BEFORE THE

FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 20220048-EI

TAMPA ELECTRIC's STORM PROTECTION PLAN

VERIFIED DIRECT TESTIMONY

OF

JASON D. DE STIGTER

ON BEHALF OF

TAMPA ELECTRIC COMPANY

VERIFIED DIRECT TESTIMONY OF JASON D. DE STIGTER

ON BEHALF OF

TAMPA ELECTRIC COMPANY

1. INTRODUCTION

Q1. Please state your name and business address.

A1. My name is Jason De Stigter, and my business address is 9400 Ward Parkway, Kansas City, Missouri 64114.

Q2. By whom are you employed and in what capacity?

A2. A2. I am employed by 1898 & Co. as a Director and I lead the Utility Investment Planning team as part of our Utility Consulting Practice. 1898 & Co. was established as the consulting and technology consulting division of Burns & McDonnell Engineering Company, Inc. ("Burns & McDonnell") in 2019. 1898 & Co. is a nationwide network of over 250 consulting professionals serving the Manufacturing & Industrial, Oil & Gas, Power Generation, Transmission & Distribution, Transportation, and Water industries.

Burns & McDonnell has been in business since 1898, serving multiple industries, including the electric power industry. Burns & McDonnell is a family of companies made up of more than 8,300 engineers, architects, construction professionals, scientists, consultants, and entrepreneurs with more than 40 offices across the country and throughout the world.

Q3. Briefly describe your educational background and certifications.

A3. I received a Bachelor of Science Degree in Engineering and a Bachelor's in Business Administration from Dordt College, now called Dordt University. I am also a registered Professional Engineer in the state of Kansas.

Q4. Please briefly describe your professional experience and duties at 1898 & Co.

A4. I am a professional engineer with 14 years of experience providing consulting services to electric utilities. I have extensive experience in asset management, capital planning and optimization, risk and resilience assessments and analysis, asset failure analysis, and business case development for utility clients. I have been involved in numerous studies modeling risk for utility industry clients. These studies have included risk and economic analysis engagements for several multi-billion-dollar capital projects and large utility systems. In my role as a project manager, I have worked on and overseen risk and resilience analysis consulting studies on a variety of electric power transmission and distribution assets, including developing complex and innovative risk and resilience analysis models. My primary responsibilities are business development and project delivery within the Utility Consulting Practice with a focus on developing risk and resilience-based business cases for large capital projects/programs.

Prior to joining 1898 & Co. and Burns & McDonnell, I served as a Principal Consultant at Black & Veatch inside their Asset Management Practice performing similar studies to the effort performed for Tampa Electric Company ("Tampa Electric").

Q5. Have you previously testified before the Florida Public Service Commission or other state commissions?

A5. Yes, I provided written and rebuttal testimony on behalf of Tampa Electric Company for the 2020-2029 Storm Protection Plan before the Florida Public Service Commission, docket no 20200067-EI. I have also provided written, rebuttal, and oral testimony on behalf of Indianapolis Power & Light before the Indiana Utility Regulatory Commission and written testimony on behalf of Oklahoma Gas and Electric. Additionally, I have supported many other regulatory filings. I have also testified in front of the Alaska Senate Resources Committee.

Q6. What is the purpose of your direct testimony in this proceeding?

A6. The purpose of my testimony is to summarize the results and methodology developed using 1898 & Co.'s Storm Resilience Model, with the following objectives:

1. Calculate the customer benefit of hardening projects through reduced utility restoration costs and impacts to customers.
2. Prioritize hardening projects with the highest resilience benefit per dollar invested into the system.
3. Establish an overall investment level that maximizes customers' benefit while not exceeding Tampa Electric's technical execution constraints.

Through my testimony I will describe the major elements of the Storm Resilience Model, which includes a Major

Storms Event Database, Storm Impact Model, Resilience Benefit Module, and Budget Optimization & Project Prioritization. Specifically, I will define resilience, review historical major storm events to impact Tampa Electric's service territory, describe the datasets used in the Storm Impact Model and how they were used to model system impacts due to storms events, and explain how to understand the resilience benefit results. Additionally, I will outline the key updates to the Storm Resilience Model for the 2022-2031 Storm Protection Plan. Throughout my testimony I will describe both how the assessment was performed and why it was performed as such. Finally, I will describe the calculations and results of the Storm Resilience Model.

Q7. Are you sponsoring any attachments in support of your testimony?

A7. Yes, I am sponsoring the 1898 & Co., Tampa Electric's 2022-2031 Storm Protection Plan Resilience Benefits Report that is being included as Appendix F in Tampa Electric's 2022-2031 Storm Protection Plan.

Q8. Were your testimony and the attachment identified above prepared or assembled by you or under your direction or

supervision?

A8. Yes.

Q9. Are you also submitting workpapers?

A9. No.

Q10. What was the extent of your involvement in the preparation of the Storm Protection Plan?

A10. I served as the 1898 & Co. project director on Tampa Electric's 2022-2031 Storm Protection Plan Assessments and Benefits Assessment. The evaluation utilized a Storm Resilience Model to calculate benefits. I worked directly with Tampa Electric's Team involved in the resilience-based planning approach. I was responsible for the overall project and was directly involved in the development of the Storm Resilience Model, the assessment and results, as well as being the main author of the report.

2. RESILIENCE-BASED PLANNING OVERVIEW

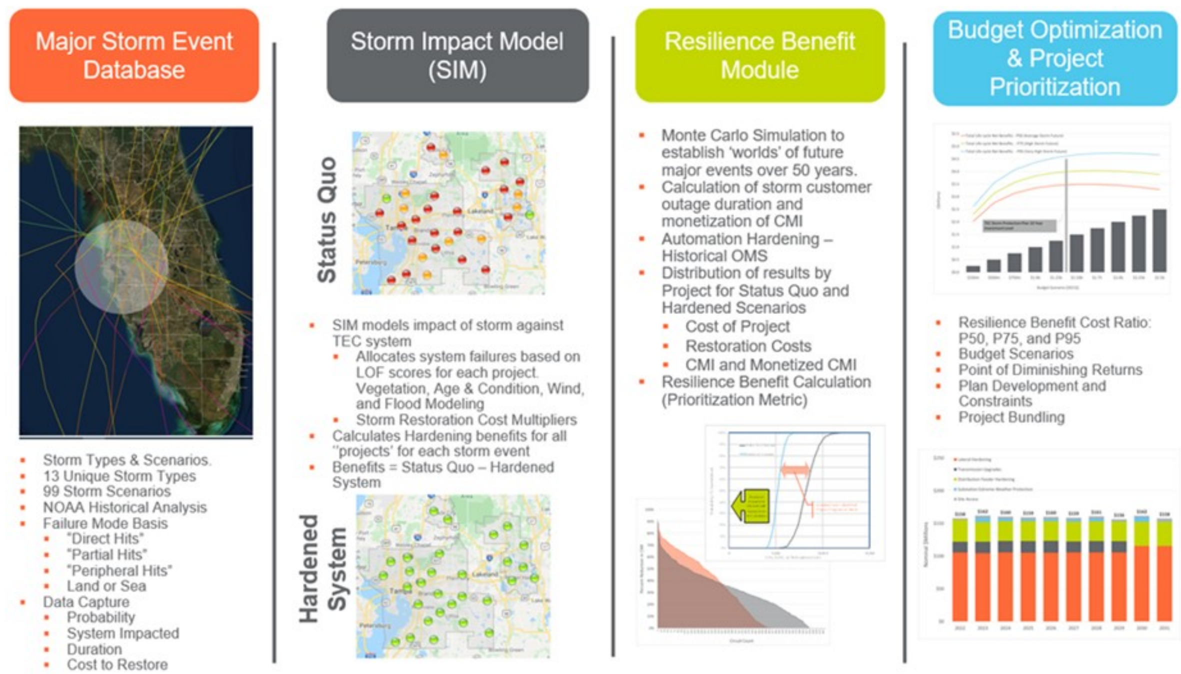
Q11. Please describe the analysis 1898 & Co. conducted for Tampa Electric.

A11. 1898 & Co. utilized a resilience-based planning approach to identify hardening projects and prioritize investment in Tampa Electric’s T&D system utilizing a Storm Resilience Model. The Storm Resilience Model consistently models the benefits of all potential hardening projects for an ‘apples to apples’ comparison across the system. The resilience-based planning approach calculates the benefit of storm hardening projects from a customer perspective. This approach consistently calculates the resilience benefit at the asset, project, and program level. The results of the Storm Resilience Model are:

1. Decrease in the Storm Restoration Costs.
2. Decrease in the customers impacted and the duration of the overall outage, calculated as CMI.

The Storm Resilience Model employs a data-driven decision-making methodology utilizing robust and sophisticated algorithms to calculate the resilience benefit. Figure 1 below provides an overview of the Storm Resilience Model used to calculate the project benefit and prioritize projects.

Figure 1: Storm Resilience Model Overview



The storms database includes the future 'universe' of potential storm events to impact Tampa Electric's service territory. The Major Storm Events Database contains 13 unique storm types with a range of probabilities and impacts to create a total database of 99 different unique storm scenarios.

Each storm scenario is then modeled within the Storm Impact Model to identify which parts of the system are most likely to fail given each type of storm. The Likelihood of Failure ("LOF") is based on the vegetation density around each conductor asset, the age and condition of the asset base, and the wind zone the asset is in. The Storm Impact Model also estimates the restoration costs and CMI for each of the projects. Finally, the Storm Impact Model calculates the benefit in decreased restoration costs and CMI if that project is hardened per Tampa Electric's hardening standards. The CMI benefit is monetized using the DOE's Interruption Cost Estimator ("ICE") for project prioritization purposes.

The benefits of storm hardening projects are highly dependent on the frequency, intensity, and location of future major storm events over the next 50 years. Each storm type (i.e., Category 1 from the Gulf) has a range of potential probabilities and consequences. For this reason, the Storm Resilience Model employs stochastic modeling, or Monte Carlo Simulation, to randomly trigger the types of storm events to impact Tampa Electric's service territory over the next 50 years. The probability of each storm scenario is multiplied by the benefits calculated for each project from the Storm Impact Model to provide a resilience weighted benefit for each project in dollars. Feeder Automation Hardening projects are evaluated based on historical outages and the expected decrease in historical outages if automation had been in place.

The Budget Optimization and Project Scheduling model prioritizes the projects based on the highest resilience benefit cost ratio. The model prioritizes each project based on the sum of the restoration cost benefit and monetized CMI benefit divided by the project cost. This is done for the range of potential benefit values to create the resilience benefit cost ratio. The model also incorporates Tampa Electric’s technical and operational realities (Transmission outages) in scheduling the projects.

This resilience-based prioritization facilitates the identification of the critical hardening projects that provide the most benefit. Prioritizing and optimizing investments in the system helps provide confidence that the overall investment level is appropriate and that customers get the “biggest bang for the buck.”

Q12. Which of the Storm Protection Plan programs are evaluated within the Storm Resilience Model?

A12. The Storm Resilience Model includes project benefits results, budget optimization, and project prioritization for the following Storm Protection Plan programs:

- Distribution Lateral Undergrounding
- Transmission Asset Upgrades
- Substation Extreme Weather Hardening
- Distribution Overhead Feeder Hardening
- Transmission Access Enhancements

Q13. Please outline the key updates that were made to the Storm Resilience Model from the 2020-2029 to the 2022-2031 Storm Protection Plan assessment.

A13. The Storm Resilience Model was used in the development of the 2020-2029 Storm Protection Plan as well as the 2022-2031 Storm Protection Plan. The following are the key updates from the 2020-2029 to the 2022-2031 Storm Resilience Model:

1. **General** – these updates include shifting of the time horizon, adding another year of storms to the historical analysis, and accounting for completed projects.
2. **Capital Cost Assumptions** – based on actual completed projects and communicated increases in commodity prices the cost assumptions for all project types were adjusted.
3. **Substation Projects Development** – Tampa Electric

completed a technical evaluation of substation hardening alternatives since the 2020-2029 Storm Protection Plan filing. The results of that evaluation, including specific substation hardening activities and their cost were included in the model.

4. **Site Access Project Development** – Tampa Electric performed additional evaluation of transmission site access and updated the projects and associated costs.

5. **Automation Hardening Capital Costs** – 1898 & Co. performed detailed analysis on 300 circuits to identify more specific scope and cost. Based on lessons learned from the 2020 projects, the cost to deploy automation had a wide range given the uncertainty in circuit reconductoring and substation upgrades needed to not overload and burn down circuits. With improved cost estimates for the 300 circuits the prioritization of projects in the Storm Resilience Model is improved. This increases the overall benefit by decreasing major outage events for customers.

6. **Lateral Undergrounding 'Branching' Approach** – Based on a lessons learned evaluation, the project definition for lateral projects was adjusted to

include a collection of electrically connected protection zones, or 'branches'. Tampa Electric's undergrounding design standard includes looping for added resilience. Based on the 2020 project execution, it was identified that some of the projects included higher costs to achieve the full loop. By undergrounding all the electrically connected protection zones off a circuit feeder / mainline the higher costs will be mitigated since it can be designed more thoughtfully to minimize the number of new underground miles.

Q14. How is resilience defined?

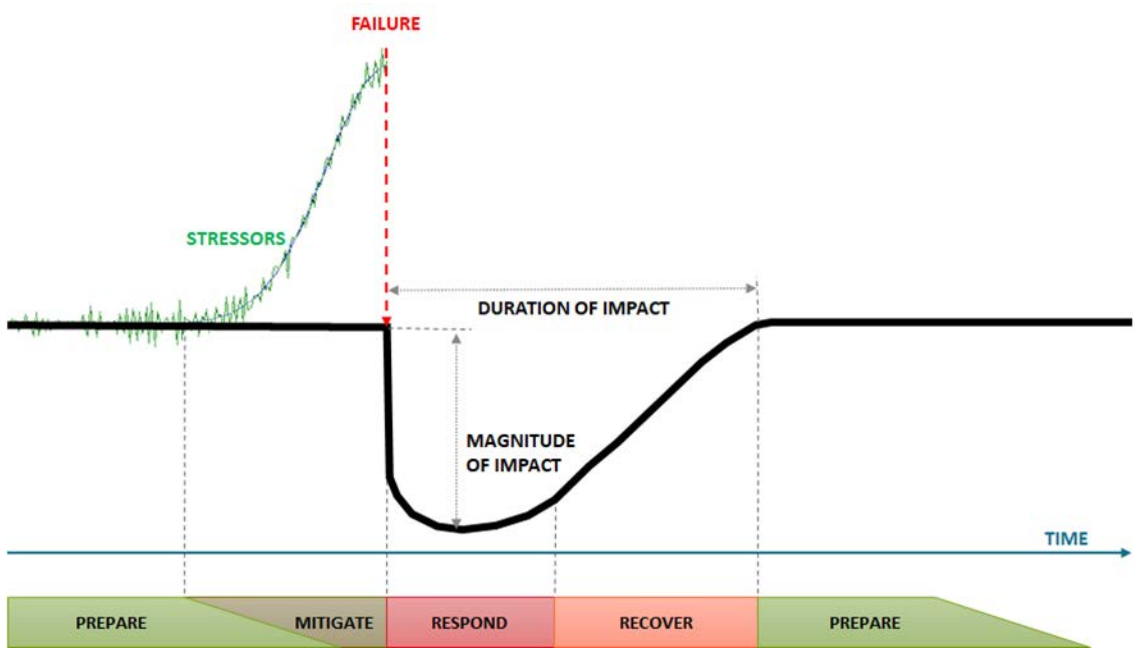
A14. There are many definitions for resilience, I gravitate to the one used by the National Infrastructure Advisory Council ("NIAC"). Their definition of resilience is: "The ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event."

This definition can be broken down into four phases of resilience described below with applicable definitions for the grid:

- **Prepare (Before)**
  The grid is running normally but the system is preparing for potential disruptions.
- **Mitigate (Before)**
  The grid resists and absorbs the event until, if unsuccessful, the event causes a disruption. During this time the precursors are normally detectable.
- **Respond (During)**
  The grid responds to the immediate and cascading impacts of the event. The system is in a state of flux and fixes are being made while new impacts are felt. This stage is largely reactionary (even if using prepared actions).
- **Recover (After)**
  The state of flux is over, and the grid is stabilized at low functionality. Enough is known about the current and desired (normal) states to create and initiate a plan to restore normal operations.

This is depicted graphically in Figure 2 below as a conceptual view of understanding resilience and how to mitigate the impact of events. The green line represents an underlying issue that is stressing the grid, and which increases in magnitude until it reaches a point where it impacts the operation of the grid and causes an outage. The black line shows the status of the entire system or parts of the system (e.g. transmission circuits). The "pit" depicted after the event occurs represents the impact on the system in terms of the magnitude of impact (vertical) and the duration (horizontal).

Figure 2: Phases of Resilience



Q15. How does the Storm Resilience Model incorporate this definition?

A15. The Storm Resilience Model utilizes a resilience-based planning approach to calculate hardening project benefits and prioritize projects. The model includes a 'universe' of major storm events as stressors on the Tampa Electric system. The database includes the probability of these events occurring as well as the magnitude of impact, in terms of the percentage of the sub-systems (e.g. substations, transmission lines, feeders, laterals), and duration to restore the system. The database also includes the restoration cost to return the system back to normal operation after each of the storm events.

The Storm Resilience Model also identifies, on a probability weighted basis, which specific portions of the Tampa Electric system would be impacted and their contribution to the overall restoration costs. The model also evaluates the storms impact for each portion of the system based on current status of the system and if that part of the system is hardened. For example, the Storm Resilience Model calculates the magnitude and duration of a storm event on a distribution circuit given its current state and after it has been hardened.

Q16. Please outline the type and count of hardening projects evaluated in the Storm Resilience Model.

A16. Table 1 below contains the list of potential hardening projects by program evaluated in the Storm Resilience Model.

Table 1: Potential Hardening Project Count

Program	Project Count
Distribution Lateral Undergrounding	12,310
Transmission Asset Upgrades	107
Substation Extreme Weather Hardening	9
Distribution Overhead Feeder Hardening	1,385
Transmission Access Enhancements	44
Total	13,855

Q17. How were these potential hardening projects identified?

A17. The potential hardening projects were identified based on a combination of data driven assessments, field inspection of the system, and historical performance of Tampa Electric's system during major storm events. The approach to identifying hardening projects employs asset management principles utilizing a bottom-up approach starting with the system assets. Additionally, hardening approaches for parts of the system were based on the balance of the resilience benefit they provide with the overall costs. I discuss this more below. Table 2 below shows the asset types and counts included in the Storm Resilience Model used to develop hardening projects.

Table 2: Tampa Electric's Asset Base

Asset Type	Units	Value
Distribution Circuits	**[count]**	**710**
Feeder Poles	[count]	58,700
Lateral Poles	[count]	122,500
Feeder OH Primary	[miles]	2,300
Lateral OH Primary	[miles]	3,900
Transmission Circuits	**[count]**	**215**
Wood Poles	[count]	5,000
Steel / Concrete / Lattice Structures	[count]	20,400
Conductor	[miles]	1,300
Substations	**[count]**	**9**
Site Access	**[count]**	**44**
Roads	[count]	25
Bridges	[count]	19

All of the assets that benefit from hardening are strategically grouped into potential hardening projects. For distribution projects, assets were grouped by their most upstream protection device, which was either a breaker, a recloser, trip savers, or a fuse.

For lateral projects, those with a fuse or trip saver protection device, the preferred hardening approach is to underground the overhead circuits. The main cause of storm related outages, especially for weakened structures, is the wind blowing vegetation into conductor, causing structure failures. Therefore, undergrounding lateral lines provides full storm hardening benefits. While rebuilding overhead laterals to a stronger design standard (i.e., bigger and stronger poles and wires) would provide some resilience benefit, it would not solve the vegetation issues, since the high wind speeds can blow tree limbs from outside the trim zone into the conductor.

For distribution feeder projects, those with a recloser or breaker protection device, the preferred hardening approach is to rebuild to a storm resilient overhead design standard and add automation hardening. Assets in these projects include older wood poles and those with a 'poor' condition rating. Additionally, poles with a class that is not better than '1' were also included in these projects. The combination of the physical hardening and automation hardening provides significant resilience benefit for feeders. The physical hardening addresses the weakened infrastructure storm failure component. While the vegetation outside the trim zone is still a concern, most distribution feeders are built along main streets where vegetation densities outside the trim zone are typically less than that of laterals. Further, the feeder automation hardening allows for automated switching to perform 'self-healing' functions to mitigate impacts from vegetation outside the trim zone and other types of outages. The combination of the physical and automation hardening provides a balanced resilience strategy for feeders. It should be noted that this balanced strategy with automation hardening is not available for laterals. As such, undergrounding is the preferred approach for lateral hardening while overhead physical hardening combined with automation hardening is the preferred approach for feeders.

At the transmission circuit level, wood poles were identified for hardening by replacement with non-wood materials like steel, spun concrete, and composites. The non-wood materials have a consistent internal strength while wood poles can vary widely and are more likely to fail. Transmission wood poles were grouped at the circuit level into projects.

Tampa Electric identified 44 separate transmission access, road, and bridge projects based on field inspections of the system.

Tampa Electric performed detailed storm surge modeling using the Sea, Land, and Overland Surges from Hurricanes ("SLOSH") model. The SLOSH model identified 59 substations with a flood risk, depending on the hurricane category. Based on Tampa Electric's more detailed assessment, nine (9) substations were identified that included flooding risk to the level that could require mitigation.

Q18. Why is this approach to hardening project identification important?

A18. This approach to hardening project identification is important for several reasons.

1. The approach is comprehensive. As Table 2 shows, the approach evaluates nearly all of Tampa Electric's transmission and distribution ("T&D") system. By considering and evaluating the entire system on a consistent basis, the results of the hardening plan provide confidence that portions of Tampa Electric's system are not overlooked for potential resilience benefit.
2. By breaking down the entire distribution system by protection zone, the resilience-based planning approach is foundationally customer centric. Each protection zone has a known number of customers and type of customers such as residential, small or large commercial and industrial, and priority customers. The objective is to harden each asset that could fail and result in a customer outage.

Since only one asset needs to fail downstream of a protection device to cause a customer outage, failure to harden all the necessary assets still leaves weak links that could potentially fail in a storm. Rolling assets into projects at the protection device level allows for hardening of all weak links in the circuit and for capturing the full benefit for customers.

3. The granularity at the asset and project levels allows Tampa Electric to invest in portions of the system that provide the most value to customers from a restoration cost reduction, customers impacted ("CI"), and customer minutes interrupted ("CMI") perspective. For example, a circuit may have 10 laterals that come off a feeder and the Storm Resilience Model may determine that only 3 out of the 10 should be hardened. Without this granularity, over-investment in hardening is a concern. The adopted approach provides confidence that the overall plan is investing in the parts of the system that provide the most value for customers.

4. The types of hardening projects include the mitigation measures over all the four phases of resilience providing a diverse investment plan.

Since storm events cannot be fully eliminated, the diversification allows Tampa Electric to provide a higher level of system resilience.

5. The approach balances the use of robust data sets with Tampa Electric's experience with storm events to develop storm hardening projects. Data-only approaches may provide decisions that don't match reality, while people-driven only solutions can be filled with bias. The approach balances the two to better identify types of hardening projects.

Q19. Why is it necessary to model storm hardening projects benefits using this resilience-based planning approach and Storm Resilience Model?

A19. The Storm Resilience Model was architected and designed for the purpose of calculating storm hardening project benefit in terms of reduced restoration costs and customer minutes interrupted to build a Storm Protection Plan with the right level of investment that provides the most benefit for customer. It was necessary to model storm hardening projects using the resilience-based planning approach shown in Figure 2 for the following reasons:

1. The benefits of hardening projects are wholly

dependent on the number, type, and overall impact of future storms to impact Tampa Electric’s service territory. Different storms have dramatically different impact to Tampa Electric’s system, for instance, in review of Tampa Electric’s historical storm reports, it was observed that tropical storm events even 100 to 150 miles away from Tampa Electric’s service territory from the Gulf side have greater impact in terms of restoration costs than larger storms 100 to 150 miles away on the Florida or Atlantic side. This is mainly caused by the energy that exists in the storm bands when they reach Tampa Electric’s service territory. For this reason, the resilience-based planning approach includes the ‘universe’ of potential major events that could impact Tampa Electric over the next 50 years, this is the Major Storms Event Database. In relation to the conceptual model showing the phases of resilience (Figure 2), I will discuss how the probabilities and system impacts of storm events were developed later in my testimony.

2. Major events cause assets to fail. Assets collectively serve customers. It only takes one asset failure to cause customer outages. The cost

to restore the failed assets is dependent on the extent of the damage and resources used to fix the system. The duration to restore affected customers is dependent on the extent of the asset damage and the extent of the damage on the rest of the system. It may only take 4 hours to fix the failed equipment, but customers could be without service for 4 days if crews are busy fixing other parts of the system for 3 days and 20 hours. All of this is dependent on the type of storm to impact the system. Modeling this series of events, the phases of resilience from Figure 2, for the entire system at the asset and project level for both a Status Quo and Hardened scenarios is needed to accurately model hardening project benefits. Therefore, the resilience-based planning approach includes the Storm Impact Model to calculate the phases of asset and project resilience for each of the 99 storm events for both scenarios. I discuss core data and calculations of the Storm Impact Model to develop the phases of resilience for every asset, project, program, and plan in further detail below in my testimony.

3. The output of the Storms Impact Model is the resilience benefit of each project for each of the 99 storm types. The life-cycle resilience benefit for each hardening project is dependent on the probability of each storm, and the mix of storm events to occur over the life of the hardening projects. A project's resilience value comes from mitigating outages and associated restoration costs not just for one storm event, but from several over the life-cycle of the assets. A future 'world' of major storm events could include a higher frequency of category 1 storms with average level impact and a low frequency of tropical storms with higher impacts. Alternatively, it could include a low frequency of category 1 type storms with high impact and a high frequency of tropical storms with lower impacts. The number of storm combination scenarios is significant given there are 13 unique types of storm events. To model this range of combinations, the Storm Restoration Model employs stochastic modeling, or Monte Carlo Simulation, to randomly select from the 99 storm events to create a future 'world' of the 13 unique storm events to hit Tampa Electric's service territory. The Monte Carlo

Simulation creates a 1,000-future storm "worlds". From this, the life-cycle resilience benefit of each hardening project can be calculated in the Resilience Benefit Module, I discuss this in more detail below in my Testimony.

4. To answer the questions of how much hardening investment is prudent and where that investment should be made, it was necessary to include a Budget Optimization and Scheduling Model within the Storm Resilience Model. The Budget Optimization algorithm develops the project plan and associated benefits over a range of budget levels to identify a point of diminishing returns where additional investment provides very little return. The Project Scheduling component uses the preferred budget level and develops an executable plan by prioritizing projects that provide the most benefit while balancing Tampa Electric's technical constraints. I outline this in more detail below.

3. MAJOR STORMS EVENT DATABASE

Q20. Please provide an overview of the Major Storms Event Database and how it was developed.

A20. The Major Storms Event Database includes the 'universe' of storm events that could impact Tampa Electric's service territory over the next 50 years. The database describes the phases of resilience (Figure 2) for Tampa Electric's high-level system perspective for a range of storm stressors. It was developed collaboratively between Tampa Electric and 1898 & Co. It utilizes information from the National Oceanic and Atmospheric Administration ("NOAA") database of major storm events, Tampa Electric's historical storm reports, available information on the impact of major storms to other utilities, and Tampa Electric's experience in storm recovery. From that information, 13 unique storm types were observed to impact Tampa Electric's service territory. For each of the storm types, various storm scenarios were developed to capture the range of probabilities and impacts of each storm type. In total, 99 storms scenarios were developed to capture the 'universe' of storm events to impact Tampa Electric's service territory. Table 3 below provides a summary of the Major Storms Event Database. The table includes the ranges of probabilities, restoration costs, impact to the system, and duration of the event.

Table 3: Major Storms Event Database Overview

Storm Type No.	Scenario Name	Annual Probability (Percent)	Restoration Costs (Millions)	System Impact (Laterals) (Percent)	Total Duration (Days)
1	Cat 3 Direct Hit-Gulf	1.0 - 2.0	306.0 - 1,224.0	60.0 - 70.0	17.4 - 34.5
2	Cat 1&2 Direct Hit-Florida	5.0 - 8.0	76.5 - 153.0	35.0 - 55.0	6.0 - 8.8
3	Cat 1&2 Direct Hit-Gulf	2.0 - 4.0	153.0 - 306.0	45.0 - 60.0	8.7 - 12.9
4	TS Direct Hit	16.5	25.5 - 76.5	12.5 - 31.3	2.6 - 5.3
5	TD Direct Hit	14.5	5.1 - 15.3	6.3 - 15.6	2.0 - 3.6
6	Localized Event Direct Hit	50.0	0.5 - 1.5	1.3 - 3.1	0.3 - 0.6
7	Cat 3 Partial Hit	3.0 - 4.0	91.8 - 184.0	36.0 - 48.0	6.4 - 9.2
8	Cat 1&2 Partial hit	7.0	15.3 - 91.8	8.5 - 28.0	2.3 - 6.9
9	TS Partial Hit	17.0 - 18.0	11.5 - 30.6	8.0 - 15.0	2.0 - 3.6
10	TD Partial Hit	12.0 - 15.0	0.4 - 3.1	2.0 - 3.8	1.5 - 2.7
11	Cat 3 Peripheral Hit	2.0 - 3.0	0.8 - 22.2	1.2 - 14.1	1.0 - 3.0
12	Cat 1&2 Peripheral Hit	10.0 - 11.0	0.6 - 8.9	0.9 - 6.5	0.9 - 2.3
13	TS Peripheral Hit	11.0 - 12.0	0.5 - 3.8	0.7 - 3.4	0.9 - 1.3

Q21. What does the NOAA data show on the number and types of major storm events to impact Tampa Electric's service territory?

A21. The National Oceanic and Atmospheric Administration (NOAA) includes a database of major storm events over 169 years, beginning in 1852. The NOAA major events database was mined for all major event types up to 150 miles from Tampa Electric's service territory center. The 150-mile radius was selected since many hurricanes can have diameters of 300 miles where some of the hurricane storm bands impact a significant portion of Tampa Electric’s service territory. Additionally, the database was mined for the category of the storm as it hit Tampa Electric’s service territory. The analysis of NOAA’s database was done for the following types of storm categories:

- **‘Direct Hits’** – 50 Mile Radius from the Gulf and Florida directions. The max wind speeds hit all or significant portions of Tampa Electric’s service territory twice, once from the front end and again on the back end of the storm. Additionally, the wind speeds cause all the assets and vegetation to move in one direction as the storm comes in and in the opposite direction as it moves out. This double exposure to the system causes significant system failures.
- **‘Partial Hits’** – 51 to 100 Mile Radius. At this radius, the storm bands hit a significant portion of Tampa Electric’s service territory. Wind speeds are typically at their highest at the outer edge of the storm bands. The storm passes through the territory once, so to speak, minimizing damage relative to a ‘direct hit’. For large category

storms, the 'Partial Hit' could still cause more damage than a 'Direct Hit' small storm.

- **'Peripheral Hits'** – 101 to 150 Mile Radius. Since hurricanes can be 300 miles wide in diameter, some of the storm bands can hit a fairly large portion of the system even if the main body of the storm misses the service area.

Table 4 below includes the summary results from the NOAA database of storms to hit or nearly hit Tampa Electric's service territory since 1852.

Table 4: Historical Storm Summary from NOAA

Event Type	Direct Hits Gulf	Direct Hits Florida	Direct Hits Total	Partial Hits	Peripheral Hits	Total
Cat 5	0	0	0	0	0	0
Cat 4	0	1	1	0	1	2
Cat 3	0	1	1	5	4	10
Cat 2	4	1	5	2	8	15
Cat 1	6	6	12	14	8	34
Tropical Storm	12	20	32	30	29	91
Tropical Depression	10	8	18	17	N/A	35
Total	32	37	69	68	50	187

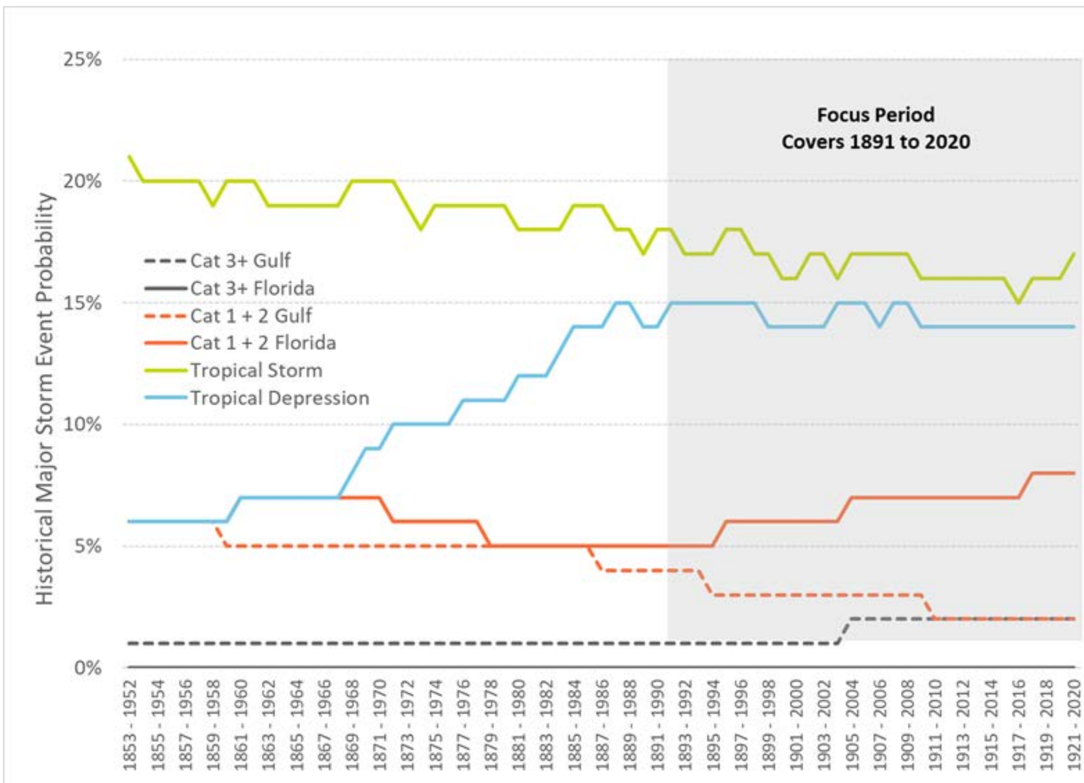
Source: https://coast.noaa.gov/hurricanes/ with analysis by 1898 & Co.

Table 4 shows a total of 187 storms to hit the Tampa area since 1852. A total of 69 were direct hits within 50 miles, 68 were partial hits in the 51 to 100-mile radius, and 50 were peripheral hits in the 101 to 150 mile radius. The table also shows very few category 4 and above events, 2 out of 187, with one 'Direct Hit'. While there are 10 Category 3 type storms, only 1 is a 'Direct Hit'. Nearly 20 percent of the events are Category 1 Hurricanes. Almost two thirds of the events are Tropical Storms or Tropical Depressions. For direct hits, the results show approximately 46 percent of the events come from the Gulf of Mexico while the other 54 percent come over Florida.

Q22. What analysis of this historical storm information was done to determine the storm probability ranges?

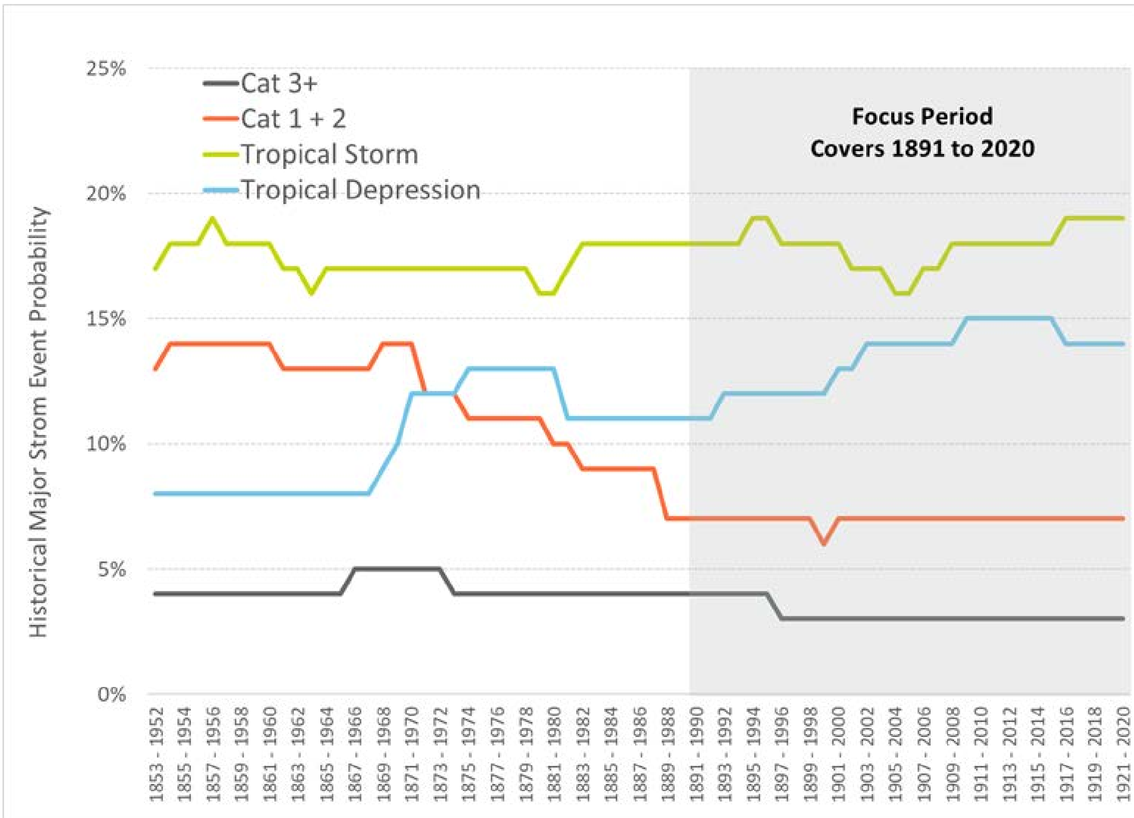
A22. 1898 & Co. converted the storm information from Table 4 above to show the total storm count for 100-year rolling average starting with the period of 1852 to 1951 ending with the period 1920 to 2020. This provides 70 distinct 100 year periods. This was done for each of the 13 unique storm events. The counts of each 100-year period for each storm type were then converted to probabilities. Starting on the page below, Figure 3, Figure 4, and Figure 5 show the 100-year rolling storm probability for "direct hits" (50 miles), "partial hits" (51 to 100 miles), and "peripheral hits" (101 – 150 miles), respectively.

Figure 3: "Direct Hits" (50 Miles) 100 Year Rolling Probability



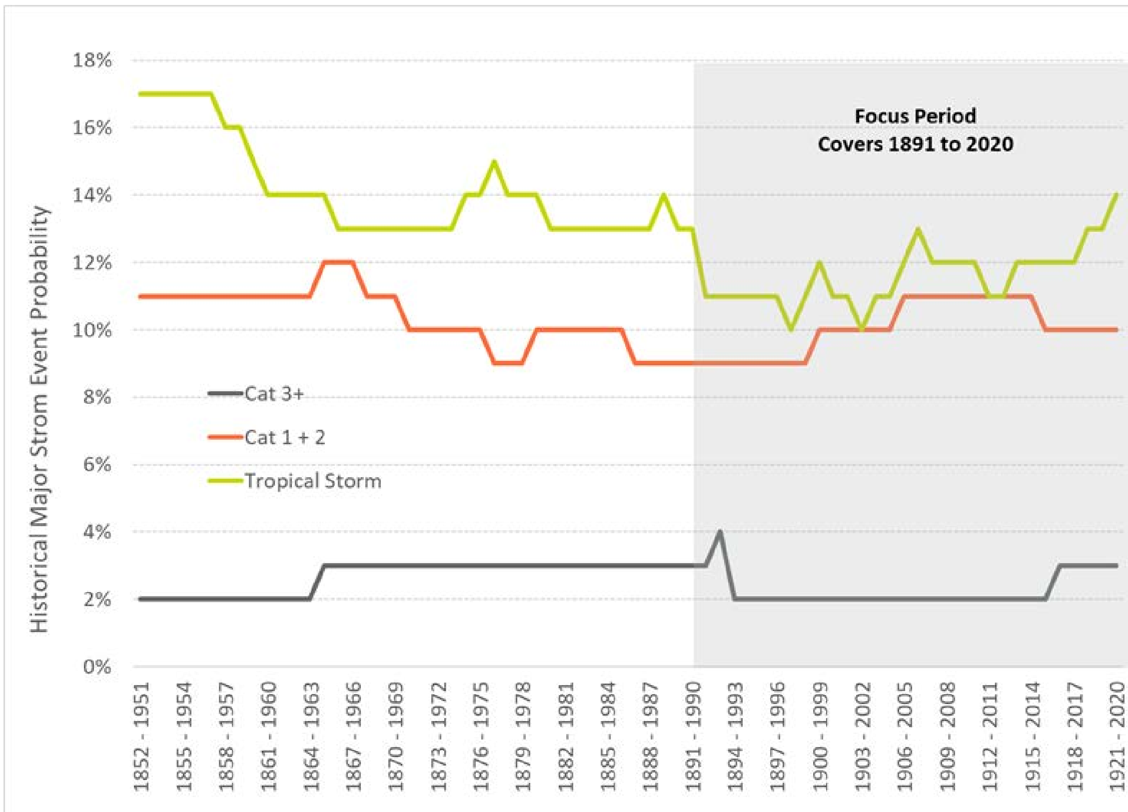
Source: https://coast.noaa.gov/hurricanes/ with analysis by 1898 & Co.

Figure 4: "Partial Hits" (51 to 100 Miles) 100 Yr. Rolling Probability



Source: https://coast.noaa.gov/hurricanes/ with analysis by 1898 & Co.

Figure 5: "Peripheral Hits" (51 to 100 Miles) 100 Yr. Rolling Probability



Source: https://coast.noaa.gov/hurricanes/ with analysis by 1898 & Co.

Each of the figures show a relative stability in the 100-year probability levels for the last 30 periods corresponding to storm events from 1891 through 2020. This time horizon served as the basis for developing the probability ranges for the 13 unique storm events.

Q23. How were the storm impact ranges developed?

A23. The range of system impacts for each storm scenario were developed based on historical storm reports from Tampa Electric and augmented by Tampa Electric's team experience with historical storm events. The database includes events that have not recently impacted Tampa Electric's service territory. The approach followed an iterative process of filling out more known impact information from recent events and developing impacts for those events without impact data based on their relative storm strength to the more known events.

4. STORM IMPACT MODEL

Q24. Please provide an overview of the Storm Impact Model.

A24. The Storm Impact Model describes the phases of resilience, Figure 2, for each potential hardening project on Tampa Electric's T&D system for each storm stressor scenario from the Major Storms Event Database. Specifically, it identifies, from a weighted perspective, the particular laterals, feeders, transmission lines, access sites, and substations that fail for each type of storm in the Major Storms Event Database. The model also estimates the restoration costs associated with the specific sub-system failures and calculates the impact to customers in terms of CMI. Finally, the Storm Impact Model models each storm event for both the Status Quo and Hardened scenario. The Hardened scenario assumes the assets that make up each project have been hardened. The Storm Impact Model then calculates the benefit of each hardening project from a reduced restoration cost, CMI, and monetized CMI perspective.

Q25. You have mentioned that the Storm Resilience Model employs a data-driven decision-making methodology. Please describe what core data sets that are in the model and how they are used in the resilience benefit calculation.

A25. The Storm Impact Model utilizes a robust and sophisticated set of data and algorithms at a very granular system level to model the benefits of each hardening project for each storm scenario. Tampa Electric's data systems include a connectivity model that allows for the linkage of three foundational data sets used in the Storm Impact Model – the Geographical Information System ("GIS"), the Outage Management System ("OMS"), and Customer Count/Customer Type.

GIS - The GIS provides the list of assets in Tampa

Electric's system and how they are connected to each other. Since the resilience-based approach is fundamentally an asset management bottom-up based methodology, it starts with the asset data, then rolls all the assets up to projects, and all projects up to programs, and finally the programs up to the Storm Protection Plan. The strategic assignment of assets to projects and the value of the approach is discussed above.

OMS - The OMS includes detailed outage information by cause code for each protection device over the last 20 years. The Storm Impact Model utilized this information to understand the historical storm related outages for the various distribution laterals and feeders on the system to include Major Event Days ("MED"), vegetation, lightening, and storm-based outages. The OMS served as the link between customer class information and the GIS to provide the Storm Impact Model with the information necessary to understand how many customers and what type of customers would be without service for each project. The OMS data also served as the foundation for calculating benefits for feeder automation projects.

Customer - The third foundational data set is customer count and customer type information that featured connectivity to the GIS and OMS systems. This allowed the Storm Impact Model to directly link the number and type of customers impacted to each project and the project's assets. This customer information is included for every distribution asset in Tampa Electric's system. The customer information is used within the Storm Impact Model to calculate each storm's CMI (customers affected * outage duration) for each lateral or feeder project.

Vegetation Density - The vegetation density for each overhead conductor is a core data set for identifying and prioritizing resilience investment for the circuit assets since vegetation blowing into conductor is the primary failure mode for major storm event for Tampa Electric. The Storm Impact Model calculates the vegetation density around each transmission and distribution overhead conductor (approximately 240,000 spans) utilizing tree canopy data and geospatial analytics.

Wood Pole Condition - A compromised, or semi-compromised, pole will fail at lower dynamic load levels then poles with their original design strength. The Storm Impact Model utilizes wood pole inspection data within 1898 & Co.'s asset health algorithm to calculate an Asset Health

Index (“AHI”) and ‘effective’ age for each pole.

Wind Zones - Wind zones have been created across the United States for infrastructure design purposes. The National Electric Safety Code (“NESC”) provides wind and ice loading zones. The zones show that wind speeds are typically higher closer to the coast and lower further inland. The Storm Impact Model utilizes the provided wind zone data from the public records and the asset geospatial location from GIS to designate the appropriate wind zone.

Accessibility - The accessibility of an asset has a tremendous impact on the duration of the outage and the cost to restore that part of the system. Rear lot poles take much longer to restore and cost more to restore than front lot poles. The Storm Impact Model performs a geospatial analysis of each structure to identify if there is road access or if the asset is in a deep right-of-way (“ROW”).

Flood Modeling - The model also includes detailed storm surge modeling using the SLOSH model. The SLOSH models perform simulations to estimate surge heights above ground elevation for various storm types. The simulations are based on historical, hypothetical, and predicted hurricanes. The model uses a set of physics equations applied to the specific location shoreline, Tampa in this case, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features to establish surge height. These results are simulated several thousand times to develop the Maximum of the Maximum Envelope of Water, the worst-case scenario for each storm category. The SLOSH model results were overlaid with the location of Tampa Electric's 255 substations to estimate the height of above the ground elevation for storm surge. The SLOSH model identified 59 substations with flooding risk depending on the hurricane category. Tampa Electric performed a more detailed assessment of the 59 substation and identified nine (9) for hardening improvement.

Q26. What were the results of the vegetation density algorithm?

A26. Figure 6 and Figure 7 below show the range of vegetation density for overhead ("OH") Primary and Transmission Conductor, respectively. The figures rank the conductors from highest to lowest level of vegetation density. As shown in the figures, approximately 30 to 35 percent of the OH Primary and Transmission Conductor have near zero tree canopy coverage, while approximately 65 to 70 percent have some level of coverage all the way up to 100 percent coverage.

Figure 6: Vegetation Density on Primary Conductor

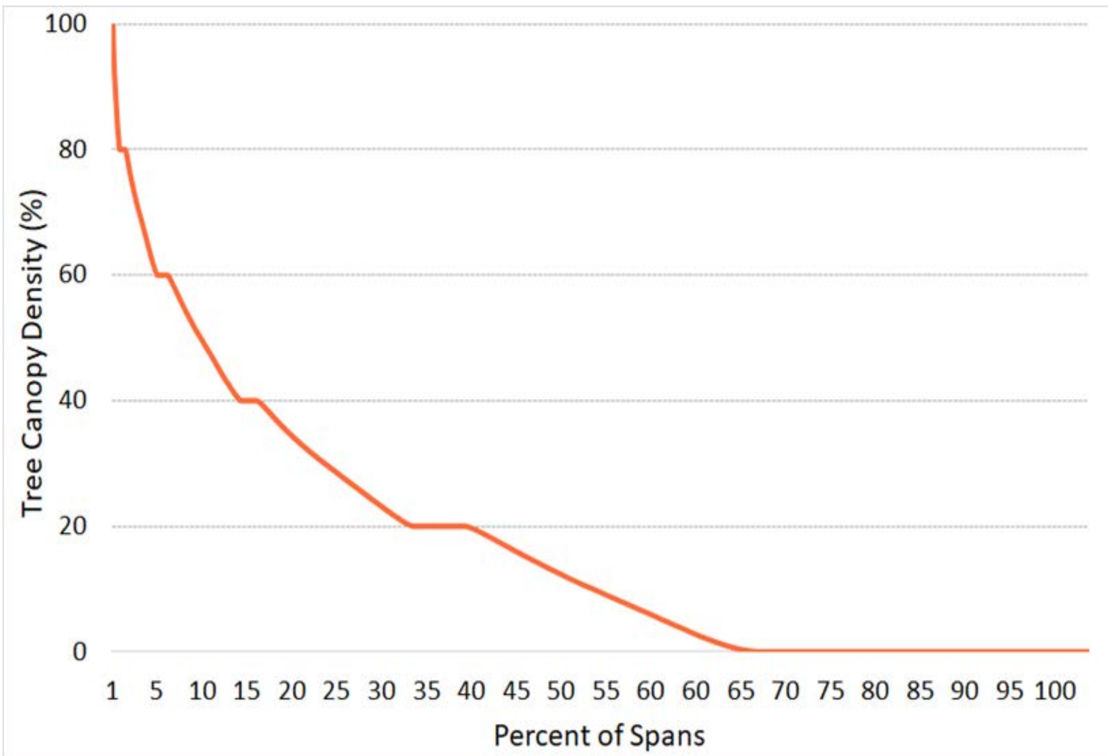
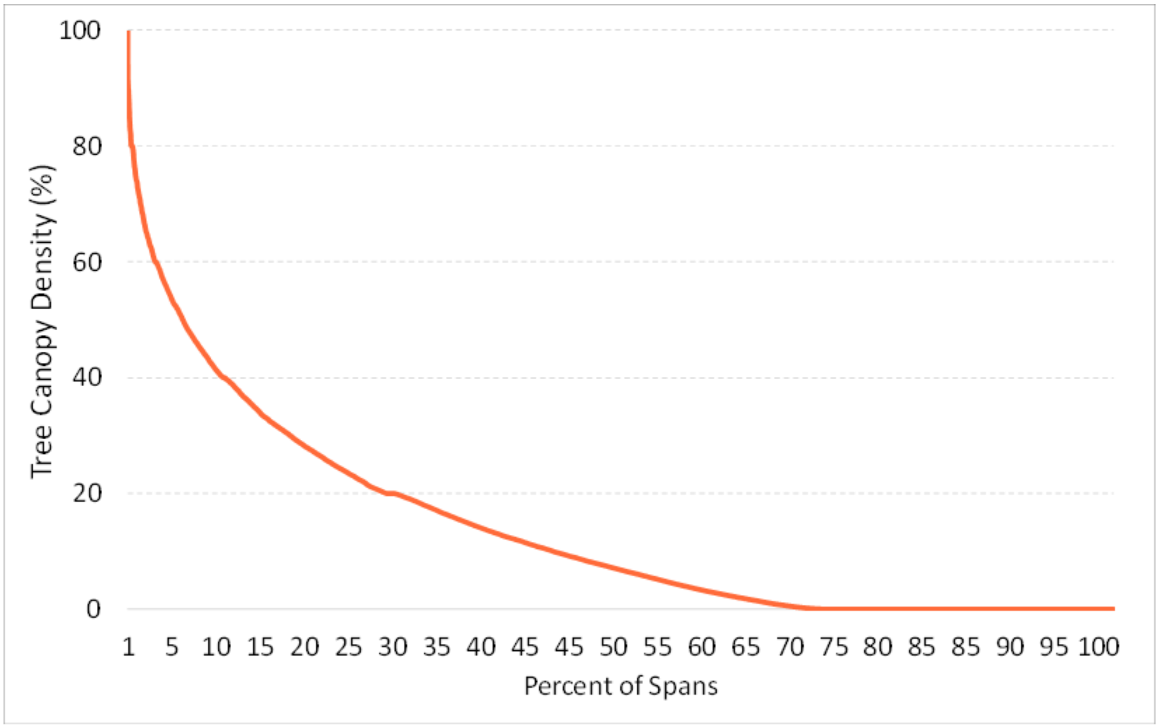


Figure 7: Vegetation Density on Transmission Conductor



Q27. How are asset and system failures during major storm events identified in the Storm Impact Model hardening projects?

A27. The Storm Impact Model identifies system failures based on the primary failure mode of the asset base. The model identifies the parts of the system that are likely to fail given the specific storm event from the Major Storms Event Database.

For circuits, the main cause of failure is wind blowing vegetation onto conductor causing conductor or structures to fail. If structures (i.e., wood poles) have any deterioration, for example rot, they are more susceptible to failure. The Storm Impact Model calculates a storm LOF score for each asset based on a combination of the vegetation rating, age and condition rating, and wind zone rating. The vegetation rating factor is based on the vegetation density around the conductor. The age and condition rating utilizes expected remaining life curves with the asset's 'effective' age, determined using condition data. The wind zone rating is based on the wind zone that the asset is located within. The Storm Impact Model includes a framework that normalizes the three ratings with each other to develop one overall storm LOF score for all circuit assets. The project level scores are equal to the sum of the asset scores normalized for length. The project level scores are then used to rank each project against each other to identify the likely lateral, backbone, or transmission circuits to fail for each storm type. The model estimates the weighted storm LOF based on the asset level scoring.

The model determines which substations are likely to flood during various storm types based on the flood modeling analysis. That analysis provides the flood level, meaning feet of water above the site elevation, for various storm types. Only the storm scenarios with hurricanes coming from the Gulf of Mexico provide the necessary condition for storm surge that would cause substation flooding.

The site access dataset includes a hierarchy of the impacted circuits. Using this hierarchy, each site access LOF is equal to the total LOF of the circuits it provides access to.

Q28. How are restoration costs allocated to the asset base for each major storm events?

A28. Storm restoration costs were calculated for every asset in the Storm Protection Model including wood poles, overhead primary, transmission structures (steel, concrete, and lattice), transmission conductors, power transformers, and breakers. The costs were based on storm restoration cost multipliers above planned replacement costs. These multipliers were developed by Tampa Electric and 1898 & Co. collaboratively. They are based on the expected inventory constraints and foreign labor resources needed for the various asset types and storms. For each storm event, the restoration costs at the asset level are aggregated up to the project level and then weighted based on the project LOF and the overall restoration costs outlined in the Major Storms Event Database.

Q29. How are customer outage durations calculated in the model for each major storm event?

A29. Since circuit projects are organized by protection device, the customer counts and customer types are known for each asset and project in the Storm Impact Model. The time it will take to restore each protection device, or project, is calculated based on the expected storm duration and the hierarchy of restoration activities. This restoration time is then multiplied by the known customer count to calculate the CMI. The CMI benefit are also monetized.

Q30. Why were CMI benefits monetized?

A30. The CMI benefits were monetized for project prioritization purposes. The Storm Impact Model calculates each hardening project's CMI and restoration cost reduction for each storm scenario. In order to prioritize projects, a single prioritization metric is needed. Since CMI is in minutes and restoration costs is in dollars, the resilience-based planning approach monetized CMI. The monetized CMI benefit is combined with the restoration cost benefit for each project to calculate a total resilience benefit in dollars.

Q31. How was the CMI benefit monetized?

A31. CMI was monetized using DOE's ICE Calculator. The ICE Calculator is an electric outage planning tool developed by Freeman, Sullivan & Co. and Lawrence Berkeley National Laboratory. This tool is designed for electric reliability planners at utilities, government organizations or other entities that are interested in estimating interruption costs and/or the benefits associated with reliability or resilience improvements in the United States. The ICE Calculator was funded by the Office of Electricity Delivery and Energy Reliability at the U.S. Department of Energy ("DOE"). The ICE calculator incudes the cost of an outage for different types of customers. The calculator was extrapolated for the longer outage durations associated with storm outages. The extrapolation includes diminishing costs as the storm duration extends. These estimates for outage cost for each customer are multiplied by the specific customer count and expected duration for each storm for each project to calculate the monetized CMI at the project level.

Q32. How are the storm specific resilience benefits calculated for each project by major storm event?

A32. The Storm Impact Model calculates the storm restoration costs and CMI for the 'Status Quo' and Hardening Scenarios for each project by each of the 99 storm events. The delta between the two scenarios is the benefit for each project. This is calculated for each storm event based on the change to the core assumptions (vegetation density, age & condition, wind zone, flood level, restoration costs, duration, and customers impacted) for each project.

The output from the Storm Impact Model is a project-by-project probability-weighted estimate of annual storm restoration costs, annual CMI, and annual monetized CMI for both the 'Status Quo' and Hardened Scenarios for all 99 major storm scenarios. The following section describes the methodology utilized to model all 99 major storms and calculate the resilience benefit of each project.

5. RESILIENCE BENEFIT MODULE

Q33. Please provide an overview of the Resilience Benefit Calculation Module

A33. The Resilience Benefit Calculation Module of the Storm Resilience Model uses the annual benefit results of the Storm Impact Model and the estimated project costs to calculate the net benefits for each project. Since the benefits for each project are dependent on the type and frequency of major storm activity, the Resilience Benefit Module utilizes stochastic modeling, or Monte Carlo Simulation, to randomly select a thousand future worlds of major storm events to calculate the range of both 'Status Quo' and Hardened restoration costs and CMI. The benefit calculation is performed over a 50-year time horizon, matching the expected life of hardening projects.

The feeder automation hardening project resilience benefit calculation employs a different methodology given the nature of the project and the data available to calculate benefits. The OMS includes 20 years of historical data. The resilience benefit is based on the expected decrease in impacted customers if the automation had been in place.

Q34. What economic assumptions are used in the life-cycle Resilience Benefit Module?

A34. The resilience net benefit calculation includes the following economic assumptions.

- 50 year time horizon – most of the hardening infrastructure will have an average service life of 50 or more years.
- Two (2) percent escalation rate
- Six (6) percent discount rate

Q35. How were hardening project costs determined?

A35. Project costs were estimated for approximately 14,000 projects in the Storm Resilience Model. Some of the project costs were provided by Tampa Electric while others were estimated using the data within the Storm Resilience Model to estimate scope (asset counts and lengths) that were then multiplied by unit cost estimates to calculate the project costs.

Distribution Lateral Undergrounding – The GIS and accessibility algorithm calculated the following scope items for each of the lateral undergrounding projects:

- Miles of overhead conductor for 1, 2, and 3 phase laterals

- Number of overhead line transformers, including number of phases, that need to be converted to pad mounted transformers
- Number of meters connected through the secondary via overhead line.

Tampa Electric provided unit costs estimates, which are multiplied by the scope activity (asset counts and lengths) to calculate the project cost. The unit cost estimates are based on supplier information and previous undergrounding projects.

Transmission Asset Upgrades - The Transmission Asset Upgrades program project costs are based on the number of wood poles by class, type (H-Frame vs monopole), and circuit voltage. Tampa Electric provided unit cost estimates for each type of pole to be replaced. The project costs equal the number wood poles on the circuit multiplied by the unit replacement costs.

Substation Extreme Weather Hardening - The project costs for the Substation Extreme Weather Hardening program are based on a report done by a third-party for Tampa Electric to evaluate substation hardening initiatives, such as raising control houses.

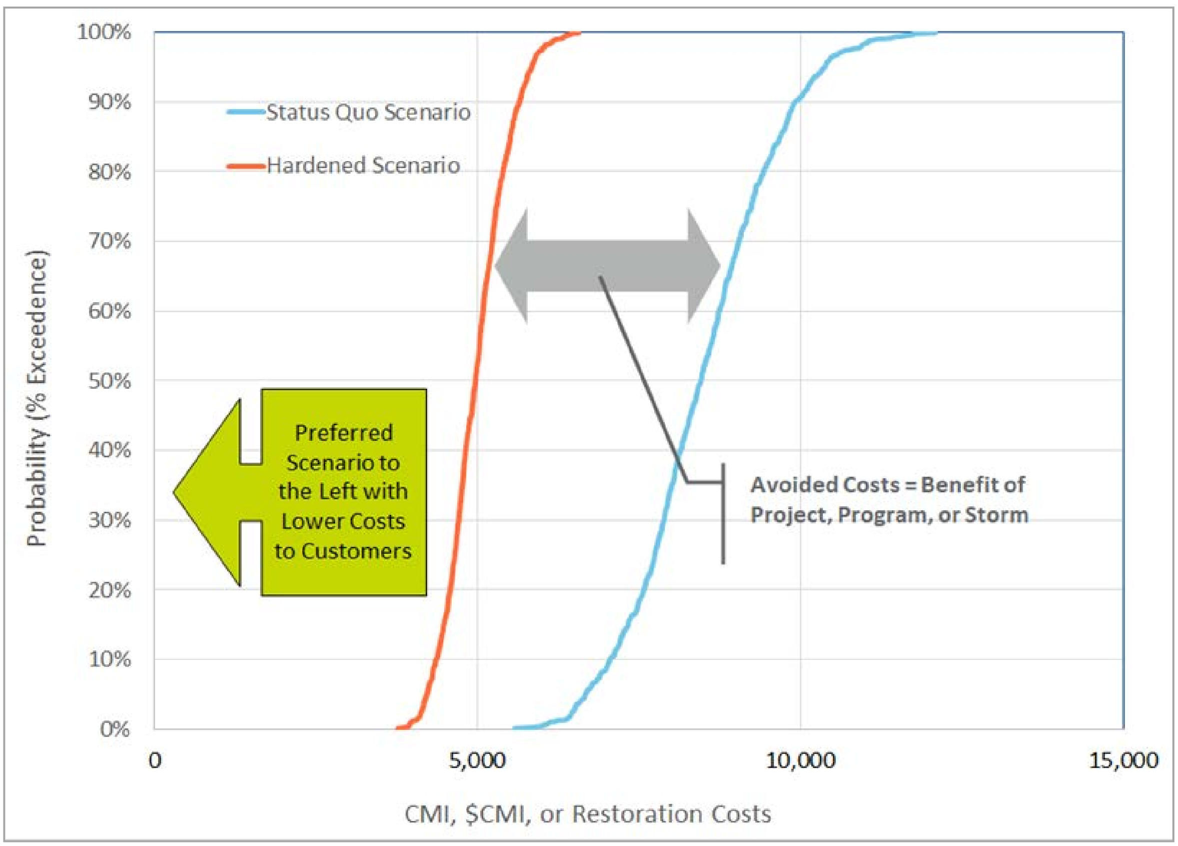
Distribution Overhead Feeder Hardening - The distribution overhead feeder hardening project costs are based on the number of wood poles that don't meet current design standards for storm hardening and the cost to include automation. Tampa Electric provided unit replacement costs based on the accessibility of the pole as well as the cost to add automation to each circuit. Automation hardening cost estimates include the cost to add reclosers, pole replacements, re-conductor portions of the line, and substation upgrades that may be needed to handle load transfer. The remaining circuits costs were based on the average of these values.

Transmission Access Enhancements – Tampa Electric provided all the project costs for the Transmission Access Enhancements as developed by a third-party.

Q36. How are the resilience results of the Monte Carlo Simulation displayed and how should they be interpreted?

A36. The results of the 1,000 iterations are graphed in a cumulative density function, also known as an 'S-Curve'. In layman's terms, the thousand results are sorted from lowest to highest (cumulative ascending) and then charted. Figure 8 below shows an illustrative example of the 1,000 iteration simulation results for the 'Status Quo' and Hardened Scenarios.

Figure 8: Status Quo and Hardened Results Distribution Example



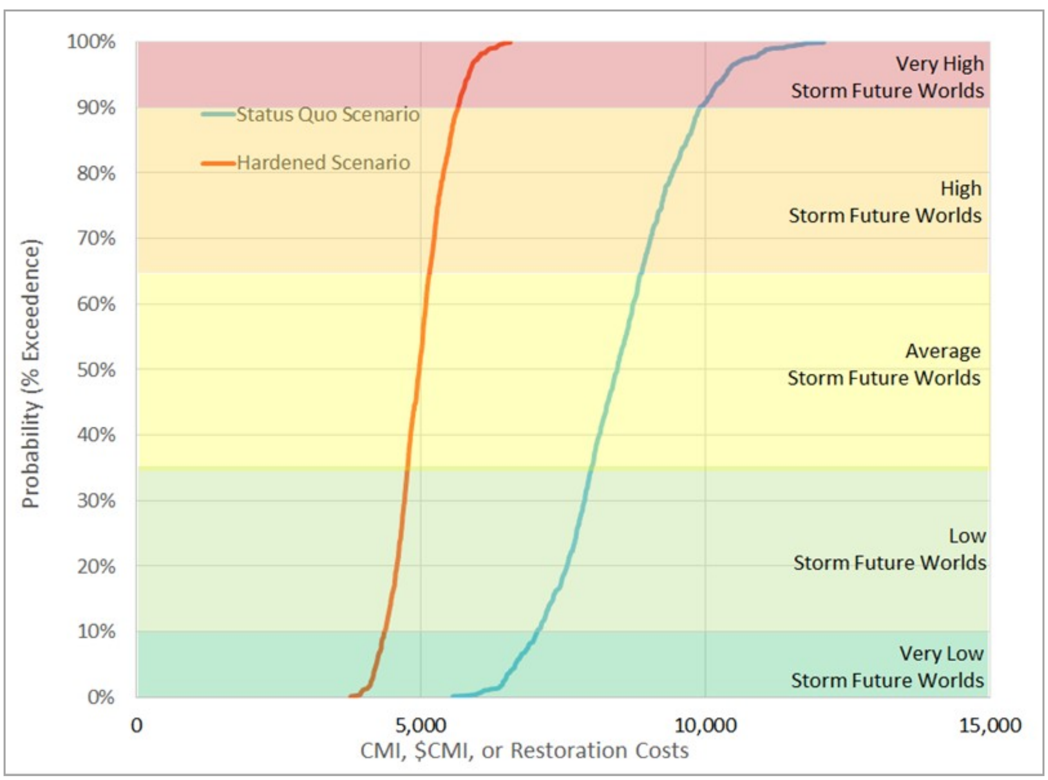
Since the figure shows the overall cost (in minutes or dollars) to customers, the preferred scenario is the S-Curve further to the left. The gap or delta between the two curves is the overall benefit.

The S-Curves typically have a linear slope between the P10 and P90 values with 'tails' on either side. The tails show the extremes of the scenarios. The slope of the line shows the variability in results. The steeper the slope (i.e., vertical) the less range in the result. The more horizontal the slope the wider the range and variability in the results.

Q37. How do S-Curves map to potential Future Storm Worlds?

A37. Figure 9 below provides additional guidance on understanding the S-Curves and the kind of future storm worlds they represent.

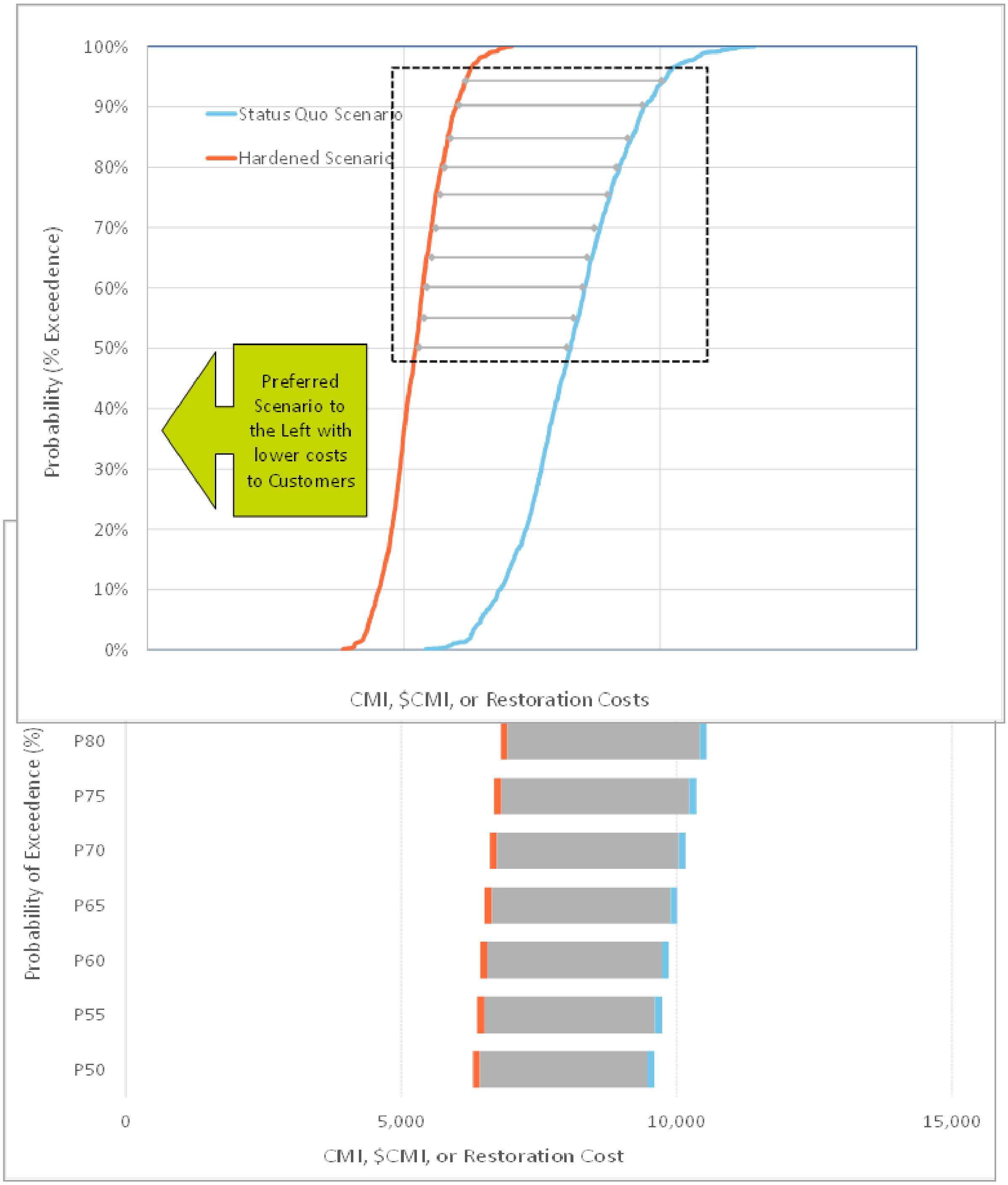
Figure 9: S-Curves and Future Storms



Q38. How are the S-Curves used to display the resilience benefit results?

A38. For the storm resilience evaluation, the top portion of the S-curves is the focus as it includes the average to very high storm futures, this is referred to as the resilience portion of the curve. Rather than show the entire S-curve, the resilience results will show specific P-values to highlight the gap between the 'Status Quo' and Hardened Scenarios. Additionally, highlighting the specific P-values can be more intuitive. Figure 10 below illustrates this concept of looking at the top part of the S-curves and showing the P-values.

Figure 10: S-Curves and Resilience Focus



Q39. Please describe the analysis to calculate resilience benefit for automation hardening projects.

A39. While many of the other Storm Protection Programs provide resilience benefit by mitigating outages from the beginning, feeder automation projects provide resilience benefit by decreasing the impact of a storm event, the 'pit' of the resilience conceptual model described in Figure 2.

The resilience benefit for feeder automation was estimated using historical Major Event Day ("MED") outage data from the OMS. MED is often referred to as 'grey-sky' days as opposed to non-MED which is referenced as 'blue-sky' days. Tampa Electric has outage records going back 20 years. The analysis assumes that future MED outages for the next 50 years will be similar to the last 20 years.

For the resilience benefit calculation, the Storm Resilience Model re-calculates the number of customers impacted by an outage, assuming that feeder automation had been in place. The Storm Resilience Model extrapolates the 20 years of benefit calculation to 50 years to match the time horizon of the other projects. Additionally, the CMI was monetized and discounted over the 50-year time horizon to calculate the net present value ("NPV"). The NPV calculation assumed a replacement of the reclosers in year 25; the rest of the feeder automation investment has an expected life of 50 years or more. The monetization and discounted cash flow methodology was performed for project prioritization purposes.

Q40. Please provide an example of this calculation.

A40. A historical outage may include a down pole from a storm event, causing the substation breaker to lock out resulting in a four-hour outage for 1,500 customers, or 360,000 CMI (4*1500*60). The Storm Resilience Model re-calculates the outages as 400 customers without power for four hours, or 96,000 CMI. That example provides a reduction in CMI of over 70 percent.

Q41. What are the benefit results of this analysis for the automation hardening projects?

A41. Figure 11 and Figure 12 below show the percent decrease in CMI and monetized CMI for all circuits ranked from highest to lowest from left to right. The figures also include the benefits to all outages.

Figure 11: Automation Hardening Percent CMI Decrease

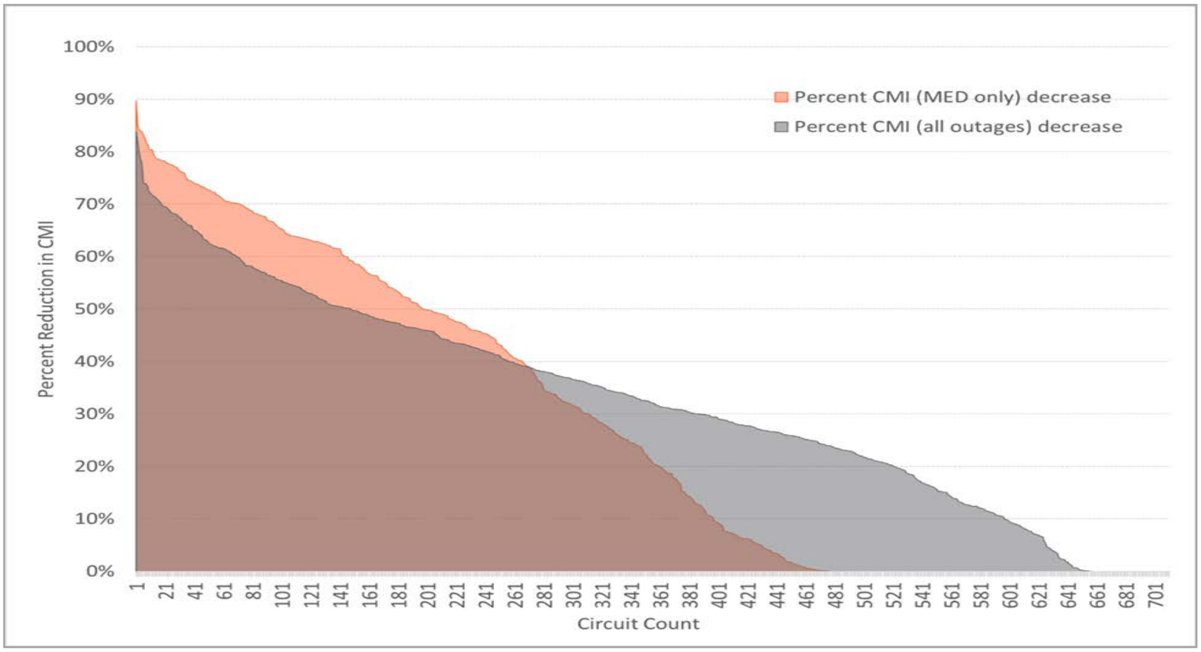
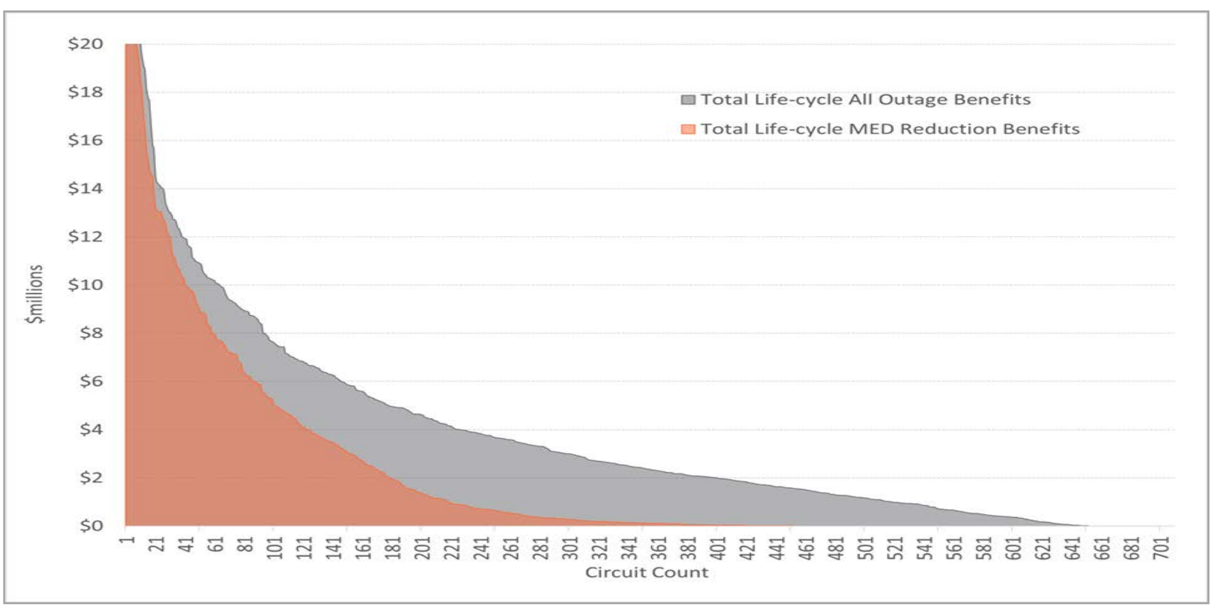


Figure 12: Automation Hardening Monetization of CMI Decrease



Q42. What are the specific outputs from the Resilience Benefit

module?

A42. The Resilience Benefit Module includes the following values for each project:

- CMI 50-year Benefit
- Restoration Cost 50-year NPV Benefit
- Life-cycle 50 year NPV gross Benefit (monetized CMI benefit + restoration cost benefit)
- Life-cycle 50 year NPV net Benefit (monetized CMI benefit + restoration cost benefit – project costs)

Each of these values includes a distribution of results from the 1,000 iterations. For ease of understanding and in alignment with the resilience-based strategy, the approach focuses on the P50 and above values, specifically considering:

- P50 – Average Storm Future
- P75 – High Storm Future
- P95 – Extreme Storm Future

6. BUDGET OPTIMIZATION AND PROJECT SCHEDULEING

Q43. How were hardening projects prioritized?

A43. All the projects are evaluated and prioritized using the same criteria allowing all 13,855 projects to be ranked against each other and compared. The Storm Resilience Model ranks all the projects based on their benefit cost ratio using the life-cycle 50 year NPV gross benefit value listed above. The ranking is performed for each of the P-values (P50, P75, and P95) as well as a weighted value.

Performing prioritization for the four benefit cost ratios is important since each project has a different slope in their benefits from P50 to P95. For instance, many of the lateral undergrounding projects have the same benefit at P50 as they do at P95. Alternatively, many of the transmission asset hardening projects are minorly beneficial at P50 but have significant benefits at P75 and even more at P95. Tampa Electric and 1898 & Co. settled on a weighting on the three values for the base prioritization metric, however, investment allocations are adjusted for some of the programs where benefits are small at P50 but significant at P75 and P95.

Q44. How and why was the budget optimization performed?

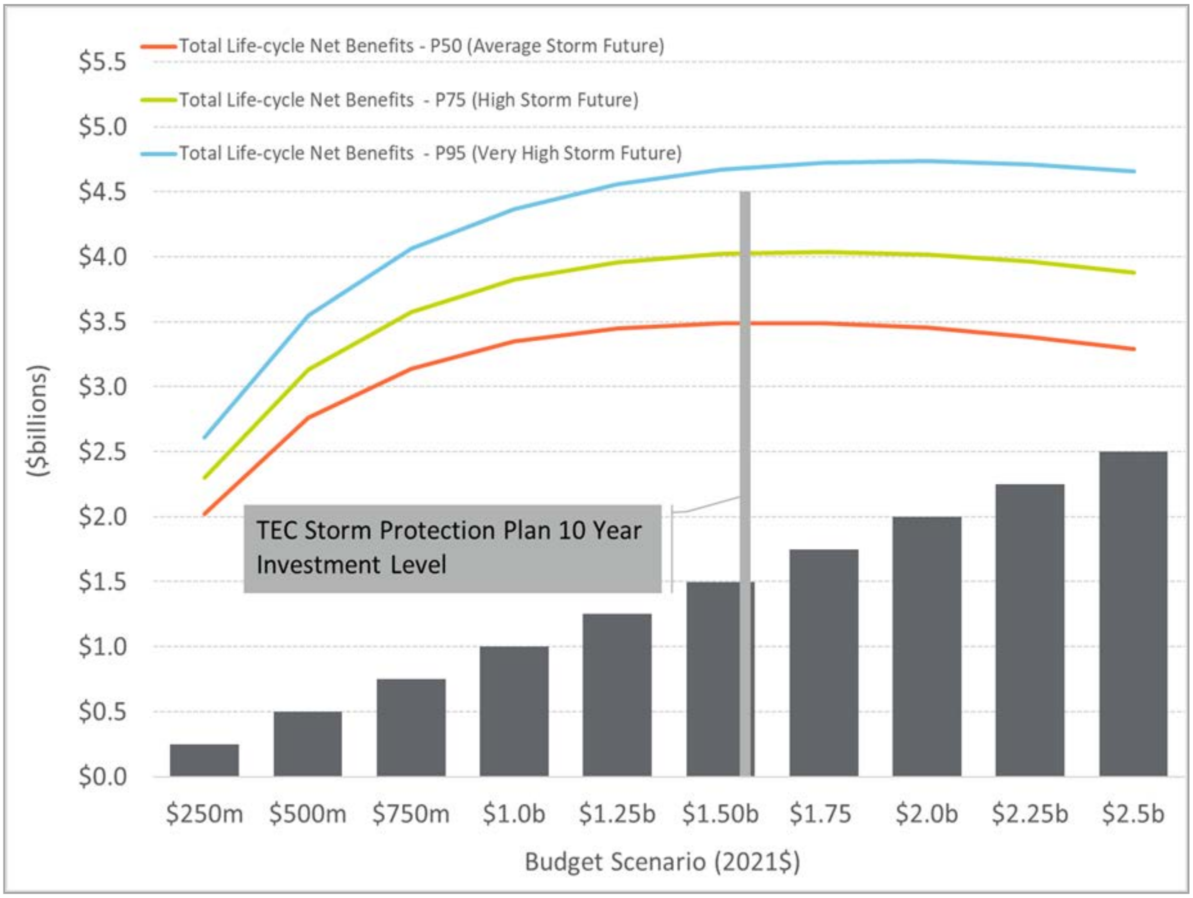
A44. The Storm Resilience Model performs project prioritization across a range of budget levels to identify the appropriate level of resilience investment.

The goal is to identify where 'low hanging' resilience investment exists and where the point of diminishing returns occurs. Given the total level of potential investment the budget optimization analysis was performed in $250 million increments up to $2.5 billion. For each budget level, the optimization model selects the projects with the highest benefit cost ratio to hardening in the next 10 years. The model then strategically groups projects by type of program and circuit. For instance, all the selected laterals on a circuit are scheduled for undergrounding in the same year. This allows Tampa Electric to gain capital deployment efficiencies by deploying resources to the same geographical area at one time.

Q45. What were the results of the budget optimization analysis?

A45. Figure 13 below shows the results of the budget optimization analysis. The figure shows the total life-cycle gross NPV benefit for each budget scenario for P50, P75, and P95.

Figure 13: Budget Optimization Results



The figure shows significantly increasing levels of net benefit from the $250 million to $1.25 billion with the benefit level flattening from $1.25 billion to $1.75 billion and decreasing from $1.75 billion to $2.5 billion.

Q46. What conclusions can be made from the results of the budget optimization analysis?

A46. The budget optimization results show that Tampa Electric's overall investment level is right before the point of diminishing returns showing that Tampa Electric's plan has an appropriate level of investment capturing the hardening projects that provide the most value to customers.

Q47. How was the overall investment level set and projects selected?

A47. Tampa Electric and 1898 & Co. used the Storm Resilience Model as a tool for developing the overall budget level and the budget levels for each category. It is important to note that the Storm Resilience Model is only a tool to enable more informed decision making. While the Storm Resilience Model employs a data-driven decision-making approach with robust set of algorithms at a granular asset and project level, it is limited by the availability and quality of assumptions. In developing Tampa Electric's Storm Protection Plan project identification and schedule, the Tampa Electric and 1898 & Co team factored in the following:

- Resilience benefit cost ratio including the weighted, P50, P75, and P95 values.
- Internal and external resources available to execute

investment by program and by year.

- Lead time for engineering, procurement, and construction
- Transmission outage and other agency coordination.
- Asset bundling into projects for work efficiencies.
- Project coordination (i.e., project A before project B, project Y and project Z at the same time)

7. RESILIENCE BENEFIT RESULTS

Q48. What is the investment profile of the Storm Protection Plan?

A48. Table 5 below shows the Storm Protection Plan investment profile. The table includes the buildup by program to the total. The investment capital costs are in nominal dollars, the dollars of that day. The overall plan is approximately $1.59 billion. Distribution Lateral Undergrounding makes up most of the total, accounting for 67.6 percent of the total investment. Overhead Feeder Hardening is second, accounting for 20.0 percent. Transmission Asset Upgrades makes up approximately 8.8 percent of the total, with Substation Extreme Weather Hardening and Transmission Access Enhancement site access making up 1.7 percent and 2.0 percent, respectively.

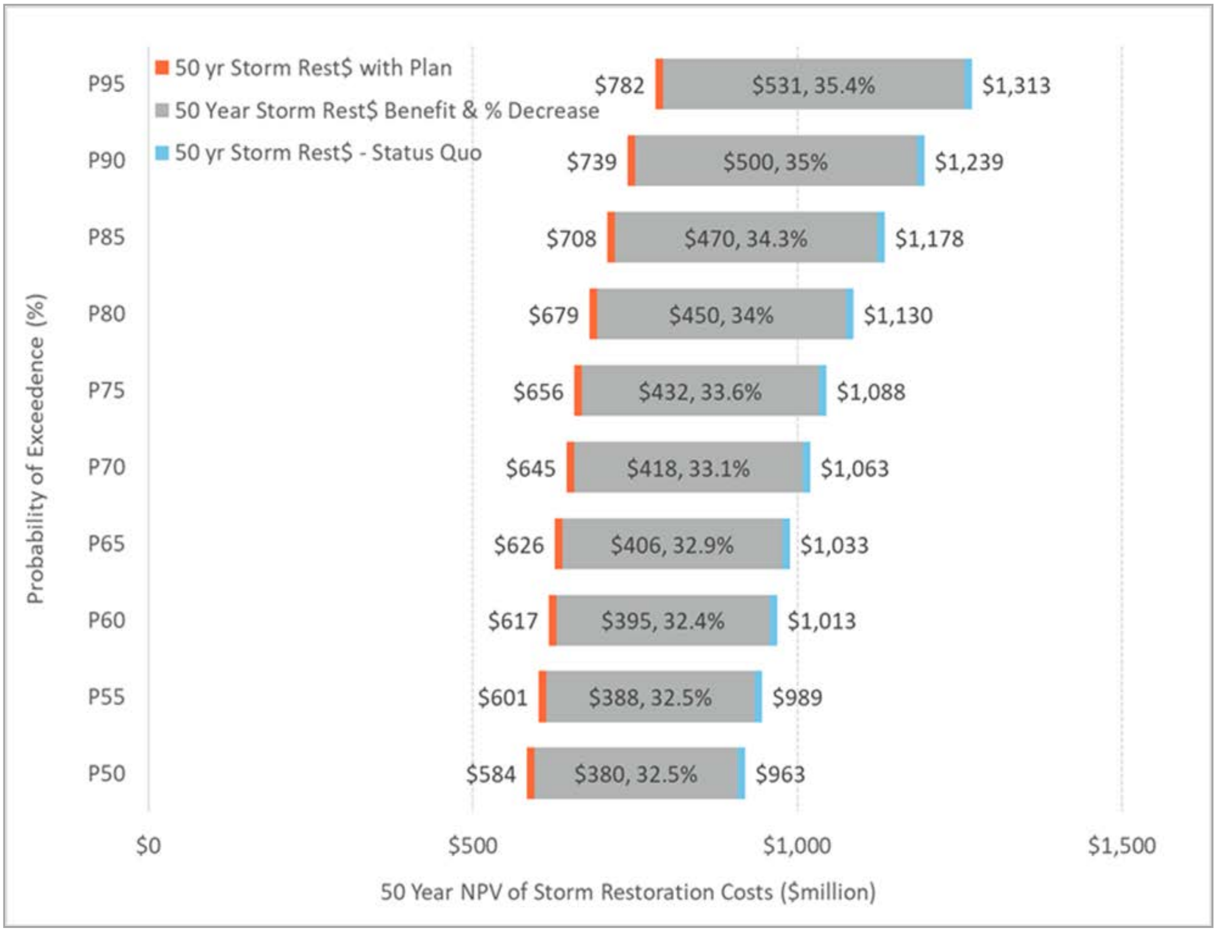
Table 5: Storm Protection Plan Investment Profile by Program (Nominal $000)

Year	Distribution Lateral Undergrounding	Transmission Asset Upgrades	Substation Extreme Weather Hardening	Overhead Feeder Hardening	Transmission Access Enhancement	Total
2022	$105,600	$16,500	$0	$33,300	$2,400	$157,800
2023	$104,500	$17,500	$700	$29,900	$3,000	$155,600
2024	$105,700	$17,500	$4,300	$30,000	$3,000	$160,500
2025	$105,100	$17,900	$2,700	$30,000	$3,700	$159,400
2026	$105,000	$18,200	$3,300	$30,000	$3,400	$159,900
2027	$105,600	$16,900	$2,900	$30,000	$3,400	$158,800
2028	$105,600	$17,300	$4,800	$30,000	$3,100	$160,800
2029	$105,600	$17,200	$700	$30,000	$2,800	$156,300
2030	$115,400	$0	$7,200	$37,000	$2,000	$161,600
2031	$115,400	$0	$900	$37,000	$4,400	$157,700
Total	$1,073,500	$139,000	$27,500	$317,200	$31,200	$1,588,400

Q49. What are the restoration cost benefits of the plan?

A49. Figure 14 below shows the range in restoration cost reduction at various probability of exceedance levels. As a refresher, the P50 to P65 level represents a future world in which storm frequency and impact are close to average, the P70 to P85 level represents a future world where storms are more frequent and intense, and the P90 and P95 levels represent a future world where storm frequency and impact are all high.

Figure 14: Storm Protection Plan Restoration Cost Benefit

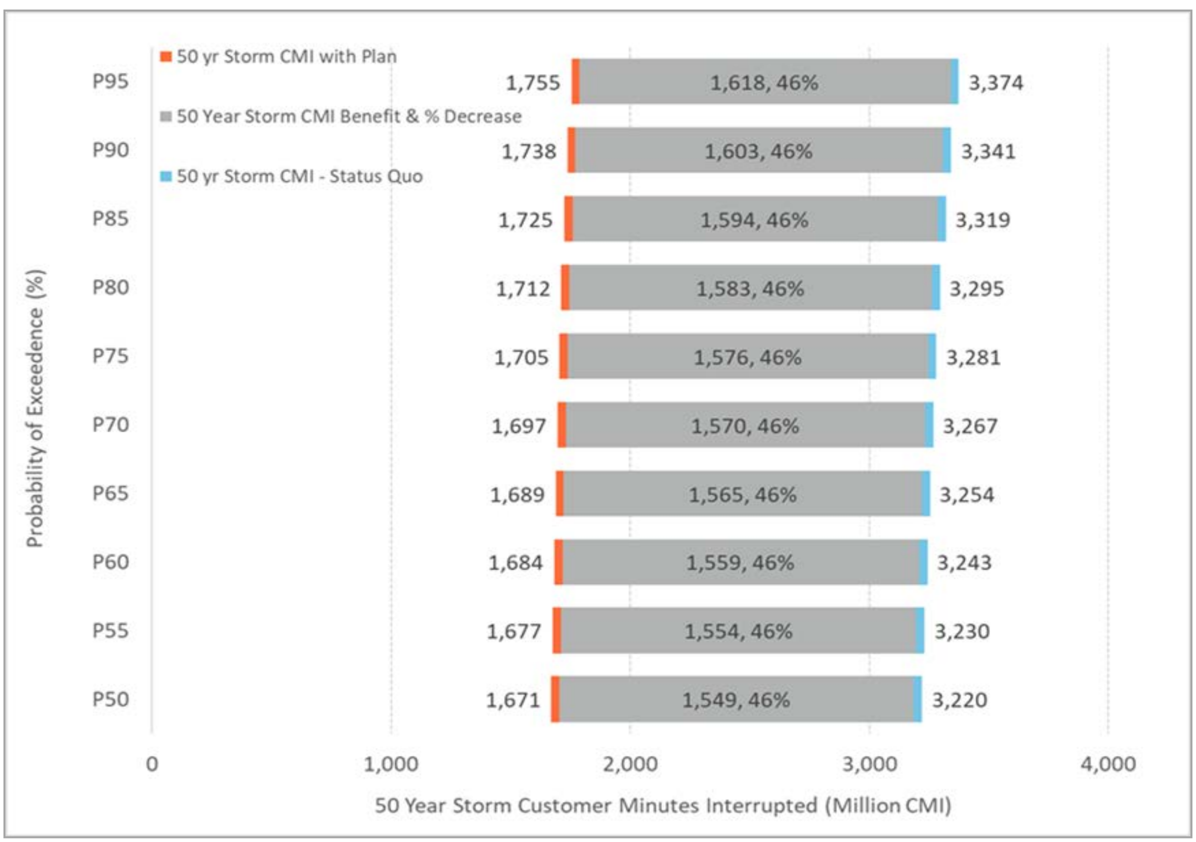


The figure shows that the 50-year NPV of future storm restoration costs in a Status Quo scenario from a resilience perspective is $960 million to $1,310 million. With the Storm Protection Plan, the costs decrease by approximately 33 to 35 percent. The decrease in restoration costs is approximately $380 to $530 million. From an NPV perspective, the restoration costs decrease benefit is approximately 24 to 33 percent of the project costs.

Q50. What are the customer outage benefits of the plan?

A50. Figure 15 below shows the range in CMI reduction at various probability of exceedance levels. The figure shows relative consistency in benefit level across the P-values with approximately 46 percent decrease in the storm CMI over the next 50 years.

Figure 15: Storm Protection Plan Customer Benefit



Q51. What are the key take-aways from how resilience-based

planning assessment was performed?

A51. The follow are the key take-aways from how the resilience-based planning assessment was performed in the Storm Resilience Model:

- **Customer and Asset Centric:** The model is foundationally customer and asset centric in how it "thinks" with the alignment of assets to protection devices and protection devices to customer information (number, type, and priority). Further, the focus of investment to hardening all asset weak links that serve customers shows that the Storm Resilience Model is directly aligned with the intent of the statute to identify hardening projects that provide the most benefit to customers. Additionally, with this customer and asset centric approach, the specific benefits required by the statute can be calculated, restoration cost saving and impact to customers in terms of CMI, more accurately.
- **Comprehensive:** The comprehensive nature of the assessment is best practice; by considering and evaluating nearly the entire T&D system the results of the hardening plan provide confidence that portions of Tampa Electric's system are not

overlooked for potential resilience benefit.

- **Consistency:** The model calculates benefits consistently for all projects. The model carefully normalizes for more accurate benefits calculation between asset types. For example, the model can compare a substation hardening project to a lateral undergrounding project. This is a significant achievement allowing the assessment to perform project prioritization across the entire asset base for a range of budget scenarios. Without this capability, the assessment would not have been able to identify a point of diminishing returns, balance restoration and CMI benefits, and calculate benefits on the same basis for the entire plan.
- **Rooted in Cause of Failure:** The Storm Resilience Model is rooted in the causes of asset and system failure from two perspectives. Firstly, the Major Storms Event Database outlines the range of storm stressors and the high level impact to the system. Secondly, the detailed data streams and algorithms within the Storm Impact Model are aligned with how assets fail, mainly vegetation density, asset condition, wind zone, and flood modeling. With this basis, hardening investment identification and prioritization provides a robust assessment to focus

investment on the portions of the system that are more likely to fail in the major storm.

- **Drives Prudency:** The assessment and modeling approach drive prudency for the Storm Protection Plan on two main levels. Firstly, the granularity of potential hardening projects, over 20,000, allows Tampa Electric to invest in the portions of the system that provide the model value to customers. Without granularity, there is risk that parts of the system "ride the coat-tails" of needed investment causing efficient allocation of limited capital resources. Secondly, the budget optimization allows for the identification of the point of diminishing returns so that over investment in storm hardening is less likely.
- **Balanced:** Hardening projects include mitigation measures over all the four phases of resilience providing a diverse investment plan. Since storm events cannot be fully eliminated, the diversification allows Tampa Electric to provide a higher level of system resilience for customers.

Q52. What conclusions can be made from the results of the resilience analysis?

A52. The following include the conclusions of Tampa Electric's

Storm Protection Plan evaluated within the Storm Resilience Model:

- The overall investment level of $1.59 billion for Tampa Electric’s Storm Protection Plan is reasonable and provides customers with maximum benefits. The budget optimization analysis (see Figure 13) shows the investment level is right before the point of diminishing returns.
- Tampa Electric’s Storm Protection Plan results in a reduction in storm restoration costs of approximately 33 to 35 percent. In relation to the plan’s capital investment, the restoration costs savings range from 24 to 33 percent depending on future storm frequency and impacts.
- The customer minutes interrupted decrease by approximately 46 percent over the next 50 years. This decrease includes eliminating outages all together, reducing the number of customers interrupted, and decreasing the length of the outage time.
- The cost (Investment – Restoration Cost Benefit) to purchase the reduction in storm customer minutes interrupted is in the range of $0.65 to $0.78 per minute. This is below outage costs from the DOE ICE Calculator and lower than typical ‘willingness to

pay' customer surveys.

- Tampa Electric's mix of hardening investment strikes a balance between investment in the substations and transmission system targeted mainly at increasing resilience for the high impact/low probability events and investment in the distribution system, which is impacted by all ranges of event types.
- The hardening investment will provide additional 'blue sky' benefits to customers not factored into this report.

8. CONCLUSION

Q53. Does this conclude your prepared verified direct testimony?

A53. Yes.