QUANTA TECHNOLOGY

Review of Industry Resilience and Reliability Practices

September 2, 2021

EVERSOURCE

Presentation Overview

Background

Eversource engaged Quanta Technology to perform an independent review of Eversource's Reliability and System Resiliency programs and to provide a summary of industry best practices related to reliability and resilience.

Outline

- The Quanta Technology Team
- Distribution Reliability Industry Practices
  - Industry Leading Practices
- Distribution Resilience Industry Practices
  - Industry Leading Practices
  - Highlights of Eversource System Resiliency Programs
  - Case Studies
- Q&A

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The Quanta Technology Team

Julio Romero Agüero, PhD, MBA and Stephen Teran, MBA will present on behalf of the Quanta Technology team.

Biographies of the full team are available in the appendix of this presentation.

Julio Romero Agüero, PhD, MBA

Julio Romero Agüero, PhD, MBA, *Executive Advisor, Vice President, Strategy and Business Innovation,* has been with Quanta Technology since 2007. Julio provides leadership to Quanta Technology in the areas of technology and business strategy, grid modernization, distribution systems analysis, planning and engineering, distributed energy resources, and emerging technologies. He has assisted electric utilities and regulatory boards in the U.S., Canada, Latin America, the Caribbean, and Asia.



Vice President
Strategy &
Business Innovation

Stephen R. Teran, MBA

Stephen R. Teran, MBA, *Principal Advisor, Asset Management*, joined Quanta Technology in 2020. Stephen has over 15 years of utility experience spanning all aspects of distribution and system planning. He has a demonstrated track record of driving organizations toward strategic objectives that require detailed, technical solutions. Stephen has led efforts to optimize capital portfolios for risk reduction, redesign engineering-related business processes, and implement technology solutions required to meet critical business and regulatory requirements.



Principal Advisor
Asset Management

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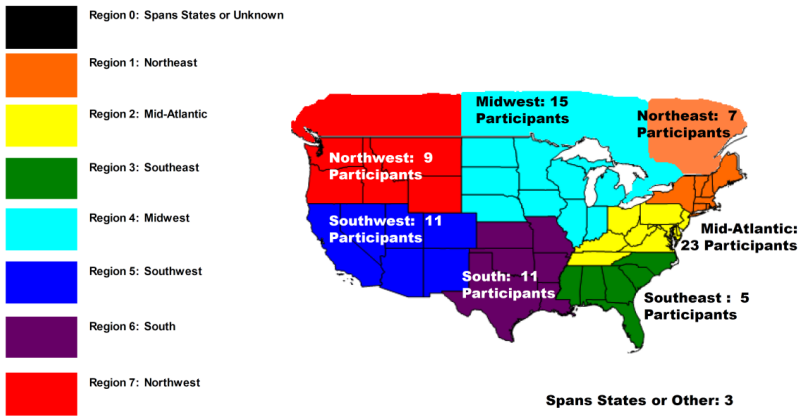
Distribution Reliability Industry Practices

Distribution Reliability Industry Overview

- Distribution reliability is an established area of power distribution system engineering
- IEEE Std. 1366-2012 – Guide for Electric Power Distribution Reliability Indices defines reliability metrics that are widely accepted and used by the utility industry in the U.S. and around the world to assess distribution system reliability performance
- Most common metrics defined by the standard are SAIDI, SAIFI, and CAIDI. Other increasingly popular metrics include MAIFI and $CEMI_n$
- Important variables that impact distribution reliability indices calculation are: 1) major event identification methodology, and 2) threshold duration for sustained and momentary interruptions
  - IEEE St. 1366 uses 1) the "2.5 Beta Method" and "Major Event Days (MED)" to identify service interruptions that are excluded from reliability calculations, and 2) defines sustained interruptions as those longer than 5 min., and momentary interruptions as those shorter than this threshold
- The Distribution Reliability Working Group (DRWG) of the IEEE Power and Energy Society (PES) conducts an annual distribution reliability benchmark that has become a key industry reference in this area https://cmte.ieee.org/pes-drwg/benchmarking/
  - Similar benchmarks are conducted by the APPA (for public power utilities) and NRECA (for rural cooperatives)
- The 2021 IEEE PES benchmark includes responses from 87 utilities
  - Utilities are classified by size as small (less than 100,000 customers, medium (between 100,000 and 1 million customers) and large (more than 1 million customers)



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Source: IEEE Distribution Reliability Working Group (DRWG)

Distribution Reliability Indices – 2021 IEEE PES Benchmark Results by Utility Size

	SAIDI ALL	SAIDI IEEE	SAIDI WOF	SAIDI	SAIFI ALL	SAIFI IEEE	SAIFI WOF	SAIFI WOP	CAIDI ALL	CAIDI
MIN	30	27	24	23	0.43	0.40	0.29	0.28	28	24
Q1	151	91	87	83	1.03	0.85	0.75	0.68	136	98
MEDIAN	321	127	112	104	1.42	1.06	0.90	0.85	206	118
Q3	525	168	152	144	1.86	1.33	1.10	1.02	333	135
MAX	8701	440	417	384	6.31	5.60	5.45	5.53	2711	230

Quartile Small	4	SAIDI ALL	SAIDI IEEE	SAIDI WOF	SAIDI WOP	SAIFI ALL	SAIFI IEEE	SAIFI WOF	SAIFI WOP	CAIDI ALL	CAIDI IEEE
0	MIN	150	107	108	86	1.06	1.06	0.82	0.63	107	77
1	Q1	155	144	120	98	1.32	1.14	0.89	0.66	117	88
2	MEDIAN	296	187	136	104	1.68	1.42	0.96	0.81	134	119
3	Q3	438	224	151	114	2.39	1.96	1.04	0.97	166	146
4	MAX	444	244	158	139	3.68	2.82	1.14	1.00	222	148
Medium	49	SAIDI ALL	SAIDI IEEE	SAIDI WOF	WOP	SAIFI ALL	SAIFI IEEE	SAIFI WOF	SAIFI WOP	CAIDI ALL	IEEE
0	MIN	30	27	24	23	0.43	0.40	0.29	0.28	28	24
1	Q1	152	99	89	86	0.99	0.87	0.72	0.68	141	100
2	MEDIAN	312	128	117	108	1.36	0.98	0.89	0.83	205	123
3	Q3	567	164	149	137	1.94	1.37	1.23	1.14	385	136
4	MAX	8701	407	391	363	6.31	5.60	5.45	5.53	2711	198
Quartile Large	31	SAIDI ALL	SAIDI IEEE	SAIDI WOF	WOP	SAIFI ALL	SAIFI IEEE	SAIFI WOF	SAIFI WOP	CAIDI ALL	IEEE
0	MIN	84	40	40	32	0.83	0.55	0.55	0.47	98	73
1	Q1	147	84	82	80	1.04	0.82	0.80	0.69	145	98
2	MEDIAN	339	103	95	91	1.45	1.06	0.91	0.86	215	108
3	Q3	484	169	154	146	1.73	1.21	1.07	1.00	301	131
4	MAX	3117	440	417	384	3.29	2.85	2.20	2.03	1550	230

- Utility reliability performance is classified by quartiles
- Top performing utilities participating in benchmark are grouped in 1st quartile
  - Top 25% utilities from sample
- 1st quartile results for sample of 84 utilities participating in 2021 benchmark are:
  - SAIDI: 91 min/cust-yr
  - SAIFI: 0.85 int/cust-yr
  - CAIDI: 98 min/int
- 1st quartile results for sample of 31 large utilities participating in 2021 benchmark are:
  - SAIDI: 84 min/cust-yr
  - SAIFI: 0.82 int/cust-yr
  - CAIDI: 98 min/int

Source: IEEE Distribution Reliability Working Group (DRWG)

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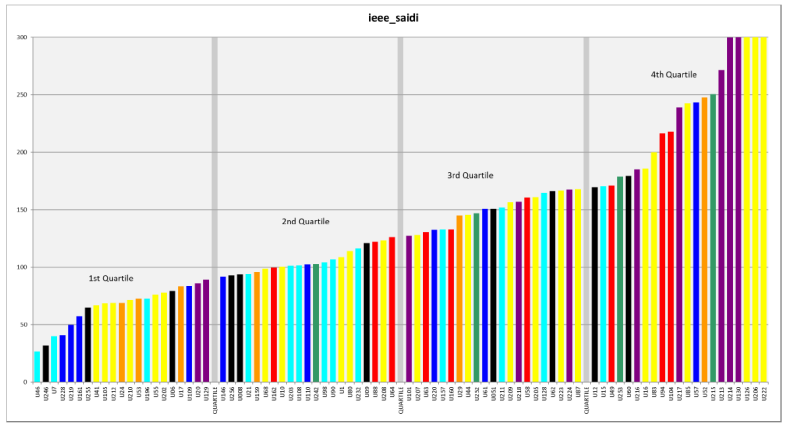
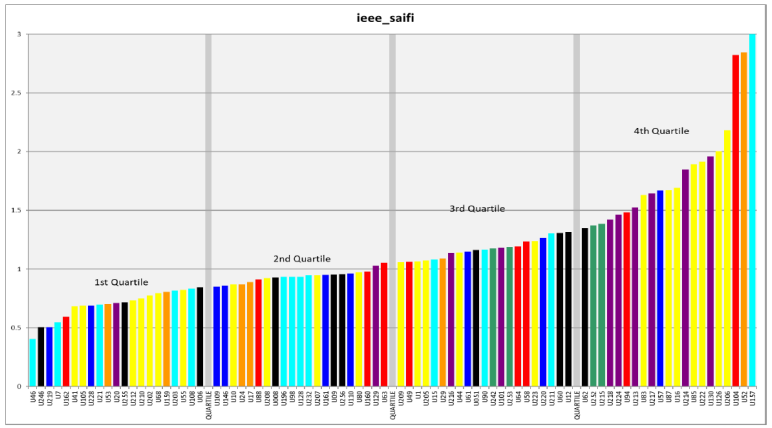
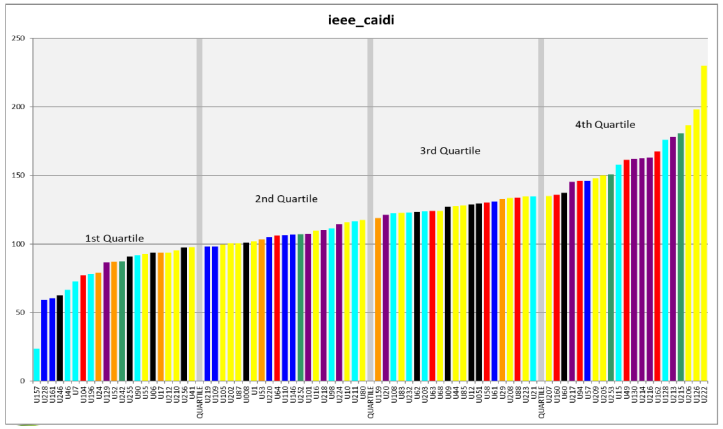
Distribution Reliability Indices – 2021 IEEE PES Benchmark Results



1st Quartile
Top Performance





Source: IEEE Distribution Reliability Working Group (DRWG)

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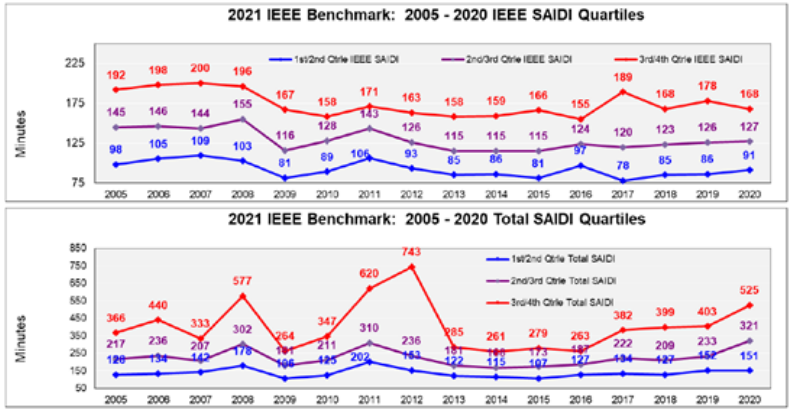
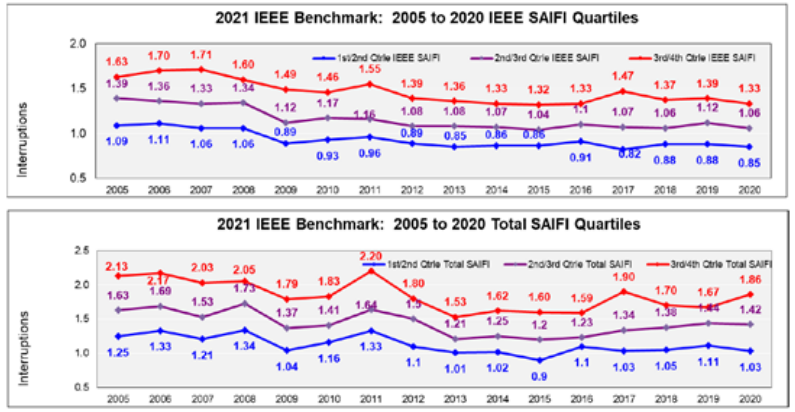
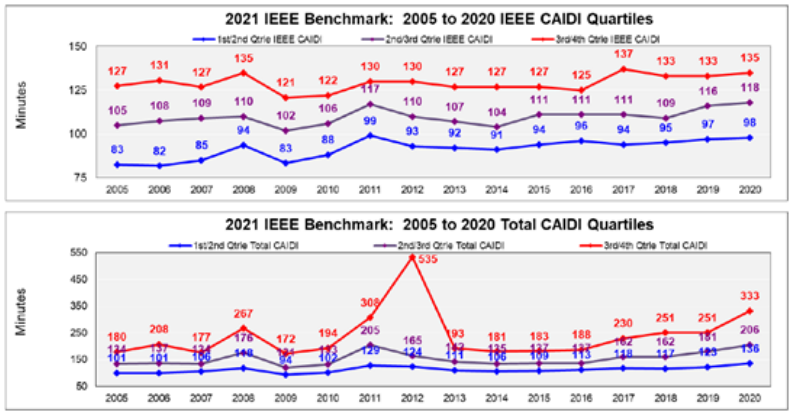
Distribution Reliability Industry Performance – IEEE PES WGDR Annual Benchmark





- Annual benchmark conducted since 2005 by IEEE PES Working Group on Distribution Reliability
- Distribution reliability indices (SAIDI, SAIFI and CAIDI) calculated as per IEEE Std. 1366-2012
- Top performing utilities are grouped in 1st quartile (top 25% utilities from sample)



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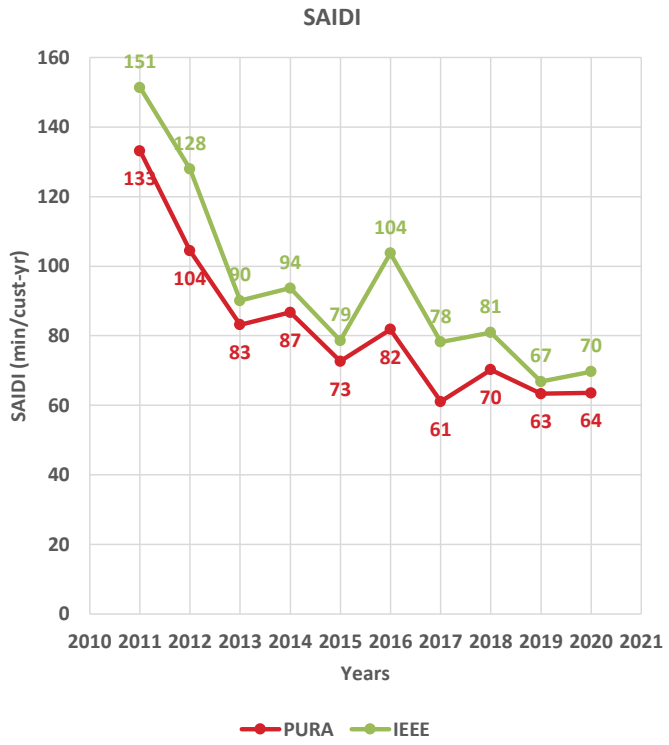
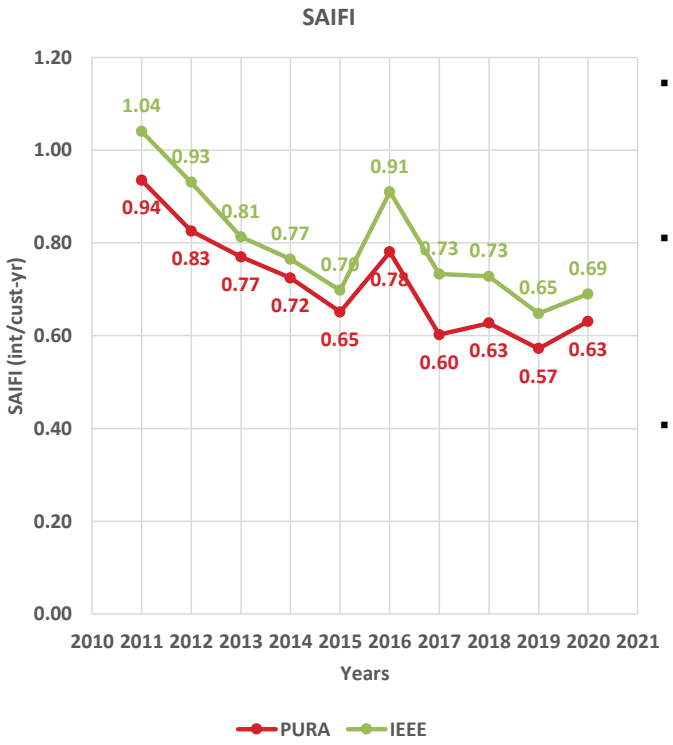
Eversource Historical Reliability Performance – PURA & IEEE Methods



Source: Eversource



Source: Eversource

- Eversource's distribution reliability performance is evaluated using PURA's methodology for major event exclusion
- Historical analysis results using the PURA methodology show that Eversource's performance has improved significantly over the last 10 years
- This trend is also observed when reliability indices are calculated using the IEEE Std. 1366-2012 methodology
  - The IEEE Std. 1366-2012 defines an approach for Major Event Day (MED) identification and exclusion, commonly known as "2.5 Beta Methodology"

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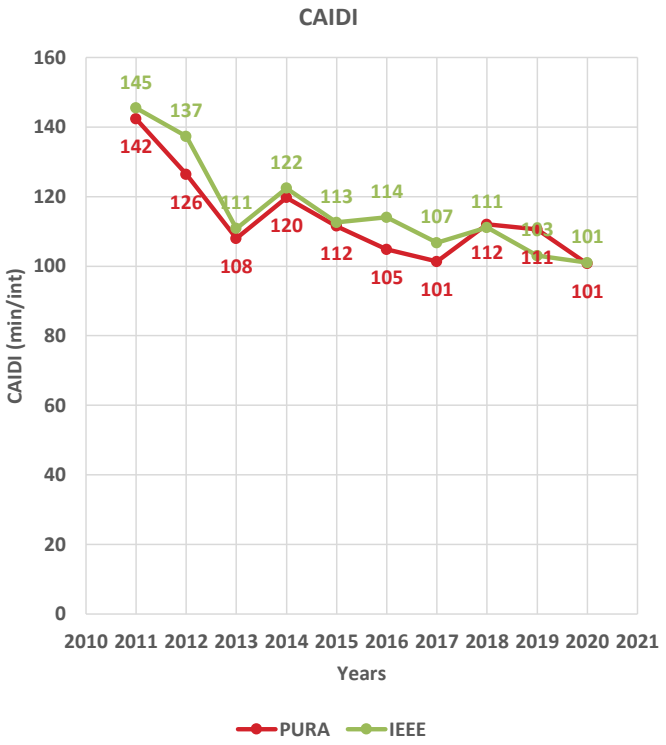
Eversource Historical Reliability Performance – PURA & IEEE Methods



Source: Eversource

- Eversource's 2020 (excluding MED) distribution reliability performance measured by SAIDI and SAIFI (calculated as per IEEE Std. 1366-2012) is in the 1st quartile (top performance) when compared versus the results of the 2021 IEEE PES DRWG Benchmark, and close to the border between 1st and 2nd quartiles for CAIDI
- Improvement over the last 10 years have been significant, Eversource's performance in 2011 (as per the IEEE PES DRWG Benchmark) was:
  - 3rd quartile for SAIDI
  - 2nd quartile for SAIFI
  - 4th quartile (bottom performance) for CAIDI

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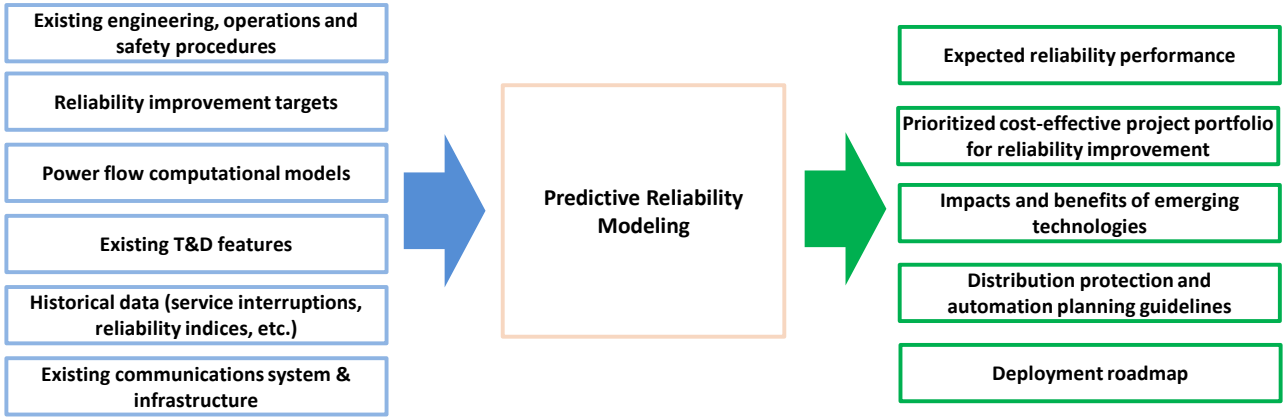
Reliability Modeling and Analysis – Best Practices



- An industry best practice for distribution reliability modeling and analysis is the utilization of predictive reliability models, which are built using the same computational models utilized for power flow analysis and specialized modules of commonly used distribution analysis software tools (e.g., Synergi, CYME)
- These models allow calculating the spatial distribution of reliability (SAIDI, SAIFI, CAIDI, MAIFI, etc.) at feeder section and customer level, this is a more granular approach than using an average reliability index for the entire feeder. This allows identifying and targeting reliability improvement investments to specific poor performing areas within each feeder (poor reliability pockets)
- Predictive reliability models allow calculating granular reliability indices before (existing performance) and after (expected performance) implementation of a portfolio of improvement projects
- Results from simulations can be used for calculating benefit/cost metrics (e.g., CMI or CI reduction vs. project cost) and project portfolio prioritization, this allows developing a cost-effective distribution reliability improvement roadmap by feeder, substation, area and service territory
- This type of approach has been used by large IOUs (e.g., Dominion Energy, Puget Sound Energy, Commonwealth Edison, Pacific Gas and Electric, Southern California Edison, San Diego Gas and Electric, We Energies, etc.), to estimate expected benefits and prioritize distribution reliability improvement projects

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Reliability Modeling and Analysis – Approach

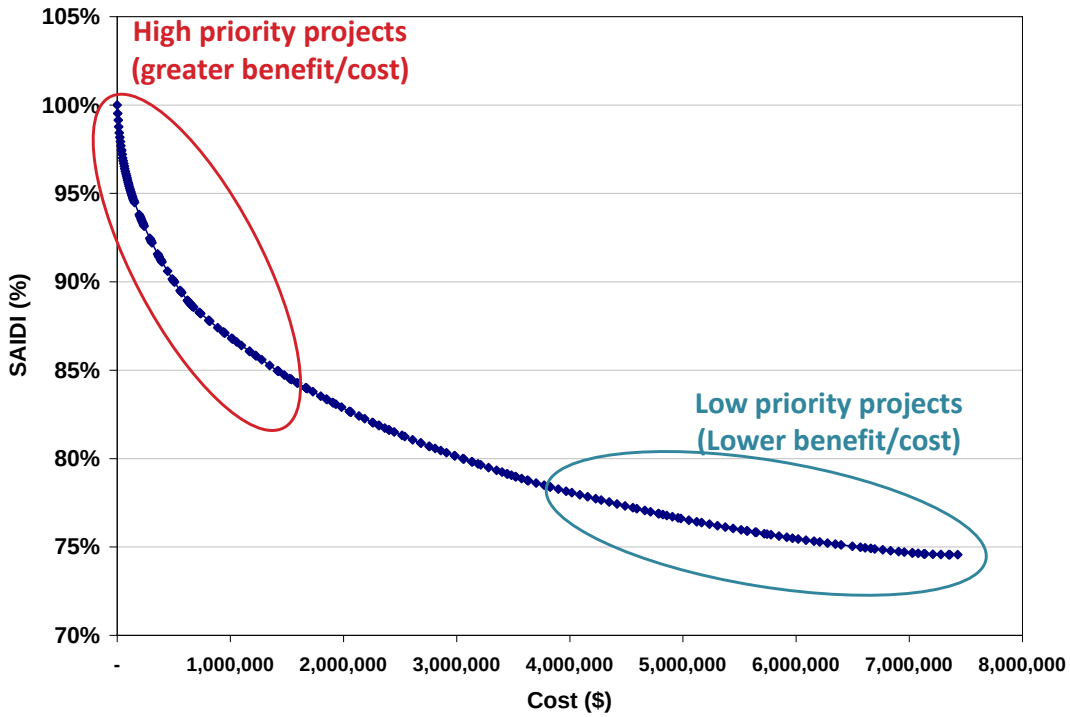
Calculate reliability improvement per candidate project using predictive reliability model

↓

Benefit-cost analysis per candidate project and project selection using "hurdle" benefit-cost ratio (e.g., CMI reduction/$ invested)

↓

Estimate the expected reliability of the study area due to the progressive implementation of the optimal mix of cost-effective projects (prioritization)



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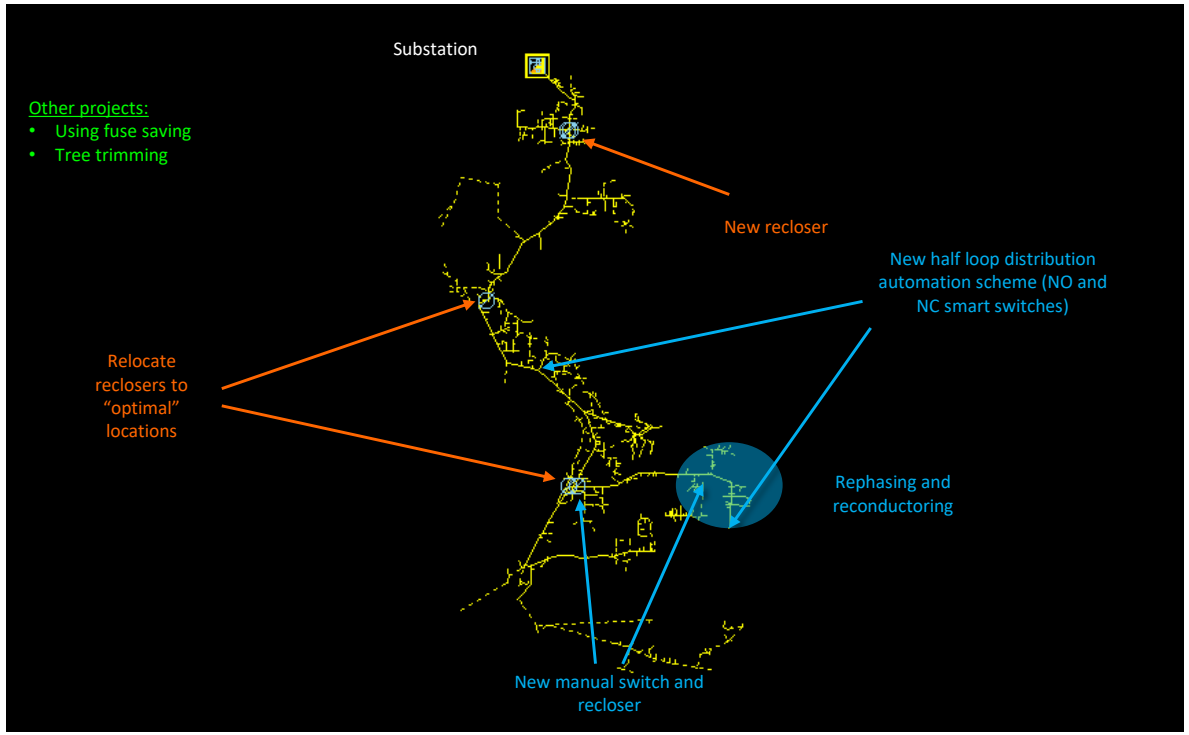
Example – Feeder-Level Predictive Reliability Modeling and Analysis



- Common objectives of predictive reliability models include
  - Estimate existing and expected reliability of distribution system
  - Improve reliability of area or service territory in a cost-effective way
  - Identify and prioritize portfolio of solutions with highest benefit/cost ratio
  - Outline deployment roadmap
- Predictive models allow to:
  - Improve and maintain reliability in a systematic, granular and cost-effective way
  - Prioritize projects and build cost-effective portfolios
  - Develop protection and distribution automation planning guidelines that incorporate reliability improvement criteria
  - Evaluate effectiveness of diverse improvement projects, from hardening and vegetation management to overcurrent protection philosophies (fuse saving, fuse clearing, etc.), and advanced reclosing practices (single-phase tripping)
  - Evaluate the potential impacts and benefits of emerging technologies and solutions, such as DER, NWAs, microgrids, etc.

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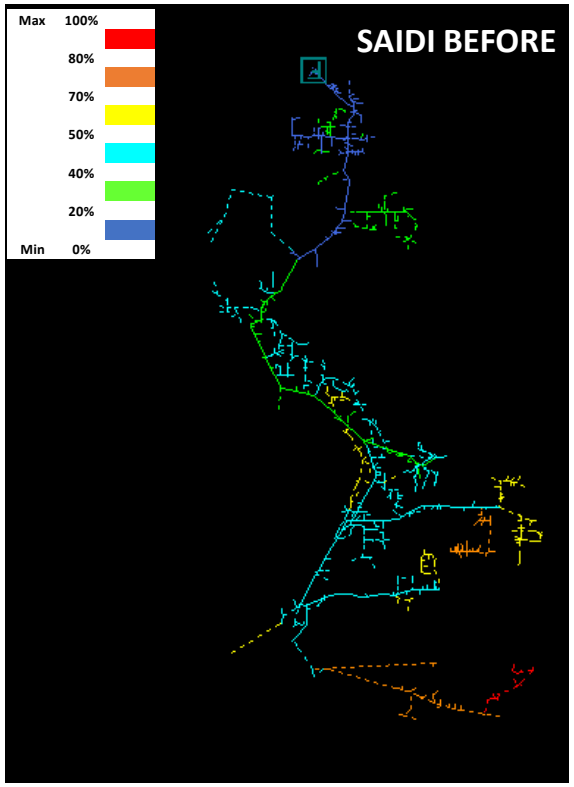
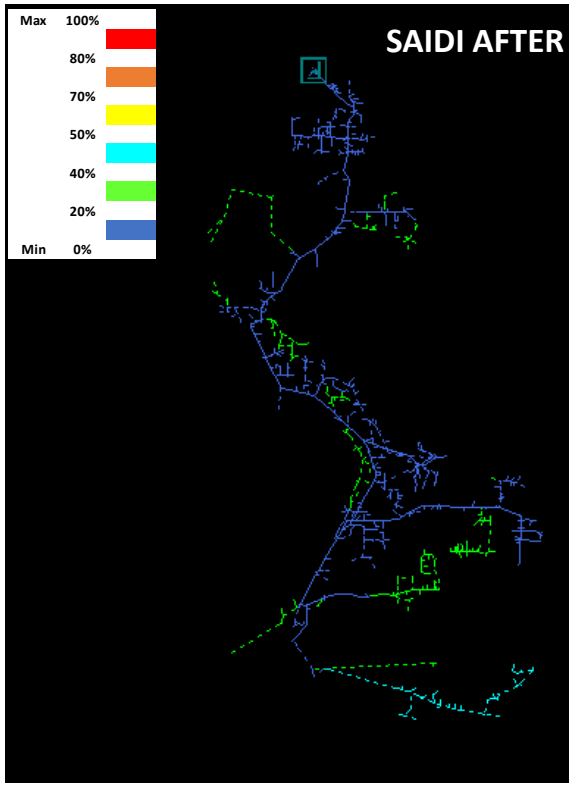
Example – Spatial Distribution of Reliability at Feeder Level





- Eversource's distribution reliability analysis, including improvement project prioritization, can be enhanced through the utilization of this type of methodology, which would provide a quantitative approach for:
  - Estimating expected benefits of reliability improvement benefits (e.g., expected SAIDI, SAIFI, CAIDI, etc. performance)
  - Targeting investments to poor-performing areas within each feeder
  - Prioritizing reliability improvement projects
- Results could be compared (validated) versus actual values to progressively improve modeling capabilities

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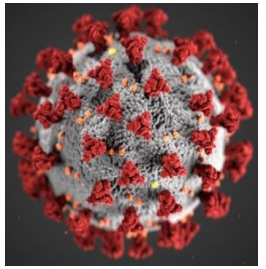
Distribution Resilience Industry Practices

Distribution Resilience Industry Overview

Compared to distribution reliability, resilience is an actively developing space. Since risks vary across regions and jurisdictions, effective resilience planning involves stakeholder agreement on definitions, objectives, metrics, and risk tolerances.

- Resilience planning activities are best targeted to defined objectives with agreed upon metrics
- Resilience planning is risk management and lends itself to probabilistic approaches
- There can be a large overlap in benefits for reliability and resilience
- Depending on the risk, mitigations designed to improve resilience can hurt reliability, and vice versa















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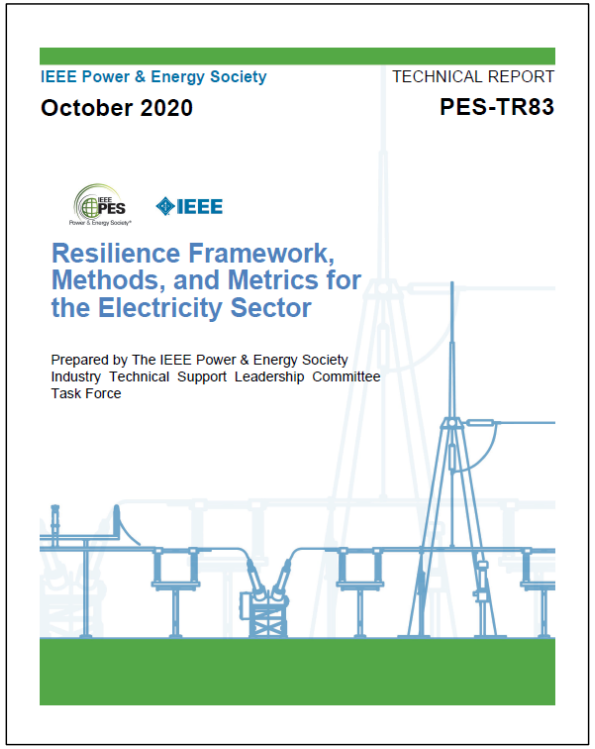
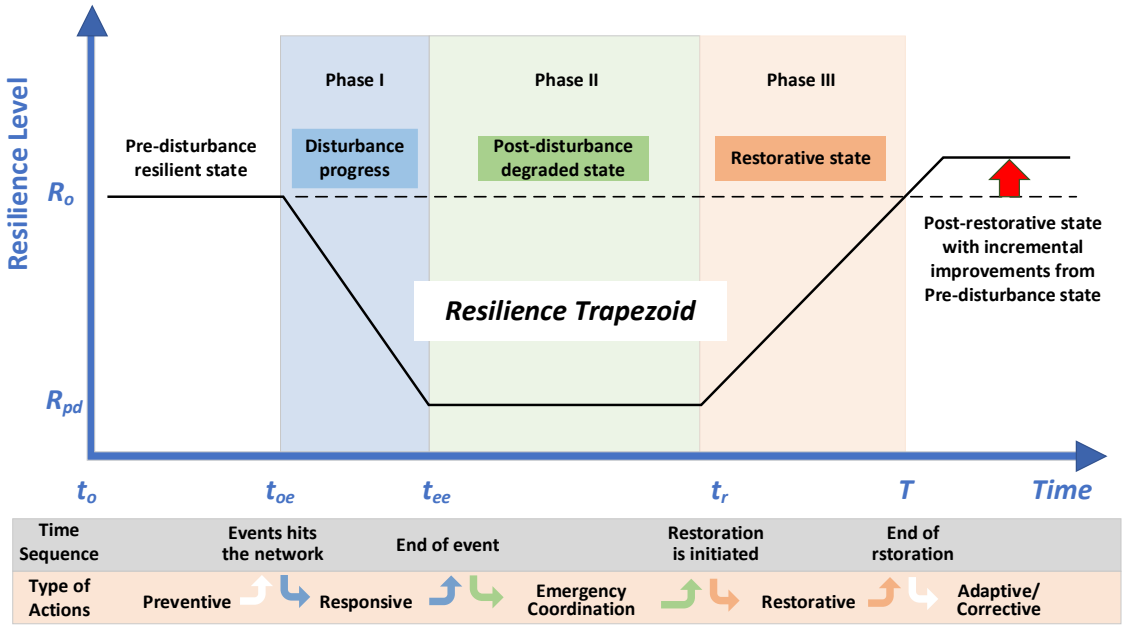
Resilience – IEEE Definition

- IEEE PES (PES-TR65 and PES-TR83): "The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."





Source: The Definition and Quantification of Resilience, Technical Report PES-TR65
http://grouper.ieee.org/groups/transformers/subcommittees/distr/C57.167/F18-Definition&QuantificationOfResilience.pdf

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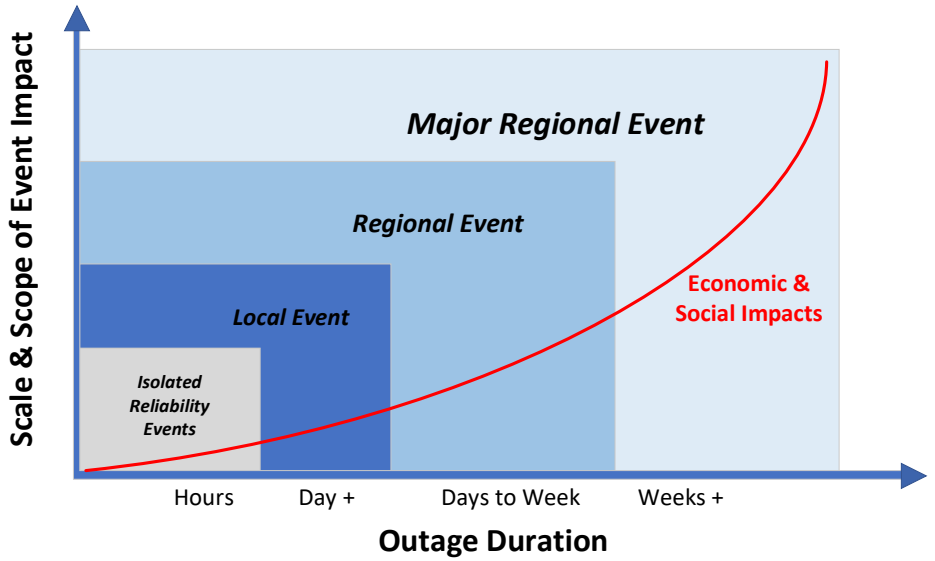
Interplay Between Reliability and Resilience

- *Reliability* is commonly acknowledged as a system performance measure
- *Resilience* is a system characteristic/capability encompassing all hazards and events, including high-impact low-probability events that are excluded from reliability calculations
  - While reliability metrics (SAIDI, SAIFI, etc.) can still be used to gauge larger scale impacts, they do not provide the complete picture of process of recovery
- *Reliability and Resilience* often improve each other (e.g., system hardening), however, there could be opposing tradeoffs
  - Traditional reliability practice of reclosing power lines could have negative resilience impact with ignitions from foreign debris during wildfire season



Source: IEEE Resilience TR83 PES Webinar

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Resilience Metrics

IEEE PES Distribution Resilience Working Group

- Storm resilience metric: focuses on the speed of recovery during the first 12 hours from the time customers lose power during a storm event

$$Storm\ event\ X = \frac{Sum\ of\ customers\ without\ power\ for\ more\ than\ 12\ hr}{Sustained\ Customer\ Interruptions + Avoided\ Customer\ Interruptions}$$

Y is the threshold: If X < Y, the storm met expectations. If X ≥ Y, the storm did not

Challenges: (1) Critical loads (2) Long duration disruptions (e.g., hurricanes) (3) Social impacts

- Non-storm, gray sky day (GSD) resilience metric: focuses on robustness and the ability to withstand most weather events
  - Captures total number of GSD in a year with no more than a threshold value of customer interruptions
  - Threshold value is defined as percentage of customer interruptions over customer base

DOE performance-based metrics

- Multi-criteria decision analysis (MCDA):
  - Survey based data collection and analysis with weighted factors
  - Calculate a resilience index (RI) that accounts for ~1,200 attributes grouped in 350 categories

- Performance-based metrics:
  - Quantify the system consequence/performance during events
  - Suitable for benefit-cost and planning analyses associated with proposed improvements and investments

Impact	Consequence Category	Resilience Metrics
Direct	Electric Service	Cumulative customer-hours of outages Cumulative customer energy demand not served Average number (or percentage) of customers experiencing an outage during a specified time period
	Critical Electrical Service	Cumulative critical customer-hours of outages Critical customer energy demand not served Average number (or percentage) of critical loads that experience an outage
	Restoration	Time to recovery Cost of recovery
	Monetary	Loss of utility revenue Cost of grid damages (e.g., repair or replace lines, transformers) Cost of recovery Avoided outage cost
Indirect	Community Function	Critical services without power (e.g., hospitals, fire stations, police stations)
	Monetary	Loss of assets and perishables Business interruption costs Impact on Gross Municipal Product (GMP) or Gross Regional Product (GRP)
	Other critical assets	Key production facilities without power Key military facilities without power

Source: IEEE Resilience TR83 PES Webinar

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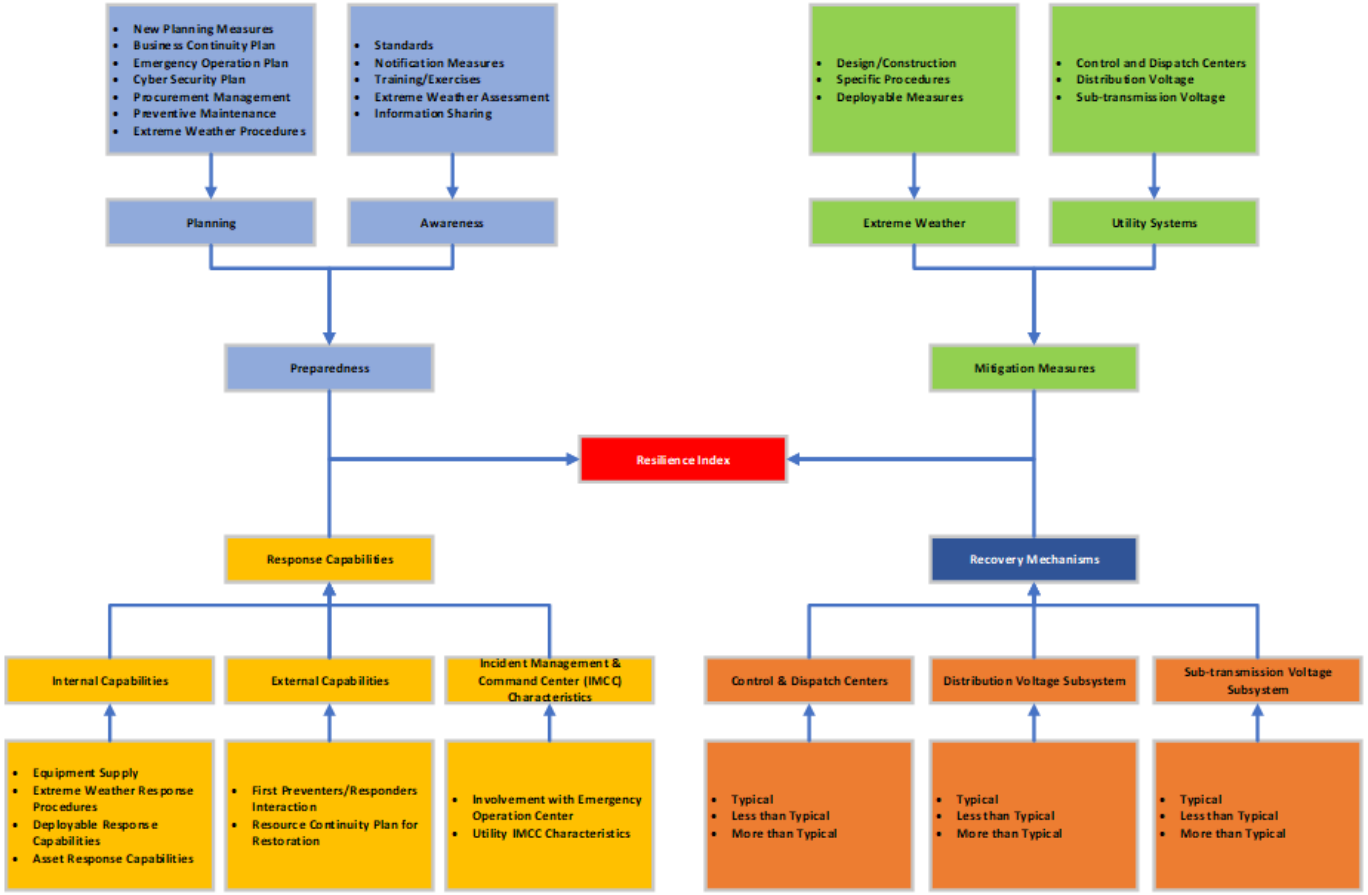
Multi-Criteria Decision Analysis (MCDA) Metrics



Source: Grid Modernization: Metrics Analysis (GMLC1.1) – Resilience Reference Document Volume 2, Mar 2019

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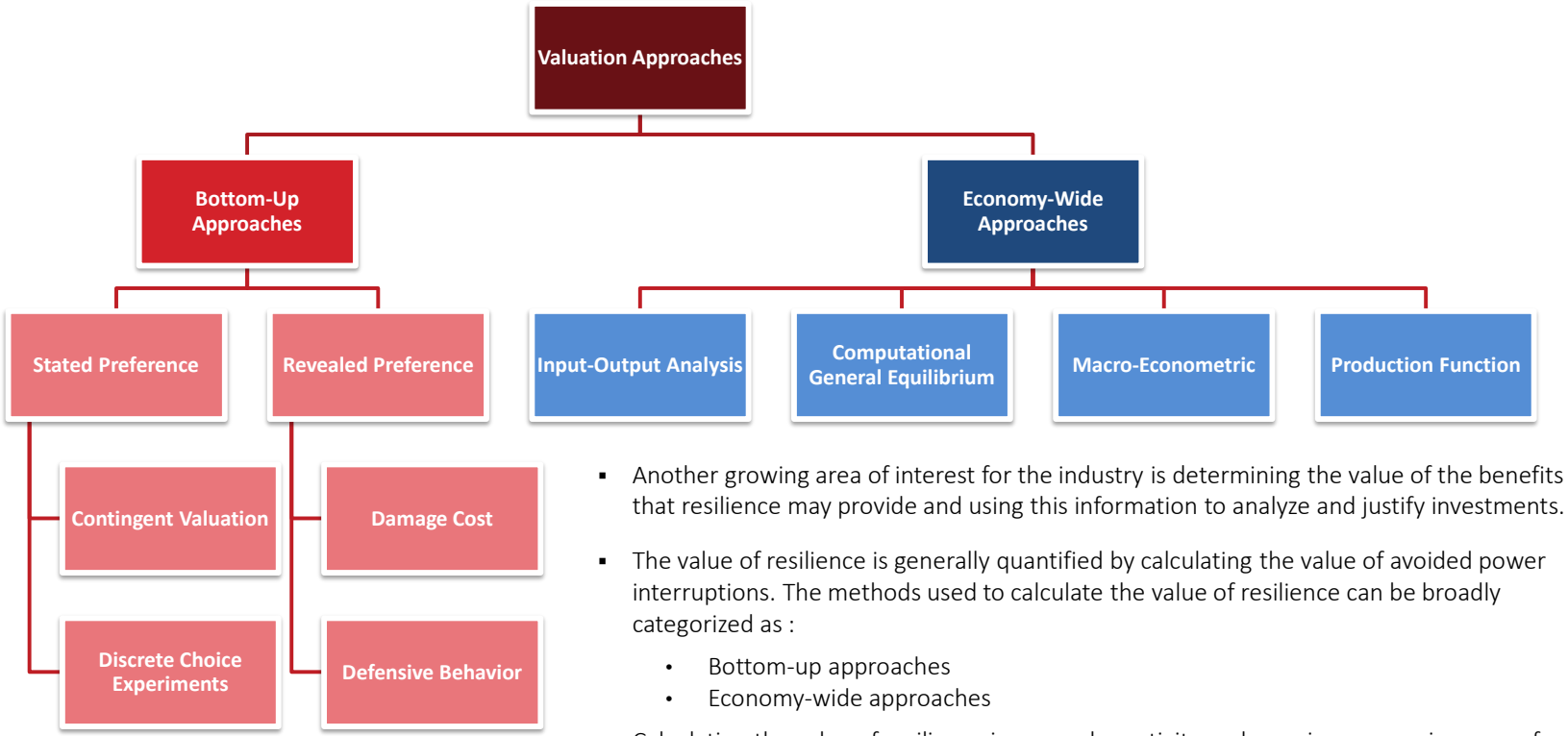
Value of Resiliency



- Another growing area of interest for the industry is determining the value of the benefits that resilience may provide and using this information to analyze and justify investments.
- The value of resilience is generally quantified by calculating the value of avoided power interruptions. The methods used to calculate the value of resilience can be broadly categorized as :
  - Bottom-up approaches
  - Economy-wide approaches
- Calculating the value of resilience is a complex activity and remains an ongoing area of research for the industry.

Source: National Association of Regulatory Utility Commissioners (NARUC), The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices, Apr. 2019 https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198

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Industry Standard Mitigations

Distribution Resilience mitigations should be considered holistically to meet resilience planning objectives with the minimal amount of investment.

Category	Planning Considerations	Example Mitigations
Infrastructure Hardening	• Long-term solutions which require significant investment • Prioritization of high-risk, high-impact areas • Alignment with Asset Management Strategy	• Enhanced design standards • Accelerated distribution overhead rebuild programs • Targeted undergrounding • Community/Critical Facility microgrids
Event Preparedness	• Availability of resources for restoration • Staging of resources and materials	• Event preparedness plans and procedures • Staging of Incident Command teams • Mutual Assistance preparations
Vegetation Management	• Enhanced practices in high-risk, high-impact areas • Work management and tree population tracking	• Expanded clearances • Hazard and high-risk tree removal
Telemetry and Automation	• Capacity of telecommunications systems • Availability of telecommunication system during events	• Expansion of fiber and wireless infrastructure • Leasing of commercial spectra • Leveraging AMI infrastructure
Event Modeling	• Availability of specialized resources to perform work • Availability of data to support machine learning approaches	• Engagement with National Labs and Universities • Improved mitigation benefits modeling to improve planning • Improved event modeling to support operations

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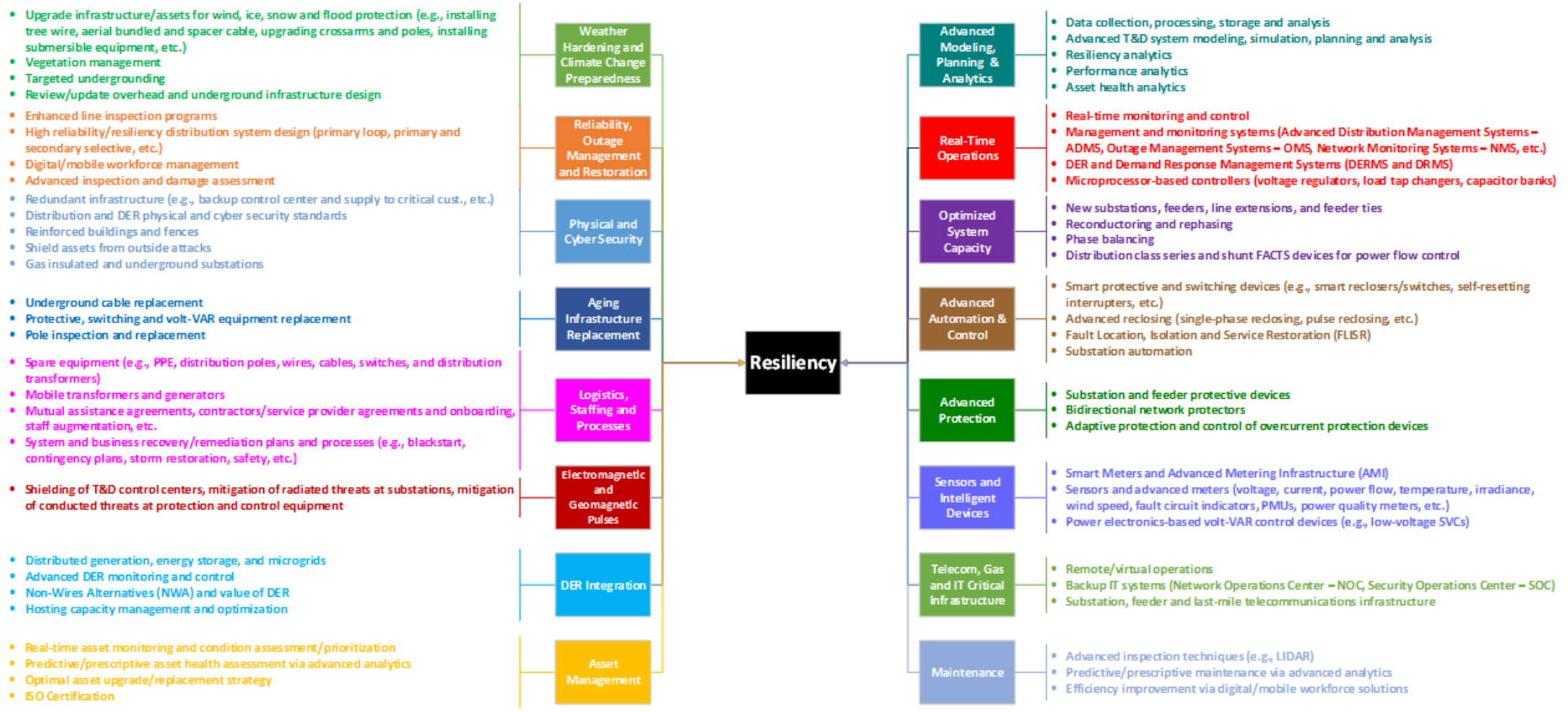
Resilience Improvement Solutions



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Eversource Structural & Electrical Resiliency Standards Enhancements

Eversource enhanced its structural and electrical resiliency design standards to harden the distribution system against, and improve system withstand during, extreme weather events. These enhanced standards align with industry best practices. Eversource applies these storm resilient standards to the worst performing circuit backbones and large laterals, as well as new construction.

Overhead Distribution System Resiliency Design Improvements

Design Standard	Previous Design	Enhanced Design
Wood Pole Class	3 to 5	2 to H2
Poles	Wood	Steel/Wood*
Cross Arms	Wood	Composite/wood
Wire	#4 to 556 kcmil tree wire (covered wire)	1/0 to 556 kcmil tree wire (covered wire)
Insulator/ Electric Insulation	15 kV, 25 kV porcelain, 36” guy insulator	35kV polymer vice-top, 78” guy insulator
Wind Loading	40 mph	95+ mph
Ice	½ inch	¾ inch
Connectors	Hot Line Clamp	Fired-On Wedge
Guying	Transverse	Transverse & Longitudinal
Protective Devices	As Needed	500 Customer Zones
Disconnect Switches	Operational needs	Aid Restoration of infrastructure & critical customers
Grounding	1 ground rod	copper pole butt, 2 ground rods

*under assessment

Eversource’s enhanced standards align with industry best practices for storm hardening.

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Highlights of Eversource System Resiliency Programs

Eversource System Resiliency – Pole Integrity Program

The Pole Integrity Program will propagate the benefits of the structural and electrical hardening initiatives to all future construction. The 15-year pole inspection cycle enables the replacement of aging and weaker poles with stronger, taller poles constructed to Eversource's more resilient current standards.

Scope of Work

- Expanded pole inspections, load analysis, pole replacement and restoration
- Integration with other Reliability programs
- Incorporation of new design criteria for distribution poles and pole tops

Scope of Work

- Specific wood pole intrusive inspections on 15-year cycle for poles that meet age and treatment criteria
- Poles rejected based on intrusive test results and remaining pole circumference and minimum shell thickness

Industry Best Practices

- Visual inspections and intrusive pole testing
- Inspection cycles based on age, treatment type, environmental conditions, and measured pole failure rates
- Pole loading surveys conducted using intrusive testing results and actual pole loads confirmed in the field
- Enhanced pole design and replacement criteria in high-risk areas
- Targeted completion dates and associated capital investments for pole replacements in high-risk areas or of high-risk poles

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Eversource System Resiliency – Vegetation Management

Reliability and resilience-driven program with a defined, system-wide vegetation management specification and enhanced vegetation management practices for high customer impact line segments. The program consists of three activities—Customer Focused Trimming (CFT), Enhanced Tree Removal (ETR), and Enhanced Tree Trimming (ETT).

Vegetation Management Process

- Annual Planning – Identify circuits, select backbone and large lateral sections for ETT, select focus of ETR, select laterals for CFT
- ETT – greater clearances and removes limbs and trees outside the normal maintenance trim zone
- CFT – ETT on laterals experiencing emerging reliability and customer experience issues
- ETR – targeted removal of risk and hazard trees along backbones and large laterals
- Post outage investigations after minor and major events for large customer impact line sections

Industry Best Practices

- More frequent inspections and enhanced tree trimming and removal specification(s) in high-risk areas
- High-risk trees are targeted for removal in addition to hazard trees
- Pre-major event inspections and preparations to assess and mitigate event-specific risks
- Post-outage or event analysis and tracking of tree caused outages/powerline contacts
- Work management system for vegetation management with tree inventory database
- Structured and rigorous quality control and quality assurance programs
- Remote sensing technologies used gain system-wide understanding of service area vegetation conditions

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Eversource System Resiliency – DSCADA Radio Expansion & Tower Replacements

Eversource has expanded its DSCADA radio system to support the deployment of Smart Switches and other automated distribution devices. This expansion also drives the replacement of towers that have degraded over time and are unable to support increased demand for additional equipment.

Scope of Work

- Installation of additional radios
- Rebuild communication towers to meet enhanced wind and ice loading design criteria
- Installation of additional battery backup capability
- Installation of propane generators as emergency power

Program Benefits

- Enabling investments to increased monitoring and automation deployments
- Improved performance during severe weather events
- Supports Connecticut State Police operations through a telecommunications sharing agreement.

Industry Best Practices

- Upgrading, expanding, and strengthening telecommunications infrastructure necessary to support safety, reliability, and resilience of the distribution systems driven by changing environmental conditions, customer expectations, and increasing penetration of Distributed Energy Resources
- Telecommunications infrastructure expansion and technology upgrades in anticipation of increasing demands and grid operations and engineering complexity

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Eversource System Resiliency – Smart Switches Program

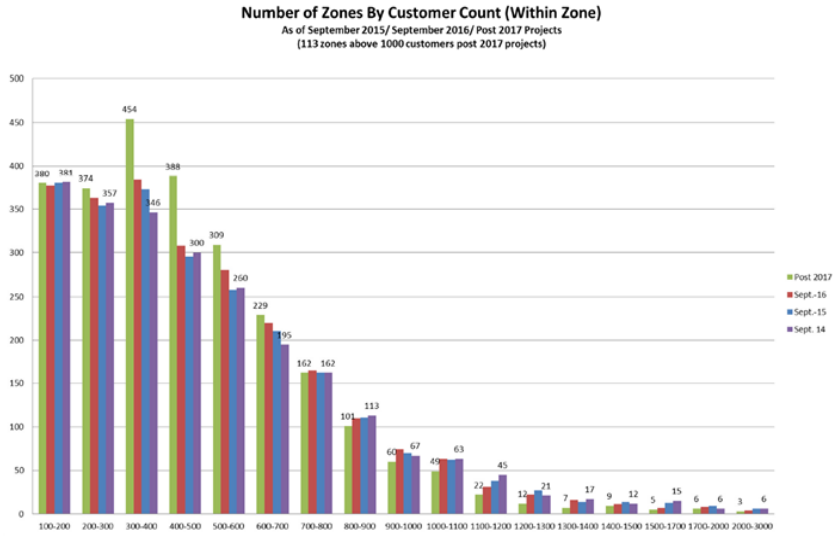
Through the deployment of Smart Switches, Eversource has improved service reliability and system resilience by increasing the number automated isolation points in the distribution system aiding outage troubleshooting and restoration.

Project Development Process

- Installation locations prioritized using the following data
  - Four-year reliability performance (including storm events)
  - Number of customers per zone
  - Availability of the radio system

Program Benefits

- Widespread deployment of sectionalizing devices aids in isolating faults with minimal collateral outages
- Reduces customers impacted during fault isolation and restoration



Industry Best Practices

- Deployment of smart switches and reclosers as part of advanced distribution automation schemes, such as Fault Location, Isolation and Service Restoration (FLISR)
- Reduction of the number of customers in switching zones (500 of less customers is a common target)
- Automation of existing normally-open feeder ties (and building new ties), as well as ensuring the availability of enough reserve capacity in tie feeders and substations to automatically reconfigure the distribution grid

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Eversource System Resiliency – UCONN Energy Center

The UCONN Energy Center is a joint venture between Eversource and the university. The Energy Center has developed models and performed assessments which have improved the information available to Eversource ultimately benefitting customers through improved investments and preparation for storm events.

Outage Prediction Model

- Granular storm impact modeling improves staging of resources and restoration efforts

Flood Modeling

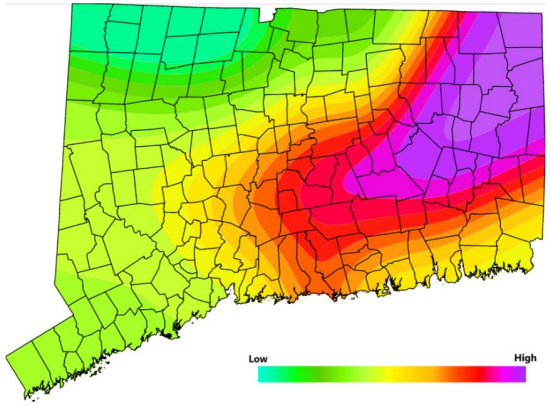
- Flood risk modeling has improved investment planning
- Real-time flood early warning system

Assessment of System Resilience Programs

- Independent assessment of performance of Vegetation Management and storm hardening informs future strategy

Industry Best Practices

- Partnerships with universities and national labs can bring expertise and perspectives not present within a utility



Source: https://www.eversource.uconn.edu/hurricane-henri-outage-forecast/

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Resilience Case Studies

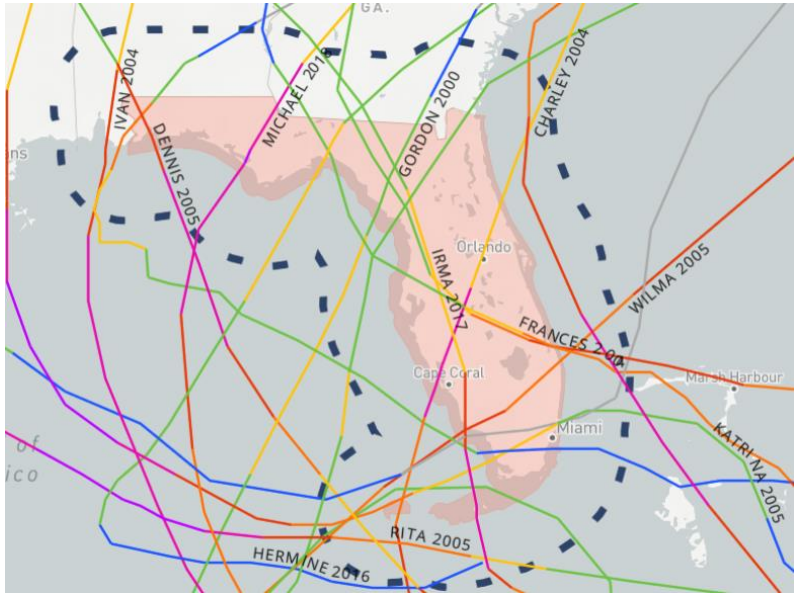
Florida – Hurricane Preparedness

Following two intense hurricane seasons in 2004 and 2005, the Florida Public Service Commission (PSC) ordered IOUs to adopt an 8-year wood pole inspection and 10 storm preparedness initiatives.

- 3-year cycle for distribution vegetation management
- Infrastructure hardening
- T&D GIS
- Increased utility coordination with local governments
- Collaborative research on effects of hurricane winds and storm surge
- Development of natural disaster preparedness and recovery program plans

Key findings after 2016 and 2017 storm seasons

- Can't eliminate storm outages, but can reduce amount and duration
- Underground performed better than overhead
- Primary causes of outages came from outside the utility rights-of-way
- NESC Extreme wind loading standards do not account for vegetation or debris
- Consideration of non-electric utility poles in hardening and restoration



Florida Hurricanes from 2000 - 2021
Source: NOAA Historical Hurricane Tracks
https://coast.noaa.gov/hurricanes/

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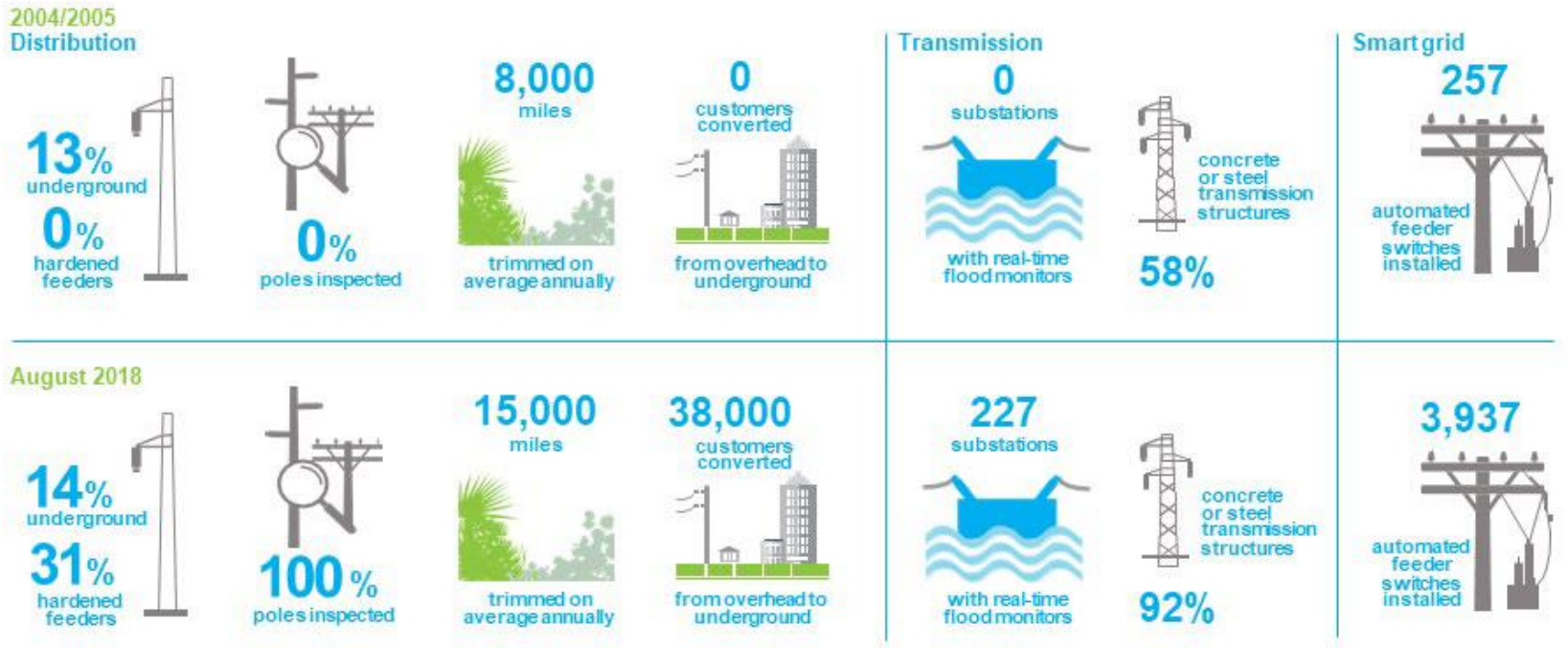
Florida Power and Light – Significant Investment to Achieve Performance



Source: B. Olnick, DOE Electric Advisory Committee – Grid Resiliency
https://www.energy.gov/sites/prod/files/2018/10/f56/1.1%20Resilience%20Panel_Olnick_10-17-18.pdf

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ComEd August 2020 Derecho Storm Event – Analyzing benefits of resilience investments

Background

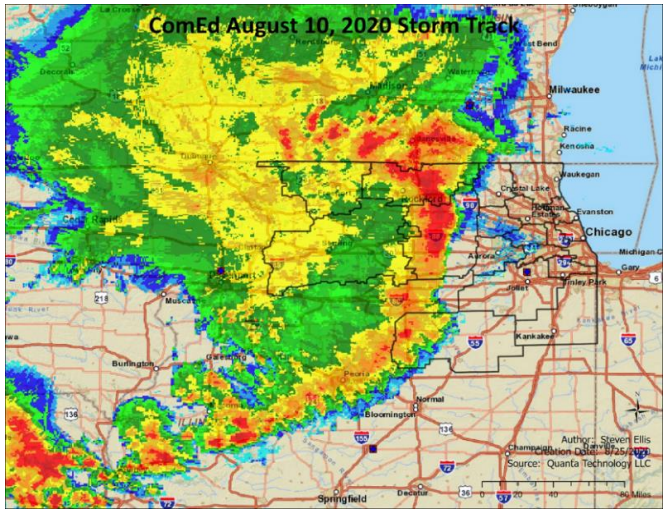
- On Monday August 10, 2020, ComEd was impacted by a severe derecho storm that impacted the entire ComEd service area. The storm caused service interruption to 860,000 customers. Wind gusts in some areas reached 112 mph. The severe derecho wind speeds plus tornado winds led to significant damage to the ComEd infrastructure.

Analysis Approach

- Evaluated the July 11, 2011, storm system performance with this August 10, 2020, storm. The evaluation included determining the additional wind force due to higher wind speeds and the potential impact it could have had in 2011. This was done to evaluate the effectiveness of ComEd reliability and resilience enhancement efforts since 2012.
- Significant system improvements such as undergrounding, pole replacement to higher construction class, distribution automation, recloser installation, improved vegetation management practice were done to improve system hardening performance.

Conclusion

- It was determined that based on the 2020 storm wind gusts, the wind force was about 2-3 times higher than the wind force from the 2011 storm. Assuming the same infrastructure and customer counts from 2011, it is estimated that the 2020 storm could have interrupted an additional 940,000 customers. This increased customer count did not occur in the 2020 storm due to on-going ComEd efforts to improve resilience.



August 10, 2020, Storm Track 60 minutes before impacting Chicago
Source: National Weather Service

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California – Wildfire Risk Mitigation

- All California utilities are required by state law to develop and implement wildfire mitigation plans (WMPs) in response to climate change and wildfire events over the past several years
- Investor-Owned Utility (IOU) WMPs are reviewed, approved, and audited by the California Public Utilities Commission (CPUC)
- IOU WMPs follow a common framework and contain the following elements tailored for each utility's situation and risks:
    a. Risk assessment and mapping
    b. Situational awareness
    c. Grid design and hardening
    d. Asset management and inspections
    e. Vegetation management
    f. Grid operations and protocols
    g. Data governance
    h. Emergency planning and preparedness
    i. Stakeholder cooperation and customer engagement



Source: CalFire
https://www.fire.ca.gov/incidents/

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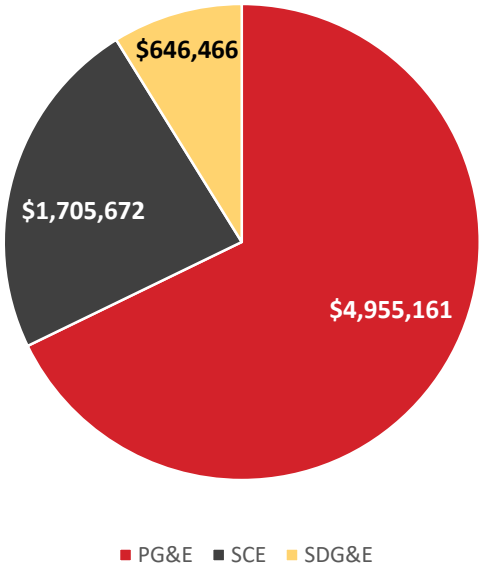
California – Wildfire Mitigation Plan Metrics

The IOUs and CPUC developed metrics in three separate categories to monitor plan progress and effectiveness.

Outcome Metrics	Progress Metrics	Stakeholder Communication Metrics
• Number of risk events (i.e., utility associated ignitions) • Property damage • Public safety incidents • Customers impacted by events	• Miles inspected • Miles hardened • Intrusive pole inspections • Level 1, 2, and 3 findings in high-risk areas	• Timeliness of event communications • Accuracy of even communications • Restoration forecast accuracy

Planned 2021 California IOU Wildfire Mitigation Plan Spend ($000)



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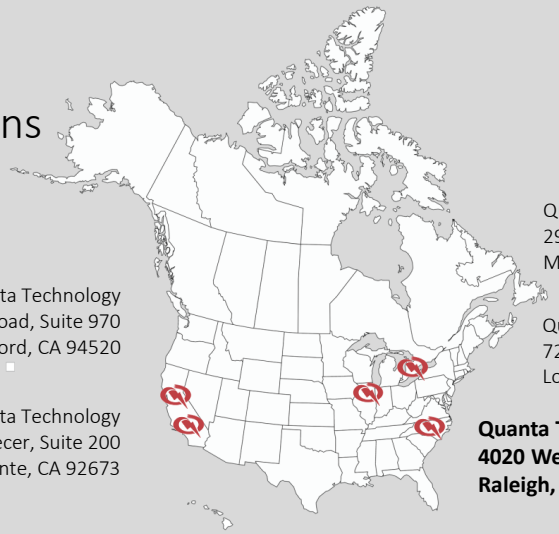
Thank you!

Office Locations



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Kevin Dasso, PE

Industry Advisor, Asset Management

QUANTA TECHNOLOGY

Areas of Expertise

- Operations
- Asset Management
- Standards
- Risk Management
- System Performance
- Maintenance Programs

Accomplishments & Industry Recognition

- Past Chairman – North American Electric Reliability Council (NERC)
- Past Board Member and Vice Chairperson – Gridwise Alliance
- Past Chair - Western Electricity Coordinating Council (WECC) Board of Trustees
- Past Member – University of California – Merced Board of Trustees

Bio

Kevin is a utility executive with over 40 years of experience in the gas and electric utility business. He has held leadership positions responsible for engineering, operations, construction, asset management, and regulatory policy. His responsibilities included all aspects of asset management, system planning, risk and compliance management, reliability performance, and technology deployment for electric transmission and distribution systems. Kevin led development and deployment of technology and smart grid strategies for a large electric transmission and distribution utility and worked with State and Federal regulators, legislators, and community and union leaders to develop and implement regulatory policies. He is past Vice Chairman of the Board of the Gridwise Alliance and served in leadership roles with the North American Electric Reliability Council (NERC) and the Western Electricity Coordination Council (WECC) industry committees.

Education	MS, Electrical Engineering, Santa Clara University, 1991 BS, Electrical Engineering, Iowa State University, 1981
Years of Experience	1981–Present
Title	Industry Advisor

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The Quanta Technology Team



Donald F. Hall, PE

Executive Advisor, Distribution

QUANTA TECHNOLOGY

Areas of Expertise

- Grid Modernization
- Distributed Energy Resources/Non-Wires Alternatives
- Distribution Load/DER Forecasting Methods
- Transmission & Distribution Planning
- Outage Management Systems
- Performance Metrics
- Utility Regulation
- Expert Witness

Accomplishments & Industry Recognition

- Ballotter of Proposed Standards IEEE Standards Association
- Senior Member IEEE Power and Energy Society
- Co-chair of the BESS Super Session 2019 IEEE PES General Meeting
- Past Chair IEEE PES General Meeting Steering Committee
- Past Vice-Chair IEEE PES Innovative Smart Grid Technologies North America Conference
- Member IEEE PES Distribution Reliability and Smart Distribution Working Groups
- Technical paper reviewer for IEEE PES Distribution Subcommittee
- Licensed Professional Engineer – District of Columbia, Maryland, and Delaware

Bio

Don is a seasoned leader with proven experience in the Engineering, Operations, and Regulatory areas of the Distribution & Transmission segments of the electric utility industry. Recent focus includes business and technical integration of Distributed Energy Resources/Non-Wires Alternatives (DER/NWAs), Distribution System Load Forecasting methods incorporating DER, addition of stakeholder involvement and transparency in the Distribution System Planning process, and initial development of performance indicators to be used in performance-based rate-making proposals. Extensive background in state and federal regulatory proceedings including serving as an expert witness. Donald is a licensed PE in Washington D.C., Delaware, and Maryland, has been published and is active in standards development (IEEE/PES), and was an adjunct college engineering instructor.

Education	MS, Electrical Engineering, Kansas State University, 2010 BS, Electronics Engineering Technology, Capitol College (Laurel, MD), 1986
Years of Experience	1981–Present
Title	Executive Advisor

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Gregg Lemler, MBA, PE

Vice President, Asset Management

QUANTA TECHNOLOGY

Areas of Expertise

- Asset Management
- Infrastructure Planning and Integration
- System Operations
- Project Engineering & Construction
- System Maintenance
- Emergency Response

Accomplishments & Industry Recognition

- Board Member (HR/GC Chair), North American Transmission Forum
- Board Member (Chair), WIRES
- Board Member, HomeAid, Northern California Chapter
- EEI Emergency Response Executive Committee
- Advisory Committee Member, Western Electricity Coordinating Council
- PG&E Rep, Western Electricity Coordinating Council
- PG&E Rep, Peak Reliability Coordinator
- Vice President, Contra Costa Economic Development Partnership
- President, Contra Costa Software Business Incubator
- Member, IEEE

Bio

Gregg has over 35 years of experience in the power industry and has been a key member of one of the largest utility companies on the West Coast. During his career, Gregg has performed in roles such as Vice President of Electric Transmission, as well as Senior Director of, both, Transmission System Operations and Distribution Maintenance & Construction. As an Executive Advisor, he works on projects in distribution and transmission planning, asset management, system maintenance, and several other areas. Gregg's expertise also includes system operations, emergency response, and project engineering/construction.

Education	Executive Program, Dartmouth College, 2011 MBA, California State University, 1993 BS, Mechanical Engineering, University of Wisconsin, 1982
Years of Experience	1982–Present
Title	Executive Advisor

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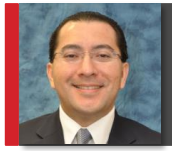

Julio Romero Agüero, PhD, MBA

Vice President, Strategy and Business Innovation

QUANTA TECHNOLOGY

Areas of Expertise

- Grid modernization
- Distributed energy resources integration and Smart Grid
- Distribution system analysis, planning and engineering
- Emerging technologies and technology strategy

Accomplishments & Industry Recognition

- IEEE Senior Member
- Former Chair of IEEE Distribution Subcommittee
- Former Chair of IEEE Working Group on Distributed Resources Integration
- Former Editor of IEEE Transactions on Power Delivery
- Former Editor of IEEE Transactions on Smart Grid
- Vice President, Membership & Image, IEEE Power and Energy Society (PES)
- Chair Innovative Smart Grid Technologies Conference (ISGT) North America (2020-2021)
- Member of Advisory Committee of DistribuTECH

Bio

Julio Romero Agüero has been with Quanta Technology since 2007. Julio provides leadership to Quanta Technology in the areas of technology and business strategy, grid modernization, distribution systems analysis, planning and engineering, distributed energy resources, and emerging technologies. He has assisted electric utilities and regulatory boards in the U.S., Canada, Latin America, the Caribbean, and Asia.

Education	MBA, North Carolina State University (NCSU), 2013 PhD, Electrical Engineering, National University of San Juan, Argentina (UNSJ), 2005 BSc, Electrical Engineering, National Autonomous University of Honduras (UNAH), 1996
Years of Experience	1995–Present
Title	Executive Advisor

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Stephen R. Teran, MBA

Principal Advisor, Asset Management

QUANTA TECHNOLOGY

Areas of Expertise

- Asset Management
- Risk Management
- Capital Portfolio Optimization
- Distribution Planning & Analysis
- DER Integration
- Profile-driven Capacity Planning
- Geospatial & Network Analysis
- General Rate Cases
- Software Development & Implementation

Accomplishments & Industry Recognition

- IEEE Member

Bio

Stephen has over 15 years of utility experience spanning all aspects of distribution and system planning. He has a demonstrated track record of driving organizations toward strategic objectives that require detailed, technical solutions. Stephen has led efforts to optimize capital portfolios for risk reduction, redesign engineering-related business processes, and implement technology solutions required to meet critical business and regulatory requirements.

Education	MBA, California State University, Long Beach, 2012 BS, Electrical Engineering, University of California, Irvine, 2008
Years of Experience	2003–Present
Title	Principal Advisor

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