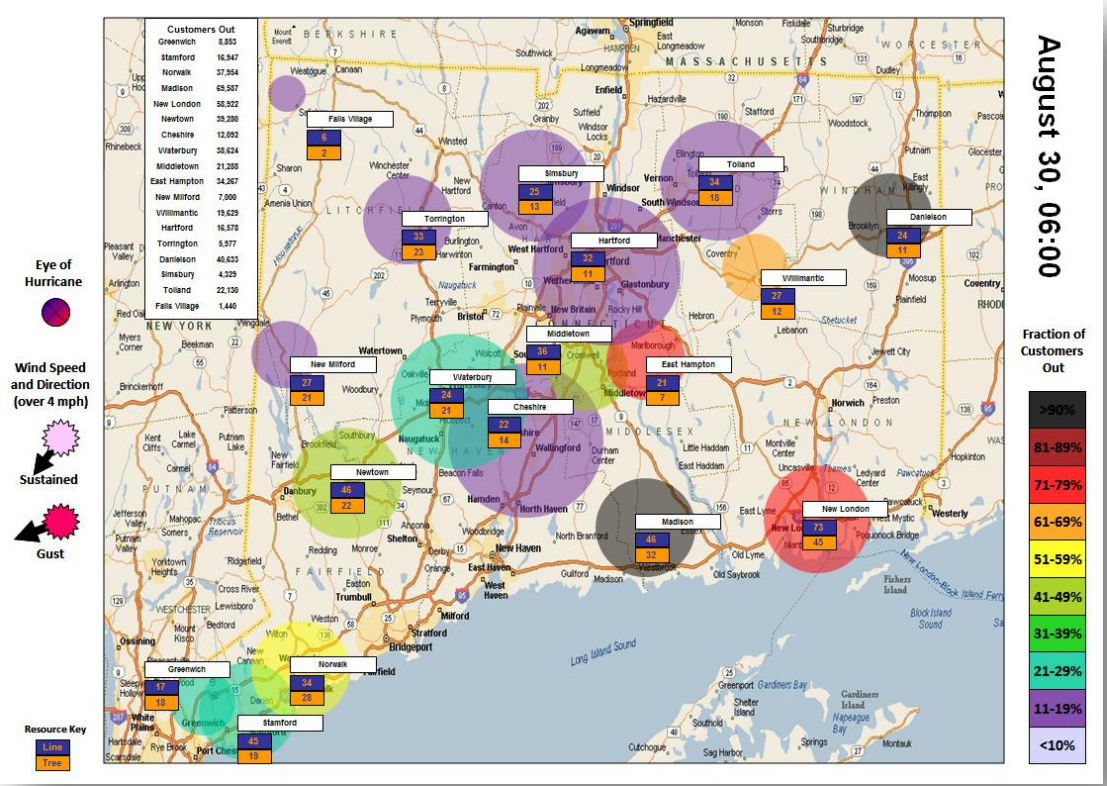
both the greatest number of customers out (more than 69,500) and, along with Danielson, the greatest percent of its customer base (more than 90%) out. New London had approximately 59,000 customers out (between 71%-79% of the total customers), but had 50% more resources allocated to it than Madison. Danielson, with more than 40,000 customers out (more than 90% of its customer base), had fewer line resources than many districts. This data reflects that, while on August 30, CL&P's other three Divisions (the Western, Northern and Southern Divisions) were transitioning from phase 1 of the storm response (E911, blocked roads, priority restorations) to phase 2 (large blocks of customers), CL&P's Eastern Division (which includes Madison, New London and Danielson) continued to work on phase 1 of its restoration response.

Figure 6: Irene Simulation – August 30, 2011



On August 31 at 6:00 A.M., the top three regions in number of customers out continued to be Madison, New London, and Danielson. The following regions had the highest number of total line resources at that time: New London; Madison, Newtown; Stamford; Middletown; Tolland; and Norwalk. By September 2, however, a significant number of resources had been moved to Madison, Danielson, and New London.

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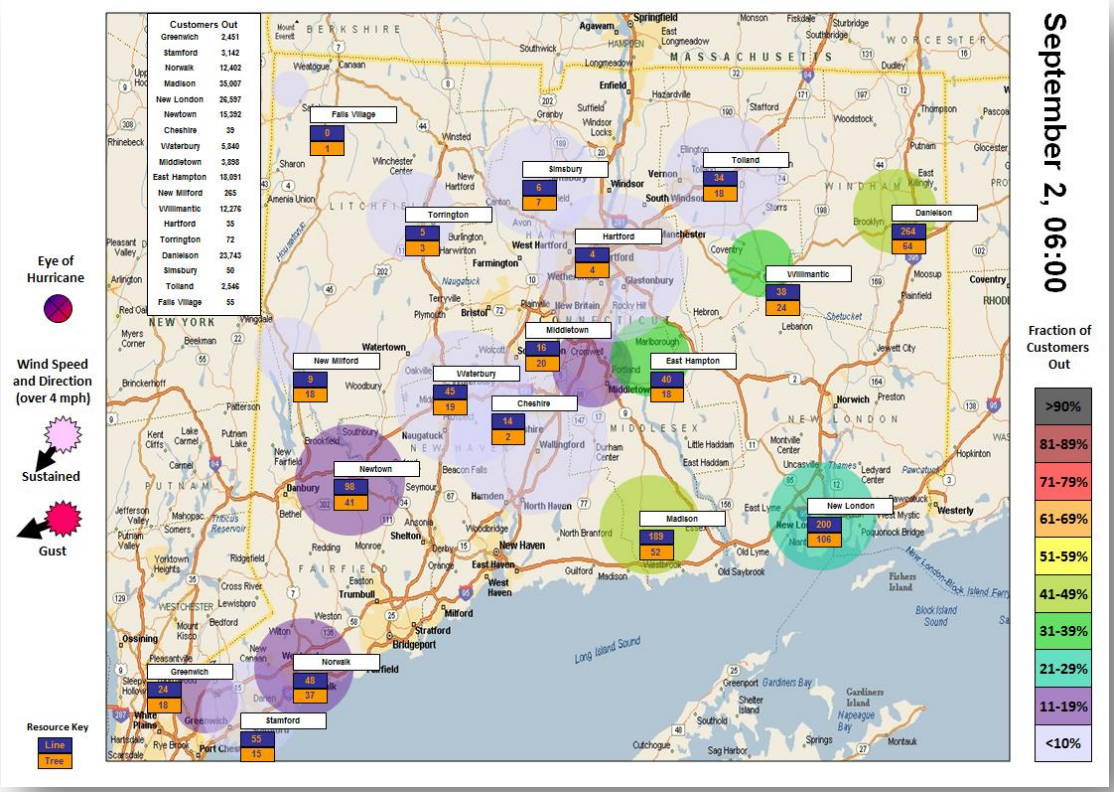
Figure 7: Irene Simulation – September 2, 2011



The simulation illustrates that CL&P may not have, in the initial stages of the restoration, allocated enough resources to the most significantly affected areas according to the number of customers (in particular, Madison, Danielson, and New London) and may have had too many resources in areas that were not as affected. As the restoration progressed, however, resources were moved to those areas, allowing CL&P to complete restoration of all customers affected by the storm in nine days.

4.2. October Nor'easter

On October 28, a cold air system moved across the Mid-Atlantic and New England while a low pressure system (the remnants of a tropical storm) was pulled north. As the system moved northeast, cold air combined with the low pressure system and moisture from the dissipated tropical storm to produce widespread snow and high winds. Early on October 29, snowfall had been reported in measurable amounts from West Virginia through Maryland. At approximately 11:00 A.M. on October 29, heavy wet snow and strong winds began affecting all of Connecticut and by 10:00 A.M. on October 30, the Nor'easter had left between 8 and 16 inches of heavy wet snow across the western and central portions of the state with lesser amounts along the shoreline and southeastern Connecticut. Connecticut suffered the most extensive damage of any state affected by

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the storm in terms of deaths (10) and peak power outages (807,228 for CL&P and approximately 16,000 for United Illuminating). The peak snowfall in Connecticut was 18.6 inches, in the Bakersville section of New Hartford, as reported by The Washington Post.[2]

4.2.1. Event Timeline and Response Description

On October 26, Telvent, CL&P's weather monitoring service, predicted that the region would be affected by light snow later in the week. By 6:00 A.M. on October 28, however, Telvent had significantly modified its earlier predictions and was forecasting that the system was "shaping up to be the first major winter system of the season bringing rain, snow, and strong winds." The snowfall depth predictions in this forecast indicated that a swath of between 6-10 inches would be possible in the Berkshires and higher elevations. At 10:00 A.M., NU participated in a mutual aid call with the New York Mutual Aid Group (NYMAG) and did not request any outside resources (at this point, none of the call participants requested resources). During the day, CL&P placed internal CL&P line and contractor tree crews on call. At approximately 1:00 P.M., CL&P requested 30 outside line crews, which were confirmed as being available within an hour. At 2:00 P.M., Telvent had become more precise on snowfall amounts – with Connecticut forecasted to receive 8-12 inches of snow over the northwest hills with amounts trailing down to around 1-2 inches in the southeast and 3-8 inches in between. The forecast predicted that rain would turn to heavy and wet snow by the late afternoon/evening on October 29. On October 28, CL&P's spokesman indicated, in an interview with News8, WTNH, that the predicted heavy and wet snow and winds, combined with the fact that leaves were still on the trees, could cause a "large problem with the electric grid."

The October 29 6:00 A.M. Telvent forecast indicated that NU would experience snowfall "ranging from 5-15 across interior operations" with a liquid equivalent of between 1.00 and 1.50 inches. On the 8:00 A.M. New England Mutual Aid Group (NEMAG) call, NU, like the other participants, did not request any additional outside resources. By 11:00 A.M., rain and heavy/wet snow were affecting all of Connecticut, with the transition from rain to snow occurring much earlier than predicted. At approximately 1:00 P.M., the Emergency Operations Center was opened and at 2:00 P.M., Telvent predicted that snow depth would total as much as 6-9 inches by 8:00 P.M. At about the same time, outages began to rapidly increase – going from 452 customers at 1:00 P.M. to more than 705,000 at midnight, only eleven hours later. On a 5:00 P.M. NYMAG call, NU requested 500 line crews for CL&P and additional crews for WMECO and PSNH. On a 10:00 A.M. NYMAG call the following day, with more than 775,000 customers without power, NU

[2] "A state-by-state look at power failures and other damage from the Northeastern snowstorm." THE WASHINGTON POST. November 1, 2011.

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requested an additional 500 crews for CL&P, bringing the total requested at that point to 1,000 crews.

Outages peaked at 807,229 on October 30 at approximately 1:00 P.M. At that time, CL&P had 57 off-system line crews and 125 tree crews on system. Twenty-four hours later, CL&P had restored approximately 7% of customers out at peak (slightly more than 50,000 customers) and had 111 off-system line crews and 194 tree crews on system. Forty-eight hours after peak (on November 1st), CL&P had restored 17% of customers out at peak (nearly 140,000 customers) and had 326 off-system line crews and 467 tree crews on system. A day later at 10:00 A.M., when more than 545,000 customers remained without power, Jeff Butler, CL&P's then-President, announced that CL&P would have 99% of all customers served restored by midnight on November 6 (meaning that fewer than 12,000 customers would be without power). CL&P had restored 90% of those out at peak by 7:00 P.M. on November 6. On November 8th (between 4:00 and 8:00 P.M.), CL&P first restored 99% of all customer served and then 99% of customers out at peak. Mutual aid/contractor line crews on system peaked at 1,666 on November 8th and tree crews peaked at 870 on November 7th.

With respect to NU's call centers, on October 28, 70 additional CSRs were scheduled at the two NU call centers. During the event (from October 29 until November 9th), CL&P handled approximately 1.118 million calls. Of the 1.118 million snowstorm calls, 270,778 (24%) were handled by representatives, 614,742 were handled in the NU IVR, and 233,204 were handled by TFCC. The average speed of answer of all calls received during the storm event was 10 seconds.

As in the graphic for Irene, Figure 8, below, depicts: the restoration curve (solid blue); off-system line crews requested (solid red); off-system line crews that have arrived on CL&P's service territory (dashed blue); number of tree trimming crews on system (dotted green); and some key points in the restoration (amber diamonds).

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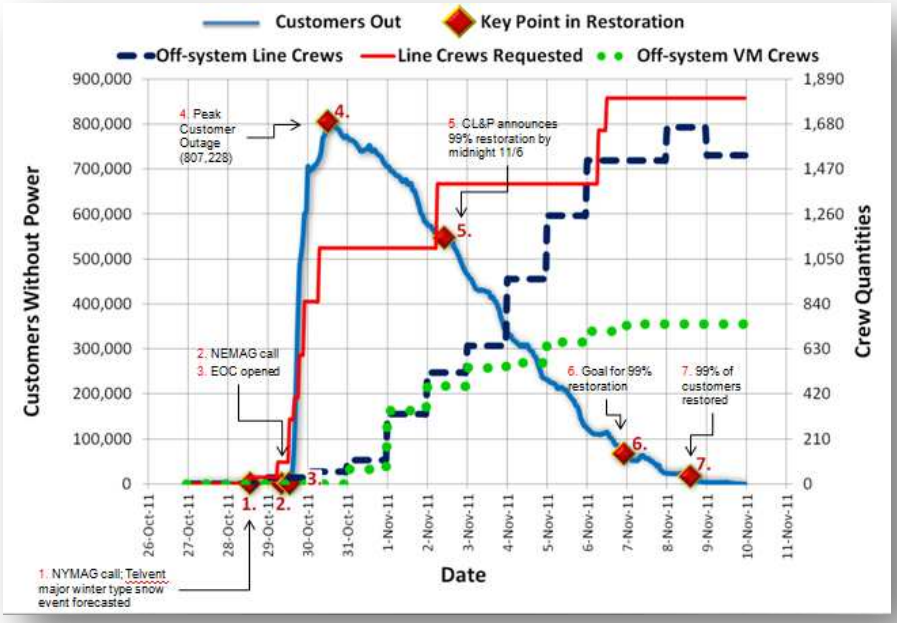
Figure 8: Nor'easter Resource and Restoration Timeline



Key items to note based on the graphic above include:

- A substantial number of outside resources were not requested until the storm struck and outages began to rapidly increase;
- Outside resources were still being requested eight days into the event;
- The arrival of outside resources was very gradual, with less than 840 line crews being on system five days into the event; and
- The "tail" of the restoration curve has been drastically shortened (attributable to CL&P's proactive use of service crews and electricians to repair not only service lines but also equipment that the customer would typically be responsible for repairing).

4.2.2. The Response Simulation Key Points

In addition to the key information provided in Section 4.1.2, the Nor'easter simulation has weather information that is specific to a snow event. More specifically, each region has a weather key that provides a color-coded overview of the weather in terms of snow depth, snow/water ratio, temperature, and wind. Red signifies the most significant weather (and most likely to cause outages) and green represents the least severe weather.

On October 29 at approximately 4:00 P.M., outages begin to occur (with Norwalk being the first region to have outages rise above 10% of the region's total customers). Within four hours, every region other than one (New London) had more than 10% of its customer base out of power and by 1:00 P.M. on October 30, outages peaked. At that time, six regions had more than 90% of their customer base out of power and an

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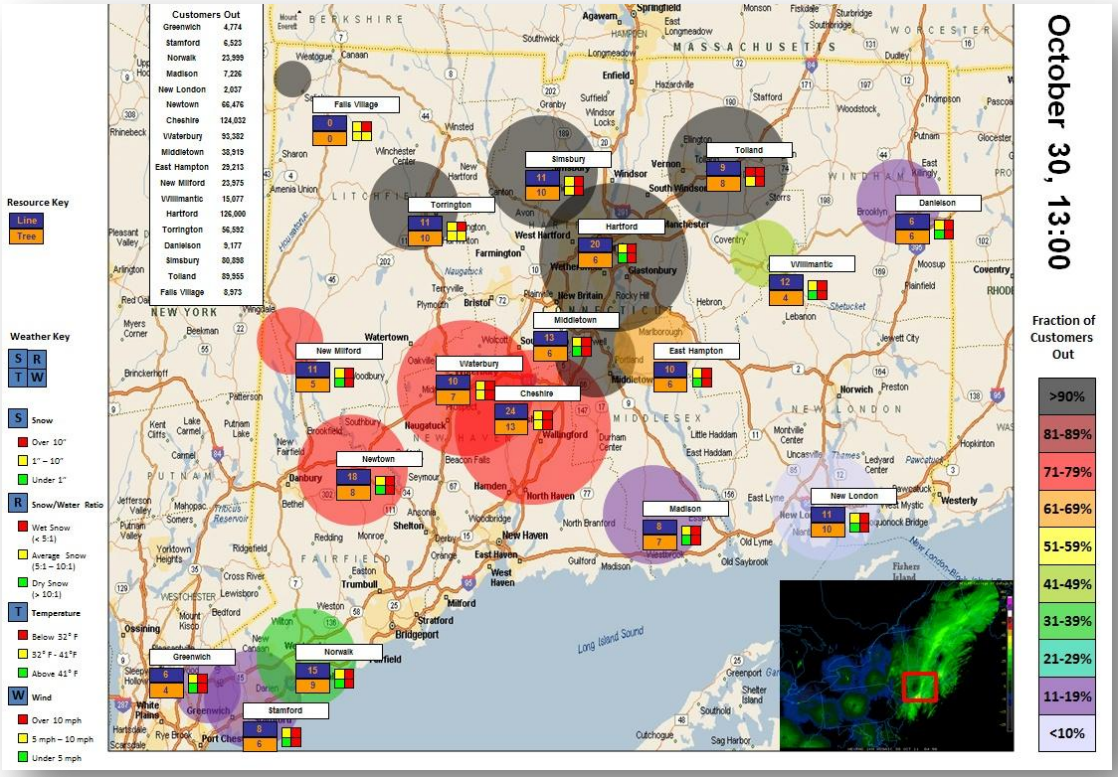
additional five had at least 60% of the customer base out. Hartford topped the list of number of customers out, with 126,000 and Cheshire followed closely behind with slightly more than 124,000. Other regions with more than 50,000 customers out included: Waterbury (93,382); Tolland (89,955); Simsbury (80,898); Newtown (66,476); and Torrington (56,592). Regions with less than 10,000 customers out included: Greenwich (4,744); Stamford (6,523); Madison (7,226); New London (2,037); Danielson (9,177); and Falls Village (8,973).

Figure 9: Nor'easter Simulation – Peak Outage View



Throughout the restoration, CL&P applied three different criteria for allocating crews to each work area, which were used in the following phases of the restoration:

- Phase 1: Make safe & priority restoration (October 30th - November 2nd) – during this phase, the resources were allocated based on the wires down calls and available outage information from the Outage Management System;
- Phase 2: Large blocks of customers (November 3rd - November 5th) – in this phase, crews were allocated based on the number of customers out; and
- Phase 3: Trouble spots to crew ratio (November 6th – end) – this methodology was based on allocating the crews to the areas based on the number of trouble spots.

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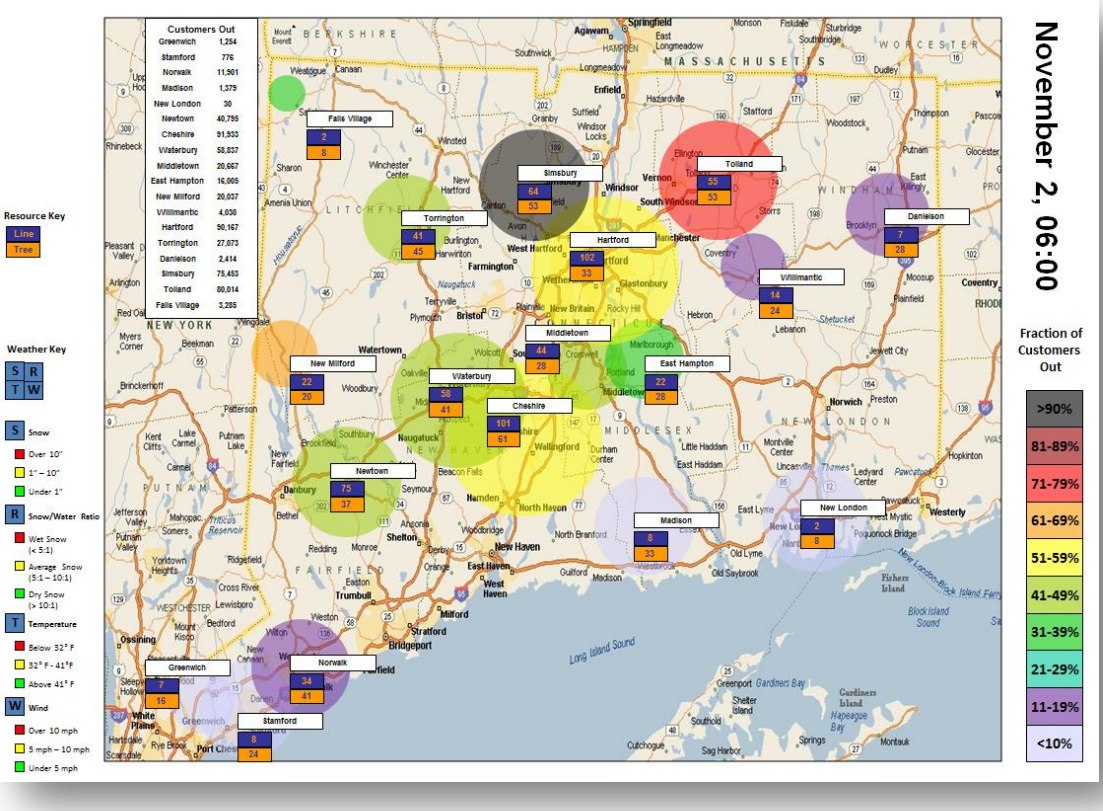
In the initial stages of the storm, the areas that that accounted for approximately 67% of the total customer outages (Tolland, Waterbury, Cheshire, Simsbury and Hartford) were allocated around 36% of the available crews. This allocation was done based on the wire down calls, town requests for road clearing and municipalities' desire to have at least one crew in each of their towns at the beginning of the storm response, which limited CL&P's ability to allocate a larger number of crews to those areas with the highest number of total customer outages. This differs from best practice in which, from Davies Consulting's experience, crews are allocated on a regional basis so that crews are first allocated to those areas with the highest number of total customer outages.

On November 2, Tolland, Hartford, Cheshire, and Simsbury each had more than 70,000 customers out (with the next closest area Waterbury having approximately 58,000 customers out). While those four areas accounted for approximately 63% of total customers out at that time, 48% of line resources were assigned to those areas.

Figure 10: Nor'easter Simulation - November 2, 2011



By November 6, all regions, other than Tolland and Simsbury, had been substantially restored. While Tolland and Simsbury had 30,103 and 39,420 customers remaining out, respectively, and accounted for more than 67% of total outages across CL&P's territory, only Newton had more than 10,000 customers out of power. Using the trouble spot to

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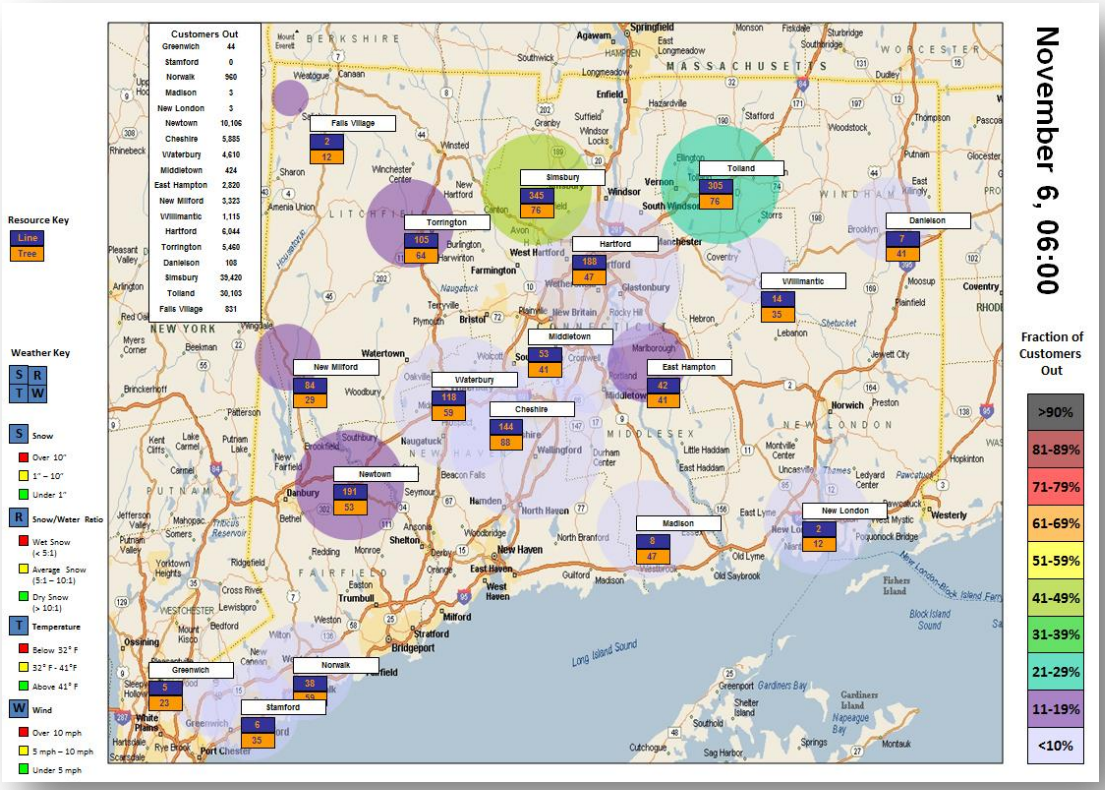
crew ration method to allocate crews to the areas, approximately 48% of crews were assigned to Tolland and Simsbury. At this point, the crews managed from Willimantic and New London also supported the restoration effort in Tolland and Simsbury.

Figure 11: Nor'easter Simulation – November 6, 2011



In the initial phase of the restoration, the crew allocation method was focused mainly on responding to town requests for road clearing and making safe, which resulted in having fewer resources available to restore customers. As the restoration event progressed and CL&P gained better situational awareness regarding the level of damage, it transitioned its crew allocation method to restoring the largest number of customers.

4.3. The Benchmark Comparison

While using benchmark information to compare the different aspects of storm restoration among companies can be useful to identify potential opportunities for improvement, it is important to understand that each storm is different (e.g., wind direction, precipitation amounts (both prior to and during the event), etc.) and that each company operates under different operating conditions (e.g., customer density, type of construction (overhead or underground), accessibility of lines (e.g., rear lot construction), vegetation density, etc.). It is also important to understand that some of

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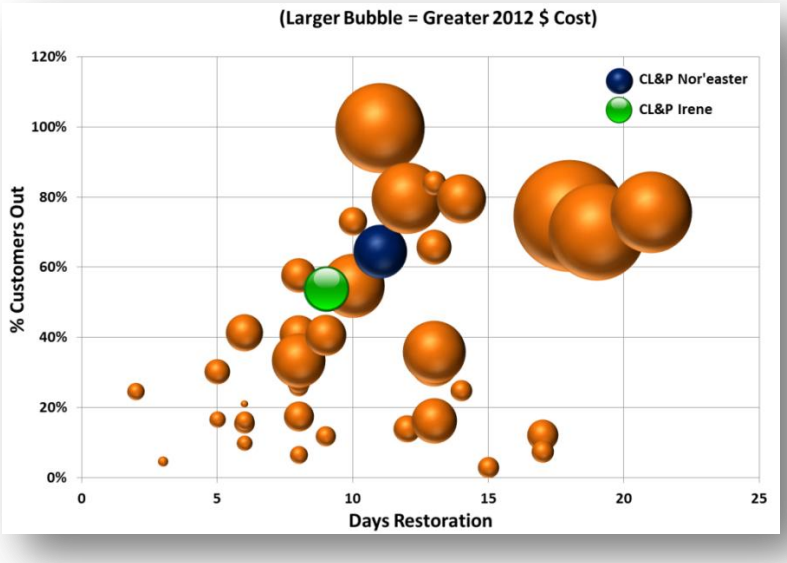
the statistics used in the comparison are preliminary and have not been finalized. This is common in these types of events since it takes time to process and finalize all of the storm data. Understanding these limitations, using the available benchmark data to compare storm restoration performance, allows companies to identify potential areas for further exploration. This section summarizes the relevant comparison for the two storms that CL&P experienced in 2011.

4.3.1. Benchmark Analysis Results

When compared against storms included in the Davies Consulting database and that caused at least 50% of a utility's customers to lose power at peak, in both events CL&P restored its customers within a reasonable timeframe.

Figure 12, below, illustrates the relative time to restore all customers (on x-axis) against the percent of customers out at peak (y-axis). The size of the bubble represents the relative cost of restoration.

Figure 12: Restoration Time vs. % Customers out at Peak



Since Irene, with winds of 35 to 40 mph and gusts up to 66 mph in Connecticut, met the tropical storm metrics and the October Nor'easter was a winter event, Davies Consulting compared CL&P's performance in those two events against other tropical storms, category 1 hurricanes, snow storms, and ice storms. A few events that appeared to be outliers (in terms of restoration duration or damage) were eliminated from the comparison, because they were non-comparable.

When comparing the amount of damage that CL&P experienced in these two storms, it appears that the number of poles that were damaged per thousand customers out at peak were slightly higher than the median within the cohort (see Figure 13, below).

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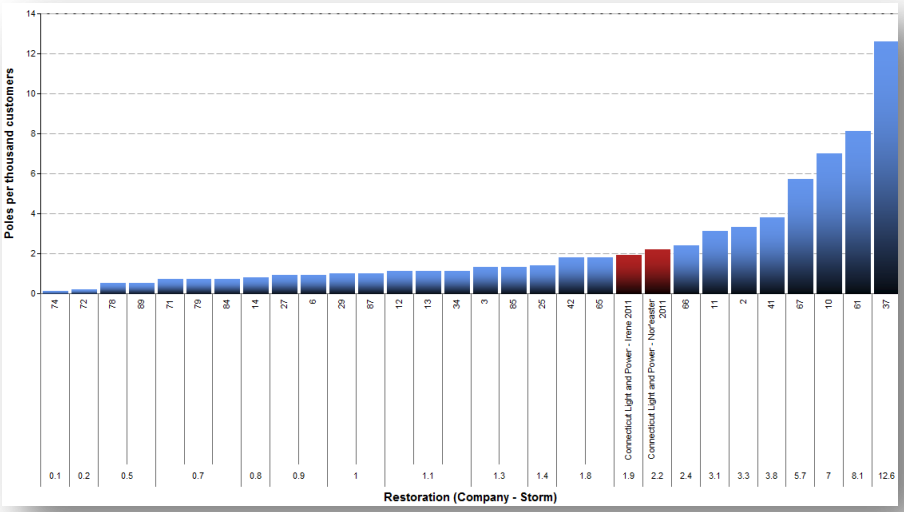
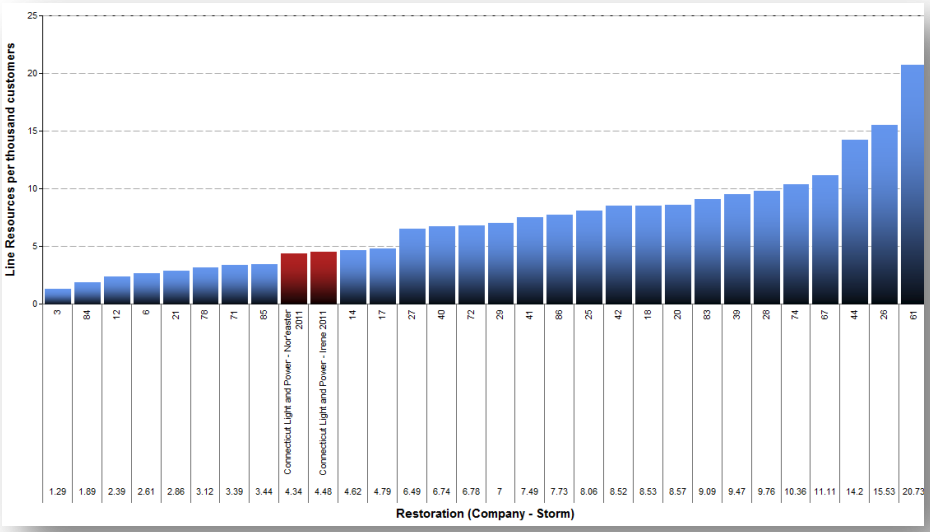
Figure 13: Number of Poles Replaced per Thousand Customers out at Peak



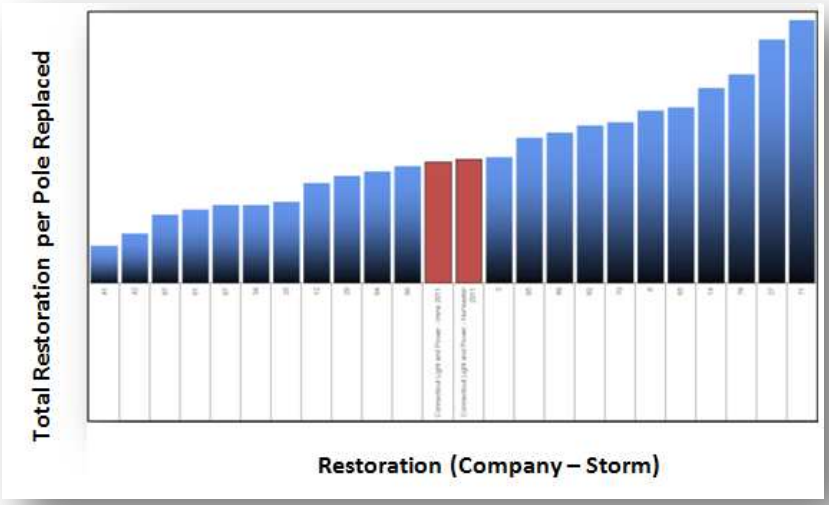
The next benchmark to review is the ratio of line resources per thousand customers out at peak. While this metric does not address the speed at which off-system resources were acquired, it can be used as one factor in determining whether the utility efficiently used resources. The number of resources represents the highest number of line full time equivalents (FTEs) at any point of restoration. Based on this analysis, it appears that CL&P had slightly less line resources per customer out when compared to the median number of resources used by utilities in the events included in the analysis (see Figure 14, below).

Figure 14: Number of Line Resources per Thousand Customers out at Peak



Finally, while comparing the number of poles replaced in an event is a reasonable method to evaluate both the damage and the level of effort that the utility will need to undertake to restore power to customers, the cost of restoration per distribution pole replaced provides a means of comparing cost performance across different restoration efforts. This metric ties the cost of personnel and material resources to a unit of infrastructure damage and normalizes across utilities for differences in customer density. When compared to other events in the database and based on the cost data provided by CL&P as of this date, CL&P's relative restoration costs per pole in both events seem to be at median, indicating that, based on current cost estimates, the overall restoration effort was efficient when compared to other events (see Figure 15, below).

Figure 15: Relative Restoration Cost per Pole Replaced



Based on the benchmark data above, it appears that while the CL&P system suffered slightly more damage than benchmarked events, and the company secured slightly fewer resources to restore power, the restoration was completed within a reasonable timeframe and cost.

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5. Findings and Recommendations

The findings and recommendations listed in this section were developed through: observations made by Davies Consulting staff during a visit in November 2011 while the Nor'easter restoration was ongoing; interviews conducted from December 2011 through January 2012; and a review/analysis of data included both in Davies Consulting data requests and also data submitted by CL&P in response to the various other ongoing investigations (Connecticut Attorney General, James Lee Witt & Associates, Governor's Two-Storm Panel, Public Utilities Regulatory Authority (PURA), and the Office of Consumer Counsel (OCC)). The findings and recommendations are grouped into the key focus areas identified in Section 2.2: Emergency Planning and Preparedness (EPP); Resource Acquisition and Mutual Aid (RA); Crisis Communication and ETRs (C); Planning and Damage Assessment (P-DA); Restoration Execution (RE); Information Systems and Technology (IT); Logistics (L); Call Center Performance (CC); Maintenance and Vegetation Management (M-VM); and Transmission (T). In addition, a separate section addressing transmission system findings and recommendations is included.

The following keys should be used with the tables in this section:

Table 2: Findings and Recommendations Keys

Initial	Grouping Description
EPP	Emergency Planning and Preparedness
RA	Resource Acquisition and Mutual Aid
C	Crisis Communication and ETRs
P-DA	Planning and Damage Assessment
RE	Restoration Execution
IT	Information Systems and Technology
L	Logistics
CC	Call Center Performance
M-VM	Maintenance and Vegetation Management
T	Transmission

Total Value	Low	Moderate	High
Ease of Implementation	Hard	Moderate	Easy
Cost to Implement	High	Moderate	Low

With regards to "Implementation Timeframe," the following definitions should be applied:

Immediate	Within 6 months
Mid-term	Within 6-12 months
Long-term	Greater than 12 months

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5.1. Findings and Recommendations Overview

The findings and recommendations in this report are based on: observations made by Davies Consulting staff during a visit in November 2011 while the Nor'easter restoration was ongoing; interviews conducted from December 2011 through January 2012; and review/analysis of data included both in Davies Consulting data requests and also data submitted in response to other ongoing investigations; and comparisons of CL&P's responses to Irene and the Nor'easter to industry data.

As indicated previously in the executive summary of this report, when Davies Consulting examined CL&P's responses to Irene and the Nor'easter, it primarily compared CL&P's performance to industry norms. However, based on the State of Connecticut's, NU's and CL&P's desire, going forward, to attempt to implement an emergency preparedness program for CL&P that is among the best in the industry, the recommendations contained in this report describe the steps NU and CL&P can implement in order to achieve best industry practices.

In both restorations, CL&P restored all of its customers within a reasonable timeframe and at reasonable cost without any serious injuries to the public or company workers (including mutual aid resources). The company performed extremely well from the call center perspective, being able to handle a record number of calls leveraging new systems and available technologies. In addition, CL&P's early adoption of ICS and its comprehensive emergency response plans helped provide a framework for managing the restoration, including the logistics for the record numbers of off-system resources, which from a lodging, food, and stores perspective, performed well during both storms.

However, these unprecedented events also exposed numerous opportunities for improvement in CL&P's existing storm response so that, if these recommendations are implemented, they would enable CL&P to achieve best industry practices. Opportunities for improvement include: the ability to scale its response to the size of the event; establishing situational awareness of the incident early in the process; ensuring consistent and accurate communication throughout the restoration; and obtaining adequate off-system resources quickly and effectively managing a large number of crews.

Although CL&P has not conducted a system-wide functional exercise since at least 2007, it has conducted the following table top exercises: four district-level in 2010, an incident command-level in March 2011, and a walk-though in anticipation of Irene. Even though NU and CL&P continue to invest in enterprise information systems, in order to facilitate restoration efforts, they should fully integrate the key systems that support the restoration efforts, such as Outage Management System (OMS), GIS (Geospatial/Geographic Information Systems), and SCADA (Supervisory Control and Data Acquisition).

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When compared with other utilities in the region, CL&P appears to be spending more on its distribution system per customer. Even though its vegetation management program follows industry standards, the current state-approved funding for vegetation management is not sufficient to maintain clearances around lines on a four year cycle, does not adequately address "danger" or "risk" trees, and results in a preventive maintenance cycle that does adequately address vegetation density, vegetation growth cycles in the region, and customer expectations for service levels. Finally, while the transmission system outages and subsequent restoration did not appear to delay any customers from being restored, a number of restoration processes were developed and implemented in real time.

The following sections describe 66 recommendations, which are separated into the key evaluation areas: Emergency Planning and Preparedness; Resource Acquisition and Mutual Aid; Crisis Communication and ETRs; Planning and Damage Assessment; Restoration Execution; Information Systems and Technology; Logistics; Call Center Performance; Maintenance and Vegetation Management; and Transmission. If the recommendations were implemented, CL&P's restoration practices would achieve best industry practices. Many of the recommendations, regardless of evaluation area, address the following general needs: improving training, processes and functional exercises; clarifying roles and responsibilities; and collaborating with stakeholders more effectively, while ensuring that restoration efforts are not detrimentally affected or delayed.

Key recommendations across all evaluation areas include:

- Establish a clear vision and guiding principles for CL&P emergency response;
- Define restoration strategies, including the type of strategy to be used depending on event size and type;
- Define more completely event roles and responsibilities of all NU/CL&P staff, including officers;
- Refine NU's/CL&P's emergency response structure;
- Create a structured certification, training, and exercise program;
- Define an end-to-end mutual aid process with fully qualified staffing;
- Explore opportunities to join additional regional mutual aid organizations;
- Implement a resource tracking system;
- Adopt a "one voice" approach to all external stakeholders and coordinate all externally-facing staff under a single communications umbrella;
- Re-vamp the Town Liaison program to focus on a broader geographic area and incorporate liaisons into the communications group during an event;
- Enhance ETR development, release, and monitoring processes;
- Develop and implement a robust training and field certification program for all damage assessors/patrollers;
- Implement a forensic analysis process for major events;

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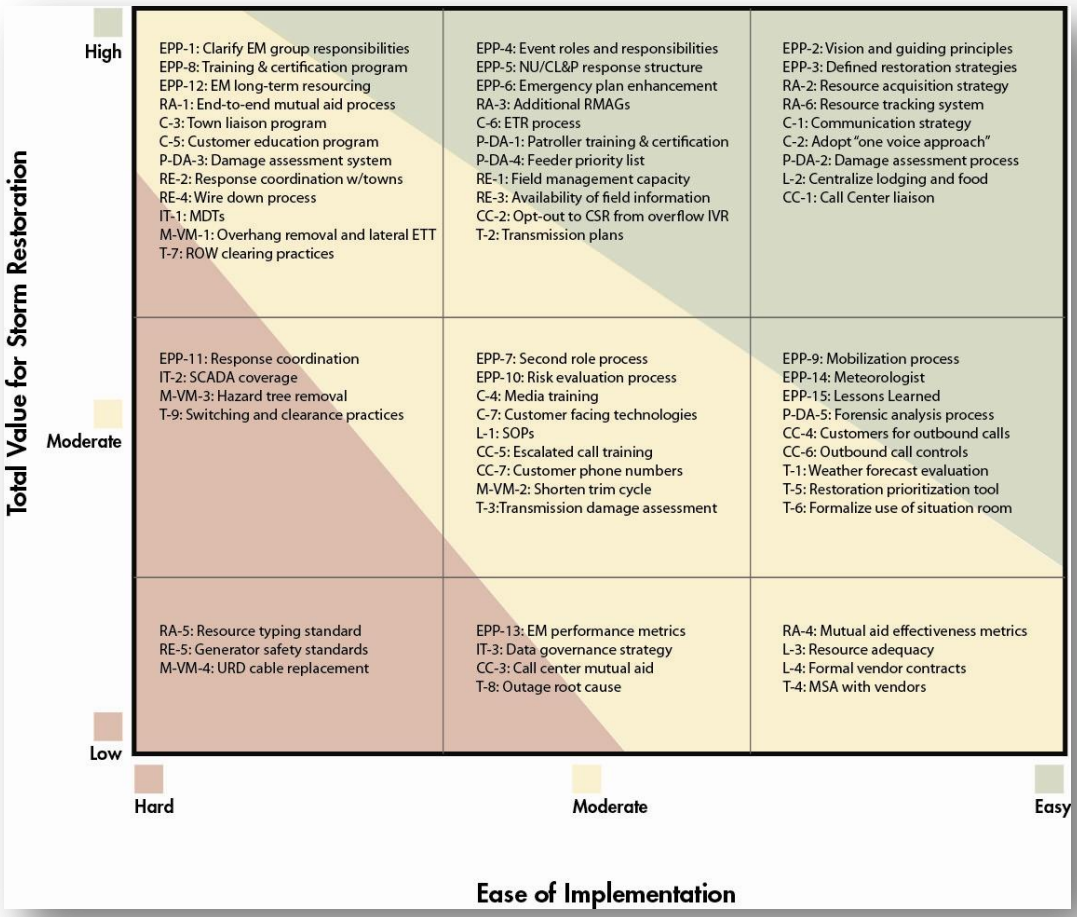
- Develop, in collaboration with external stakeholders, critical facility/customer lists and prioritize feeders/circuits;
- Deploy MDTs;
- Integrate key IT systems to store and manage situational awareness information;
- Centralize food and lodging functions;
- Seek additional funding and changes to applicable state law in order to implement a more aggressive vegetation management program;
- Develop a more comprehensive hazard tree removal program and work with the appropriate stakeholders to secure adequate access and approvals;
- Develop, approve and implement a transmission Emergency Response Plan, including damage assessment process; and
- Review, adjust and formalize the transmission line restoration prioritization approach.

Figure 16, below, depicts all of the recommendations detailed in the following sections in a prioritized matrix. More specifically, each recommendation has been evaluated by the Davies Consulting team and, based on several factors, including the effect on customer satisfaction, effect on restoration efficiency and success, and the suggested, timeline for implementation, assigned an overall value. Each recommendation was also assigned an ease of implementation score (ranging from easy to hard), which was based on consideration of several factors, including consideration of cost, required collaboration with outside agencies/entities, and amount of change to existing processes and culture.

Figure 16: Summary Recommendations Matrix



5.2. Emergency Planning and Preparedness

Large storms should be seen as community events that require strong collaboration among different parties to bring the community back to "normalcy" as quickly as possible. Historically, utilities have focused on restoring power without integrating their efforts with the other agencies; however, recent events and experiences have forced the discussion and increased this collaboration. As a result, in the electric utility industry, formal emergency management programs and organizations are beginning to be established and corporate boards and executives are outlining emergency response visions and guiding principles that clearly communicate a focus on emergency planning and response. Structured emergency management organizations act as an insurance policy against catastrophic events. As a result, the costs associated with funding robust emergency management structures are justified when compared to the risk of having a less-than-successful response to a catastrophic event. Because strategic stakeholders

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and customers are increasingly calling for more efficient responses to emergencies, utilities should make emergency management a core competency of their business models.

In addition to the establishment of an emergency management business group and development of a vision and guiding principles, additional best practices (which exceed industry norms) to consider related to emergency planning and preparedness include:

- Incorporation of the Incident Command System (ICS) into the emergency response organization and event management;
- A formal process for assigning, evaluating and removing staff from second role positions, that is tied to Human Resources (HR) and training systems;
- Annual system-wide exercises designed to stress response processes and enable the company to identify improvement opportunities prior to an actual event;
- Coordinating with local and state agencies in exercises and planning efforts;
- Developing and executing training programs to ensure utility staff are prepared to adequately fulfill their second roles during emergency;
- Establishing partnerships with regulatory stakeholders to ensure that the emergency management organization is appropriately staffed and resourced; and
- Tying emergency preparedness and response performance to key performance indicators for staff.

Adopting the above practices drive organizations to internalize emergency management strategies into everyday management decision making rather than only during an event.

5.2.1. Findings

CL&P was one of the first utilities to adopt ICS for emergency response several years ago, which is a utility-industry best practice. The company's Emergency Response Plan is based on ICS principles and includes emergency plan operations procedures (EPOPs) that describe key restoration processes in detail. Despite the fact that ICS is a scalable system, CL&P did not identify a sufficient number of people to fill critical roles and ensure that the organization could be effectively scaled to an event the magnitude of either Irene or the Nor'easter. Additional gaps in the preparedness areas were related to training and certification program for the key storm roles, clarity for key senior management staff, and functional exercises to learn and test the response plan. While the plan in general meets industry standards, the training and drills program needs to be improved.

The immediate creation and filling of a new position at CL&P (Senior Vice President of Emergency Management) brought necessary focus and will drive improvement across CL&P.

On November 17, approximately a week after the conclusion of the worst outage event ever experienced by the company, CL&P made the proactive decision to create and staff a new senior executive emergency management position. The creation of a formal

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emergency planning and preparedness group is critical to effective emergency response because it not only ensures that adequate focus is placed on the preparations (planning, training, collaborating with external stakeholders, etc.) necessary for effective response, but also demonstrates to CL&P staff that preparedness is part of the company's fabric.

CL&P does not have a documented emergency management vision or guiding principles.

An emergency management and response vision clearly communicates to company personnel the company's approach to emergency management, including both response and also preparedness. Furthermore, through the process of developing a vision, senior management staff identify, from the company's perspective, the key elements to a successful event (whether it be safety, communications with customers, collaborating with communities before and during events, training, etc.) and then, through internal education campaigns, ensure that all company staff understand the vision and its importance to the company. Having a well-communicated and understood vision prior to an event ensures that company personnel understand and internalize that responding effectively to emergencies (including communicating effectively and restoring power) is a primary business objective of the utility.

CL&P does not have a clearly-defined restoration strategy for different levels/sizes of events.

A clearly defined process for identifying an appropriate restoration strategy (order-, area-, or circuit-based) and transitioning from one strategy to another is imperative to a successful restoration. In order-based restorations, which are typically limited to small events, the company manages resources and work based on OMS orders. In area-based responses, a utility will decentralize crew and work management to regions or divisions, with a centralized System Operations group retaining control over crews restoring feeder lockouts and responding to 911 calls. All major restoration work is referred to the decentralized region, where work is prioritized, resource needs identified and resources managed, and ETRs developed. In circuit-based restorations, resources are assigned to work on a circuit or portions of a circuit, and the circuit is isolated, defeating the ties between the circuits, and transferring switching authority to the field supervisor. This approach typically eliminates the bottlenecks in switching and tagging. An example of how a restoration strategy can be graphically represented is shown below, in Figure 17:

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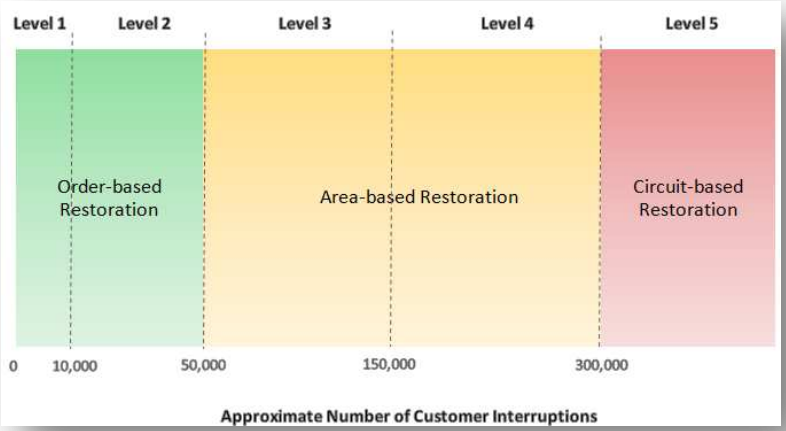
Figure 17: Restoration Approach Example



CL&P does not appear to have a formally defined way to transition its restoration strategy to a circuit- or area-based restoration. In both restorations, CL&P attempted to restore customers by assigning specific orders to line crews and sending them to specific locations based on OMS data. In these events, CL&P should have immediately transitioned to a substation-based or a circuit-based restoration approach. While CL&P used this approach with PSNH crews in a limited way, the current CL&P emergency response plans do not describe the type of event, scope of damage (customers out/trouble orders, type of damage, location of damage, etc.), associated event level classification, and the preferred restoration strategy (order-based, area-based, circuit-based) that should be adopted to restore customers.

CL&P has a comprehensive set of emergency plans based on ICS concepts, but a more complete implementation and understanding of ICS is critical to effective response.

ICS is evolving into a standard practice in the utility world for good reason – it is a standardized, on-scene, all-hazard incident management concept, which allows responders to adopt an integrated organizational structure to match the complexities and demands of single or multiple incidents without being hindered by jurisdictional boundaries. According to FEMA, ICS is designed to:

- Meet the needs of incidents of any kind or size;
- Allow personnel from a variety of agencies to meld rapidly into a common management structure;
- Provide logistical and administrative support to operational staff; and
- Be cost-effective by avoiding duplication of efforts.

Through the use of span of control management (generally one supervisor to between three and seven reports) and a top-down organizational structure, ICS helps ensure full utilization of all incident resources, decreases confusion, and improves communication.

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ICS places emphasis on the development and use of Incident Action Plans (IAPs) to identify and communicate incident objectives to response personnel.

CL&P's Emergency Response Plans, as they relate to ICS, are well-written and generally in-line with industry standard. The company should be commended for recognizing the importance of ICS and being one of the early adopters in the industry. Including ICS in the plans does not, however, ensure that staff understands the company's emergency response organizational structure or plans. For example, by creating the Division Commander position in the most recent version of the plans, but neither providing the Division Commander with a staff nor providing training on the new structure, CL&P moved slightly away from traditional ICS and confused staff as to reporting structures, roles, and responsibilities during the outage events.

One of the benefits of ICS is the use of common nomenclature across the company and with outside agencies and utilities, but during the storms and in interviews conducted after the events, there was a general lack of understanding or awareness of ICS terminology – for example, when interviewees were asked "Who was the Incident Commander," the answers varied greatly depending on individual, location during the response, role during the response, etc.

While the majority of staff has pre-assigned storm assignments that are tracked in a database, the Emergency Response Plans do not define the role of NU officers in operating company responses.

As noted in Section 5.2, a key element of a best practice emergency planning and preparedness program is recognizing that in an emergency, all company staff may be needed to assist in the restoration effort. As such, every employee should be assigned a role, be clear on their responsibilities and the expectations of their role, and should understand the assignment and evaluation process. Finally, each person should be trained to fulfill that role. More specifically, key elements of a robust storm assignment procedure include the following clearly defined processes and metrics:

- Assessment;
- Assignment/Re-assignment;
- Expectations;
- Training;
- Mobilization;
- Evaluation (both by the storm assignment and supervisor); and
- Tracking.

While CL&P has worked to ensure that a majority of staff have storm assignments and tracks these assignments in a database, several opportunities for improvement exist:

- The database is not integrated with training programs to clearly track whether staff have met training requirements for the role;

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- Assignment processes (how an individual is assigned to a specific role) are not clear to staff;
- Senior management ICS roles, responsibilities, and accountabilities are not clearly defined for major events; and
- Some executives from NU and CL&P did not have a second role assigned, leading to confusion about roles and responsibilities as well as lines of authority and accountability.

Industry-wide, utility executives grapple with their roles in an emergency response. Many executives are eager to contribute during restoration, but, injecting opinions can, if not carefully delivered, disrupt the restoration hierarchy and may adversely affect communication and candor at the middle and lower ranks of an organization. In the Irene and Nor'easter responses, and in part as a result of the lack of clarity in roles and responsibilities for senior management, senior executives and managers participated in tactical conference calls and were present in service centers during key decision making processes. Notwithstanding that CL&P's culture is one that promotes honest and open dialogue, the lack of clarity in roles and responsibilities could have prevented some staff from questioning decisions made concerning the storm restoration process.

Training for emergency response is inadequate and no annual functional exercises (drills) have been executed since at least 2007.

Establishing a robust training program and conducting a system-wide functional exercise is critical to being able to execute an effective restoration – actual response should not be a substitution for training and exercise. While training is used to teach processes, responsibilities, etc., an exercise is intended to practice the restoration process – not learn it. Exercises should test a company's effectiveness at responding to an event, including, how personnel respond to their second roles, the communication flow between operations and the communications group and customers, and the emphasis placed on all elements of the response (rather than merely operations). Objectives of exercises include:

- Verifying staffing requirements and identifying gaps;
- Verifying that non-operations staff understand their roles and how they interface and communicate with operations, other first responder organizations, and local, state and federal agencies;
- Ensuring that key response staff know their roles and responsibilities;
- Testing plan scalability and the transition from one event level to another;
- Assessing automated storm tools and programs; and
- Testing internal and external communications processes.

Interviewees indicated that CL&P has not conducted a functional exercise since approximately 2007. CL&P conducted a table top exercise on August 26, 2011 in the days leading up to Irene, executed a table top on March 11, 2011 with limited participation, and conducted four district table tops in the fourth quarter of 2010.

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During both Irene and the October Nor'easter, some key decision makers were not adequately familiar with the emergency response plans, the Incident Command System, or their roles and responsibilities, due to lack of training and exercises.

CL&P has an industry-leading Emergency Operations Center (EOC) facility, but did not staff it early enough in either Irene or the Nor'easter.

CL&P's EOC facility has been set-up to accommodate Area Command staff and a small group of communications personnel. While the facility should be expanded to house additional communications staff, the facility is well-organized with ample room, access to computer work stations, and multiple monitors that show crew locations, outage status, and overall system status.

The criteria for when to open and staff the EOC did not seem to be clearly defined and as a result, CL&P did not open the EOC early enough for either event. This left Area Command staff insufficient time to adequately execute the emergency plan and develop a restoration strategy. During Irene, CL&P opened the EOC on August 26 at 12:02 P.M. However, the EOC was not fully staffed until 6:00 A.M. on August 28, when more than 110,000 customers were already without power. During the Nor'easter, CL&P did not open the EOC until 1:13 P.M. on October 29. Within four hours of opening the EOC during the Nor'easter, EOC staff were dealing with more than 240,000 customer outages. In Irene, given the advance notice of the event, the EOC should have been fully staffed at the very least before customers began to lose power.

CL&P's process to evaluate risks, analyze outage impacts, and identify resource needs, anticipated costs, and preparedness options is not well-defined.

Leading to the Nor'easter, weather forecasts identified a threat of significant heavy snow approximately 36 hours prior to the weather system reaching CL&P's service territory. With the significant foliage on the trees, CL&P should have better understood the risk that the October 28 forecast of heavy wet snow would pose on the vegetation around its facilities by October 29. CL&P does not appear to have a clearly defined process for examining weather forecasts, using historical data, and leveraging the expertise of vegetation management staff to evaluate the risks associated with different weather forecasts. Also, although Telvent is a credible source of information, the company was overly-reliant on Telvent's weather forecast. Although CL&P has engaged the University of Connecticut to develop a tool that will help better evaluate the potential system damage based on weather forecast, the company does not have an internal expert with a meteorology background who can interpret different forecasts and make evaluations specific to the company's service territory.

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CL&P did not anticipate an event of this magnitude and did not plan for catastrophic, systematic damage to its system, including having enough experienced resources to manage an incident as complex as either Irene or the Nor'easter.

Figure 18: CL&P Event Classifications

Level	Characteristics	Outages	Expected Duration	Frequency
I	Small Impact Event	<10,000	<12 hours	<75/year
II	Moderate	<20,000	12-24 hours	<25/year
III	Serious	<40,000	24-48 hours	<10/year
IV	Major	<80,000	48-72 hours	<5/year
V	Extreme	>100,000	>72 hours	Once in 5 years

As depicted in Figure 18, CL&P's current emergency plans anticipated five different event levels – with outages ranging from less than 10,000 to more than 100,000 and duration of outages expected to last from less than twelve hours to greater than 72 hours. These levels currently used by CL&P correspond to the criteria recently adopted by the Massachusetts Department of Public Utilities. While in reality, an effectively implemented ICS structure should be scalable to any event, regardless of the number of outages, the table above seems to limit CL&P's perception of the scope of damage that the company could experience. In other words, while a fully activated and trained ICS structure should be able to manage an incident of any size (whether it is 100,000 or 800,000 customers) effectively, the inability to anticipate the scope and type of damage suffered during the Nor'easter affected preparation and planning. These planning assumptions were incorporated into the development of the overall emergency plan and therefore limited the company's ability to respond optimally to this magnitude of event.

As the plans currently provide, all area work centers/districts have an Incident Commander that is responsible for managing that district's response to an event, including everything from damage assessment to restoration and frequently acting not only as the IC, but also as the Operations Chief and the Planning Chief. The combining of three different roles into one in an event the size of either Irene or the Nor'easter made managing the incident difficult, if not impossible, and placed too many responsibilities on a single individual. Furthermore, the large number of distinct ICs (with limited coordination at a regional/division level) resulted in a lack of consistent execution of restoration processes (everything from damage assessment and planning to switching and tagging). In Irene, in addition to the thirteen area work centers and six line shops, two satellites were established. In the Nor'easter, in addition to the area work centers and six line shops, nine satellites were established. By having a structure with ICs at a minimum of thirteen area work centers (assuming no additional satellites) in reality means that CL&P must have at least 26 district ICs available (to account for the need for 24-hour coverage). Maintaining this number of ICs is challenging if the

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company wants to have experienced, trained, and effective leaders in those positions and simultaneously fill all other required restoration roles.

The process for conducting, analyzing, and implementing lessons learned is not consistently followed.

While CL&P has a database for tracking lessons learned, the process for conducting after action lessons learned, capturing follow-up actions, tracking them to completion, and ensuring they are properly communicated to all necessary personnel does not seem to be consistently applied. There also appears to be lack of clarity around responsibility for managing the process and making improvements based on the feedback.

5.2.2. Recommendations

EPP-1: Clarify emergency management responsibilities between NU and operating company organizations.

Creating the CL&P executive emergency management position was key to CL&P moving forward, but NU should consider clarifying the roles and responsibilities between NU and each operating company's emergency preparedness organization and ensure consistency in preparedness, planning, and response processes. NU and its operating company emergency preparedness organizations should have responsibility for leading emergency planning and preparedness processes, including, but not limited to:

- Serving as the primary liaison on emergency preparedness issues to local, state, and federal emergency management agencies;
- Developing, coordinating, facilitating, and participating in emergency management training, workshops, conferences and exercises;
- Managing all preparedness activities, including training and exercises;
- Overseeing all NU/Operating company response plans, continuity of operations, pandemic, etc. plans;
- Managing second roles assignment, evaluation, and removal; and
- Supervising, planning and conducting special studies and surveys related to emergency management activities.

EPP-2: Develop an emergency response vision and guiding principles.

CL&P senior management, in collaboration with the NU management team, should create a common vision statement and develop key guiding principles that define the overall expectations for the company's emergency response. This will ensure that the entire senior management team is aligned around the expectations and that the rest of the organization has clear direction and a framework for implementing key improvements going forward.

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EPP-3: Define restoration strategies, including the type of strategy to be used depending on event size and type.

Having a clear process for determining what restoration approach the company will take in any type or size event is critical to a successful response. CL&P should define the restoration strategies it intends to use, the transition process for moving from one strategy to another, the strategies that should be applied to different event sizes, and any other applicable processes required to effectively undertake each strategy.

EPP-4: Better define event roles and responsibilities for all emergency response staff, including officers and senior management.

CL&P should review current assignments and either re-assign staff to appropriate existing roles or establish new roles for those not currently assigned to a storm role. Several utility companies rely on a "crisis management team," comprised of executives, to provide policy-level advice and support (but *not* to run the event or question the tactical approach adopted by the incident commander and his/her team unless there is a significant risk to the company). Each role should have defined responsibilities pre-, during-, and post-event and include checklists to support staff.

Once the new roles are identified and a new organization is established (see EPP-5), NU should purchase, and require the use of, vests identifying roles and responsibilities during events. The use of vests allows response personnel to quickly identify others' role and reduces the confusion inherent to any large event response.

EPP-5: Refine the emergency response structure to ensure consistent execution across the company and provide adequate resources for all roles.

As noted previously, CL&P's organizational structure is focused on managing incidents from the district or area work center level, which works in small localized events, but is overly granular for major restorations. CL&P should use the current organizational structure as a foundation and focus incident management at the region/division and Area Command levels, with Operations and Planning personnel located at area work centers reporting to the regional/division commanders. These regional/division commanders would have complete staffs (Division Operations Chief, Division Planning Chief, etc.). This will not significantly differ from the current approach (since in practice, the districts are truly operations centers) but will drive consistency in restoration processes across the company. In addition, by focusing on the division, the number of required Incident Commanders will be less and CL&P will be able to ensure that the company has adequate qualified and experienced resources to fill key incident management roles. In the new organization, CL&P should retain Operations, Planning, and Communications liaisons or coordinators at the district level that report to regional command staff.

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EPP-6: Review and enhance emergency plans to address scalability and consistency across NU.

As part of the preparedness process, CL&P should plan for a catastrophic outage affecting at least 80% of its customer base. In doing so, it will be able to adequately define what its restoration would look like during a large scale outage and allow its customers and key stakeholders to better understand what limitations CL&P will face so that they may better prepare for a prolonged outage. The Emergency Preparedness organizations must work together (until all emergency preparedness functions are integrated) to create consistent plans that allow all NU operating companies to easily share resources during a catastrophic event and remain consistent across NU and within each operating company. Revised Emergency Plans should also reflect lessons learned from both Irene and the Nor'easter.

EPP-7: Develop and implement a second role process that addresses assignment, training, and evaluation of staff in second roles.

Although CL&P has a "second roles" database that is integrated with the company's HR system, additional improvements should be made – including:

- Integration with training software to identify role training requirements and easily track whether training has been met; and
- A mechanism for incident management personnel to export data and easily create organizational charts with personnel assigned to appropriate roles.

In addition, CL&P should clearly define the process for assigning, evaluating, training, and removing staff in second roles.

EPP-8: Create a structured certification, training, and exercise program, including a comprehensive annual exercise that includes external stakeholders.

Since the abilities, experience, and readiness to respond varied greatly in Irene and the Nor'easter depending on the individual, their blue-sky role, and a number of other factors, CL&P should design and conduct a formal schedule of training classes, table top exercises, and functional exercises to prepare staff for future disasters. Training programs should ensure that staff understand roles and responsibilities and general ICS concepts, including how command should be transferred. CL&P's existing in-house ICS training course should be used in conjunction with FEMA courses (IS-100PW at a minimum) to certify NU/CL&P employees to the awareness level. A certification process should be implemented for damage assessors (see P-DA- 2). Damage assessment is critical to any restoration effort and the successful execution of the damage assessment process requires trust that the data is accurate. The role of the new emergency management group within CL&P should include performing periodic audits to ensure that response staff are properly trained to perform their second roles and understand the restoration plans.

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Finally, CL&P should commit to conducting annual exercises that test the entire system's ability to respond to a catastrophic event affecting all of NU's operating companies. This should be at least a full-day event and test all aspects of the response – from system operations to planning to communications. CL&P should also engage outside agencies in the system-wide exercise to improve coordination between the company and external stakeholders.

EPP-9: Review mobilization process to ensure early activation of response organization.

CL&P should evaluate its mobilizations process to ensure that, if the company has advance notice of an event, the EOC is activated and adequately staffed prior to the storm being in the service territory and customers being without power.

EPP-10: Develop a process to evaluate risks, analyze outage impacts, and identify resource needs, anticipated costs, and preparedness options.

Based on the experiences from Irene and the Nor'easter, there appears to be an emerging expectation from CL&P stakeholders that the company acquire and pre-stage off-system resources earlier than it has in the past. A more aggressive acquisition of off-system resources and pre-staging of company crews will ultimately result in increased storm response costs to the company. It is important for CL&P to collaborate with regulators and legislators to evaluate the costs and benefits of different triggers for crew acquisition based on weather forecasts and a risk assessment. CL&P should use this analysis to gain agreement with regulators on expectations and define the cost recovery mechanisms associated with this process change.

EPP-11: Work with the state and communities to coordinate responses.

CL&P should, with its emergency management program, reach out to the communities it serves to better define what support the communities can provide CL&P during a catastrophic event and to set expectations both for the communities and for CL&P. For instance, CL&P already defines critical infrastructure before a storm, but there is an opportunity to identify each town's restoration priorities well in advance of events (see C-5). For prolonged outages, it is important for CL&P to understand how each town defines priorities to bring a sense of normalcy and in support of overall town law and order. This work should be conducted in conjunction with efforts to clearly define expectations related to CL&P clearing and making safe work and restoration during outage events.

EPP-12: Establish partnership with regulatory stakeholders to ensure that the CL&P Emergency Preparedness organization is appropriately staffed.

Learning from best practices in neighboring utilities and regulatory agencies, CL&P should develop (and gain approval from regulators to fund) a robust and fully-funded emergency management program, which will demonstrate to customers that preparing for and responding to events effectively is as important to CL&P as reliable delivery of

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power during blue-sky days. The natural tendency is to have emergency management budgets decrease as the memory of the last catastrophic incident and public outcry/media attention recedes. Therefore, CL&P should partner with regulators to include the entire emergency management program in the cost of service and capital budget plan. This focus will not only benefit CL&P by ensuring longer-term focus on increased readiness, but will also enhance the engagement with state and local agencies to improve the overall response at the community level.

EPP-13: Include Emergency Management in CL&P's performance appraisal system.

As part of the emergency management vision, CL&P should recognize the importance of emergency management and emergency response skills to the long-term sustainability of CL&P and the companies' ability to respond to catastrophic events. CL&P should establish key performance metrics for evaluating the level of preparedness and include those metrics as part of the performance appraisal system.

EPP-14: Employ a meteorologist.

CL&P should employ a meteorologist who can review forecasts from different sources and analyze them from the perspective of the risk that a particular forecast presents to the company's infrastructure. The meteorologist should be able to provide input into decisions on whether to activate the restoration plan. This person should participate in the development and evolution of the model that CL&P is creating with the University of Connecticut to project damage associated with different weather forecasts.

EPP-15: Improve the lessons learned process.

CL&P should formalize the emergency response lessons learned process and assign responsibility for implementation of all identified actions to the newly formed CL&P Emergency Preparedness organization. The process should include: conducting after action reviews after every significant event, table top, and functional exercises; assignment of clear accountability for implementation of improvements to appropriate individuals; and tracking implementation progress. The implementation of improvements should be measured as a part of the performance management process.

5.2.3. Prioritized Matrix

Table 3: Emergency Planning and Preparedness Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
EPP-1	Clarify emergency management responsibilities between NU and operating companies	High	Hard	Moderate	Long-term
EPP-2	Develop an emergency response vision and guiding principles	High	Easy	Low	Immediate

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
EPP-3	Define restoration strategies, including the type of strategy to be used depending on event	High	Easy	Low	Immediate
EPP-4	Clearly define event roles and responsibilities	High	Moderate	Low	Immediate
EPP-5	Refine CL&P emergency response structure	High	Moderate	Low	Immediate
EPP-6	Review and enhance emergency plans	High	Moderate	Low	Mid-term
EPP-7	Develop and implement a second role process	Moderate	Moderate	Moderate	Mid-term
EPP-8	Create a structured certification, training, and exercise program	High	Hard	High	Mid-term
EPP-9	Review mobilization process	Moderate	Easy	Low	Immediate
EPP-10	Develop process to evaluate risks, analyze outage impacts, and identify resource needs, anticipated costs, and preparedness options	Moderate	Moderate	Moderate	Long-term
EPP-11	Work with the state and communities to coordinate responses	Moderate	Hard	Low	Mid-term
EPP-12	Adequately staff Emergency Preparedness organization over long-term	High	Hard	Moderate	Long-term
EPP-13	Include Emergency Management in NU's performance appraisal system	Low	Moderate	Moderate	Long-term
EPP-14	Employ meteorologist	Moderate	Easy	Moderate	Immediate
EPP-15	Improve lessons learned	Moderate	Easy	Low	Immediate

5.3. Resource Acquisition and Mutual Aid

Utilities are designed, in organizational structures, staffing levels, and system composition, to provide safe and reliable service to their customers on a blue-sky day in a cost-effective way. Therefore, the number of internal line resources utilized by each utility is determined by evaluating the staff needed to complete the capital investment and operations and maintenance work required to operate the utility's infrastructure while keeping staffing levels reasonable. As a result, during major events, utilities need to acquire additional resource support in order to restore customers in a reasonable amount of time. In fact, during both the Irene and Nor'easter restorations, CL&P brought in five to ten times more line resources to support the recovery effort than

what is typically on the system. Effective management of mutual aid resources is one of the most important aspects of successfully responding to a significant event.

In order to acquire these additional resources during peak periods, utilities participate in regional mutual aid groups (RMAGs). These RMAGs collectively utilize their resources to address the needs of their members. As one might expect, when there are widespread weather events, each of the RMAG members may experience significant outages on their respective systems, thus precluding each one's ability to provide resources for other utilities within the region. As a result, some utilities participate in more than one RMAG in an effort to increase the likelihood of being able to procure additional resources when widespread events occur. During regional events, when all of one RMAG's resources are engaged in restoration efforts and the members need additional resources, that RMAG can request resources from other RMAGs.

In addition to RMAGs, nearly every utility also participates in a nationwide mutual aid agreement through the Edison Electric Institute (EEI). This agreement facilitates sharing of resources among utilities that are not joined together through RMAGs without having to address legal formalities and define financial arrangements during a major event and governs the sharing of overhead, underground and vegetation management resources. The agreements relied upon by the RMAGs and EEI are generally the same, establishing billing requirements, standard crewing requirements, transfer documentation, and rules for making a request. As part of these agreements, the costs of mobilizing and the associated travel time necessary to transport resources to the requesting utility begin when the one utility requests and another commits to provide resources. Resources that are allocated to a requesting utility normally charge a fully loaded rate, which accounts for the costs associated with trucks and equipment as well as medical and pension benefits for the resource. As a result, requesting and using mutual aid resources can be a costly undertaking for any utility and it is further increased by paying the cost of travel as the distance to reach the requesting utility increases.

In addition to relying on mutual aid organizations, utilities often leverage their partnerships with contract organizations that are normally utilized to address the peaks and valleys associated with capital/O&M programs. In these instances, utilities often negotiate, in advance of an event, the ability to draw upon large contractor resources that may be otherwise working on projects for other utilities (home utilities still have to release those contractor resources). These agreements are generally tailored to the needs and desires of the utility and are dependent on the capability of the contractor, so the process and standard principles are not as standardized as they are in the mutual aid agreements.

With the mergers of the past ten years, a number of utilities have acquired access to their "sister company" crews, which can be directly deployed (and treated as equivalents to internal crews) by the newly combined companies. In addition, as a company's service territory grows with a merger, the number of RMAGs that the

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company can be a member of also increases. As a result, the merged company's resources are not as available to mutual aid sharing as they may have been before the merger. Another complicating development has been the increased propensity by state governments to control the movement of crews across state boarders. For example, the state of New York does not allow National Grid's operating company Niagara Mohawk (NiMo) to deploy its resources to support National Grid restorations in other states (MA and RI) until all New York customers are restored, irrespective of whether they are served by NiMo or another utility in the state. In the most recent events, the New Jersey government forced New Jersey utilities to hold out of state crews until all electric customers in the state were restored, even though most of the resources had completed their work.

As a result of the complexities associated with acquiring mutual aid resources and the significant adverse impact of not being able to procure resources to address the inevitable weather events, many utilities have a mutual aid strategy as part of their emergency management plan. The strategy and plan may include:

- Detailed description of the company's mutual aid strategy (when mutual aid is used, how requests are made, how resources are on-boarded and managed during an event, de-mobilization, etc.)
- Descriptions of mutual aid group processes, roles, and responsibilities;
- All agreements between the utility and mutual aid partners/RMAGs/contractors;
- Damage assessment retainers with third party providers;
- Mutual aid group rosters;
- Mutual aid request forms;
- Responding company information forms; and
- Travel status forms.

Once mutual aid has been procured by a utility, it is imperative that the utility manage the process to utilize the resources effectively. This is usually the most challenging part of acquiring and utilizing mutual aid resources. Every utility designs its day-to-day organization to manage the number of resources that are normally on the property, but during a widespread event, it is not uncommon for a utility to acquire many multiples of resources to effectuate a timely restoration. This significant increase in resources presents various challenges beyond the expected logistics of lodging, providing food, supplying gas for vehicles, and providing appropriate material for reconstruction. The often overlooked challenges focus on actual utilization and optimization of the resources. Usually, the sending utility sends a supervisor for every 5 to 10 crews (approximately 10-20 full time equivalents), but the supervisors are not usually familiar with the work rules and the system that they are going to and are often not familiar with the area from a navigation standpoint. In an effort to address these issues, utilities often provide incoming mutual aid crews with someone who is familiar with the system and/or service territory ("bird dog"). In some cases, the bird dogs can help manage crews and facilitate organizing incoming groups of crews into discrete qualified teams to

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address system problems. In many cases, however, utilities are unable to spare "qualified" personnel to manage incoming resources. Since the utility does not operate on a day-to-day basis with the number of resources that are necessary during significant events, the utility does not retain the number of underlying support staff required to evaluate and properly identify, assign, and manage work and track progress and record completion. It is therefore important for utilities to identify staff capable of managing field resources by creating storm rosters that include former field staff who may perform other functions, retirees and even some third party supervisors that can be deployed during an emergency. In addition, having clearly-defined processes and supporting technologies helps ensure a more effective use of off-system resources

5.3.1. Findings

CL&P did not fully recognize the risks associated with the Nor'easter forecast it received on October 28, approximately 36 hours before the start of the storm, and, as a result, did not aggressively pursue off-system resources prior to the storm. By the time CL&P recognized the need for resources and formally requested help through its RMAGs, a significant number of east coast utilities were also looking for resources. Being geographically isolated (since New England is essentially a peninsula) and belonging only to NYMAG and NEMAG, CL&P had a difficult time securing resources early in the restoration effort. In addition, once the crews arrived, CL&P did not have either sufficient supervisory resources to optimally manage the number of resources or systems to accurately assign and track resource allocations to different parts of the system.

NU uses a centralized group to acquire mutual aid resources for the entire system, so that operating companies are not competing for the same resources.

Managing mutual aid, including both requests and on-boarding, through a centralized system (NU) group is a best practice. While improvements can be made (see below) at NU in on-boarding crews, the management of resource requests from the NU level (rather than separately at CL&P, WMECO, and PSNH) ensures that each operating company is not competing for the same resources.

While CL&P requested and received off system resources prior to Irene striking the system, during the Nor'easter, it did not identify the need for mutual aid resources in a timely manner.

As described previously, during the Nor'easter, CL&P did not ask for a substantial number of off-system resources (500) from NYMAG until 5:00 P.M. on October 29, when more than 240,000 customers were already out of power. The outages caused by the Nor'easter increased rapidly, since the storm had begun to affect the CL&P service territory approximately six hours earlier. CL&P did not initially request mutual aid resources based on a weather forecast that indicated, on October 28, that Connecticut could expect significant snowfall, with the largest swath of the state receiving between

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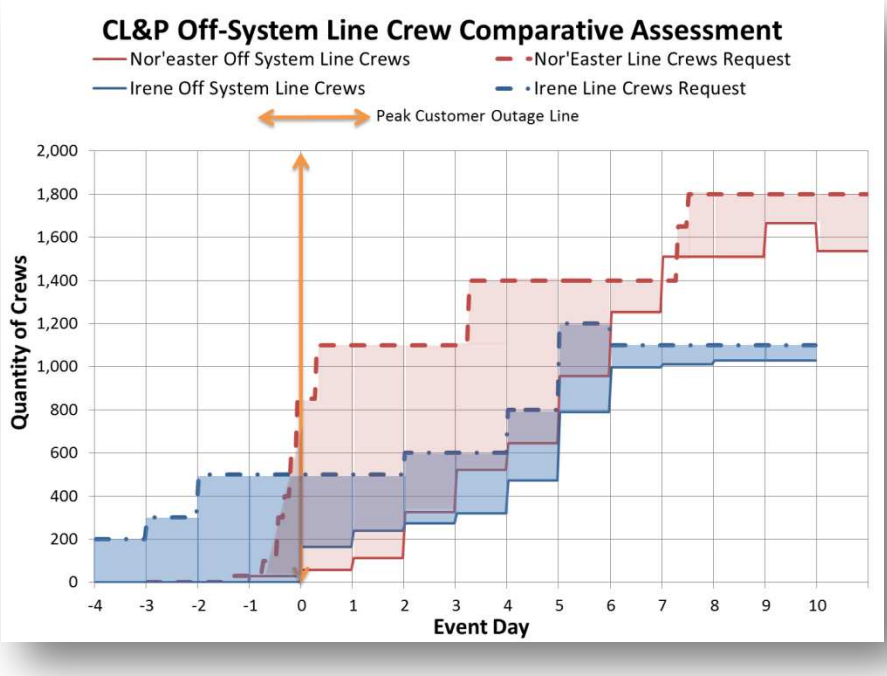
3-8 inches of wet heavy snow, while the trees still had foliage. This failure to proactively request mutual aid ultimately forced the company to request a large number of resources in a short timeframe in an effort to recover. The delay in requesting mutual aid also resulted in obtaining resources that were from further distances because nearby resources had already been allocated to requesting utilities south of CL&P and because many utilities did not want to release their crews until they better understood how the storm would impact their states. Figure 19, below, compares the timing of resource requests and resource arrivals for the two storms. The shaded area between the broken lines (number of resources requested) and the solid line (number of resources on system) illustrates the time between CL&P's requests for off-system line crews and when the crews arrived on system.

Figure 19: Restoration Approach Example



The process of securing mutual aid resources during the Nor'easter delayed acquisition of off-system line resources.

Interviews with external stakeholders, including RMAG representatives and external utilities, indicated that there was a perception that CL&P was being overly specific both in the type and travel distance of resources it was willing to take, which limited the pool of resources to which the company had access. There also appears to be a definitional difference in some key terms between NU and a large segment of the industry. For example, while NU requested mutual aid "crews," most RMAGs use "full-time equivalents" or FTEs in requesting and committing resources. The logic of using FTEs,

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rather than crews, is that there is currently no standard resource typing system used by RMAGs or EEI to define a crew size, so while an NU crew compliment may be 2 FTEs and a bucket truck, another utility may classify a crew as 3 FTEs, one bucket truck, and a digger derrick. This can lead to confusion in resource tracking and management – if expectations do not match reality as crews arrive on system. NU also assumed that contract crews were not part of the mutual aid process and so attempted to secure contractor crews directly from contractor companies, rather than through the RMAG process. Some major RMAGs (e.g., SEE), however, treat contractor resources the same as their member utility line crews from the perspective of releasing them and allocating them to requesting utilities. The logic is that these contractors are under management of the utilities that have hired them for specific work and as such should be released by those utilities before being re-assigned. This misunderstanding may have detrimentally affected NU's ability to obtain crews that the mutual aid group believed were available. There has been, and continues to be, an effort by the federal government (the Department of Homeland Security, Federal Emergency Management Agency, associated Emergency Support Functions (ESFs), etc.), to establish standard definitions for different resource types, including electric utility crews.

NU Emergency Plan Operating Procedure ME-EP-2006, Rev. 01 – Mutual Aid and Deployment Point Support provides that "[c]rews should be requested from utilities located geographically closest to the areas impacted. Initial requests should be for 25 to 50 Mutual Aid Crews, where possible." During a widespread event, RMAGs are typically unable to provide ample support because each of its member utilities cannot release resources due to outages within their own service area. Specifically prescribing that mutual aid crews should be requested closest to the area affected may delay the initial acquisition of resources from outside of the NEMAG and NYMAG (or Mid-Atlantic Mutual Aid) early in an event, which can compound problems with getting resources on-system quickly. A review of mutual aid resource arrivals, however, seems to indicate that NU requested and accepted at least some resources from outside of a two day travel window relatively early (since resources from as far as Louisiana were arriving on system as early as November 2). Regardless of whether there was a miscommunication between CL&P and NU (since NU has responsibility for obtaining mutual aid resources for all of its operating companies), between NU and its RMAGs, or between RMAGs and their member utilities, the process for securing resources during the Nor'easter led to delays in acquiring off-system line resources.

When NU did request resources from RMAGs in the Nor'easter, its requests (through NEMAG and NYMAG) totaled 2,000 FTEs for CL&P, or approximately 1,000 crews. This request was made without a prediction regarding the potential damage that the storm would cause and without a pre-defined plan for crew utilization and assignment to specific districts/area work centers.

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The existing Mutual Aid document does not provide adequate guidance for a large scale, 1,000+ mutual aid crew size events.

While the procedure is reasonably designed for an event where a few hundred crews may be procured throughout the service territory, the plan does not adequately provide guidance for large scale – 1,000+ mutual aid crew events. Specifically, this document (consistent with the objective of "dispatching of mutual aid crews") does not provide guidance regarding assigning work, adequately supervising mutual aid resources, providing clearance, capturing information regarding restoration efforts, lock out/tag out procedures, assignment of additional work upon completion of assigned work and capturing assigned work into OMS. While this may be managed during small scale events, it is highly unlikely that this will be managed effectively during large scale events. In addition, the roles and responsibilities set forth in NU's Mutual Aid plan provides a list of six pre-designated deployment point locations, which is not likely adequate to support over 1,000 mutual aid crews. Additionally, the plan does not include a list of Mutual Aid Guides and, based on interviews, delays associated with switching suggested that the number of guides is not adequate to effectively support a decentralized restoration effort.

CL&P did not use centralized on-boarding centers and did not effectively track off-system crews throughout the two restorations.

CL&P did not use a centralized on-boarding process in either event. The crews that were secured were asked to contact the NU mutual aid coordinator once they were within an hour of the Connecticut border. At that point, the NU Mutual Aid Coordinator would give the arriving crews a point of contact on the CL&P territory and direct them to report to a specific district or satellite. Once the resources arrived at the location, the crews received a safety debriefing (either at the office or in their hotels) and were processed by the local office.

Gateway, or on-boarding, centers are used to process and assign outside crews efficiently to work centers and staging sites. By having all crews check-in, upon arrival, to a utility's gateway center, there is little opportunity for confusion. Furthermore, by performing both safety and work requirements briefings at a gateway prior to the release of crews to staging or work areas, crews are provided with consistent messages. Crew rosters and equipment inventory are also captured at this central location to allow for better resource planning and tracking. Under the gateway system, and because crews are tracked on a centralized basis, resource management is performed in the following fashion:

- The utility receives the resources on a system level and allocates them based on company or area work center need (depending whether the gateways are at a system or operating company level);

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- Upon completion of restoration work at the district, resources are released to the region level, where supervisors are able to look across regions to determine how to best re-allocate the resources;
- When a region is no longer in need of its full complement of resources, supervisors release the crews to the company level, which then compares resources across regions to determine which other regions might have a need for those resources or that equipment; and
- If no regions need the resources, the company releases them to the holding company (NU). If the event is greater than a single operating company, this allows the system to conduct a needs assessment across operating companies.

By removing the burden of checking-in and briefing the arriving crews from local field supervision, local personnel are better able to focus on planning the restoration efforts more effectively. Davies Consulting believes that the gateway process is an emerging best practice in the utility industry.

As noted previously, in catastrophic outage events, a utility might bring on more than 10 times the number of internal resources it manages on blue-sky days. This creates significant difficulties in both managing resources effectively and in tracking locations, equipment types, etc. Although CL&P manages resource requests, tracks resource movements across the utility's system, and supports logistics efforts, it does not use an integrated tool to do so.

CL&P field supervisory resources were stretched with the number of line crews supporting restoration.

Interviews conducted during this engagement indicated that CL&P did not have an adequate number of qualified personnel to optimally manage mutual aid line crews in the field. The number of line and tree resources during the two restoration efforts was five to ten times greater than the typical number of crews on the CL&P system. CL&P activated a number of staff to serve as crew guides for the off-system crews, including former supervisors who serve different functions in their daily jobs and qualified retirees. However, some of these resources did not have the appropriate skills required to supervise line crews effectively. It also appears that in some areas, the crew to supervisor ratio was greater than an optimal ratio of 4 to 7 crews per supervisor. This created additional complexity in optimally utilizing the mutual aid resources throughout the restorations.

5.3.2. Recommendations

RA-1: Define end-to-end mutual aid process with fully qualified staffing to operate, utilize, and manage off-system resources and a mutual aid matrix that establishes resources required by event size.

CL&P should develop a storm matrix for various storm levels that identifies the necessary mutual aid resources necessary to restore customers within a prescribed

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period of time. Additionally, the matrix should identify different types of storms, (i.e. ice versus wind) and establish resource requirements specific to those types of events, (i.e., pole events requiring auger trucks versus fuse events requiring line trucks). CL&P should identify all available staff that have previous line supervisory experience, including retirees who are willing to help in a major event. Based on the number of individuals available, CL&P needs to determine the maximum number of off-system crews that those supervisors can effectively manage. If the total number is not sufficient to handle major events similar to Irene and the Nor'easter, CL&P should consider identifying contractors who can provide additional field supervisory resources. As a part of this effort, CL&P should also identify all OSHA switching and tagging (CL&P Procedure TD800) qualified personnel to support a fully decentralized restoration operations. Finally, this organization should have appropriate administrative and engineering support to optimize the utilization of mutual aid crews and ensure that work assigned to mutual aid crews is accurately captured within CL&P's OMS. Individuals should be assigned to this position as a primary storm assignment.

RA-2: Establish a resource acquisition strategy that incorporates cost/benefit and risk analysis.

This analysis should evaluate the information presently contained in M3-EP-2006 Rev.01; Mutual Aid and Deployment Point Support and should identify the likelihood and impact of potential events on the system, incorporating lessons learned from these two events. Furthermore, the resource acquisition strategy should evaluate the risks and impact, including financial impact, of inaction or delayed requests.

RA-3: Explore opportunities to join additional regional mutual aid organizations, especially Mid-Atlantic, SEE and Great Lakes.

NU/CL&P should consider ways it can increase its footprint for acquiring mutual aid resources. NU should request to join the Southeastern Electric Exchange (SEE) and the Mid-Atlantic Mutual Aid and Great Lakes RMAGs. Membership in SEE could provide significant benefits, particularly since its focus is broader than just mutual aid. SEE sponsors a number of industry working groups focused on subjects that are of critical importance to electric utilities, including NU and its operating companies.

RA-4: Define and establish metrics to determine the effectiveness of mutual aid resource utilization.

It is important for a utility to fully understand the value of procuring mutual aid resources during a significant restoration, because mutual aid resources are a critical component of an effective restoration and generally, represent the single most significant expense realized during a storm restoration. When a utility (including CL&P) seeks mutual aid crews, the number of crews requested is generally determined by evaluating the quantity and type of trouble locations and estimating the number of crew hours necessary to restore the location, which establishes the estimated total crew

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hours required to restore service to all customers. The utility then determines its target restoration completion date, and from that, identifies the necessary outside resources to meet that target, taking into account travel time for the mutual aid crews. Following the restoration, utilities generally do not assess whether the resource predictions were accurate. Furthermore, utilities generally do not evaluate the effectiveness of the mutual aid crews that are utilized, either on a per company basis or on a per crew basis. Establishing a mechanism to evaluate the accuracy of the resource prediction and the effectiveness of the actual crews procured will provide NU with insight into the value of its investment.

RA-5: Work with RMAGs and EEI to implement resource typing across industry.

As noted in Section 5.3.1, lack of consistency in how utilities request resources and commit both resources and equipment may lead to difficulty not only in obtaining resources but also in managing resources and equipment once on-system (if a larger number of digger derricks arrives than a requesting utility anticipated or planned for, significant logistical issues could arise). NU should work with its RMAGs and EEI to establish standard resource types and define terminology (for example, defining that a "crew" would mean two qualified (non-apprentice) linemen and one bucket truck, etc.) to be used across the entire industry and all RMAGs.

RA-6: Implement resource tracking system.

CL&P should investigate available resource tracking systems and implement one that meets the needs of the company – focusing both on tracking and managing off-system resources and on assisting with managing logistical support for these resources.

5.3.3. Prioritized Matrix

Table 4: Resources Acquisition and Mutual Aid Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
RA-1	Define end-to-end mutual aid process	High	Hard	Moderate	Immediate
RA-2	Establish a resource acquisition strategy	High	Easy	Low	Immediate
RA-3	Join additional regional mutual aid organizations	High	Moderate	Moderate	Immediate
RA-4	Establish metrics to determine effectiveness of mutual aid utilization	Low	Easy	Low	Mid-term
RA-5	Implement resource typing across industry	Low	Hard	Low	Long-term
RA-6	Implement resource tracking system	High	Easy	High	Mid-term

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5.4. Crisis Communication and ETRs

Communicating effectively not only to external stakeholders (customers, regulators, elected officials, media, etc.) but also to internal company staff is *at least as important as* restoring power. In order to meet expectations, return the community back to "normalcy" in the shortest time possible, and maintain customer and stakeholder satisfaction during major power outages, a utility must:

- Demonstrate that it knows the customer is without power;
- Convey a sense of urgency about restoring power;
- Provide consistent and accurate information on restoration progress; and
- Provide customers with accurate and reasonable estimated times of restoration.

As noted in Section 2.2, and keeping the objectives of communication in mind, the high-level questions to be evaluated related to communication and ETRs include:

- Have processes been put in place to ensure "one voice" communication during major events and are these processes followed?
- Is there a process for creating and managing ETRs that are sufficiently granular to meet the needs of stakeholders?

The utility should designate a single individual who is responsible for communicating with the media and public, leaving the rest of the utility free to focus on the restoration. The content of the messages delivered during the restoration should be confined to helping customers understand the prioritization and restoration process, issuing safety advisories, delivering progress updates, and providing ETRs. Introducing additional voices during a major restoration effort can lead to inconsistencies in messaging. This creates confusion that must be addressed, and ultimately draws resources away from the restoration effort.

The occurrence of a major event requires a utility not only to mobilize en masse to restore service in a safe and timely manner, but also to keep customers apprised of its progress. To succeed in each of these tasks, the utility must do more than simply work faster than they would during normal operations. Roles shift, the complexity of the operation increases, and the need for structured internal communications increases dramatically.

5.4.1. Findings

Prior to the events, CL&P restructured its communications group and assigned different staff to key roles, but did not fully implement the new structure. Since the changes were not drilled, the new structure created confusion around roles and responsibilities and, as a result, there was no clear responsibility for development and execution of a communication strategy. While the company seems to have adopted social media and was able to leverage it to communicate with customers, information from the field was not adequate for communication staff purposes. Finally, although the company appears

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to have a good tool for developing ETRs, some of the underlying assumptions that the initial projections were based on turned out to be inaccurate. The process for establishing, communicating, and managing ETRs is not well-defined and responsibility for managing the process is not clearly assigned.

There is no clear understanding of who has responsibility for developing or implementing a communications strategy during storm restoration.

During the Nor'easter, CL&P did not appear to have a clear communications strategy, which compounded the problems associated with the statement that 99% of customers would be restored two days prior to when they ultimately were. For example, a strategy to either address the statement itself or clearly identify the steps that needed to be taken if and as soon as it became apparent that the goal would not be reached was not established. As a result, external stakeholders perceived that CL&P was either intentionally misleading the public or simply did not understand the scope of the damage to its own system. Indeed, CL&P did not communicate the fact that the goal would be missed until 6:00 P.M. on November 6 – when more than 72,000 customers remained without power.

The communications group worked hard to keep the public informed; however, CL&P failed to utilize a "one voice" approach.

Notwithstanding that CL&P has been proactive in using social media (Facebook, Twitter, YouTube, etc.) to communicate with customers and that during the event, the company had more than 700 interactions with media personnel, several key shortcomings in communications detrimentally affected the company's overall response and stakeholders' perception of CL&P. By not incorporating all externally-facing staff (Corporate Communications, Customer Experience, Account Executives/Town Liaisons, Government Relations, etc.) into a "crisis information center," stakeholders were provided with inconsistent information, talking points, messaging, etc. In addition, changes to the communications group structure prior to Irene had not been adequately communicated and/or drilled, resulting in a lack of understanding of roles, responsibilities, and titles, which ultimately led to some confusion in development and implementation of a communications strategy, including an one-voice approach to messaging. Finally, the lack of communications liaisons in district storm rooms made the flow of information from the operations side of the restoration and the field to the centralized communications group difficult.

Use of a senior CL&P executive not involved in the management of the incident to manage communications with the State is a good practice.

Early in the Nor'easter restoration, CL&P management decided to commit CL&P's President to focus on communications with key external stakeholders and allow other staff to focus on the restoration. CL&P's President, however, was ultimately required to devote all of his time to the Connecticut Governor's press conferences and was not able

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to conduct any separate company-sponsored press conferences. The level of preparation and consistency in messaging during these press conferences was not adequate to build public trust and set realistic expectations for the event.

The concept of the Town Liaison program is a good practice but was not consistently implemented.

While interacting with elected officials and customers through a community-based structure during an event is a good practice, the reliance on the town structure and the resulting possibility of activating 149 Town Liaisons is an overly granular approach and may lead to unreasonable expectations related to restoration practices and priorities and has resulted in inconsistent messaging across the CL&P service territory. In addition, during the Nor'easter, there was confusion among Account Executives and Town Liaisons regarding their reporting relationships under the CL&P ICS structure, which may have resulted in Town Liaisons obtaining information from varied sources – a contradiction to the one-voice approach. Staff who served as Town Liaisons had different skills and while some were able to develop relationships with the towns they worked with, others were not effective in managing town expectations and extracting information elected officials sought from operations personnel.

CL&P's use of a model to proactively project restoration curves based on perceived damage and projected resources is a good practice that is dependent on having a more effective damage assessment process.

CL&P has developed a model that allows it to project restoration curves and establish ETRs based on damage information and available resources. During the Nor'easter, the damage information does not appear to have been accurately reflected in the model, resulting in a suboptimal allocation of resources to the districts and satellites and ultimately generating an inaccurate predictive restoration curves. Interestingly, the model did fairly accurately project the ultimate completion of the restoration (the time when 100% of the customers were restored).

CL&P has not adequately educated or effectively collaborated with external stakeholders (customers, elected officials, businesses, etc.) on community priorities, restoration practices, and coordination opportunities.

Customers, elected officials, and other external stakeholders have not been adequately educated on restoration practices or engaged in developing restoration priorities. Perceptions in some towns as to what CL&P's priorities should be with regards to restoration, clearing, and making safe will delay restoration of power to customers. Furthermore, the identification of town priorities in the midst of a restoration delays restoration efforts.

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The majority of customers in both storms either did not receive sufficiently granular ETRs or received inaccurate ETRs.

Currently, CL&P does not have an efficient method for determining how many customers during a specific event received ETRs (and at what level), the number of times that any customer's ETR may have been changed and a longer ETR provided, and the number of accurate versus inaccurate ETRs. The only way of analyzing the accuracy of ETRs at this point is through a month-long view, which includes all non-blue sky outages occurring and all associated ETRs provided during that month. Based on analysis of the monthly data, it is apparent that the majority of customers did not receive an ETR and if they did receive an ETR, it was likely inaccurate. More specifically, in the September to October period, only 44% of customers experiencing an outage received an ETR and of those, only 49% were accurate (approximately 22% of customers received an accurate ETR). In the October to November period, only 31% of customers that were out of service received an ETR, and only 43% of those were accurate (approximately 13% of customers received an accurate ETR). In addition, CL&P does not have an adequately detailed process for establishing, releasing, and monitoring ETRs. A robust ETR process establishes goals related to type of ETR, timing of release, and monitoring of expiring or expired ETRs.

5.4.2. Recommendations

C-1: Assign clear responsibility for developing or implementing a communications strategy.

The Communication Plan should be re-visited to assign responsibility to a single individual (typically the Communications or Public Information Officer) for developing a communications strategy during an event. This person should report directly to the Area Commander and have oversight of a "crisis information center" that includes representatives/liaisons from all externally-facing groups.

The Communication Plan should be reviewed at least annually (and immediately following any changes that affect roles, responsibilities, or other key facets of event response) and tested at least annually during a table top exercise and a system-wide exercise. The system wide exercise should include development and implementation of a clear communications strategy and messaging.

C-2: Adopt a "one voice" approach to all external stakeholders and coordinate all externally-facing staff under a single communications umbrella.

As noted above, a key element to successfully moving toward a "one-voice" communications approach is the establishment of a centralized communications group, reporting to the Area Commander, with responsibility for developing and releasing *all* messages, regardless of external stakeholder type. Therefore, NU and CL&P should begin the process of establishing a "crisis information center" that reports to the CL&P Area Commander, and includes representatives from *all* externally-facing staff

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(Corporate Communications, Customer Experience, Account Executives/Town Liaisons, Government Relations, etc.). Furthermore, in order to promote communications between communications staff and the operationally-focused staff at the districts and regions, CL&P should locate communications liaisons, responsible for gathering specific data (crews in the district, number of outages, etc.) on a pre-defined timeline at each mobilized district/region. While the seating of the Communications Group in the EOC is a positive, the current room is not adequately sized to incorporate the necessary representatives from groups not currently included (such as Customer Experience, Account Executives/Town Liaisons, etc.). Therefore, NU and CL&P need to identify a means of co-locating the new "crisis information center" with the EOC while providing adequate space for a robust team.

C-3: Re-vamp the Town Liaison program to focus on a broader geographic area and incorporate liaisons into the communications group during an event.

NU and CL&P should work with the state and towns to develop a regional approach to outreach – which will be more in-line with how CL&P's system works and how restoration is conducted and will allow for a more coordinated communications strategy. The use of this program during an outage event should not hinder CL&P's ability to safely and efficiently restore power in line with best practices in the *utility* industry.

In addition, the Account Executives/Town Liaisons should be incorporated into a broader "crisis information center" to ensure consistent and one-voice messaging. CL&P should not only engage elected officials to determine whether having liaisons with more system/operations knowledge would assist officials in understanding restoration practices but also proactively work with the towns to identify community restoration priorities well in advance of an event. These priorities should be reviewed annually and should be factored into a prioritization scheme for restoration.

Formalizing training for liaisons and developing the expectations between towns and CL&P and exercising with the regions/towns will ensure that future incidents are more successful.

C-4: Conduct media training for NU/CL&P staff with responsibility for media interactions.

All staff with responsibility for interacting with media on blue-sky days or during outage or other crisis events should take media training to ensure that they are adequately comfortable with media interactions and will remain calm and on-message during crises. In addition, CL&P should work with union leadership to identify several linemen who the company believes would act as good field spokesmen during events and ensure that these representatives also attend media training. A list of media-trained linemen/crews should be maintained by the newly formed "crisis information center" and these crews should be used in any situations where media requests field interactions.

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C-5: Develop a strategy to educate external stakeholders (customers, elected officials, businesses, etc.) on electric system restoration and collaborate with them on community priorities, restoration practices, and coordination opportunities.

NU and CL&P should develop a customer outreach plan for elected officials, key chamber of commerce representatives, and customers with the objective of engaging these stakeholders and educating them on restoration practices and communication priorities during an outage event. This effort should be developed as part of an integrated communication plan that incorporates branding, advertising, and outreach/education efforts into a single strategy.

Due to the large number of municipalities and the intricacies associated with each, it may be useful to establish regionally-based Municipal Task Forces to gather necessary information to adequately understand the needs and priorities of the communities and define mechanisms for on-going collaboration. Liaisons, in a regional approach, would be assigned multiple towns, should be pre-identified, and should collaborate with their assigned towns and elected officials on an ongoing basis (rather than only during events).

C-6: Enhance ETR development, release, and monitoring processes.

Although CL&P has processes in place to develop global, town, and individual ETRs, the process should be enhanced in several ways:

- Impose goals for releasing ETRs following the end of an event, based on event size and ETR granularity. These timeframes for ETR delivery should be communicated pre-event to media and customers so that external stakeholders have reasonable expectations as to when they will receive an ETR and during an event to emphasize that CL&P's objective is to keep external stakeholders informed and prepared.
- Clearly assign responsibility for developing accurate and timely ETRs to a single individual (Planning Section Chief) within the Area Command and ensure that the Communications Officer has responsibility for meeting established time goals for information release.
- Establish an "ETR Monitor" position, reporting to a member of the Area Command (either Area Commander or Planning Section Chief), with responsibility for monitoring ETR status' and notifying his/her storm supervisor of impending ETR expirations or the need to revise the ETR.
- Based on the lack of post-event ETR evaluation tools currently in place, develop a process and tool for auditing ETRs after an event to determine: number and type of ETRs provided; accuracy of each ETR provided; number of times any customer's ETR may have been changed for the worse; number of times an ETR was missed and the customer was left with an inaccurate ETR; etc.

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C-7: Enhance customer-facing systems and technologies (smart phone application, outage maps, and storm website) to provide better information and develop a mobile application (app) that allows customers to report and track outages.

Although CL&P currently has a mobile-friendly website (www.cl-p.com), best practice utilities have smart phone applications that allow customers to report outages, receive ETRs, check the status of an outage (whether a crew has been dispatched, etc.), and pay bills. The ease of accessing mobile apps makes such an approach preferable to using a mobile-friendly website. CL&P's outage map, available at http://www.cl-p.com/outage/outagemap.aspx, presents outage information in a way that is difficult to interpret (see Section 5.7.1 and Section 5.7.2) for customers, since the data is presented as a percentage of customers affected by town – so while a more urban town might have only 10% of its customers out, it may have a significantly greater number of customers out than a rural town with 90% out. Therefore, CL&P should consider revising its outage maps to more accurately portray damage by number of customers, which is the more common approach in the industry. Finally, CL&P should create a storm webpage that replaces the company's regular home page during a significant event and provides customers with easy access to outage-related information, including safety messaging, press releases, other key messaging, ETRs, etc.

5.4.3. Prioritized Matrix

Table 5: Crisis Communication Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
C-1	Assign clear responsibility for developing or implementing a communications strategy	High	Easy	Low	Immediate
C-2	Adopt "one voice" approach to and coordinate all externally-facing staff under a single communications umbrella	High	Easy	Low	Immediate
C-3	Re-vamp the Town Liaison program	High	Hard	Low	Immediate
C-4	Conduct media training for NU/CL&P staff	Moderate	Moderate	Moderate	Mid-term
C-5	Develop education/collaboration strategy for external stakeholders	High	Hard	High	Mid-term
C-6	Enhance ETR development, release, and monitoring processes	High	Moderate	Low	Immediate
C-7	Enhance customer-facing systems and technologies	Moderate	Moderate	Moderate	Mid-term

5.5. Planning and Damage Assessment

Effective planning and damage assessment is a critical factor in and the cornerstone of a successful restoration. During major events, utilities use damage assessment teams (patrollers) to evaluate damage before a line crew is dispatched to perform repairs. Damage assessors patrol feeders while identifying trouble locations, evaluating the extent of the damage, and developing initial estimates of the labor and materials required to repair the damage. In its broadest utility application, damage assessment:

- Enables the efficient development of crew work plans;
- Identifies disabling damage greater than predicted by OMS;
- Verifies OMS data and damage predictions;
- Provides a foundation for ETRs, resource planning, daily work plan development, and customer communications; and
- Identifies safety issues/dangerous conditions.

This assessment generates the information required to more effectively identify the volume of work, prioritize restoration efforts, and assign resources. This function is typically handled by line resources or "trouble crews" during day-to-day operations or minor events, but when major events occur, trouble crews should focus exclusively on repairing the electrical plant and restoring power. Second roles, established in a restoration plan, should clearly identify the other resources (engineers, retired linemen brought on system as contractors, and other qualified and trained individuals) that should perform damage assessment.

At the beginning of the restoration, the damage assessment teams work just ahead of the crews, relaying assessment information to the Planning Section in the Area Command. This information is then used to prepare the job site, arrange all appropriate switching, and obtain required material. As the assessment teams outpace the line crews, they continue to provide information about problems on the lines, which the Planning Section uses to prioritize crew work and develop ETRs. Most utilities complete their damage assessment within two to three days of an event that takes seven to ten days to restore. The actual number of days to complete damage assessment should be scalable to the amount of damage and total time to restore.

In evaluating whether the damage assessment process is defined and executed; how damage information is captured and used; and the reliance on planning to optimize crew productivity, consideration of industry "best practices" is necessary:

- Preparation and Planning
  - — Utilize training/certification process with re-fresher training
  - — Use standard templates/processes/technology to collect and transfer damage data to planning section
  - — Utilize integrated mobile technologies to streamline damage reporting (MDTs, handhelds, GIS/OMS connectivity, etc.)

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  - Pre-prioritize feeders
- Damage Assessment Teams
  - Use internal teams supplemented by external contractors
  - Staff damage assessment teams with field engineers as assessors and utility personnel with area familiarity as drivers
  - Assign one team per circuit, and multiple circuits to a team
- Mobilization
  - Pre-position teams where possible (if potential for outage event is known in advance)
  - Deploy teams early (as soon as storm/event is declared over and it is safe to move around the service territory)
  - Preliminary assessment of system by staff on pre-assigned feeders (to aid in initial storm level determination and development of global ETR)
- Response
  - Ensure adequate information about damage is captured (type of damage: broken poles, spans of wire down, damaged transformers, etc. , with estimated man-hours to fix)
  - May require multiple damage assessments during certain types of events (e.g., ice storms)
  - Complete bulk of assessment during day, with skeleton crew at night, and conduct order management and planning at night
  - Provide planning group with damage information as soon as identified (do not wait to provide until end of day/assessment period)
  - Complete damage assessment within 48 hours

Finally, leading utilities have implemented a forensic analysis process that allows them to collect enough detailed information on the specific equipment and structure failures to conduct statistical analysis and determine the main causes of outages during major events.

5.5.1. Findings

Effective damage assessment in the early stages of the restoration is critical for successful restoration and for establishing situational awareness. Although CL&P has a defined process for conducting damage assessment in its plan, the process was not executed well in the field. Some areas did not conduct damage assessment, others gathered incomplete information that was not useful, and some did not use the information because of a lack of trust in its accuracy. Most of the information was captured in different forms and never integrated with OMS and damage assessment resources do not appear to be adequately trained to provide the type of information needed. The planning function that takes the damage assessment information and develops work assignments for the following day was also inconsistently executed. In

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some districts, the night shift only had one or two resources that performed several roles at the same time, which is impossible to do in large events.

During Irene, the damage assessment process worked well in some districts, using field technology to capture damage data.

During Irene, and in areas where wireless cell service was available some districts used wireless cards to enter damage information directly into OMS in the field and the damage information was then associated with specific trouble tickets within OMS. If this approach were used on a company-wide basis, the CL&P planning function could be improved and OMS could be used as a tool to support proactive resource and equipment needs identification and work management, including prioritization. By entering damage information into OMS remotely and *real-time*, CL&P would be better able to utilize damage assessments as a basis for managing restorations. In major storms like Irene and the Nor'easter, when wireless service is unavailable, wireless cards cannot be used to enter damage information, so CL&P must maintain an alternate process as a backup.

Damage Assessors/Patrollers have not undergone consistent and in-depth training and field certification.

CL&P does not have a robust training and certification program for non-line damage assessors/patrollers. As noted above, a robust training and certification program for damage assessors is critical in a best practice planning and damage assessment process. The need for a structured training program is based on several factors, including: there is a tendency, across the industry, to disregard damage assessments not conducted by line crews or retired linemen because of a lack of trust in the ability of non-linemen staff to correctly identify equipment, describe damage, or accurately estimate hours to repair; damage assessors need to not only be familiar with equipment on CL&P's system, but also comfortable with the entire planning process flow (how activation occurs, how assessment assignments are made, how damage information is collected and when it is submitted, and how the information is used); and there should be a process for identifying staff who do not have the capability to conduct accurate damage assessment and either provide remedial training or remove that person from the role.

Damage information was not captured or provided to planning staff consistently or in a timely manner and pre-existing forms do not provide enough detail to effectively plan resource and equipment needs and develop ETRs.

Depending on the district, damage assessments were/were not conducted, and were/were not used to plan the restoration and prioritize work. In addition, in those districts where damage assessments were done, the data was captured in myriad ways: CL&P damage assessment forms, circuit maps, notepaper, or wirelessly through OMS. The quality of the damage data also varied greatly depending on which assessors were collecting it and the district.

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In addition, the damage assessment forms do not contain adequate detail to plan resource and equipment needs and develop ETRs. A robust damage assessment form (whether electronically or paper-based) includes detail such as:

- Damage location and assessor information;
- Damage specifics;
- Damage type; and
- Required materials.

In part, as a result of the different methods of capturing data and the lack of adequate detail in data that was captured, the damage assessment information was not used consistently across CL&P to prioritize and support restoration and to develop ETRs. There were cases where damage assessment information was not utilized and some repetitive assessments were conducted by line crews and bird dogs once they arrived in the field. Interviewees consistently claimed that, in those cases where repetitive damage assessments were conducted, they believed this repeat assessment was necessary because line crews could not or would not rely on assessments that they themselves had not conducted.

CL&P did not fully appreciate the risk that the Nor'easter weather forecast presented.

CL&P's evaluation of the risks that the Nor'easter presented to the company before the event led to an under-estimation by CL&P of the impact that the storm would have on its system, resources, and work flows. As a result, CL&P's situational awareness was limited during the early stages of the restoration. Multiple interviewees indicated that a snowfall of 6 inches would be very damaging to the system (because of the fact that leaves remained on the trees) and greater than 6 inches would be "catastrophic."

Feeder/circuit priorities and critical facility lists are not pre-defined.

During both events, town liaisons worked directly with elected officials on a daily basis to identify that day's priorities. This prioritization took place during restoration and was combined with internal and undocumented knowledge of system-wide critical facilities to prioritize work. A lack of pre-defined community priorities and a failure to use any system of prioritization or weighted customer count (assigning additional weighting to critical facilities) to establish a circuit restoration priority list likely resulted in misalignment with external stakeholders' expectations. Managing the restoration at a district level, without having a pre-defined and pre-established means of prioritizing across the regions or the entire company, may cause inconsistent restoration prioritization practices among districts (so while one district may, based on that day's community priorities opt to restore a fire department as the highest priority, another district may decide to focus its resources on restoring a warming or cooling center).

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Planning (work prioritization and resource assignment) was not coordinated and consistently executed across CL&P.

While some districts used damage assessments to conduct work prioritization and resource management, others did not. Work packages were developed inconsistently and were not used across the entire company. Prioritization and work planning was not always completed at night, based on damage assessments conducted that day and using pre-established circuit priorities and estimated hours to complete work, resulting in delays getting the crews to the work locations in the morning.

5.5.2. Recommendations

P-DA-1: Develop and implement a robust training and field certification program for all damage assessors/patrollers.

CL&P should develop a field certification process for damage assessors, including post-event evaluation of how assessors performed. This certification should be completed prior to assignment as an assessor – and those failing to meet pre-identified performance metrics should either have remedial training and be re-tested, or should be reassigned to another role. Following certification, annual refresher training (classroom and on-line module) must be completed to ensure that assessors are up to speed on their roles and responsibilities, the assessment process, and key equipment and damage types.

P-DA-2: Develop a single NU/CL&P damage assessment process that is managed at the Area Command level.

CL&P should develop a single damage assessment process that is managed at the Area Command level (rather than the districts) and is consistent across the company. In any event, all damage assessors should perform assessments in the same manner, identify damage using common terminology, capture data in a single tool, and submit that data back to a regional Planning group. Finally, the information itself should be used across CL&P to prioritize and manage work and identify resource needs.

P-DA-3: Revise the existing damage assessment form to include adequate detail and move toward electronic collection and submission of data and integration with OMS, material procurement software, and ETR tools.

CL&P should revise its existing damage assessment form to include, at a minimum:

- Damage location and assessor information, including: assessment crew identifying number; date/time of report; circuit/feeder number; device; outage/trouble ticket #; and circuit map page/grid #;
- Damage specifics, including: affected section (circuit, lateral, service); phase affected; location (street, rear lot, etc.); whether a tree crew is required; general comments;

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- Damage type (specific type of equipment (pole, fuse, transformer, etc.)), number of each type of equipment damaged, whether it is accessible, etc.; and
- Required materials, by ID, name, and quantity.

Ultimately the form should be available via Mobile Data Terminals (MDT) or in a handheld computer system that automatically uploads damage information to other systems and tools (e.g., OMS, procurement systems). This integration will assist material and stores management, development of ETRs, and overall management of the event.

P-DA-4: Develop, in collaboration with external stakeholders, critical facility/customer lists and prioritize feeders/circuits across CL&P, within each region, and within each district.

CL&P should prioritize circuits across the company, within each region, and within each district in order to reduce the burden on the planning group to manage work/outage incidents during an event. One approach to prioritizing is to develop a "weighted customer count" for all facilities across the company. So, while a hospital might have a customer equivalent count of 10,000, a fire/police station would have a customer equivalent count of 2,500, and a single family home would have a customer count of 1. Therefore, a circuit with both a hospital and a fire/police station would be prioritized above one with only a police/fire station and a single family home. This is a very simplistic example of how CL&P can, relatively quickly, prioritize its feeders – during an event, additional considerations should be included in prioritizing work (for example, if one circuit has a slightly higher priority than another, but will require two days of work and the lower priority circuit would only require five hours, it might make sense to give the lower priority circuit precedence in actual restoration). The method of prioritization should be easily understandable and, if subject to outside scrutiny, defensible. In addition, CL&P should work with external stakeholders to identify community priorities (rather than relying purely on company priorities).

P-DA-5: Implement a forensic analysis process.

CL&P should implement an independent forensic analysis process that clearly defines the process and requirements for data gathering in the field immediately after a major event and identifies the types of analyses that should be conducted using that information. This process should be independent of damage assessment and should ensure that sufficient data is captured to provide an adequate sample for statistical analysis. This information will help identify specific modes of failure for different pieces of equipment and structures and allow CL&P to better evaluate the costs and benefits of different system hardening options. There should be a single point of responsibility for gathering forensic data and conducting the analysis at CL&P. CL&P has already begun to develop this process.

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5.5.3. Prioritized Matrix

Table 6: Planning and Damage Assessment Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
P-DA-1	Develop and implement a robust training and field certification program	High	Moderate	Moderate	Mid-term
P-DA-2	Develop single NU/CL&P damage assessment process managed at the Area Command and regional level	High	Easy	Low	Immediate
P-DA-3	Revise damage assessment form and integrate system	High	Hard	Moderate	Immediate
P-DA-4	Develop critical facility/customer lists and prioritize feeders/circuits	High	Moderate	Moderate	Mid-term
P-DA-5	Implement forensic analysis process	Moderate	Easy	Low	Immediate

5.6. Restoration Execution

As noted previously, effective restoration of large outage events requires significant use of off-system resources, often resulting in a workforce several times larger than the resources available for day-to-day work. Efficient and safe deployment of such a large number of resources requires careful coordination, effective field management and adequate pre-planning of the work.

Restoration typically follows a set of agreed upon priorities to ensure that critical infrastructure is restored first. However, in order to re-energize certain facilities, utilities have to restore the upstream part of the system first. For example, in order to restore a hospital that is at the end of a circuit, crews have to ensure that the transmission, substation, and main sections of the distribution circuits are restored first and worked in the appropriate order.

In large events that affect significant portions of the system, utilities decentralize the restoration function and manage the work locally, frequently giving control over a town, substation, or a set of circuits to a group of line crews and supervisors to restore. This reduces the risk of creating bottlenecks in the centralized dispatch and switching organizations. Since utilities have different switching procedures, it is important to understand the transition to a decentralized model, where crew dispatching is done from a local office and some of the switching and tagging procedures is managed by field supervision instead of the distribution or system operations center. These

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procedures entail changes from day-to-day processes and have to be clearly-defined, practiced, and implemented to maintain safety for workers and the public alike.

Some events cause limited accessibility to electric facilities due to blocked roads either from significant snow fall or debris and trees on the road. In areas with overhead electric lines, some wires may get entangled in the trees and have to be cut clear and made safe in order to allow clearing crews to open roads. Careful coordination of this work between the utility and local government resources is necessary to provide safe access without delaying restoration.

During major events, there are usually many downed wire locations throughout the service territory, which can cause a significant demand for restoration resources. Fallen overhead wires that are energized pose a public safety threat during any outage event and while the public is asked to report wire down situations, they often cannot differentiate electric wires from telecommunications wires, calling the electric utility to report a telecommunications wire down. This increased volume on wire down locations further exacerbates the strain on utility resources. In typical events, anywhere from 25% to 75% of the total wires down calls are non-electric wires. In order to facilitate the wires down process, many utilities have created the role of wires down guard, assigning utility staff without any other restoration/second role to the position. The wire down guards receive training to identify utility wires and secure wire down sites and are dispatched to literally stand next to the wire down location in the field to ensure that members of the public stay at a safe distance from the electric facilities. These resources are not trained to determine whether the wire is dead or alive and therefore have to treat each location as though the wire is live. Some utilities have scaled back on using wire down guards in major events since the number of locations is much greater than the number of available staff (while utilities would typically have around 200 wire down guards, the total number of wire down calls in a significant event could easily exceed two thousand locations). The utilities that have chosen to move away from wire down guards instead use public campaigns and communications channels to educate the public on the dangers of approaching downed wires during major events and only focus on wire down locations identified through 911 emergency calls and where wires are visibly arcing, smoking, or on fire. The rest of the wires down locations are repaired over the course of the restoration processes according to restoration priorities. The recent proliferation of generators in private homes and small commercial facilities has created a new challenge during restoration, however, where improper installation can backfeed the electric system and energize secondary and primary electric wires on circuits whose source is de-energized. This presents a safety threat for utility workers as well as the public.

Finally, service lines that serve single residences or small groups of customers are frequently restored at the end of the event, resulting in a long “tail” on the restoration curve, with multiple days at the end spent restoring very small enclaves of customers. Some utilities have service crews and electricians who are not qualified to work on

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primary voltage lines and good restoration practice is to deploy these resources early and begin restoration of the service drops while line crews work on restoring primary lines. By proactively working on service outages, a utility can decrease the overall outage duration for some customers, because those whose services were damaged will be restored as soon as the circuit or lateral is energized.

5.6.1. Findings

When compared to other outage events and considering the number of customer interruptions, CL&P restored service to its customers within a reasonable timeframe in both Irene and the Nor'easter. The company followed a 16/8 hour shift schedule, which is the standard practice in the industry for extended restoration efforts. The restorations were completed without any serious or life threatening injuries to the workforce or public and CL&P's overall safety performance was better than blue-sky day safety performance when measured by the Occupation Safety and Health Administration (OSHA) recordable rate. In response to town requests, for the first several days of the Nor'easter, CL&P crews were engaged in clearing roads, so resources were not available for restoring power to customers. CL&P also had to handle an extraordinary number of wire-down calls, which also took resources away from restoration activities.

CL&P's safety performance during both restorations was better than blue-sky day safety performance.

CL&P was able to restore all customers after both Irene and the Nor'easter without any serious life threatening injuries to the workforce or public. The overall OSHA total recordable rate and Days Away Restricted or Transferred (DART) rate were lower during both restorations than the blue-sky safety rates at NU and CL&P. A lower rate in this case indicates better performance. For example, the DART rate for Irene was 1.5 and for the Nor'easter was 1.8, while CL&P's 2011 Dart Rate was 4.13. OSHA total recordable rates for Irene and the Nor'easter were 3.0 and 2.8 respectively, while the 2011 OSHA total recordable for CL&P was 6.30. Most of the reported injuries were related to trips, slips and strains, and in Irene, a large portion of the injuries were reported after the restoration was completed.

During both events, the CL&P safety team did a good job in meeting with off-system crews prior to engaging them in the restoration effort and giving them a safety briefing. The safety team also created a booklet (yellow book) containing key information about the CL&P system, safety procedures, and key phone numbers, which it handed to off-system crews upon arrival. The safety team also provided crews with daily safety messages with the latest news and updates on safety hazards throughout the event as key issues or hazards were identified.

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CL&P quickly decentralized the restoration to the district level; however, restoration approaches and restoration execution were inconsistent across the company.

The CL&P restoration plan calls for quick decentralization of restoration processes in events that affect large portions of the service territory. In both events, CL&P decentralized to the district level and transferred the crew dispatch function to local supervision. Most of the districts also decentralized other functions, including food and lodging, damage assessment, planning, and switching and tagging. While decentralization provided better oversight of the work and reduced the risk of creating bottlenecks, the approaches used varied among the districts. Some districts continued to restore using an order-based approach, while others attempted to use circuit-based restoration. Only one district transferred control of a substation to PSNH crews and allowed them to work under their company's switching procedures. This transfer was completed in accordance with CL&P's procedures for switching and tagging (TD800).

Pro-active use of service line workers and electricians to restore customer service drops reduced the overall restoration time.

During both restorations, CL&P deployed service line crews and hired electricians to restore service drops at the same time as other line crews were restoring primary voltage lines. For the Nor'easter, in addition to internal service crews, CL&P deployed approximately 252 crews, consisting of licensed electricians and apprentices, to perform residential service attachments. Based on crew repair sheets returned, CL&P estimates that these electricians visited and/or responded to 9,550 residential sites. In some cases, the electricians hired by CL&P repaired equipment that customers would typically have responsibility for repairing without charging the customers. This significantly reduced the duration of the outage to those customers whose service drops were damaged as a result of the storm.

The directive related to clearing roads and making safe delayed initial restoration.

Damage caused by the Nor'easter resulted in a number of road closures because of snow depth and trees that had fallen across the roadways and main thoroughfares. Since some of the trees brought down electric, cable, and telephone wires, the town crews needed support from electric line crews to ensure that the downed wires were dead. In order to support the needs of the towns in their initial recovery stage, CL&P deployed its available line and tree crews to support road clearing activities, instead of restoring customer service. Standard restoration practice is to have crews simultaneously working on clearing/making safe efforts and restoring/fixing feeder lockouts – particularly those lockouts that can be fixed with relatively little effort. CL&P's participation in the road clearing and making safe effort, which was an important effort demanded by state and town officials and other stakeholders, delayed CL&P's restoration of service to a portion of customers.

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Information on job status was not provided in a timely manner.

Throughout the restoration effort, information on closed jobs and restored circuits was often provided only at the end of the day. This caused discrepancies in the outage status information in OMS compared to the actual status of the restoration in the field. The restoration crews should be updating outage status upon arrival on-site to adjust ETRs and following the process to close the tickets immediately upon completing restoration work and restoring service to customers.

Lack of sufficient resources with TD800 switching qualifications caused a bottleneck and may have delayed energizing lines after physical repairs were completed.

CL&P switching procedures require the operations to be executed by TD800 qualified technician. A small portion of circuit breakers and a majority of circuit reclosers on the CL&P distribution system can be controlled remotely using SCADA, but most of the operations of circuit breakers require a qualified switching technician to physically open or close the device. Given the large number of outages and limited number of staff qualified to do the switching during the events, there was a bottleneck in writing instructions and executing switching in the field that may have resulted in delays in energizing circuits (closing circuit breakers) after the physical restoration of the line was completed.

The wire down process was challenged by the number of wire down locations across the territory.

Downed live wires pose a serious public safety threat, in part because as already noted, even in the event that a circuit is de-energized from the source, it may be backfed from improperly installed customer generators. Although there are already legal requirements under the National Electric Code regarding the installation of generators on systems without proper distribution system isolation protection, many people do not follow it. CL&P has a pre-defined policy and process for handling wires down calls and dispatching trained staff to secure wire down locations. The company has identified 626 staff members throughout the NU and CL&P organizations, and trained them to serve as wires down guards during major events. During Irene and the Nor'easter, the number of wires down calls from across the service territory, quickly surpassed the number of available wire down staff available to guard the wire down location.

The Company trained additional staff in the wires down position in the midst of the event. Notwithstanding that CL&P did an excellent job training additional staff in wires down and this materially aided CL&P's restoration efforts, the company should have either had an adequate number of wires down personnel prior to the event (in anticipation of a catastrophic event on the CL&P system) or developed a strategy to prioritize the wires down locations when the number of those locations is greater than the number of resources available. For emergency 911 wires down calls, the company dispatches a line crew to clear the line and make it safe.

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In some areas, tree crews were assigned to line crews.

Effective restoration during major events requires coordination of tree removal and line repair work. Since vegetation typically causes most of the damage in storms, trees that have fallen on the lines have to be removed before the line crews can restore power. At the same time, vegetation management crews cannot remove trees that are entangled in power lines until those lines have been confirmed dead and properly grounded by a qualified lineman. During the Nor'easter, CL&P bird dogs in some districts were able to identify enough work for both line and tree crews to keep them moving efficiently. However, in some districts and towns, line crews waited for tree crews and vice versa before moving to the next case of trouble. This was either the result of assigning tree crews to a line crew or working with towns that demanded that CL&P resources stand by until the town's clearing and make safe work was completed.

Some batteries required to operate reclosers needed to be recharged, causing some delay in energizing circuits.

The types of overhead line reclosers that CL&P uses require a charged battery to operate the device. Although the maintenance organization procured batteries in contemplation of this event, in a number of cases, the device batteries were dead by the time repairs were made (the duration of the outage for the event exceeded the useful life of these batteries). As a result, once crews repaired the physical damage, they needed a charged battery to operate the devices and restore power to customers. Technicians ultimately used a charged battery to operate the device and restore power, then re-inserted the drained battery into the device in order to re-charge. While this process worked, CL&P initially experienced slight delays in re-energizing circuits after the physical restoration was completed.

5.6.2. Recommendations

RE-1: Identify, train and qualify adequate field resources to oversee and execute timely restoration during large events.

In addition to the recommendation under RA-1, which includes identification of resources to assist in supervising and managing off-system resources, CL&P should also identify enough TD800 qualified personnel to support a fully decentralized restoration operation in a catastrophic storm event.

RE-2: Establish a process for coordinating the response with town and state agencies to ensure that expectations, needs, and limitations are understood and utilization of resources is optimized.

EPP-11 provides that CL&P should, through its emergency management group, coordinate with the state and local communities in coordinating responses. At the same time, however, CL&P should work with towns and state agencies to clearly define a process for supporting a road clearance program without unreasonably delaying customer restoration efforts.

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Section 4.2.2 above demonstrates that, especially during the Nor'easter, crews were initially allocated based on wires down calls, town requests for road clearing and municipalities' desire to have at least one crew in each of their towns at the beginning of the storm response, which limited CL&P's ability to allocate a larger number of crews to those areas with the highest number of total customer outages. In the future, CL&P should coordinate with the State, regulators, municipalities and stakeholders to pursue a regional approach to CL&P's a storm response, in order to expedite the overall restoration effort.

RE-3: Improve the process for capturing timely and accurate field information regarding the status of the restoration.

Develop a clear process and set expectations for both CL&P line crews, mutual aid resources, and supervisors on providing information updates on the status of outages. Ensure that the ETR information for a specific circuit, lateral section of a circuit, or trouble spot are updated upon the crews' arrival and that open outage tickets in OMS are closed immediately upon work completion and service restoration. This may include both process improvements and enhancements to field access of the key IT systems (OMS).

RE-4: Review and revise CL&P's wires down process for major events.

CL&P should evaluate the scope of its wires down procedure during catastrophic system events, where the vast majority of customers are interrupted and the number of wire down locations is multiple times greater than the number of wire down patrollers available. Rather than focus valuable resources on a potential safety issue, it may be more economical and efficient to proactively eliminate the possibility of potential wire down hazards by isolating (de-energizing) all circuits (although this may mean the interruption of additional customers). As a result, resources devoted to wire down guarding can focus on restoring or validating the integrity of critical infrastructure and priority circuits. This would ensure that all resources are focused on actual restoration efforts as opposed to focusing on efforts that dilute the overall effectiveness of the response. Resources that may have otherwise been identified to "stand-by" at wire down locations can be utilized to validate those circuits where there are no reported outages prior to the "system shutdown" and that can be selectively restored (effectively working backward).

RE-5: Implement and enforce generator installation safety standards.

To enhance the probability of safe installation of generators and ensure that customers are not backfeeding electric lines or creating unsafe situations, CL&P should consider developing a customer education program relying on the University of Connecticut Co-operative Extension (the Land Grant Universities) or a similar venue. Additionally, CL&P should consider partnering with companies like Home Depot or Lowes, which sell these

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generators before and during events, to help ensure people do not inadvertently feed back into the distribution system. CL&P may also partner with the state to develop legislation, including potential penalties, if necessary.

5.6.3. Prioritized Matrix

Table 7: Restoration Execution Recommendations Matrix

Number	Recommendation	Effect on Restoration	Ease of Implementation	Cost to Implement	Implementation Timeframe
RE-1	Identify, train and qualify adequate field resources to manage restoration work	High	Moderate	Moderate	Immediate
RE-2	Establish process for response coordination with towns and state	High	Hard	Low	Immediate
RE-3	Improve timeliness, accuracy and availability of field information	High	Moderate	High	Mid-term
RE-4	Revise wires down policy for large events	High	Hard	Low	Mid-term
RE-5	Implement and enforce generator installation safety standards	Low	Hard	Moderate	Long-term

5.7. Information Systems and Technologies

Utility best practices in systems and technologies can be characterized into three categories:

- Electric operations outage management systems (OMS, GIS, MDT);
- Web portal customer information systems; and
- IVR systems.

Combined, the three technologies provide incident managers with the ability to identify, process, and comprehend critical restoration information (customers out, location of outages, devices that have operated, location of crews, etc.). Through this information, these systems provide incident managers with "situational awareness" during storm restorations. Without these systems and tools and their integration into command and control decision making processes at the strategic, operational and tactical level, extended restorations may be caused by flawed decisions.

When a customer calls a CSR or the IVR and indicates that their power is out, a trouble ticket is produced in OMS that represents the specific customer's outage. When additional notifications are received from the IVR or CSRs indicating additional customer outages in the same area as the first call, OMS will utilize algorithms to determine what upstream device operated to interrupt service to the entire group of customers. OMS will then create an outage ticket for that upstream device. In companies with MDTs,

the trouble tickets are sent, via dispatchers, to trouble or line crews via the MDT. In utilities without MDTs, a dispatcher will typically radio the ticket information to the crew and the crew will then initiate a paper ticket process to provide the required information to clear the ticket from OMS. A robust OMS is critical to effective restoration – since it enhances the incident management team's ability to identify hard hit areas and number of customers out.

MDTs are a best practice technology that has been proven to aid in situational awareness and operational decision making. MDTs installed in line trucks provide GPS and trouble spot information and enable restoration crews to interface directly with work management systems, OMS, and dispatchers to streamline execution of operational decisions. MDTs can be used to capture damage assessment information, or as a tool to better communicate ETRs from crews in the field to customers. The drawback is that while each device may be reasonably priced, outfitting an entire vehicle fleet can be costly.

GIS is used to enhance a utility's ability to track assets, develop circuit maps, and, in some cases, view tree canopy in relation to the system's equipment and assets.

SCADA systems at the breaker level provide an understanding of the scope of the outages and allow operators to remotely open and close device in the field. This works well to improve reliability on a day-to-day basis but makes the system more complex to restore in a major outage event and may delay energizing circuits once the physical restoration is completed.

5.7.1. Findings

NU and CL&P have implemented several major IT systems to support the company's operations. The company has implemented a new OMS and GIS system and is undertaking an effort to increase the coverage of its SCADA system to all breakers over the next several years. However, these systems do not seem to be fully-integrated and did not provide the incident management team with adequate information to improve situational awareness and support better decision making. As a result, the information on the status of outages, estimated times of restoration, and crew locations that CL&P provided to outside stakeholders could have been more accurate if these systems would have been fully integrated.

CL&P has not put the most current version of the OMS in service.

CL&P currently uses Oracle Network Management System (NMS) version 1.7.10. There are two pieces to OMS - WorkSpace and Exceed. While WorkSpace is a Java-based application that is accessible through the internet, Exceed is a Unix-based application that is accessed by users on the workstation. Although a damage assessment module is included in CL&P's current version of OMS, the module is not accessible through the internet, since it resides on the Unix-based application. An upgrade to OMS would eliminate the Unix version and replace it with a Java-based version and would then

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allow staff to remotely access the damage assessment module. NU and CL&P are evaluating options for better integrating OMS. If a decision is made to implement an OMS upgrade, it is estimated to take approximately 12 months for final implementation to be completed.

CL&P does not have MDTs installed in its fleet.

CL&P does not currently have MDTs installed in its fleet vehicles or available in portable cases, forcing manual crew dispatch, outage/restoration status updates, closing of outage tickets, and development of order-based/individual ETRs. In the case of damage assessment, having MDTs (or even handheld devices) allows a utility to dispatch damage assessors and, more importantly, allows the damage assessors to enter damage data immediately upon discovering the damage and in a consistent format. Without access to MDTs in trucks, crews tend to update all of their tickets at the end of the day instead of closing jobs as they complete repairs in the field. This was despite CL&P's repeated requests, toward the end of both storms, that crews and supervisors promptly phone-in or radio-in such updates as soon as repairs were completed in order to mitigate this concern. This results in inaccurate restoration status information throughout the day and creates bottlenecks at night when the system is updated and jobs completed during the day are closed.

Crew locations and restoration status was not available to customers during Irene or the Nor'easter.

As noted previously, the timeliness and accuracy of information provided to customers and other external stakeholders was lacking. Exacerbating this is the fact that customers were not able to proactively obtain information they seek (such as restoration status, crew locations, etc.) at an adequately detailed level to meet their expectations. In addition to CL&P's website not having some key information that customers seek on what work is being done and in what locations, the color codes used for "Percentage of Customers Without Power" (at http://www.cl-p.com/outage/outagemap.aspx) changed midway through the Nor'easter restoration. While the initial color codes were in 20% increments, CL&P made a decision to change the increments to 10%. While the idea was to provide more granular information concerning restoration progress and to better educate customers about the severity of the outages in their municipality, the unintended consequence was that customers felt like CL&P was trying to make itself look better.

Overall situational awareness was not adequate for events the size of Irene or the Nor'easter due to a lack of supporting systems.

Decisions in both the Nor'easter and Irene restorations, in some instances, relied on limited or inaccurate information. Although CL&P has deployed a number of technologies to provide situational awareness (OMS, GIS, SCADA, etc.), the systems are designed for normal day-to-day operations and are not fully integrated. More

specifically, CL&P's OMS (like OMS tools used throughout the industry) uses algorithms that roll outages up to the device that was most likely to have operated based on the number of customers reporting outages. This algorithm overstated the number of customers that were actually without power. For example, multiple outage calls behind adjacent fuses did not necessarily mean there was an upstream device that was out. An OMS "estimated" value was corrected by a user input "actual" number, which was done manually, when possible, and usually at night and was much more difficult to execute than in normal daily operations. OMS' provision, in several instances, of inaccurate information and the lack of damage assessments to update OMS had a direct effect on strategic, tactical, and operational decisions and the overall situational awareness of both Irene and the Nor'easter.

The majority of CL&P reclosers and a small portion of circuit breakers can be controlled remotely by SCADA.

More than 70% of reclosers on the CL&P distribution system can be controlled by SCADA, but only 25% (approximately) of its circuit breakers have SCADA connectivity. While increasing SCADA connectivity could enhance situational awareness regarding outage location and type, it may have unintended consequences. SCADA allows CL&P to remotely switch breakers/reclosers from closed to open position and vice versa, changing the route of energy supply and simultaneously restoring the power to a portion of customers who would otherwise experience a sustained service interruption. Although this works well to improve reliability on a day-to-day basis, in storm restorations, the automated switching may have an unintended consequence of making the restoration more difficult to understand. This lack of understanding can, however, be enhanced with a rigorous damage assessment process that, combined with the SCADA information, can lead to better informed decisions.

CL&P's SCADA system is not tied to the OMS.

Currently, CL&P's SCADA system does not automatically update OMS, so information on the status of reclosers and circuit breakers that have SCADA is not available to OMS users.

5.7.2. Recommendations

IT-1: Deploy mobile data terminals (MDTs).

Trouble and line crews (including both CL&P and off-system) and damage assessment teams should have a direct link to OMS and procurement systems to streamline restoration, improve data sharing, enhance situational awareness and streamline the material ordering process.

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IT-2: Expand SCADA coverage to all breakers on the CL&P system to allow for remote switching.

Increasing SCADA coverage on the CL&P system will allow operations to make more flexible decisions in switching and restoring power during major events. It will also eliminate bottlenecks and requirements for TD800 certified technicians, who currently have to physically open and close circuit breakers inside the substations.

IT-3: Establish a data governance process that provides the basis for capturing, tracking and monitoring asset information and ensures that all key IT systems (CIS, OMS and GIS) are in sync.

CL&P should develop a data governance structure that clearly defines the type and format of asset information that the company will maintain and defines the frequency with which this information will be updated. It should also define what type of information will reside in which system and the frequency that other systems will be updated with the most current asset information. This effort will require cross-functional collaboration between business and IT experts.

5.7.3. Prioritized Matrix

Table 8: Information Systems and Technologies Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
IT-1	Deploy mobile data terminals	High	Hard	High	Immediate
IT-2	Enhance SCADA coverage	Moderate	Hard	High	Long-term
IT-3	Establish data governance strategy	Low	Moderate	Moderate	Mid-term

5.8. Logistics

Best practices in logistics during emergency management and storm restoration include:

- Clearly defined and established processes and procedures for identifying logistics needs, acquiring logistical support, and deployment of logistics facilities;
- Logistics response structure that defines who executes what logistics responsibility and who makes what decisions concerning logistics support;
- Inventory management procedures to rapidly increase available supplies prior to an outage event or emergency;
- Pre-established master support agreements with suppliers or vendors; and
- Automated tracking capabilities for logistics supplies and centralized information management systems.

The logistics function should be centralized in the organization (and reporting to the incident commander) to ensure that the tactical response to an event is adequately and seamlessly supported. During a significant outage event, where hundreds or thousands

of resources may be brought into a utility service territory, the logistical needs are significant and may include: lodging; feeding; transportation; fueling of trucks; maintaining fleets; and doing laundry for resources that may be away from home for more than one or two weeks. All of these needs should be managed at a centralized incident management level, where staff is able to consider the role of logistics in relation to the entire restoration. Fragmented and disjointed logistics decisions will fail to meet the needs of field and response personnel and often slow down acquisition and deployment of logistics support, with multiple individuals attempting to contact the same vendors and competing over the same resources.

Once an event occurs, logistics and stores staffing need to deploy vendors (equipment, food, catering, fuel, fleet, etc.) and supplies rapidly, so entering into a pre-established master service agreement eliminates potential delays in securing logistical support in a time of crisis. By entering into an agreement with supplier(s) on, at least, an annual basis, utilities can reduce the risk of not meeting the logistics needs for storm restoration.

In general, utility "stores" groups perform well during events because the services they provide mirror their day-to-day responsibilities. The pace of the work and the volume of equipment required, however, can stress a system that is not adequately prepared with master service agreements in place and excess equipment available (the need to balance a large inventory of excess materials has to be balanced with the costs). In a best practice utility, the ability to plan equipment needs and palletize equipment for specific work is based on effective damage assessment that is integrated with procurement systems.

5.8.1. Findings

Overall, logistics functions (both from a lodging and food perspective and stores perspective) performed well during both storms. CL&P never ran out of material during these two events and was able to secure lodging and food for all off-system resources. The company used an outside expert, Base Logistics, to quickly establish staging areas. Fueling was provided overnight for the most part to maximize working hours for the crews. There was some confusion around the responsibilities for lodging between the centralized logistics organization and the local (district) logistics organizations, as well as among different districts that resulted in different organizations within the company competing for the same facilities. Overall, the logistics function was performed according to the industry standards.

The CL&P stores section has established master service agreements with vendors and did not experience any shortages in materials over the two events that delayed restoration.

CL&P's execution of material acquisition and delivery was commendable during both events and the company did not experience any shortages that caused delays in

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restoration. CL&P's focus on establishing solid, pre-existing relationships with vendors (master service agreements, suppliers of choice) allowed the company to rely on vendors to deliver equipment directly to worksites and maintain excess stock in anticipation of CL&P needs. This reduced the amount of equipment located at the warehouses and supported field crews in restoring power as quickly as possible.

A shortage of trained stores clerks stressed the process of stocking trucks and supplying material.

The granularity of CL&P's response structure, combined with an inadequate number of stores clerks to staff an event of the magnitude of the Nor'easter (with all the districts, satellites, and staging sites) resulted in a need for more stores clerks (or second role personnel trained as stores clerks) than were available.

Some logistics functions were not performed consistently across districts.

Depending on the district, crews were fed at Base Logistics facilities, buffet style in restaurants, or via box lunches. Also depending on the district, fueling of trucks was done while crews were eating breakfast, overnight at hotels while crews slept, or at Base Logistics sites, where crews were bussed to and from in the morning and evening. The lack of consistency in food, lodging, and refueling practices led to some inefficiencies in getting crews out of the staging or parking facilities – with crews in some districts waiting for fueling, re-stocking, etc. that should have been completed overnight. In addition, Customer Experience staff did not receive lodging or transportation support from the NU logistics section and had to manage lodging and food separately.

Some districts, satellites, and system command targeted the same lodging simultaneously without coordinating with each other

While Area Command attempted to obtain lodging and food, district staff did the same thing – resulting in competition between CL&P districts and the EOC in obtaining access to the same facilities. In addition, district logistics staff competed amongst each other in attempting to obtain lodging (for example, when one district needed hotel rooms, that district's logistics staff had already begun obtaining lodging from neighboring district hotels and motels, without coordinating with the neighboring district).

The use of Base Logistics worked well and enabled quick setup of staging sites.

NU's use of Base Logistics for support worked well, though CL&P should evaluate the costs and benefits of using a turnkey service that also includes laundry and lodging in addition to food and parking. While there is no evidence that any crews were not provided with lodging, in the Nor'easter, multiple interviews indicated that travel time for some crews was significant. In an event the size of the Nor'easter, where an entire state is affected, the use of centralized sleeping facilities (e.g., tent cities or sleeping trailers) may be required to reduce crew travel time and enhance restoration efficiency. One area of concern raised during interviews was the adequacy of sanitary facilities at

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the staging sites where meals were served. Ensuring clean and sanitary facilities is critical for maintaining the health and safety of the workforce.

There are no formalized pre-established master agreements for staging sites, caterers, lodging, or helicopters.

Although the CL&P material/stores group has master service agreements in place with a number of equipment vendors, other logistics functions do not currently have such MSAs in place and do not have a full list of pre-identified locations for potential staging sites. This pre-planning is necessary to ensure that logistics can rapidly set-up and provide field crews and other response personnel (such as call center staff) with the support they need.

5.8.2. Recommendations

L-1: Establish standard operating procedures for NU logistics.

CL&P should establish company-wide processes and procedures for re-stocking equipment and re-fueling during shift down times. The processes and procedures should address large scale incidents, such as the Nor'easter, where crews are using satellite and staging areas (mall parking lots, etc.) for overnight parking with provisions that facilitate re-fueling and re-stocking at the locations. This will reduce delays in getting crews in the field and to the restoration sites. Logistics should be executed the same way in every service area or satellite.

L-2: Centralize food and lodging functions at the System (if activated) or Area Command level and consider positioning coordinators at the local level (e.g., district) who report to the area logistics chief.

Logistics should be managed at the Area Command level and, if the System Command is activated, the System Logistics group should provide support in the event that logistics is required across operating company service territories. This will ensure coordination both within CL&P and across NU, if needed, and simultaneously decrease the likelihood of competition for lodging, food, etc. This Area Command logistics group should understand logistical support requirements across the entire restoration service area and obtain support accordingly, while ensuring a unified response. This will require coordination with the mutual aid group and operations staff managing and tracking resources.

L-3: Assess the adequacy of resources to support logistics operations for major events.

After assessing resource needs to support logistics and stores/material during a major event, CL&P should, if necessary, assign and train additional staff in second roles to provide needed resources (stores clerks, staging site managers, logistics liaisons in all staging sites, etc.)

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L-4: Formalize agreements with key staging and satellite sites and suppliers.

As noted previously, while the use of Base Logistics provided substantial logistical support to CL&P, the lack of pre-existing agreements with potential satellite sites and logistics suppliers may have complicated logistics efforts. CL&P should work with local organizations/entities with land/facilities that could be used for staging sites (malls, schools, bus lots, sports facilities, etc.) to establish agreements in advance of an outage event. Similar agreements should be executed with other vendors, including caterers, lodging, restaurants, fleet/truck rental, etc. These agreements should be reviewed annually and updated as necessary.

5.8.3. Prioritized Matrix

Table 9: Logistics Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
L-1	Establish SOPs	Moderate	Moderate	Low	Immediate
L-2	Centralize Logistics	High	Easy	Low	Immediate
L-3	Assess the adequacy of resources	Low	Easy	Moderate	Mid-term
L-4	Formalize agreements with key staging and satellite sites	Moderate	Easy	Moderate	Mid-term

5.9. Call Center Performance

How responsive a call center is to customers during a major storm is key to meeting communications objectives. As noted in Section 2.2, the high-level questions to be evaluated related to call center performance include:

- Is there a proactive plan for addressing the increased volume of calls from customers?
- Are there pre-event IVR messages scripted and were outbound calls performed?
- Were the plans successfully implemented?

It is imperative that a utility have a plan to address the high call volumes associated with major storms or other events causing large percentages of the utility's customer base to be out of power. During major storms, the number of incoming calls during the initial day or two of a storm can be 350 times (or more) the expected call volume for a typical day. It is therefore critical that the company have a plan to handle this tremendous increase in customer calls.

Successful plans might include contracts with vendors providing interactive voice response solutions, contracts with vendors supplying trained customers service representatives, in-house resources from outside the call center who are trained and have system access allowing them to take outage calls, and mutual aid arrangements

with other utility call centers. Plans alone are not enough—those plans must be quickly executed to avoid large numbers of frustrated callers.

It is also important that a utility have multiple channels by which a customer can contact them to communicate about the outage. Having a robust IVR system used by customers to conduct business during non-outage conditions will reduce the number of customers desiring to speak with a representative. Website, e-mail, live-chat, mobile phone, and texting applications—which allow customers to report outages and track outage status—also allow customers to communicate without calling the call center. Social media avenues, when available, provide an alternative method for customers to obtain information in lieu of calling.

Call centers rely on many different technologies to effectively handle their day-to-day business with customers, and those technologies must be scaled to handle the increased volumes associated with major storms and other such events. Customer information systems, telephony capacity, and other systems must be sized to adequately handle the volumes significant storms can bring.

Most call centers have outbound calling technology that can be employed to provide messaging to customers during storms. This technology can push telephone calls to customers with or without a representative attending the call. Proper use of this technology during outages can enhance the company's effectiveness in meeting the communications objectives stated above.

In recent years, First Contact Resolution (FCR) has become an important measure of call center success. Many call centers strive to measure and reduce the number of customers who call their company more than once in order to have an inquiry or request satisfactorily resolved. The fewer the number of repeat calls to a company, the greater the customer satisfaction, at a lower cost. During extended outages, customers often become frustrated and insist on talking with a supervisor or manager. Reducing escalated calls during storms helps in meeting the customer satisfaction and cost reduction goals of FCR.

5.9.1. Findings

Based on key indicators of call center performance, NU did an excellent job handling the high number of customer calls during both events. The Customer Experience organization leveraged new systems and technologies to handle the high number of calls and overflows and was able to bring more than 350 trained CSRs to support the organization. The performance of the call center in both events should be considered to be best practice.

Overall, Customer Experience (CE) did an excellent job handling the high call volume associated with both Storm Irene and the October Nor'easter.

NU has robust technologies that stood up well to the extremely high volume of customer contacts. CE implemented their emergency plan across both call centers for

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all three operating companies for the first time in Irene and then followed the plan again during the Nor'easter. In post-storm reviews of Irene, CE management found only very minor items that needed to be addressed for succeeding storms.

Besides the ability to bring in over 350 trained customer services representatives to staff the phones, CE has technology in place to provide customers with the ability to report outages and receive outage information without the need to talk to a representative.

NU has contracted with 21st Century Communications (TFCC) to provide IVR support during periods of high call volume. During Irene, call volume for the entire storm period of 10 days was approximately 1.03 million calls, which is about 23% of the Company's typical annual call volume. Together, the company IVR and the TFCC IVR were able to handle approximately 74% of the total call volume coming into the call center, allowing customer service representatives to focus on talking to customers who needed to speak to a representative. From Sunday, August 28 through Monday, September 5, CL&P's average speed of answer to speak to a customer service representative ranged from a daily average of 2 seconds to a daily average of 67 seconds.

During the Nor'easter, NU handled approximately 1.118 million calls from CL&P customers. Of the 1.118 million snowstorm calls, 270,778 (24%) were handled by representatives, 614,742 were handled in the NU IVR, and 233,204 were handled by TFCC. Overall average speed of answer to reach a representative during the storm was 43 seconds. Many call centers, both within and outside of the utility industry, set annual average speed of answer goals at 40 or more seconds. Daily average speed of answer, during the storm period, ranged from 4 seconds on October 31 to 196 seconds on October 29. Percent of abandoned calls for the storm averaged 1.55% with a range of 0.26% on Nov. 7 to 12.1% on October 30.

NU has a number of communication channels available to customers. During the Nor'easter, for CL&P 36% of trouble orders were taken by representatives, 32% were taken in the NU IVR system, 18% were taken in the TFCC IVR, and 13% were taken by website outage application. In addition, the company has text messaging capability that provides customers some outage information.

Outbound calling technology employed by CE for everyday business was used extensively during the storms. During the October snowstorm, NU implemented 100 different outbound calling campaigns for a total of 1.87 million calls to CL&P customers.

In addition to the robust telecommunications technology that enabled CL&P to communicate with customers during the storms, the customer information system (C2) held up to the volume.

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Customers using the TFCC IVR cannot opt to talk to CSR.

If customers call at a time of high call volume during an event, their call may be directed to the TFCC IVR. Although the customer can report their outage in the IVR system, as it is currently configured, they do not have an option to speak with a representative.

Despite the technology and the performance as reported in these statistics, information provided to customers during these thousands of customer contacts was less than adequate.

Customers have decisions to make regarding their living arrangements and businesses, and therefore depend on the information CL&P provides. Current systems at CL&P do not provide granular enough information about what is happening in the field for representatives to provide the desired information to customers. There are many forums for communications during storms (meetings within area work centers, executive conference calls, and conference calls by functional organizations), but the substance of the information available in those forums needs to be improved in order to better communicate with customers. Information provided by Town Liaisons to town officials and customers was sometimes in conflict with information provided to representatives to discuss with customers.

NU staff handled an unprecedented number of escalated calls from CL&P customers during the Nor'easter. As the snowstorm outage progressed and as a result of the lack of accurate information being provided to customers, the number of customers asking to talk to a supervisor or manager (escalated calls) rose to unprecedented levels. Many customers calling to inquire about estimated times of restoration were extremely angry and some were threatening. Management was proactive in pulling together staff well-suited to handling customers who insisted on speaking to a higher authority. Attorneys were recruited to help with some of the escalated calls and measures were taken to increase security at the Windsor facility. At times, the level of escalated calls was so great that it became necessary for the original representative to inform the customer that a "supervisor" was not immediately available and that someone would have to call the customer back. It was reported that some representatives became so weary of not having adequate information on the status of outages that they were "offering" escalated calls.

Outbound calls confirming restoration were placed to a significant number of customers that had not been restored and CSRs were not always informed prior to the call about its key messages.

In several interviews within CE, it was reported that there were a number of customers who received outbound automated calls regarding the status of their service when they should not have gotten calls. From the number of calls received, it appeared outage tickets may have been cleared on laterals (still requiring field work) when the circuits were restored. It was also reported that outage tickets were being closed long after the

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outage in an area was over, which may indicate further training is needed for people closing outage tickets.

Interviews revealed that although representatives felt CE management tried hard to ensure all available information was provided to them, there were a number of circumstances wherein customers were calling about an outbound calling campaign before the representatives had been informed of the campaign.

CE management proactively addressed stress in staff by bringing therapists into the call center.

Recognizing the stress level that representatives were under (because of call levels, customer frustration, and lack of logistics support, CE management contacted Human Resources to bring in Employee Assistance therapists to meet with individual employees who chose to do so – a best practice considering the amount of stress that CSRs were under.

NU does not use any mutual aid call centers for supplemental staffing.

NU's call center structure, with centers located in Windsor, Connecticut, and in Manchester, New Hampshire, is robust for handling large storms and provides redundancy with two geographically separate centers of similar size. It would, nevertheless, be difficult to provide the same quality of service CL&P customers experienced during Hurricane Irene and the Nor'easter, if either the event had stretched across all operating companies or one of the two call centers were damaged/destroyed at the same time as a significant portion of NU customers were without service. A tornado could potentially cause this situation, as could an explosion in one of the buildings housing an NU call center, during a major event.

5.9.2. Recommendations

CC-1: Incorporate Call Center Liaison in "crisis information center" (See C-ETR-2).

CL&P should include a Call Center Liaison in the "crisis information center" to ensure "one-voice communications." This Liaison will provide timely, accurate messaging for representatives to use while communicating with customers. This Liaison will also provide appropriate information to staff responsible for implementing outbound calling campaigns and messages on the IVR.

CC-2: Work with TFCC to develop a process that allows customers to opt to talk to a customer service representative when their call is handled by the TFCC IVR.

The ability to speak with a representative is particularly important if the customer wants to report a wire down or some other safety condition. Other utility companies using TFCC have procedures in place to allow a customer to opt out of the system to speak with a company customer service representative.

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CC-3: Consider developing mutual aid agreements with other utility call centers to provide back-up in the event of a disaster which destroys one of the NU call centers.

Some utilities include call center operations in their mutual aid agreements with other utilities. NU should consider working with other utilities or "crisis call centers" to develop this additional back-up capability.

CC-4: Refine the process for identifying customers to receive outbound calls confirming service restoration.

CE should work with CL&P to determine the exact nature of the outbound calls and establish a procedure to limit the number of outbound calls confirming restoration where power has not been restored. If the goal of outbound calls is to identify nested outages, CL&P should include the outbound calling process in customer education campaigns.

CC-5: Improve training of representatives (both first and second role representatives) on escalated call procedures with the goal of reducing escalated calls in future events.

In order to improve the customer experience during major events in the future, CE should take steps to reduce the number of escalated calls. Additional training on this subject should be provided to all representatives (including second role representatives). Perhaps call statistics from the period of the Nor'easter could be analyzed to identify those representatives referring the largest number of calls to the escalated call group. With that information and by listening to some of the calls recorded during the Nor'easter, supervisors and trainers could identify employees needing one-on-one coaching. At the same time, NU should identify calls to be used in training sessions that highlight conversations in which representatives were particularly effective in a difficult situation.

CC-6: Implement controls to ensure that representatives are given information about outbound calling campaigns prior to the calls going to customers.

The approval process for executing an outbound calling campaign should include a control to ensure that representatives get information about the campaign before it is pushed to the customers.

CC-7: Consider an initiative to obtain the phone numbers customers prefer CL&P to use when doing outbound calling during events.

The phone numbers used in outbound calling come from C2, the company's customer information system. The phone numbers populating the C2 are most often associated with customers' land-line home phones, however, which frequently do not work during electrical outages. To increase the effectiveness of outbound calling, the company should consider an initiative which would ask customers to identify the phone numbers they would prefer outbound calls be sent to during outages.

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5.9.3. Prioritized Matrix

Table 10: Call Center Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
CC-1	Incorporate Call Center Liaison in "crisis information center"	High	Easy	Low	Immediate
CC-2	Develop process that allows customers to talk to a CSR when call is handled by 21st Century	High	Moderate	Moderate	Mid-term
CC-3	Consider developing mutual aid agreements with other utility call centers	Low	Moderate	Moderate	Mid-term
CC-4	Refine process for identifying customers to receive outbound calls	Moderate	Easy	Moderate	Mid-term
CC-5	Improve training of representatives on escalated call procedures	Moderate	Moderate	Low	Immediate
CC-6	Implement controls to ensure that representatives are given information about outbound calling campaigns prior to the calls going to customers	Moderate	Easy	Low	Immediate
CC-7	Consider initiative to obtain the phone numbers customers prefer	Moderate	Moderate	Moderate	Mid-term

5.10. Maintenance and Vegetation Management

In order to ensure safety of electric utility construction, NESC has established guidelines for pole loading based on historic weather patterns by geographic area. The guidelines are expressed in terms of the minimum wind speeds and ice loading that the structures are expected to withstand. Utilities are expected to follow this guideline and ensure that their construction standards and structures, including wood poles, meet the NESC loading guidelines at the time of installation.

During major storms, distribution system failures are typically caused by falling trees, tree limbs or debris on electric facilities, or broken poles due to extensive wind or ice loading. Since the strength of wood poles may deteriorate over time due to environmental factors, utilities have pole inspection and replacement programs that are based on a pre-defined cycle, which depend on environmental factors and type of wood poles that are used. In most major weather events, however, the poles that fail and cause interruptions are typically brought down by vegetation or other debris or extensive wind and ice loading that are beyond NESC structure loading guidelines.

Vegetation is typically the single largest culprit of outages during major events. Trees and limbs tend to fall into distribution lines and take down wire and equipment, including poles, creating interruptions to customer service. While most utilities manage vegetation line clearance on a pre-defined cycle, the trees and limbs that cause outages in major events tend to fall in from outside the typical clearances or rights-of-way (ROWs). Some companies have expanded their vegetation management (VM) programs to increase clearance specifications, remove overhangs, and remove hazard trees from outside the ROW. Aggressive VM programs can reduce damage during major events, but are difficult to execute since they require access and approvals by property owners.

Lastly, utilities maintain substation and major distribution line equipment on a pre-defined cycle to ensure that it is operational and can be used to reduce the impact of the outage or restore customer service. Best practice utilities use either timed-based or reliability-based maintenance approach depending on the type of equipment. In addition, these utilities have a strong process to ensure that the maintenance is carried out and that the replacements are completed on a timely basis. For example, a number of utilities are beginning to experience problems with URD cable that was installed forty or more years ago and is now experiencing increased failure rates. While URD cable does not typically fail during storms, there has been an increase in failures during restorations. Once the overhead failures are repaired and main circuits re-energized, the power surge that is created stresses the URD sections of the circuit and can result in failures. These underground cable faults create additional outages during major event restoration that further extend the outage to customers that have already experienced extended service interruptions.

5.10.1. Findings

CL&P appears to be spending more than other comparable companies on its distribution system, indicating that the damage caused by these two events was not a result of a lack of spending on the system. Although the company has implemented a robust pole inspection and replacement system which is in its fifth year of implementation and the vegetation management program meets industry standard, it may not be funded adequately to address the vegetation density, growth cycles, and stakeholder expectations for service levels. A few years ago, CL&P underwent a major effort to review and revise its asset maintenance programs, which resulted in the creation of the NU Maintenance Manual (NUMM). The effort also created a process to reduce a maintenance backlog, which has virtually been eliminated. The current maintenance program is well-defined and managed, but the vegetation management program could be improved to enhance the line clearances, address risk trees and shorten preventive maintenance cycles.

CL&P follows NESC construction standard requirements.

NESC defines the design requirements for electric facilities construction based on the typical wind and ice loading for a specific geographic area. Based on a review of CL&P's

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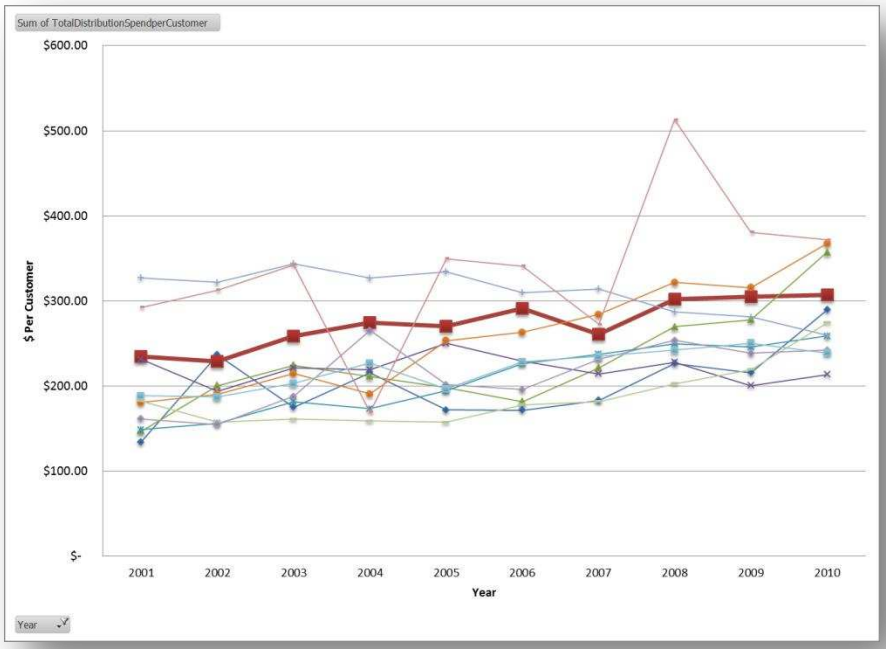
documentation, its current construction standards meet the NESC loading requirements. It is important to note that NESC standards change over time and that utilities are not required to upgrade pre-existing infrastructure to meet current standards (there is no retroactivity). Therefore, CL&P, like all other utilities, operates some facilities that met standards at the time when they were put in service but may not meet current NESC requirements.

CL&P appears to have adequately funded its distribution system when compared to other utilities.

In order to evaluate whether CL&P has adequately invested in its distribution system, Davies Consulting used the publically available FERC Form 1 data to compare CL&P's total distribution spending (Capital and O&M) on a per customer basis against other similar utilities in the mid-Atlantic and Northeast. Based on this analysis, it appears that in the period from 2001 through 2010, CL&P consistently spent more per customer than most comparable utilities. CL&P spending level is depicted by the heavy red line in the graph on Figure 20, below.

Figure 20: FERC Form 1 – Distribution Capital and O&M Spending per Customer (2001-2010)



Improved maintenance programs likely resulted in no incidents of equipment failing to operate as designed.

Several years ago, NU undertook a company-wide effort to revamp its equipment maintenance strategy, practices, and processes. As a result of this undertaking, the

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company developed the NU Maintenance Manual (NUMM) which defines maintenance cycles for each piece of equipment on the distribution system (including substations). Since the implementation of the new process, CL&P has successfully eliminated the backlog of maintenance activities and is managing a maintenance program that is consistent with the new manual. As a result, there is no evidence that any of the outages during the two storms were caused by mis-operating equipment due to a lack of maintenance.

Pre-established alliance contracts enabled timely acquisition of required VM resources to support restoration.

CL&P has strong alliance contracts with two major utility vegetation management services providers, Asplundh Tree Experts (ATE) and Lewis Tree. Through these contracts and relationships with these premier suppliers, CL&P has access to a large number of VM resources that the contractors can provide to support large restoration efforts. The process for acquisition of these additional resources, work hour expectations, and billing rates for storm work are pre-established in the existing contracts, making procurement of additional resources relatively simple.

In 2006, CL&P implemented and continues to manage a 15-year wood pole inspection and replacement cycle on the distribution system.

In 2006, CL&P established a 15-year pole inspection and replacement program, which requires that one-fifteenth of all company poles are inspected in the field through a combination of visual, sound and bore, and ground line inspections, depending on the type and age of poles. In 2006 and 2007, CL&P conducted pole inspections and developed unit cost data that informed the 2007 rate case. In 2007, CL&P requested and was granted funding to inspect approximately 30,000 poles per year beginning in 2008. Since then, CL&P has followed through and inspected approximately 30,000 poles per year. The number of poles inspected in each year from 2006 through 2011 is presented in the table below:

Table 11: Poles Inspected – 2006 – 2011

Year	Number of Poles Inspected
2011	29,694
2010	35,913
2009	27,453
2008	37,763
2007	12,682
2006	3,497

In this period, CL&P has replaced all priority one rejected poles within the pre-defined timeframe and has virtually eliminated the backlog of non-priority poles identified for replacement or reinforcement. Starting in 2012, CL&P is further streamlining the pole inspection program by combining both inspection and replacement portions of the process under the same organization.

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Most of the tree damage was from the trees and limbs that are outside the clearance zone.

During the two storms, CL&P experienced extensive damage from trees and tree limbs falling on electric lines and poles. According to the staff that participated in the restoration, in Irene, the damage was mostly due to high winds and trees and limbs falling into the lines from outside the ROW, while in the Nor'easter, most of the damage was from snow loading, breaking or uprooting trees and bringing down overhanging limbs. In both cases, the trees that caused damage would not have been addressed through a regular maintenance program. Appropriate forensic data from the storms is not available to support a statistical analysis of the tree failure modes and determine the failure trends for the tree-related outages.

Current state-authorized Vegetation Management Program spending may not be adequate based on vegetation density, vegetation growth cycles in the region, and customer expectations for service levels.

Connecticut is one of the most densely vegetated states in the union, which provides a challenge for electric utilities with predominantly overhead delivery systems. CL&P's vegetation management program consists of three components: routine maintenance trimming (SMT), enhanced tree trimming (ETT), and capital-related tree trimming. In the late 1990s and early 2000s, CL&P invested a significant amount of capital dollars to enhance vegetation clearances on the backbones of its circuits, which significantly improved tree-related reliability. Even though the new clearances were much greater, in many areas, CL&P was not able to gain the requisite permission from property owners to remove tree overhangs on backbones as a part of the ETT effort. Starting in 2006, CL&P began to increase its O&M budget to maintain the newly established clearances on backbones and maintain lateral sections of circuits. The O&M portion of the VM budget increased more than two fold from 2005 to 2011.

Table 12: VM Budget Breakdown – 2001 – 2011

Year	O&M	ETT	Capital	Total
2011	23,380	3,638	1,660	28,678
2010	20,595	4,484	2,285	27,364
2009	19,688	4,546	2,825	27,059
2008	19,184	8,383	2,798	30,365
2007	14,219	9,463	2,674	26,356
2006	12,566	2,727	2,040	17,343
2005	10,072	2,940	2,466	15,478
2004	10,461	2,915	2,942	16,318
2003	7,806	13,444	4,176	25,426
2002	6,177	11,442	3,924	21,543
2001	9,582	14,687	6,321	30,590

However, despite the increase in spending, the current O&M budget level only allows CL&P to maintain its circuits on an approximately 5.5 year cycle, meaning that about

one-fifth to one-sixth of all miles are trimmed each year. Since the current vegetation clearance specifications call for removal of approximately four years of tree growth, the current level of spending may not be adequate.

CL&P experienced outages to its underground system during the restoration.

Distribution circuits typically include both overhead and underground facilities depending on the specific areas served. Most of the CL&P circuits are predominantly overhead, but feed neighborhoods where electric facilities are underground. During the restoration, CL&P experienced some outages in the underground portions of the circuits once the overhead repairs were completed and circuit re-energized.

5.10.2. Recommendations

M-VM-1: Implement a more aggressive VM program that targets removal of overhangs on circuits and includes ETT trimming on laterals.

In order to reduce the risk of vegetation-related outages during major events, CL&P should work with regulators and local governments to obtain the necessary funding and support to enhance its current VM program to remove overhang on backbone portions of the circuits and expand its ETT program to key lateral sections of circuits. This approach will require funding and support from key stakeholders, since it will result in much greater clearances and vegetation removal.

M-VM-2: Increase VM program maintenance budget to reduce the current trimming cycle.

Given the vegetation growth cycles in the region, vegetation density, current clearances, and customer expectations for reliable service, CL&P should re-evaluate its current level of VM maintenance budget and spending. CL&P should leverage the use of available decision-support tools to assess the costs and benefits of reducing its trimming cycle, evaluate potential alternatives, and determine the optimal cycle. Based on the required level of spending for the optimal cycle, CL&P should work with the regulators to secure sufficient funding to implement that cycle.

M-VM-3: Develop a more comprehensive hazard tree removal program and work with the appropriate stakeholders to secure adequate access and approvals.

Hazard trees present a significant threat to distribution lines during major events, since they cannot withstand excessive snow, ice, or wind loading and, as a result, may fall on electric lines. CL&P should define a practical program to identify hazard trees that can adversely impact lines and develop a process to remove those trees. Since most of these trees are outside the traditional utility ROW, CL&P will have to work with towns, the legislature, regulators and property owners to secure adequate access and approvals from property owners to remove hazard trees.

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M-VM-4: Review the adequacy of the funding for the URD cable replacement program.

As a part of the asset management strategy implementation, CL&P should implement the proposed URD cable replacement program and secure adequate funding.

5.10.3. Prioritized Matrix

Table 13: Maintenance and VM Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
M-VM-1	Implement overhang removal and lateral ETT program	High	Hard	High	Long-term
M-VM-2	Reduce current trim cycle	Moderate	Moderate	Moderate	Long-term
M-VM-3	Develop hazard tree removal program	Moderate	Hard	Moderate	Long-term
M-VM-4	Review URD cable replacement program funding	Low	Hard	High	Long-term

5.11. Transmission

The CL&P transmission system, which has 1,638 miles of overhead lines, 135 miles of underground lines, and is connected to 120 substations, is part of the ISO-New England (ISO-NE) system, supplying uninterrupted power to CL&P's distribution system customers. This system is heavily regulated by the Federal Energy Regulatory Committee (FERC) and the North American Electric Reliability Council (NERC). NERC compliance is also monitored by the Northeast Power Coordinating Council (NPCC). There are approximately a hundred mandatory reliability standards that govern the Bulk Electric System (BES) and Bulk Power System (BPS). For purposes of this report, these regulations apply to most of CL&P's 100kV and above transmission facilities. The major exception to this rule is Vegetation Management NERC standard FAC-003, which is applicable to 200kV and above facilities. At the time of Hurricane Irene and the Nor'easter, only the 345kV portions of the CL&P transmission system were subject to NERC's VM reliability standards. Compliance with these mandatory standards is enforced through NERC and NPCC compliance audits and strict requirements for voluntarily reporting of non-compliance events. In 2012, in response to FERC Order No.743, the definition of the BES for compliance purposes was modified to include all transmission elements operated at 100kV or higher. The CL&P transmission system is operated by The Connecticut Valley Electric Exchange (CONVEX), which, in addition to having operating responsibilities on a "blue-sky "day, has responsibilities during power system emergencies defined in CONVEX Operating Instruction O.I. #8703.

5.11.1. Findings

The transmission organization mobilized quickly once outages started to occur and restored interruptions on the system effectively. The staff developed a good

prioritization scheme and leveraged available technology, including SCADA, relay data, and helicopter patrols to conduct damage assessment. At the same time, transmission does not have a formal Emergency Response Plan and has not adopted the ICS structure for emergency response. Some of the processes that were developed during the event should have been created, tested, formalized, and exercised in advance of the major events.

Transmission did not fully staff an emergency response organization or Command Center prior to the Nor'easter's arrival.

Although transmission personnel were monitoring the changing winter weather forecasts, the emergency response team was not fully activated and staffed prior to the first actual interruptions to the CL&P transmission system. The first two individuals called to report into CONVEX to start analyzing transmission outage events arrived late Saturday night. The emergency response leadership team reported in to CL&P headquarters at 6:00 A.M. on Sunday morning.

There is no formal Emergency Response Plan, based on ICS principles, with pre-defined storm event triggers for transmission.

Despite not having a formal storm emergency response plan, similar to the distribution system's plan, which includes ICS management principles, the transmission leadership team organized quickly and initiated analysis of data to assist in the transmission system's damage assessment and mobilized to repair the damage.

Transmission does not have a pre-defined damage assessment process.

Leading into the two events, CL&P did not have a pre-defined process for assessing damage on the transmission system. Despite this, the transmission organization did a good job of identifying transmission facilities that were damaged during the storm in a timely manner. In the immediate aftermath of the Nor'easter, on the night of October 29, transmission staff analyzed outage information, SCADA system and remote relay data to pinpoint damage locations. The team also defined damage assessment and restoration priorities based on potential customer impact, load, and redundancy of the lines that were damaged. Using output from the location analysis and a newly developed prioritization tool, the leadership team assigned and dispatched resources to conduct a physical assessment of the transmission system damage.

A restoration prioritization scheme was developed shortly after the storm event began.

By design, certain elements of the transmission system are more critical than others and therefore should have higher priority during restoration. Normally, the higher the voltage, the more critical the transmission line is to the BES backbone. However, there are other criteria that have to be considered when assigning restoration priorities, such as redundancy and number of substations fed by the line. Leading into the event, CL&P did not have a pre-defined priority system for restoring transmission system damaged

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during a storm this severe. Nevertheless, transmission staff developed a solid restoration priority system immediately after experiencing outages and used those categories to assign damage assessment and restore the system. Priorities were classified into the following five categories:

- Priority P1 - Transmission line restoration brings back multiple substations;
- Priority P2 - Transmission line restoration brings back one substation;
- Priority P3 - 345 kV voltage lines;
- Priority P4 - Transmission line restoration eliminates single line loss contingency; and
- Priority P5 – Transmission line out is not affecting customers.

The categorization scheme worked well and as a result, the transmission restoration does not appear to have delayed restoration to any customers.

The use of the CONVEX Situation Room enabled better coordination of the restoration effort.

During the Nor'easter, and for the first time, the transmission team used the situation room next to CONVEX to manage the restoration. Proximity of the situation room to CONVEX enabled better coordination with transmission operations staff and improved communications among restoration team members. Having a pre-defined and dedicated location within the CONVEX building and the required infrastructure to lead emergency events for the electric transmission system are an industry best practice.

CL&P used helicopters to conduct damage assessment through aerial patrols.

Within the first 24 hours of the restoration, transmission used helicopters to conduct aerial patrol and expeditiously assess damage to transmission lines and structures. The contractor involved in building new transmission lines had two helicopters on site and made them available to CL&P to conduct aerial patrols of the affected lines to quickly identify physical damage and determine what resources would be required to make repairs. Aerial patrols were also helpful in identifying access points to the damage site.

Transmission facilities experienced 33 interruptions during the Nor'easter, mostly as a result of trees.

NERC Standard FAC-003 places mandatory vegetation management compliance requirements on 200kV and higher transmission system elements. The CL&P transmission system is maintained in compliance with the NERC requirements in terms of vegetation clearance around electric lines. During the Nor'easter, CL&P experienced 33 interruptions on the transmission system, including three 345kV line outages, twenty-nine 115kv line interruptions, and one 69kV outage. The loss of transmission lines affected supply to twenty substations (69kV and above). According to available data, most of the tree contacts were from trees located outside the edge of the transmission ROW easement area.

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Out of the three interruptions on the 345kV system, only one was caused by vegetation. According to reports, a tree from outside the ROW came down a hill and caused damage to a lattice tower structure. The other two failures were caused by a mechanical failure at a river crossing and the snow loading on an angled section of line with a long span. Convex, which has responsibility for FERC/NERC compliance reporting, appears to have filed the required incident reports for events impacting the 345 kV system in a timely manner.

The causes of the faults on the 115kV system were as follows:

- Twenty five outages were caused by trees;
- Three outages were caused by heavy wet snow loading on structures; and
- One outage was caused by a relay mis-operation, resulting in a breaker failing to trip.

The outage on the 69kV line was also caused by a tree.

Switching and obtaining clearances from distribution operations may have caused delays in transmission restoration especially during Hurricane Irene and may have caused some delay in the early part of the Nor'easter.

During the initial stages of the transmission system restoration, the switching process led by distribution operations may have caused a minor delay to the restoration of transmission facilities. The distribution operations electricians were switching and giving clearances for both transmission and distribution restoration crews and did not appear to have had sufficient resources to conduct all the required switching in a timely manner. As soon as this issue was identified, transmission and distribution directors worked together to adjust the process and minimize switching delays. Lessons learned from Hurricane Irene improved the process during the Nor'easter.

Convex Transmission Operations appears to have done a good job under severe storm situations to contain and confine outages to damaged transmission elements. The balance of the transmission system continued to supply electricity without having cascading events. From 2007 through 2011, NU has invested over $50 million on transmission system protection at CL&P to ensure optimum reliability and prevent cascading outages.

5.11.2. Recommendations

T-1: Work with distribution emergency preparedness to improve forecasting and risk assessment of weather events.

Work with the CL&P distribution emergency preparedness team to improve the process for acquiring and analyzing weather forecasts and assessing the potential risk on the CL&P transmission infrastructure. Ideally, CL&P should consider hiring a meteorologist (see EPP-14) whose efforts would include forecasting for transmission operations.

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T-2: Develop, approve, and implement a transmission Emergency Response Plan based upon the ICS model.

The transmission organization should develop and implement an emergency response plan that defines the response organization with key roles and responsibilities that matches ICS. The plan should also codify the key processes, such as the restoration prioritization matrix, damage assessment, and communications. The plan should identify any training requirements and should be drilled on a regular basis.

T-3: Develop, approve, and implement a transmission damage assessment process.

CL&P transmission should develop a single damage assessment process that is managed at the transmission emergency command level and is consistent across the Transmission Business Unit. Transmission damage assessors should perform assessments in the same manner, identify damage using common terminology, capture data in one single tool, and submit that data back to the appropriate personnel at the Emergency Command. Finally, the information itself should be used across NU transmission to prioritize and manage work and identify resource needs.

T-4: Establish master service agreements with necessary equipment and service providers.

The CL&P transmission team should create and negotiate master service agreements with key vendors for major restoration support. This would include any contractors that provide specialty equipment, such as helicopters, and should define response times and rates.

T-5: Review, adjust, and formalize the transmission line restoration prioritization framework.

CL&P should review the restoration priority categories defined during the Nor'easter restoration to ensure that they take into account at least: different types of events; input from ISO-NE; employee and public safety; reliability impact to the region and CL&P customers; voltage; and the impacts to substations and contingency plans. CL&P should then develop a restoration prioritization process that considers the quantity and expertise of available human resources and equipment at any given time during the emergency response activities. This approved prioritization model should be documented and integrated into the Transmission Emergency Response Plan.

T-6: Formalize use of the situation room to manage the restoration of transmission system.

CL&P should agree upon using the situation room adjacent to the CONVEX facility as the central location for the transmission incident command and managing future restoration efforts. The situation room should be equipped with the necessary infrastructure to support the work of the incident command and provide access to key systems required to ensure situational awareness during restoration efforts.

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T-7: Review and potentially revise the present practice of clearing some Transmission ROWs to their historical widths versus the full clearing width allowed by easement or ownership.

CL&P appears to have an opportunity to negotiate increased clearing widths on select corridors to reduce the potential of future tree-caused outages in future weather events. This is especially true along 115kV ROWs. CL&P should conduct a reliability-based and vegetation management review to select the corridors that could benefit from increased ROW width. A strategy should then be developed and pursued in front of the Connecticut Siting Council to support additional clearing for system reliability and to secure the necessary funding from the appropriate regulator. A good example of a recent successful VM program improvement initiative is the revised "Cedar Policy" executed in 2010. In addition, the transmission group should periodically review vegetation management program policies and practices for clearance and side trimming including cycle duration.

T-8: Perform a Root Cause Investigation (RCI) on each transmission outage during the Nor'easter on the 345kV and 115kV system.

Although CL&P has performed root cause analyses of the transmission outages, CL&P should carefully review the results to determine whether there are any systemic opportunities for improvement. In addition to a thorough tree contact analysis, and as part of the RCI, CL&P should compare "as builts" and "as founds" to current engineering design criteria. While the lines affected were probably constructed according to the construction criteria at the time they were put in service, some of the requirements have changed. Based on the findings from the RCI, if the RCI reveals that any critical lines do not satisfy current loading standards, then CL&P should determine the cost of bringing some of those critical lines up to current loading standard.

T-9: Review and improve the switching and safety clearance practices performed during significant events to safely and efficiently support crews performing restoration of Transmission and Distribution equipment.

Continue to review and improve switching and safety clearance procedures on the transmission and distribution system that may create delays in the restoration of the transmission system. Review the number of resources that are trained and qualified relative to future needs anticipated. Maximize the capabilities of the different classifications to switch within existing work rules and tagging authority and eliminate the risk of bottlenecks during major restoration efforts.

5.11.3. Prioritized Matrix

Table 14: Transmission Recommendations Matrix

Number	Recommendation	Value	Ease of Implementation	Cost to Implement	Implementation Timeframe
T-1	Identify and agree upon a source or sources of weather forecasts	Moderate	Easy	Low	Immediate
T-2	Develop Emergency Response Plan based upon ICS model	High	Moderate	Moderate	Immediate
T-3	Develop a transmission damage assessment process	Moderate	Moderate	Low	Immediate
T-4	Establish master service agreements	Low	Easy	Low	Immediate
T-5	Develop, approve and implement a transmission prioritization tool	Moderate	Easy	Low	Immediate
T-6	Review and agree upon the future physical space to be utilized by the Transmission Incident Command	Moderate	Easy	Low	Immediate
T-7	Revisit, review and potentially revise the present practice of clearing ROWs	High	Hard	High	Mid term
T-8	Perform RCI on each transmission outage	Low	Moderate	Moderate	Immediate
T-9	Review improve switching and obtaining safety clearance practices	Moderate	Hard	Moderate	Immediate

Appendix

Davies Consulting Background

Davies Consulting was founded in 1991 as an international strategic management consulting firm. Focusing primarily on the energy industry, Davies Consulting provides its clients with a comprehensive range of services, experience, ideas, decision support tools, and strategies to ensure that they successfully meet challenges to their businesses and prepare for the future. Our current and former clients include top energy companies in North America and leading healthcare, pharmaceutical, international funding, chemical, technology, and manufacturing companies in the U.S., Canada, and Europe.

The Davies Consulting energy practice is committed to providing quality methods, tools, and experience to advance the effectiveness of our clients' energy businesses. Our clients consistently indicate that our consulting teams have the unique ability to build internal capability through collaboration at all organizational levels to provide customized, strategic, and analytic solutions. Relying on a mix of industry and management consulting expertise and analytic solutions, Davies Consulting provides energy companies with successful management consulting services in the following areas:

Organizational and Operational Effectiveness

Davies Consulting provides in-depth Organizational and Operational Effectiveness consulting services in support of energy companies trying to thrive in today's complex environment. Davies Consulting's energy team provides clients with a unique combination of hands-on industry expertise and proven management consulting expertise and approaches. Organizational and Operational Effectiveness services ensure that operational objectives are linked with customer expectations, regulatory requirements, financial objectives, and other stakeholder goals.

Business Process Improvement

Davies Consulting works with companies to enhance business efficiency, increase profit margins, and build stakeholder relationships through enhancement, development, and implementation of business process improvement plans. These plans typically require development or modification of budget and resource allocation processes and tools and organizational structures, roles, and responsibilities. Davies Consulting consultants use their extensive change management and strategic consulting experience to ensure that the recommended business processes are not only implemented, but also adopted by client stakeholders, resulting in sustainable business results.

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Regulatory Strategy

With the resurgence of cost recovery proceedings, rate cases, and performance audits, regulators have directed their attention to energy delivery service performance. Some states have already implemented performance-based rates (PBRs), while others are imposing severe penalties on those utilities within their jurisdictions that do not meet specific customer satisfaction or reliability targets. At the same time, the large numbers of severe storms that have affected large swaths of the country have led to increased regulatory scrutiny. Davies Consulting works with energy companies operating across multiple jurisdictions to help them develop regulatory strategies that best fit their business objectives and minimize their risk.

Strategy Planning

Davies Consulting's strategic planning consulting services support clients seeking to develop a solid business foundation through strategic and business plan development. Our consulting team provides clients with a unique combination of hands-on industry expertise and management consulting experience. We work with our clients to ensure that their decisions on business, product prioritization, merger and acquisition strategy and implementation, and IP valuation are linked with regulatory requirements, financial objectives, and stakeholder objectives.

Reliability Performance

Success in today's environment depends on an energy company's ability to proactively address regulator and customer expectations, and provide reliable service at the lowest possible cost. Davies Consulting energy consultants work with clients to ensure the availability of accurate and easily accessible reliability data, establish clear accountability for all process participants, and link financial system information to reliability performance in order to enhance the decision-making process. Davies Consulting's Integrated Reliability Strategy services include: strategy development, vegetation management, and implementation of several decision support tools.

Asset Management Strategy

Energy companies are under increasing pressure to better optimize the balance of risk, cost, and performance of their complex and distributed asset bases. Energy executives are challenged every day to make decisions to ensure better financial return, more efficient operations, better service reliability, and improved customer service. Davies Consulting's Financial and Human Resource Allocation services enhance the effectiveness of management decision making. Our resource allocation services support decision making at multiple organizational levels, across and within different business units.

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Market Development and Entry Strategy

Companies are constantly weighing the risks and benefits of expanding into new product and geographic markets. To support these decisions, Davies Consulting works with clients to conduct extensive market research studies and develop market entry and forecasting models. Our team then uses its extensive industry expertise to develop and successfully implement strategic marketing and product positioning strategies for our clients.

Emergency Planning and Response

Utilities have come under increasing scrutiny from regulatory agencies, local, state, and federal governments, customers, and the media as a result of concerns over extended outages due to natural disasters, events such as the August 2003 blackout, and man-made threats. Davies Consulting works with energy companies to assess their preparedness for major events, develop integrated restoration plans and strategies, and prepare for regulatory audits. To enhance our emergency response services, Davies Consulting consultants have extensive operational emergency experience and are certified by the Federal Emergency Management Agency on the Incident Command System, National Incident Management System, and National Response Plan. Over the past ten years, Davies Consulting has worked with more than twenty utilities throughout North America to improve their ability to restore customers after major events. The Davies Consulting team includes experts in utility operations, emergency management, regulatory, communications, and engineering. All of the consultants that participated in the CL&P work have conducted multiple reviews of utility responses and several have managed different facets of major event restoration and have led improvement efforts subsequent to major events while employed by the utilities.

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