- Includes grid modernization resiliency measures that emphasize automation as an efficient and cost-effective approach to improve transmission and distribution ("T&D") performance during resiliency events.
- Results from Guidehouse's benefit-cost analysis ("BCA") indicate that, overall, the benefits of these measures significantly outweigh the costs and, in most cases, the benefits outweigh costs over the life of the individual measure. Further, in many cases there is additional qualitative value that supports inclusion of the measure in CenterPoint Houston's Resiliency Plan. These findings indicate that CenterPoint Houston's Resiliency Plan will provide positive value to the customers and communities it serves. Guidehouse further notes that several resiliency measures are complementary, such that additional benefits are realized when resiliency measures are combined. For example, pole replacements that are proposed on distribution circuits where intelligent grid switching devices ("IGSD") schemes or TripSaver® are proposed will yield greater benefits than on a standalone basis.
- Guidehouse's benchmark survey of peer utility resiliency planning practices indicates that CenterPoint Houston's proposed resiliency measures are generally consistent with those deployed at peer utilities.

To summarize, Guidehouse's risk and BCA analysis confirms that each resiliency measure is either cost-effective based on the calculated BCA ratio or otherwise provides qualitative benefits that support their inclusion in CenterPoint Houston's Resiliency Plan. Further, Guidehouse's benchmark survey of peer utility resiliency planning practices indicates that CenterPoint Houston's proposed resiliency measures are generally consistent with those deployed at peer utilities.

II. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND CURRENT POSITION.

A. My name is Eugene L. Shlatz. I have been employed in various capacities by Guidehouse Inc. (Guidehouse)[1] since 1999, including twelve years as a Director in Guidehouse's Energy, Sustainability, and Infrastructure Practice. My business address is 70 South Winooski Ave., Burlington, Vermont.

Q. PLEASE SUMMARIZE YOUR BACKGROUND AND CURRENT RESPONSIBILITIES.

A. I hold Bachelor's and Master's degrees in Electric Power Engineering from Rensselaer Polytechnic Institute and am a registered Professional Engineer in Vermont, specializing in electrical engineering. I am a member of the Institute of Electrical and Electronics Engineers ("IEEE") and previously was a Section Chair in the State of Vermont.

I have more than 35 years' experience in electric utility operations, engineering, and pricing. I have been responsible for numerous technical and economic studies of electric supply and reliability for investor-owned, municipal, and cooperative electric utilities throughout North America and worldwide. My experience most relevant to resiliency planning includes evaluation of electric system reliability and resiliency, distribution system planning and design, electric operations, and capital planning.

I have worked for Guidehouse over the past 23 years, with responsibility for managing studies of electric utility system reliability and resiliency, renewable energy, and advanced energy systems. Prior to my tenure at Guidehouse, I was employed by Green Mountain Power, an electric utility based in Vermont, in various positions of increasing

[1] Previously, Navigant Consulting, Inc.

responsibility, including Director of Engineering and Operations, where I was responsible for the planning, design, and operation of Green Mountain Power's generation, transmission, and distribution systems. I recently retired from Guidehouse, but continue to offer the same services that I previously provided as a full-time consultant.[2] I have supported filings before federal, state, and Canadian provincial regulatory commissions on a range of electric utility matters, including system planning and operations, reliability and resiliency, renewables integration, and retail and wholesale rates. My full experience is provided in Exhibit ELS-1.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of CenterPoint Energy Houston Electric, LLC ("CenterPoint Houston").

Q. IS GUIDEHOUSE'S ANALYSIS AND REVIEW OF CENTERPOINT HOUSTON's RESILIENCY PLAN INDEPENDENT AND UNBIASED?

A. Yes. Guidehouse regularly consults for electric investor-owned, municipal, and cooperative utilities in addition to state and federal agencies. As a matter of practice, Guidehouse is committed to maintaining an independent and unbiased approach to its engagements. Specific to our analysis and review of CenterPoint Houston's Resiliency Plan, we took the following steps to maintain independence:

- Performing a critical assessment of CenterPoint Houston's proposed resiliency measures to those adopted by other utilities that have successfully implemented resiliency measures. Recommendations were provided to further improve CenterPoint Houston's proposed resiliency measures;

[2] Mr. Shlatz currently is assigned Contingent Worker status by Guidehouse.

- Quantifying benefits via a rigorous fact-based approach, using data collected from CenterPoint Houston from prior storms and applying forecasted risk to determine the value each resiliency measure is expected to provide in terms of mitigating the impacts of extreme weather events on CenterPoint Houston's transmission and distribution system;
- Conducting a forecast of weather variability and hazards using independent sources, absent direct input or advice from CenterPoint Houston on the methods applied;
- Comparing CenterPoint Houston's resiliency measures to those of leading utility practices obtained from an independent survey of electric utility resiliency programs conducted by a reputable firm with expertise in benchmarking; and
- Proposing metrics reporting and measures of effectiveness that CenterPoint Houston and the Public Utility Commission of Texas ("Commission") can rely on to determine if CenterPoint Houston's proposed resiliency measures are enhancing the resiliency of CenterPoint Houston's transmission and distribution system and reducing impacted customers, restoration times, and restoration costs due to an outage caused by a resiliency event.

Q. HAVE YOU TESTIFIED PREVIOUSLY?

A. Yes. I have testified before state utility commissions on electric reliability and resiliency, distribution system planning, system design, emergency storm response, and the approval of capital projects proposed for inclusion in electric rates. I have also testified before the Federal Energy Regulatory Commission on Transmission Open Access and the United States Congress on Grid Modernization recommendations for the Island of Puerto Rico to

address damage caused by Hurricane Maria. On resiliency matters, I have testified in Illinois, Kentucky, Arizona, Ontario, and Vermont. Previously, I was the Chief Storm Officer responsible for emergency restoration while employed by Green Mountain Power. My full testimony experience before regulatory agencies appear is provided in Exhibit ELS-1.

III. OVERVIEW OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to provide an overview of Guidehouse's independent analysis and review of CenterPoint Houston's Resiliency Plan with a focus on proposed operations and physical security resiliency measures. My testimony that follows provides evidence that the operations and physical security resiliency measures CenterPoint Houston proposes over the years 2025 through 2027 are reasonable and appropriate to include in its Resiliency Plan. Specially, my testimony and exhibits confirm that CenterPoint Houston's proposed operations and physical security resiliency measures and the corresponding resiliency-focused investments can provide value to customers and communities located within its service area by reducing impacted customers, restoration times, and restoration costs due to an outage caused by a resiliency event. My testimony also supports the direct testimony of Mr. Brad Tutunjian as it relates to the evaluation and justification of each CenterPoint Houston Resiliency Plan operations or physical security resiliency measure for which it seeks approval from the Commission.

Q. WHAT QUALIFICATIONS DOES GUIDEHOUSE HAVE AS AN INDEPENDENT EXPERT IN RESILIENCY PLANNING FOR ELECTRIC UTILITIES?

A. Guidehouse has conducted several engagements addressing resiliency planning, each of

which I had direct responsibility for managing or providing subject matter expertise. Examples include:

1. **Duke Energy Florida** – Guidehouse conducted a detailed analysis of storm hardening investment to support two successive Storm Protection Plans that were approved by the Florida Public Service Commission. Several of the measures approved by the Florida Commission are similar to those proposed by CenterPoint Houston.
2. **New Jersey Board of Public Utilities ("NJBPU")** – Guidehouse was engaged by the NJBPU to conduct an independent investigation of Jersey Central Power & Light's emergency storm procedures, restoration practices, and resiliency measures to address customer interruptions caused by Hurricane Sandy. Guidehouse's recommendations were approved by the NBJPU.
3. **AEP Kentucky Power** – Guidehouse recently assessed Kentucky Power's storm reliability performance and proposed measures to enhance distribution system resiliency. Our assessment included an electric utility benchmark survey similar to the benchmarking of resiliency measures described later in my testimony. I appeared as expert witness on behalf of Kentucky Power in a rate filing before the Kentucky Public Service Commission.
4. **Commonwealth Edison** – Guidehouse conducted an independent assessment of Commonwealth Edison's maintenance and operational practices in response to an investigation by the Illinois Commerce Commission ("ICC") to address customer interruptions during major storms. I appeared as an expert witness before the ICC

in this matter.[3]

Q. WHAT EXHIBITS HAVE YOU INCLUDED WITH YOUR TESTIMONY?

A. I have prepared or supervised the preparation of the exhibits listed in the table of contents, including Exhibit ELS-2 which is a full-length report for Guidehouse's Independent Analysis and Review of CenterPoint Energy Houston Electric's Resiliency Plan. With regards to Exhibit ELS-2, my responsibility was primarily focused on the assessment of natural disaster and other extreme weather threats and review of operations and physical security resiliency measures considered for inclusion in CenterPoint Houston's Resiliency Plan.

Q. WHAT INFORMATION IS CONTAINED IN THE GUIDEHOUSE REPORT PROVIDED AS EXHIBIT ELS-2?

A. The Guidehouse report includes:

- **Background** – Guidehouse's understanding of resiliency risks CenterPoint Houston must manage and the policy context for how Texas and other states are addressing resiliency of the electric system.
- **Purpose of Guidehouse's Analysis and Review** – Overview of Guidehouse's qualification as an independent expert on resiliency planning for electric systems as well as the objectives and approach taken to perform Guidehouse's independent analysis and review of CenterPoint Houston's Resiliency Plan.
- **Resiliency Risk Analysis** – Independent assessment of resiliency risks facing CenterPoint Houston's service area due to natural disaster, cybersecurity, and

[3] In Docket No. 11-0662, the Illinois Commerce Commission determined that Commonwealth Edison was entitled to a waiver of liability under section 16-125(e)(1) where the evidence demonstrated that the great majority of the power interruptions that occurred were the result of "unpreventable damage due to weather events or conditions.", Commonwealth Edison Company Petition for Review of Orders of the Illinois Commerce Commission in Docket Nos. 11-0588 and 11-0662, July 31, 2014.

physical security threats and vulnerabilities. The assessment includes evaluation of historical weather-driven resiliency events, human threats (including cyber threats to CenterPoint Houston's IT/OT systems), as well as forecasting of weather-driven risk based on historical data and climate trends.

- **Resiliency Plan Review** – Independent review of CenterPoint Houston's Resiliency Plan, including benchmarking against best practices in resiliency planning among peer utilities, analysis of potential benefits for resiliency measures included in the Resiliency Plan, and recommendations provided to CenterPoint Houston based on this review.
- **Benchmark Survey** – Results of independent survey of industry resiliency programs and practices covering a range of measures, many of which are similar to those proposed by CenterPoint Houston.
- **Summary Findings and Recommendations** – Summary of the findings, conclusions, and recommendations from Guidehouse's independent analysis and review.

Q. WHAT WERE THE OBJECTIVES OF GUIDEHOUSE'S ANALYSIS AND REVIEW OF CENTERPOINT HOUSTON'S RESILIENCY PLAN?

A. The purpose of Guidehouse's independent analysis and review of CenterPoint Houston's Resiliency Plan is to present evidence of the potential need and value of resiliency-focused investments for CenterPoint Houston's service area.

Specific objectives included:

1. Advise CenterPoint Houston on best practices in electric utility resilience planning based on Guidehouse industry expertise and experience working with utilities in

other jurisdictions on resiliency planning efforts;

2. Provide independent analysis of weather-driven and human threat risks faced by CenterPoint Houston, including a forward-looking forecast of weather-driven risk considering climate trends, which could be used as evidence of the potential need for investments that address specific resiliency events; and
3. Conduct an independent review and analysis of CenterPoint Houston's Resiliency Plan, including all resiliency measures under initial consideration by CenterPoint Houston, to help inform CenterPoint Houston's selection and prioritization of resiliency measures to pursue. This includes a comparison of proposed Resiliency Plan resiliency measures to those adopted by electric utilities in regions most susceptible to extreme weather events.

Q. HAVE YOU REVIEWED THE DIRECT TESTIMONIES OF OTHER CENTERPOINT HOUSTON WITNESSES PROVIDING DIRECT TESTIMONY IN THIS DOCKET?

A. Yes. I have reviewed the testimonies of CenterPoint Houston witnesses Jason Ryan, Brad Tutunjian, Ronald Bahr, and Jeff W. Garmon. My testimony is consistent with and supports the findings and conclusions provided by each witness, particularly for Mr. Tutunjian, who addresses each of CenterPoint Energy's proposed operations and physical security resiliency measures. I have also reviewed the testimony of Guidehouse witness Dr. Joseph Baugh, who addresses technology and cybersecurity measures included in CenterPoint Houston's Resiliency Plan.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. My testimony is organized as follows: First, I provide a summary of Guidehouse's

independent analysis of resiliency risk attributed to natural disaster threats and other extreme weather events for CenterPoint Houston's service area, including a summary of how historical evidence and its current and forecasted risk profile justifies the need for resiliency investments. Then, I provide a summary of Guidehouse's independent review and analysis of CenterPoint Houston's Resiliency Plan for operations and physical security resiliency measures including qualitative and quantitative evidence of how those measures can provide benefits to customers and communities served by CenterPoint Houston. Next, I present the results of an independent survey of electric utilities that have implemented resiliency measures. Finally, I summarize the findings and recommendations made by Guidehouse to CenterPoint Houston based on our independent analysis and review of its Resiliency Plan related to operations and physical security measures and projects.

IV. INDEPENDENT ANALYSIS OF RESILIENCY RISK FOR CENTERPOINT HOUSTON

Q. WHAT APPROACH DID GUIDEHOUSE FOLLOW TO CONDUCT ITS ANALYSIS OF RESILIENCY RISK FOR CENTERPOINT HOUSTON'S SERVICE AREA?

A. First, Guidehouse assessed climatological risk in Texas and the area bounded by CenterPoint Houston's service territory, noting that Texas is particularly susceptible to weather-driven resiliency events due to the range of topographic and climatological conditions. Notably, the National Aeronautics and Space Administration ("NASA") stated that Texas is ranked first in the U.S. in variety and frequency of natural disasters.[4] The Texas Department of Emergency Management ("TDEM") cites economic losses caused by weather-driven hazards in Texas for the period of 2000 to 2021 of over $50 billion in total recorded property and crop damage. TDEM estimates anticipated losses over the next five-year planning cycle (2022-2026) to be over $13 billion. Within CenterPoint Houston's service territory (TDEM Region 4), economic losses between 2000 and 2021 were over $6 billion. The severity of extreme weather events has become more prominent in recent years in Texas, as demonstrated by statistics released by the National Center for Environmental Information ("NCEI") that indicate the average annual frequency of extreme weather events causing over $1 billion in damage has increased from 3.9 events per year over the 43-year period between 1980 and 2023 to 11.0 events per year for the past five years.[5] Each of these findings underscores the contribution of the Houston area to the economic

[4] National Aeronautics and Space Administration [NASA]. (2017). *Natural and Manmade Hazards in the State of Texas* [NASR Report]. https://nisar.jpl.nasa.gov/documents/7/NISAR_Applications_Hazards_Texas.pdf

[5] National Oceanic and Atmospheric Administration National Centers for Environmental Information. (2024 January). *Billion-dollar weather and climate disasters: Texas* [NOAA-NCEI Technical Report]. Texas Summary - Billion-Dollar Weather and Climate Disasters | National Centers for Environmental Information (NCEI) (noaa.gov)

vitality of the region and state of Texas. As noted in Mr. Tutunjian's testimony, although CenterPoint Houston's service territory is small compared to other Texas utilities, its high load density and criticality of load served underscores the need to continue the types of resiliency investments the Company has made in prior years and proposes in its current Resiliency Plan.

Guidehouse then demonstrates how CenterPoint Houston's Resiliency Plan is responsive to state legislation adopted under House Bill 2555 in 2023 and subsequent regulatory requirements for Resiliency Plans adopted as 16 TAC §25.62 (Transmission and Distribution System Resiliency Plans), hereinafter referred to as the "Resiliency Rule" to address risks posed by resiliency events. Specifically, this section of my testimony describes how CenterPoint Houston's Resiliency Plan addresses each of the following requirements found in the Resiliency Rule:

- Definition of the type of resiliency events and resiliency-related risks (including magnitude threshold) that each measure included in the Plan is designed to address;
- Description of how CenterPoint Houston's T&D system is susceptible to the defined resiliency events included in the Plan;
- Historical evidence of the utility's experience with the identified resiliency events; and
- Forecasted risk of the identified resiliency events.

To address the above requirements, Guidehouse analyzed natural disaster threat risks posed by extreme weather events, including hurricanes, flooding, tornadoes, extreme heat, and extreme cold in each of the counties within CenterPoint Houston's service territory.[6] Guidehouse collected weather data for 10 major weather events over the past 15

[6] Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Waller, and Wharton.

years from 12 National Oceanic and Atmospheric Administration ("NOAA") weather stations located within these counties to analyze historical trends for each of the above events, especially maximum wind speeds and flood levels. Guidehouse applied an aggregation model to isolate NOAA weather data to a period of two days before and after each of the 10 events. Guidehouse projected flood, wind speed, and extreme temperature risks in CenterPoint Houston's territory for 2025 and 2030 using Jupiter Intelligence's ClimateScore Global Indices model.

Q. CAN YOU PROVIDE FURTHER DETAIL ON HOW THE ANALYSIS PERFORMED BY JUPITER INTELLIGENCE GENERATES A FORECAST OF TRENDING INCIDENTS DUE TO CLIMATE TRENDS?

A. Yes. As indicated above, Guidehouse focused its analysis on 10 storms and extreme weather events using NOAA data at the county level to predict weather variability and severity for 2025 and 2030. In addition to the weather station data, storm reports from NOAA were used for Hurricane Ike, Hurricane Harvey, Tropical Storm Imelda, and Hurricane Nicholas.[7] Further, Guidehouse aggregated weather data for areas north and south of U.S. 59/Interstate 69 and Highway 110 as points of demarcation for purposes of evaluating extreme weather impacts (e.g., high wind) on CenterPoint Houston's transmission and distribution systems, differentiating the level of risk between the coastal and inland portions of CenterPoint Houston's service territory. The 10 storms and extreme weather events Guidehouse analyzed using NOAA data appear below.

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[7] National Oceanic and Atmospheric Administration. (2009 January). *Tropical Cyclone Report Hurricane Ike.* [Hurricane Ike Report]. Tropical Cyclone Report (noaa.gov)
National Oceanic and Atmospheric Administration. (2018 May). *NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT HURRICANE HARVEY.* [Hurricane Harvey Report]. Hurricane Harvey (noaa.gov)
National Oceanic and Atmospheric Administration. (2020 February). *NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT TROPICAL STORM IMELDA.* [Tropical Storm Imelda Report].Tropical Storm Imelda (noaa.gov)
National Oceanic and Atmospheric Administration. (2021 September). *NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT HURRICANE NICHOLAS.* [Hurricane Nicholas Report]. Hurricane Nicholas (noaa.gov)

1. Hurricane Ike: September 2008
2. Thunderstorm and Wind: February 2013
3. Hurricane Harvey: August 2017
4. Tornadoes and Flash Flood: January 2019
5. Tornadoes: April 2019
6. Tropical Storm Imelda: September 2019
7. Winter Storm Uri: February 2021
8. Hurricane Nicholas: September 2021
9. Tornadoes: March 2022
10. Tornadoes: January 2023

For future projections, Guidehouse applied Jupiter Intelligence's ClimateScore Global Indices model, which uses 100 equidistant points from county weather stations to calculate county averages of metrics for wind, flood, and extreme temperatures. The model combines the output of downscaled global climate models ("GCMs") with a digital elevation model ("DEM")[8] and land cover data to derive metrics prospectively for 2025 and 2030.

Q. WHAT SPECIFIC TYPES OF RESILIENCY RISKS DID YOU ANALYZE?

A. A review of the historical extreme weather events in CenterPoint Houston's service area indicates that CenterPoint Houston's T&D system is subject to the following extreme weather events:

1. Wind damage driven by hurricanes, tornadoes, and microbursts;

[8] A global Climate Model (GCM) is defined by NOAA as "a complex mathematical representation of the major climate system components (atmosphere, land surface, ocean, and sea ice), and their interactions. Earth's energy balance between the four components is the key to long-term climate prediction"
National Oceanic and Atmospheric Administration. (n.d.). *Climate Modeling*. Climate Modeling – Geophysical Fluid Dynamics Laboratory (noaa.gov)

A digital elevation model (DEM) is defined by the U.S. Geological Survey (USGS) as "a representation of the bare ground (bare earth) topographic surface of the Earth excluding trees, buildings, and any other surface objects"
United States Geological Survey. (n.d.). *What is a digital elevation model (DEM)?* **What is a digital elevation model (DEM)? | U.S. Geological Survey (usgs.gov)**

2. Flood damage driven by coastal storm surges during a hurricane and flash floods during extreme precipitation events;
3. Extreme cold during winter storms; and
4. Chronic and rising high temperature events.

Guidehouse chose these four extreme weather resiliency risks as CenterPoint Houston's T&D circuits and power delivery equipment are particularly vulnerable to these hazards based on CenterPoint Houston data and reports from prior storms. Guidehouse also considered the impact of increased severity and frequency of weather events on vulnerable CenterPoint Houston T&D assets.

Q. WHAT IS YOUR UNDERSTANDING OF PHYSICAL THREATS TO ELECTRIC UTILITIES SUCH AS CENTERPOINT HOUSTON ATTRIBUTED TO EXTREME WEATHER EVENTS?

A. The physical threat the above resiliency events pose to CenterPoint Houston's electric system and to those of similarly situated electric utilities was amply evident from equipment damage and outages CenterPoint Houston experienced during the 10 storms cited in my prior two responses. While CenterPoint Houston's electric distribution system was constructed based on design standards established by the National Electrical Safety Code ("NESC") that were in effect at the time the system was constructed, the increased severity of extreme weather events indicate enhancements are needed to withstand these conditions. Further, design standards have changed over time in recognition of the increased variability and severity of resiliency events. For example, many of CenterPoint Houston's distribution circuits built under prior design standards are capable of withstanding winds speeds up to 70 miles per hour ("mph"), which are far less than the

wind speeds measured during several recent storms. Similarly, extremely high winds measured during microbursts and tornados have exceeded transmission circuit design standards, resulting in tower failures on susceptible structures during recent extreme weather events. Similarly, recent floods have resulted in de-energization of substation equipment and customer outages. I address these risks in subsequent sections of my testimony.[9]

Q. WHAT IS THE HISTORICAL, CURRENT AND FUTURE RISK TO CENTERPOINT HOUSTON'S SERVICE AREA FOR HURRICANE EVENTS BASED ON YOUR ANALYSIS?

A. NOAA data indicates the frequency and intensity of hurricanes in CenterPoint Houston's service area has been rising similar to other parts of the U.S.10 The current risk to CenterPoint Houston's T&D system is demonstrated by Hurricane Ike in 2008, where the Harris County coastal weather station captured wind measurements exceeding 130 mph, and Hurricane Nicholas in 2021 where Matagorda County and Galveston County experienced wind speeds over 95 mph with interruptions in electric service to approximately 500,000 customers.

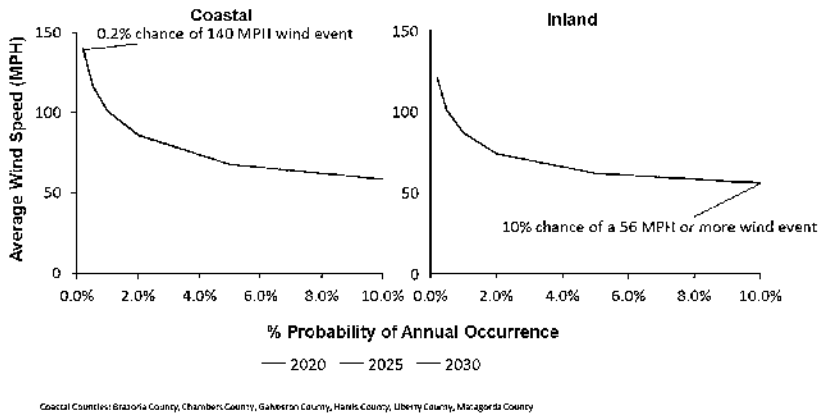
Guidehouse's analysis indicates the frequency and severity of hurricane events is expected to increase by 2030, with maximum wind speeds increasing from 2020 to 2050 for nearly all the counties served by CenterPoint Houston for 100-year, 200-year, and 500-year events. By 2030, almost all of these counties are expected to experience maximum

[9] Damage to transmission structures in Harris County during the January 2023 tornados and outages caused by substation flooding during Hurricane Harvey are recent manifestations of these risks.

[10] Charts presented in our report in Exhibit EJS 2 indicate higher wind speeds during recent hurricanes impacting CenterPoint Houston's service territory.

wind speeds exceeding 140 km/h (87 mph) for a 500-year event, with coastal counties experiencing wind speeds exceeding 160 km/h (99 mph), well exceeding the distribution equipment threshold of 70 mph described previously. Guidehouse used the projected wind speed for return periods between 10-year and 500-year events to calculate probabilities of exceeding different wind speeds; results are presented in Figure ELS-1 below. From these curves, the 70 mph wind threshold has an annual probability of exceedance[11] of 4.5% in coastal counties and 2.7% in inland counties by 2030. These values are referred to later in my testimony where I present the results of our assessment of CenterPoint Houston's proposed resiliency measures such as Pole Replacement and Distribution Circuit Resiliency measures.

FIGURE ELS-1



Source: Guidehouse analysis

Q. WHAT IS THE HISTORICAL, CURRENT, AND FUTURE RISK TO CENTERPOINT HOUSTON'S SERVICE AREA FOR FLOODING EVENTS BASED ON YOUR ANALYSIS?

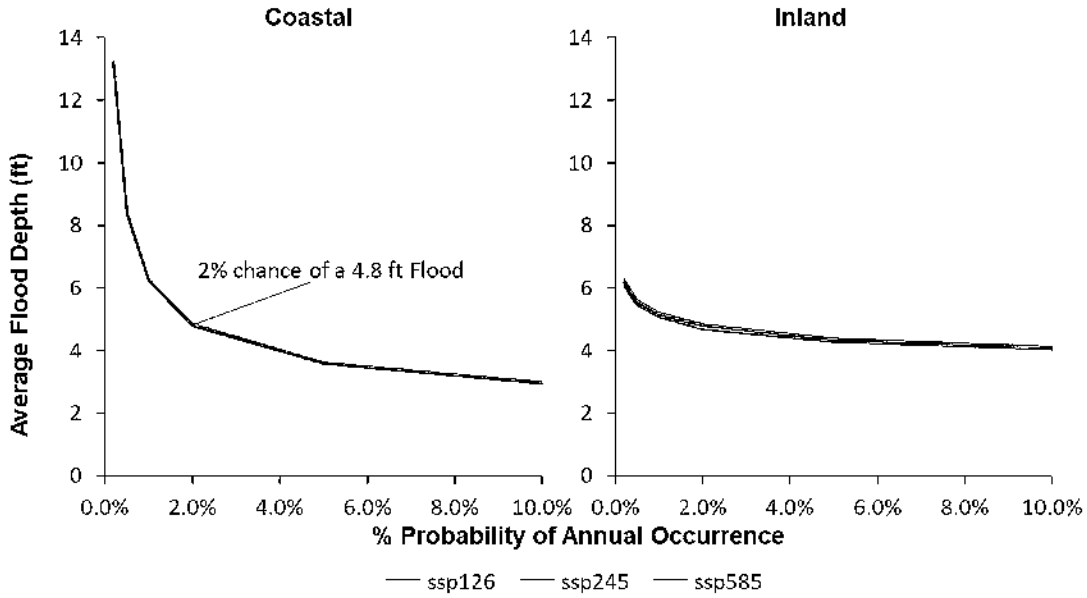
[11] Probability of Exceedance is the likelihood that wind speed will be greater than the stated percentage on an annual basis.

A. Similar to hurricanes, NOAA data indicates the frequency and intensity of flood events in CenterPoint Houston's service area has been rising similar to other parts of the U.S.[12] Current risk is evidenced by recent storms such as Hurricane Harvey in 2017, where elevated levels of rainfall and coastal storm surges caused floods along the coastal and inland counties of southeastern Texas, resulting in inundations of 6 to 30 feet. Within CenterPoint Houston's service area during this event, 17 substations flooded, causing 8 substation outages that collectively resulted in loss of service to over 1 million customers.

Our analysis indicates the frequency and severity of flood events is expected to increase by 2030 with maximum flood inundation levels increasing from 2020 to 2050 for nearly all the counties served by CenterPoint Houston for 100-year, 200-year, and 500-year events. By 2030, almost all of these counties are expected to experience increases in mean flood depths as well as flooded fractions (i.e., percentage of buildings flooded). We used the projected flooding for return periods between 10-year and 500-year events to calculate probabilities of exceeding different flood levels as presented in Figure ELS-2. Based on these probability curves, CenterPoint Houston's 5-foot threshold for damage to substation equipment such as switchgear and relays has a probability of exceedance of 3.6% in coastal counties and 1.2% in inland counties by 2030. These values are referred to later in my testimony where I present the results of our assessment of CenterPoint Houston's proposed Substation Flood Control (elevation) resiliency measure.

FIGURE ELS-2

[12] For example, parts of the Houston metro region have experienced three 500-year floods in the last 20 years.



Source: Guidehouse analysis

Q. WHAT IS THE HISTORICAL, CURRENT, AND FUTURE RISK TO CENTERPOINT HOUSTON'S SERVICE AREA FOR EXTREME TEMPERATURE EVENTS BASED ON YOUR ANALYSIS?

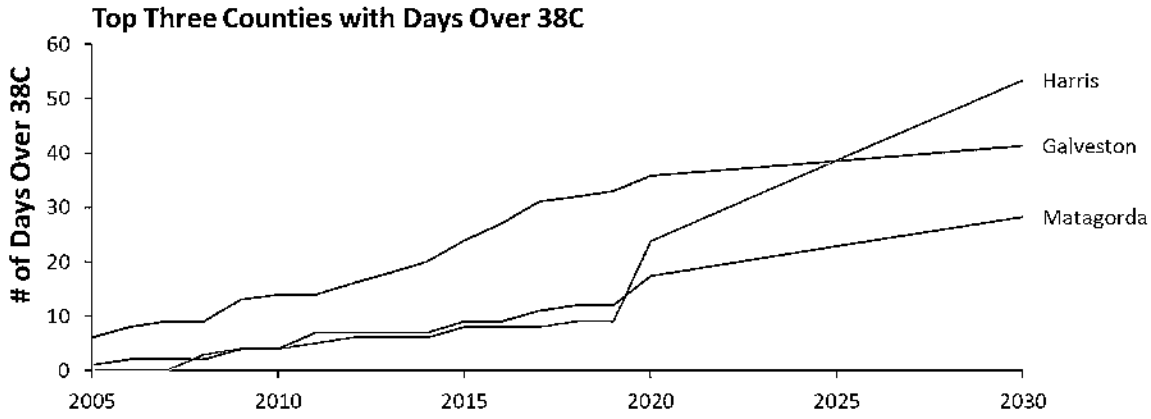
A. Extreme temperatures can have a significant negative impact on utility operations. For example, extreme heat will degrade transformer condition and cause a significant increase in customer demand while extreme cold can also result in significant increase in customer demand. Winter Storm Uri in 2021 resulted in below freezing temperatures for several days according to NOAA climatological data obtained from weather stations. The Federal Reserve Bank of Dallas estimated the state's storm-related financial losses associated with Winter Storm Uri to range from $80 billion to $130 billion.[13]

Guidehouse combined historical data and future projections to predict the change in number of days exceeding 38°C (100°F) from 2005 to 2030 for Harris, Galveston, and

[13] Federal Reserve Bank of Dallas (2021 April). *Cost of Texas' 2021 Deep Freeze Justifies Weatherization.* [Deep Freeze Analysis]. **Cost of Texas' 2021 deep freeze justifies weatherization - Dallasfed.org**

Matagorda counties. These results, presented in Figure ELS-3, show a projected increase in the number of days with temperatures exceeding 100°F for all counties. The increase for Harris County is particularly prominent with a rise in expected days above 100°F from about 20-25 in 2024 to over 50 in 2030. Average temperature in August, typically the hottest month of the year in Texas, is projected to rise across CenterPoint Houston's service area, with a mean temperature rise in August averaging 1.5°F. Further, our analysis indicates the frequency of heat wave events is expected to rise, with an average increase of 11 days between 2020 and 2030.

FIGURE ELS-3



Source: Guidehouse analysis

Q. FOR EACH TYPE OF RESILIENCY EVENT ANALYZED, DOES YOUR ANALYSIS INDICATE THAT RESILIENCY RISK IS EXPECTED TO INCREASE OVER TIME, AND THAT RESILIENCY INVESTMENTS ARE NEEDED IN CENTERPOINT HOUSTON'S SERVICE AREA TO REDUCE RESILIENCY RISK AND IMPROVE THE SAFETY, RELIABILITY, AND RESILIENCY OF ITS ELECTRIC SYSTEM?

A. Yes, my testimony, supported by Guidehouse's assessment of future risk of hurricanes, floods, and temperature, each of which are expected to increase in severity and frequency, places CenterPoint Houston's T&D assets at higher risk of failure over time. Given this as well as the historical evidence from prior extreme weather events resulting in significant interruption in service to CenterPoint Houston's customers, I conclude that risk mitigation measures to address these types of resiliency events is becoming increasingly needed for CenterPoint Houston. The potential for service interruptions to rise in the future, absent resiliency measures, is significant given the results of Guidehouse's independent risk analysis. My assessment of the resiliency measures that CenterPoint proposes to undertake in its Resiliency Plan to address these risks is presented later in my testimony.

Q. WHAT FINDINGS AND RECOMMENDATIONS RELATED TO GUIDEHOUSE'S RESILIENCY RISK ANALYSIS WERE PROVIDED TO CENTERPOINT HOUSTON FOR CONSIDERATION IN THE DEVELOPMENT OF ITS RESILIENCY PLAN?

A. CenterPoint Houston's proposed portfolio of resiliency measures is well suited to help mitigate negative impacts caused by high wind and flooding events forecasted to 2030. However, while our county-level quantification of resiliency event risk is reasonable for a measure-level analysis for which I have testified to herein, more-granular spatial quantification would be desirable to operationalize CenterPoint Houston's Resiliency Plan and target projects or other specific investments at locations with greatest risk.

In addition to our recommendation to use more granular analysis for implementation of CenterPoint Houston's Resiliency Plan, we recommended that CenterPoint Houston also consider adding resiliency measures to address the impact of

rising temperatures on transformer derating in future resiliency plans. Examples of such resiliency measures include transformer replacement and capacity expansion- whether through conventional or distributed generation resources.

Q. DID CENTERPOINT HOUSTON MAKE MODIFICATIONS TO ITS RESILIENCY PLAN BASED ON THE FINDINGS AND RECOMMENDATIONS PROVIDED BY GUIDEHOUSE?

A. CenterPoint Houston considered the findings from Guidehouse's resiliency risk analysis to further refine its plan. For example, CenterPoint Houston added wildfire mitigation resiliency measures after Guidehouse completed its initial review, which is supported by the wildfire risk analysis included in Guidehouse's report.

V. INDEPENDENT REVIEW AND ANALYSIS OF CENTERPOINT HOUSTON'S RESILIENCY PLAN

Q. WHAT APPROACH DID GUIDEHOUSE FOLLOW TO CONDUCT ITS ANALYSIS AND REVIEW OF CENTERPOINT HOUSTON'S RESILIENCY PLAN?

A. Guidehouse critically reviewed each of CenterPoint Houston's proposed operations and physical security resiliency measures to determine whether the measure is reasonable and beneficial for inclusion in CenterPoint Houston's Resiliency Plan. A key objective of Guidehouse's assessment was to determine the effectiveness of each resiliency measure at mitigating the impact of resiliency events on CenterPoint Houston's transmission and distribution system. Guidehouse analyzed each measure in accordance with good utility practice and quantified the extent to which each resiliency measure is projected to reduce outage frequency and duration, restoration costs, equipment damage, and operation and maintenance. An important element of Guidehouse's assessment was consideration of future forecasted risk attributed to resiliency events as described in Section IV of my testimony. For example, the projected increase in flood inundation levels in various parts of CenterPoint Houston's service area was a factor that Guidehouse incorporated into its analysis of potential benefits of CenterPoint Houston's Substation Flood Control resiliency measure.

To derive resiliency benefits, Guidehouse collected relevant data from CenterPoint Houston to analyze assets at risk of failure during resiliency events. This included identifying the likelihood of equipment failure and extent to which inoperable systems will negatively impact reliability. We obtained details on CenterPoint Houston's proposed

resiliency investments along with historical data to assess resiliency measure effectiveness. Guidehouse then derived benefit-cost ratios using a BCA approach for each resiliency measure (i.e., CenterPoint Houston resiliency measure or project). The BCA approach is a life-cycle analysis of project costs and benefits. BCA provides a consistent measure to determine whether estimated benefits (translated into monetary value) outweigh the estimated costs, suggesting the investment is worthwhile to pursue. A BCA ratio above 1 indicates the benefits outweigh the costs, suggesting the resiliency measure or project should move forward. A value under 1 indicates the costs outweigh the benefits, however, additional qualitative considerations (e.g., enables other measures or projects with relatively high BCA ratios) may suggest the resiliency measure should move forward regardless of the BCA ratio. For this reason, my testimony discusses both quantitative and qualitative benefits for each of the resiliency measures in CenterPoint Houston's Resiliency Plan. We also compared CenterPoint Houston's proposed resiliency measures with industry practices based on a peer utility benchmarking survey described in Section VI of my testimony.

Guidehouse analyzed CenterPoint Houston's proposed Resiliency Plan measures for each of the following evaluation categories:

- **Resiliency Measure Description** – Guidehouse's independent review of each resiliency measure includes a summary of Guidehouse's understanding of the objectives and rationale, including how the measure reduces the risk of resiliency events. It documents the quantity and cost for resiliency investment proposed over the three-year Resiliency Plan (2025 – 2027).

- **Alternatives Considered** – Alternatives CenterPoint Houston considered in lieu of the proposed resiliency measure, and why these alternatives were determined to be less effective than the proposed resiliency measure.
- **Resiliency Measure Metrics and Effectiveness** – Metrics and measures CenterPoint Houston proposes to report to the Commission annually for each resiliency measure.
- **Benefits Analysis** – Guidehouse's derivation of Resiliency Plan benefits, both quantitative and qualitative, for each resiliency measure. Includes a BCA ratio for each resiliency measure.
- **Resiliency Measure Assessment and Conclusions** – For each resiliency measure, Guidehouse summarizes its findings and conclusions as to whether and how each measure achieves Resiliency Plan objectives.

Q. WHICH RESILIENCY MEASURES IN CENTERPOINT HOUSTON'S RESILIENCY PLAN ARE YOU ADDRESSING IN YOUR TESTIMONY?

A. The 19 CenterPoint Houston resiliency measures I reviewed follow the categories outlined in Mr. Tutunjian's testimony. These measures are listed below and addressed in my responses to questions that follow.

Hardening Facilities

1. Transmission System Hardening
2. S90 Tower Replacements
3. 69kV - 138kV Conversion Projects
4. Coastal Resiliency Upgrades
5. Substation Transformer Fire Protection Barriers

6. Distribution Pole Replacement/Bracing

7. Distribution Resiliency – Circuit Rebuilds

8. Strategic Undergrounding/Freeway Crossings

Grid Modernization

9. TripSaver®

10. IGSD Installation

11. Texas Medical Center Substation

Flood Mitigation

12. Substation Flood Control

13. Control Center Facility Upgrades

Information Technology

14. Advanced Aerial Imagery Platform / Digital Twin

15. Advanced Distribution Technology

16. Digital Substation

Physical Security

17. Substation Physical Security Fencing

18. Substation Security Upgrades

Vegetation Management

19. Targeted Critical Circuit Vegetation Management

BENEFITS ANALYSIS

Q. WHAT WAS THE PURPOSE OF THE BENEFITS ANALYSIS CONDUCTED FOR RESILIENCY MEASURES INCLUDED IN CENTERPOINT HOUSTON'S RESILIENCY PLAN?

A. Guidehouse determined the value each CenterPoint Houston resiliency measure is expected to provide to its customers using a benefits analysis approach. The analysis included an evaluation of both quantitative and qualitative benefits. Guidehouse quantified net benefits by performing a life-cycle analysis of costs versus benefits (i.e., benefit-cost analysis or BCA).[14] The BCA incorporates future risk based on the flood inundation, temperature, and wind speed forecasts presented in Section IV of my testimony. Resiliency measure costs are those projected for years 2025 through 2027, and exclude amounts spent in prior or subsequent years, except for the Texas Medical Center Substation and Advanced Aerial Imagery Platform / Digital Twin where costs were incurred prior to 2025; and Coastal Resiliency Upgrades where costs were incurred prior to 2025 and are expected to occur after 2027. The BCAs are derived for the composite total of all individual projects within each resiliency measure, except where investment mitigates impacts at a specific location (e.g., Control Center Facility Upgrades). Although Guidehouse's evaluation of CenterPoint Houston's resiliency measures are evaluated at the composite level, individual projects within each resiliency measure will be evaluated and selected for implementation based on an asset level evaluation by CenterPoint Houston.

Quantitative benefits considered include the following:

- **Avoided Circuit Outages and Equipment Failures** – The reduction in customer interruptions achieved by resiliency measures during resiliency events.
- **Reduced Outage Duration** – The decrease in outage duration achieved by resiliency measures during resiliency events.

[14] Although some of the programs may continue for up to 10 to 15 years, CenterPoint Houston's Resiliency Plan and Guidehouse's evaluation focuses on costs and outage reduction measures over the three-year Plan.

- **Avoided Collateral Damage** – The avoidance of the additional cost incurred caused by equipment failure on nearby devices; for example, catastrophic substation transformer failures that cause adjacent transformers to fail.
- **Reduced Restoration Cost** – The savings in crew labor, truck rolls, and trouble order processing achieved by resiliency measures during resiliency events.
- **Operation and Maintenance (O&M) Cost** – The decrease (or increase for new equipment installed) in O&M resulting from the resiliency measure.

Qualitative benefits are those associated with societal factors such as regional impacts, economic considerations, public safety, inconvenience, capacity investment deferral, and disruption of critical facility operations. Guidehouse assessed the value each resiliency measure is expected to provide to its customers based on both quantitative and qualitative benefits, as BCA alone may not capture the full spectrum of benefits Resiliency Plan measures will provide to CenterPoint Houston's customers and the Houston region.

Q. HAS GUIDEHOUSE PERFORMED SIMILAR ANALYSIS FOR OTHER ELECTRIC UTILITY RESILIENCY PLANNING EFFORTS?

A. Yes. Guidehouse has conducted BCA studies to support reliability and resiliency investments for FirstEnergy's operating companies in Ohio, Pennsylvania, and New Jersey; Pepco Holdings, Inc. in Washington D.C., Maryland, and New Jersey; Alectra Utilities in Ontario, and Duke Energy Florida, among others. I managed or provided subject matter expertise in each of these engagements.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE BENEFITS ANALYSIS AND HOW THIS PROVIDES AN INDICATOR OF POTENTIAL VALUE OF RESILIENCY INVESTMENTS TO CUSTOMERS AND COMMUNITIES SERVED BY CENTERPOINT HOUSTON.

A. Guidehouse's benefits analysis produced BCA ratios that appear in Table ELS-1. The BCAs were derived using a Value of Lost Load ("VOLL") of $25,000 per MWHr.[15] These results indicate that most resiliency measures achieved a BCA ratio at or above 1.0 and therefore, should be approved by the Commission, The one resiliency measure, Texas Medical Center Substation, that has a BCA below 1.0 is a project serving current and future critical load that justifies its inclusion in CenterPoint Houston's Resiliency Plan, as described later in my testimony. The total 3-year CMI savings is 940 million and 468 million annually by 2027.

TABLE ELS-1

Measure	Cost ($MM)	O&M ($MM)	BCA Ratio
System Hardening			
Transmission System Hardening	$ 376.0	$ 0.75	6.0
S90 Tower Replacements	$ 103.8	$ -	4.9
69kV-138kV Conversion Projects	$ 268.4	$ -	1.9
Coastal Resliency Upgrades	$ 259.0	$ 0.75	1.4
Substation Transformer Fire Protection Barriers	$ 2.4	$ -	3.7
Distribution Pole Replacements/Bracing	$ 99.3	$ -	6.2
Distribution Resiliency – Circuit Rebuilds	$ 312.8	$ -	7.0
Strategic Undergrounding/Freeway Crossings	$ 31.2	$ -	3.8
Grid Modernization			
Trip Savers	$ 58.9	$ 0.03	61.3
IGSD Installations	$ 53.8	$ 0.82	15.7
Texas Medical Center Substation	$ 102.0	$ 0.15	0.7
Flood Control			
Substation Flood Control	$ 30.6	$ -	7.5
Control Center Facility Upgrades	$ 7.0	$ -	12.5
Information Technology			
Advanced Aerial Imagery Platform/Digital Twin	$ 9.9	$ 0.06	3.4
Advanced Distribution Technology	$ 225.8	$ 15.00	4.8
Digital Substation	$ 25.0	$ (0.60)	1.9
System Secuity			
Substation Physical Security Fencing	$ 15.0	$ -	15.6
Substation Security Upgrades	$ 19.5	$ 0.09	20.5
Vegetation Management			
Targeted Critical Circuit Vegetation Management	$ -	$ 25.00	1.8
Totals	**$ 2,000.4**	**$ 42.05**	**6.6**

[15] $25,000/MWh was adopted by the PUCT as an interim VOLL on February 1, 2024. See memo dated January 25, 2024: PUCT Staff recommendations for interim VOLL https://interchange.puc.texas.gov/Documents/55837_9_1361634.PDF

IDENTIFICATION OF ALTERNATIVES

Q. DID GUIDEHOUSE IDENTIFY AND/OR ANALYZE ANY ALTERNATIVES TO THE RESILIENCY INVESTMENTS INITIALLY IDENTIFIED BY CENTERPOINT HOUSTON FOR ITS RESILIENCY PLAN?

A. Yes. For each resiliency measure, Guidehouse identified potentially viable alternatives; for some resiliency measures, there were no viable alternatives identified. Additional details on these alternatives are presented in the individual resiliency measure assessments that follow.

Q. DID CENTERPOINT HOUSTON MAKE MODIFICATIONS TO ITS RESILIENCY PLAN BASED ON THE IDENTIFICATION AND ANALYZIS OF ALTERNATIVES IDENTIFIED BY GUIDEHOUSE?

A. CenterPoint Houston used the Guidehouse analysis to make adjustments to its plan as stated in Mr. Tutunjian's testimony. For example, as noted in CenterPoint Houston's Resiliency Plan, CenterPoint Houston collaborated with Guidehouse to identify alternatives and metrics for inclusion in its Resiliency Plan. Also, CenterPoint Houston added wildfire mitigation resiliency measures to its Resiliency Plan following Guidehouse's initial review.

RESILIENCY MEASURE ASSESSMENT

Q. WHAT IS GOOD UTILITY PRACTICE?

A. Good Utility Practice is defined by the Commission as: "Any of the practices, methods, or acts engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods, or acts that, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety, and expedition. Good utility practice is not intended to be limited to the optimum practice, method, or act, to the exclusion of all others, but rather is intended to include acceptable practices, methods, and acts generally accepted in the region."[16]

Q. BASED ON YOUR EXPERIENCE IN THE ELECTRIC UTILITY INDUSTRY, IS THE COMMISSION'S DEFINITION OF GOOD UTILITY PRACTICE CONSISTENT WITH HOW GOOD UTILITY PRACTICE IS GENERALLY DEFINED IN THE ELECTRIC UTILITY INDUSTRY?

A. Yes.

Q. IN THE CONTEXT OF CENTERPOINT HOUSTON'S RESILIENCY PLAN, IS GOOD UTILITY PRACTICE A FACTOR THAT SHOULD BE CONSIDERED?

A. Yes. Good Utility Practice is one factor that should be considered in analyzing the resiliency measures that CenterPoint Houston has proposed in its Resiliency Plan. For example, Good Utility Practice helps inform whether CenterPoint Houston should elevate at risk substations to mitigate flooding and high water events that have previously occurred in CenterPoint Houston's service area. Similarly, Good Utility Practice helps inform the comparison of a proposed resiliency measure to corresponding alternatives. For example,

[16] §25.5. Definitions. (Substantive Rules Applicable to Electric Service Providers, Subchapter A)

an alternative to CenterPoint Houston's proposed resiliency measure of transmission system hardening would be to relocate (i.e., bury) transmission lines underground. Good Utility Practice would favor transmission system hardening because relocating transmission lines underground is relatively costly. Further the Commission's definition of Good Utility Practice highlights the value of considering peer utility benchmarking, as presented in Section VI of my testimony.

Q. BASED ON YOUR EXPERIENCE IN THE ELECTRIC UTILITY INDUSTRY, ARE THERE CERTAIN MEASURES THAT ARE WELL-KNOWN WITHIN THE ELECTRIC UTILITY INDUSTRY AS BEING PROVEN TO ENHANCE RESILIENCY?

A. Yes, and I agree with Mr. Tutunjian's testimony on this issue. There are resiliency measures that are well-known within the utility industry as being proven to enhance resiliency. One example is the physical hardening of structures, which CenterPoint Houston is proposing to do in many of its resiliency measures.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF MEASURES FOR WHICH CENTERPOINT HOUSTON SEEKS COMMISSION APPROVAL IN ITS RESILIENCY PLAN?

A. My assessment of each CenterPoint Houston operations or physical security resiliency measure is presented in my responses to the following 19 sets of questions, following the order presented earlier in my testimony, starting with Transmission System Hardening. For each resiliency measure, I address each of the evaluation categories outlined in prior sections of my testimony.

Alternatives that CenterPoint Houston evaluated and metrics the Company proposes to submit to the Commission to track and measure effectiveness are addressed in Guidehouse's report and the Company's Resiliency Plan.

TRANSMISSION SYSTEM HARDENING

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S TRANSMISSION SYSTEM HARDENING RESILIENCY MEASURE.

A. CenterPoint Houston's Transmission System Hardening resiliency measure will replace wooden poles (single pole and H-Frame) in line segments where a substantial number of poles do not meet CenterPoint Houston's current wind loading design standard for 138kV structures.[17] It includes the installation of air flow spoilers to mitigate galloping conductors along transmission lines, further mitigating potential failures during high wind events. CenterPoint Houston proposes to replace wood poles with concrete or metal monopole poles, or lattice towers, along with the installation of galloping conductor mitigation on all structures. The capital cost of the project over the three-year Resiliency Plan is $376 million. The total expense to inspect and maintain the new structures is $750,000 over the three-year Resiliency Plan.

Additional detail on CenterPoint Houston's Transmission Hardening resiliency measure, including alternatives considered and metrics for evaluating effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

[17] CenterPoint's current wind loading standard conforms to ASCE 7-16 and is based on the 100-year MRI Exposure C or D (dependent on proximity to Gulf of Mexico).

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S TRANSMISSION SYSTEM HARDENING RESILIENCY MEASURE?

A. The Transmission System Hardening resiliency measure should reduce the number of sustained interruptions during resiliency events for transmission circuits where new poles are installed, thus avoiding the cost of repairing damaged equipment and crew labor needed to restore service. The resiliency measure is projected to reduce total customer minutes interrupted ("CMI") over the three-year Resiliency Plan by approximately 206 million. At the end of the three-years resiliency measure in 2027, annual CMI savings are approximately 87.6 million. Guidehouse's analysis produced a BCA ratio of 6.0 for this measure, which includes the capital cost and maintenance expense cited in my response to the prior question.[18]

Furthermore, the impact of outages from transmission line failures on a widespread basis could have severe consequences, ranging from the loss of critical infrastructure (e.g. water and sewage treatment), law enforcement challenges, and public safety, among other societal impacts. Some lines proposed for hardening, if unaddressed and interrupted, may contribute to the degradation of reliability and operational integrity of the regional high voltage transmission grid during major storms.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED TRANSMISSION SYSTEM HARDENING RESILIENCY MEASURE.

A. Guidehouse concludes that CenterPoint's Transmission System Hardening resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons.

[18] A BCA ratio above 1.0 indicates life-cycle benefits exceed measure costs; measure costs exceeding benefits results in a BCA ratio below 1.0.

1. The replacement of wood poles with steel or concrete poles, or lattice towers will meet CenterPoint Houston's current design standard for 138kV transmission structures
2. The replacement of wood poles with steel or concrete poles will result in fewer pole failures and interruption of critical load during resiliency events. CenterPoint Houston has targeted transmission line sections with a high percentage of poles that do not meet its current design standard and that are susceptible to outages during high winds
3. The 6.0 BCA ratio confirms the measure is cost effective
4. Further, the installation of more robust steel or concrete monopoles also is consistent with practices deployed at other utilities as outlined in Section VI
5. Lastly, the potential for widespread outages and resulting societal consequences of pole failures underscore the criticality of maintaining a reliable transmission network

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that the majority of electric utilities surveyed include transmission pole replacement/hardening investments in their resiliency plans. Figure ELS-4 indicates that nine utilities which responded to the question regarding types of investments each are deploying include pole replacements. Additionally, Figure ELS-3 indicates that 8 of the 10 utilities surveyed prioritize transmission lines as a resiliency initiative. Further, 7 of the utilities address aging

infrastructure through resiliency measures, while 10 focus on mitigating extreme windstorm hazards. Pole Replacement/Line Rebuilds was also one of the most common resiliency initiatives reported by peer utilities.

FIGURE ELS-4

Type of Investments	Utility Companies								
	102	103	106	107	108	109	114	122	123
Changes to emergency response plans		✓		✓			✓	✓	
Governance risk and compliance tracking		✓				✓	✓		
Threat intelligence and management	✓	✓					✓	✓	
Line/Circuit rebuilds	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pole replacements	✓	✓	✓	✓	✓	✓	✓	✓	✓
Undergrounding of key lines or portions (e.g. freeway crossings)	✓	✓	✓		✓	✓		✓	✓
Conversion projects – e.g. from 69kV to 138kV	✓	✓				✓		✓	
Raising substations	✓	✓	✓		✓				
Reconductoring projects	✓	✓		✓	✓		✓		
Smart grid upgrades	✓	✓	✓	✓		✓	✓	✓	
Data Center Facilities upgrades	✓	✓					✓	✓	
Data storage and handling	✓	✓				✓	✓	✓	
Smart grid data modifications	✓	✓					✓	✓	
Operational data resiliency	✓	✓				✓	✓	✓	
Cyber Security	✓	✓	✓				✓	✓	✓
Monitoring of assets	✓	✓				✓	✓	✓	
Cloud based data handling improvements	✓	✓					✓	✓	
Application security							✓	✓	
Telecommunication infrastructure	✓	✓					✓	✓	
Microwave communications	✓	✓					✓	✓	
Voice and mobile data enhancements	✓	✓					✓	✓	
Use of monitoring cameras, communications	✓	✓	✓				✓	✓	
Substation fencing	✓	✓	✓				✓	✓	
Substation security upgrades	✓	✓	✓				✓	✓	
Network security	✓	✓					✓	✓	
Trip savers	✓	✓		✓		✓			
Digital substation OT systems	✓	✓				✓	✓	✓	
Substation automation	✓	✓	✓			✓	✓	✓	

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) indicate that Pole Replacement/Hardening measures are commonly included in electric utility resiliency investments for the jurisdictions examined. Eleven of the fifteen jurisdictions summarized in Table 2 - 1 either propose investments generally consider pole replacement/hardening resiliency investments to be within scope. For example, Connecticut includes system hardening such as stronger wood poles and steel poles as part of their resiliency efforts. Additionally, Hawaii identifies hardening and

reinforcing critical transmission circuits as in-scope, which includes upgrading structures and using enhanced construction materials.

S90 TOWER REPLACEMENTS

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S S90 TOWER REPLACEMENT RESILIENCY MEASURE.

A. CenterPoint Houston's S90 Tower Replacements resiliency measure will replace corner lattice towers on 345kV transmission circuits vulnerable to high wind events (e.g., microbursts). Towers that will be replaced are those that have deteriorated or those where the design at the time did not meet CenterPoint's current wind loading standard for extreme wind events. Most towers will be replaced with stronger monopole steel or concrete structures. The cost of the project over the three-year Resiliency Plan included in the BCA value presented below is $103.8 million.

Additional detail on CenterPoint Houston's S90 Tower Replacements resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S S90 TOWER REPLACEMENTS RESILIENCY MEASURE?

A. Similar to Transmission System Hardening, the S90 Tower Replacements resiliency measure should reduce the number of sustained interruptions during resiliency events on transmission circuits targeted for new towers, thus avoiding the cost of repairing damaged equipment and crew labor to restore service. The S90 Tower Replacements resiliency

measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 41.7 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 16.4 million. Guidehouse's analysis produced a BCA ratio of 4.9 for this measure.

Further, the impact of outages from transmission line failures on a widespread basis could have severe consequences, ranging from the loss of critical infrastructure (e.g., water and sewage treatment), law enforcement challenges, and public safety, among other societal impacts. Some lines proposed for hardening, if unaddressed and interrupted, may contribute to the degradation of reliability and operational integrity of the high voltage transmission grid during major storms.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED S90 TOWER REPLACEMENT RESILIENCY MEASURE.

A. Guidehouse concludes that CenterPoint Houston's S90 Tower Replacements resiliency measure is reasonable and beneficial for inclusion in CenterPoint Houston's Resiliency Plan for the following reasons.

1. The replacement of lattice towers with stronger steel or concrete monopoles poles will meet CenterPoint Houston's current wind loading design standard for 138kV transmission structures
2. The replacement of existing lattice towers with stronger steel or concrete monopoles poles will result in fewer tower failures and interruption of critical load during resiliency events. CenterPoint Houston has targeted transmission line sections with a high percentage of towers that do not meet its current design standard and that are susceptible to outages during high wind events

3. The 4.9 BCA ratio confirms the measure is cost effective
4. The replacement of towers with more robust steel or concrete poles also is consistent with practices deployed at other utilities as outlined in Section VI.
5. Lastly, the potential for widespread outages and resulting societal consequences of tower failures underscore the criticality of maintaining a reliable transmission network

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI , indicates that 8 of the 10 electric utilities surveyed prioritize transmission lines for resiliency investments, as shown in Figure ELS-3. Additionally, Figure ELS-1 shows that 7 of the utilities address aging infrastructure through their resiliency programs, while all ten direct their focus towards mitigating extreme windstorm hazards.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) indicates that transmission programs are commonly included in electric utility resiliency investments for the jurisdictions examined. Seven of the 15 jurisdictions in Table 4 either have proposed investments or generally consider transmission investments to be within scope. For example, Connecticut includes system hardening such as steel poles and fiberglass cross arms as resiliency measures. Additionally, Hawaii identifies hardening and reinforcing critical transmission circuits as in-scope measures, which include upgrading structures and using enhanced construction materials.

69KV - 138KV CONVERSION PROJECTS

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S 69KV - 138KV CONVERSION PROJECTS RESILIENCY MEASURE.

A. CenterPoint Houston's 69kV to 138kV Conversion Projects resiliency measure will convert existing 69kV transmission lines to operate at a higher voltage. The resiliency measure has several purposes: (1) remove aged 69kV transformers and replace deteriorated poles or structures that do not meet CenterPoint Houston's current wind loading design standard; (2) eliminate the need to maintain 69kV spare equipment; (3) provide additional 138kV paths into downtown Houston to relieve high loading on existing 138kV circuits; and (4) further enhance grid resiliency by increasing line ratings via voltage conversion. For these conversions, CenterPoint Houston proposes to replace wood poles with concrete or metal monopole poles and replace conductor, insulators, and associated hardware. Over time, similar to trends adopted by other utilities I have advised, CenterPoint Houston proposes to eliminate or convert its entire 69kV network to operate at a higher voltage. The cost of the project over the three-year Resiliency Plan included in the BCA ratio presented below is $268.4 million.

Additional detail on CenterPoint Houston's 69kV - 138kV Conversion resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S 69KV - 138KV CONVERSION PROJECTS RESILIENCY MEASURE?

A. The 69kV - 138kV Conversion Projects resiliency measure should reduce the number of sustained interruptions during resiliency events on transmission circuits targeted for conversion, thus avoiding the cost of repairing damaged equipment and crew labor to restore service. The 69kV - 138kV Conversion Projects resiliency measure is projected to reduce total CMI over the three-year Resiliency Plan by approximately 46.8 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 20.0 million. Guidehouse's analysis produced a BCA ratio of 1.9 for this measure. The measure also increases the amount of load the new 138kV lines can serve; however, this non-resiliency benefit is not included in the BCA ratio.

Similar to the transmission resiliency measures discussed in the prior two measure reviews, the impact of outages from 69kV transmission line failures on a widespread basis could have severe consequences, ranging from the loss of critical infrastructure (e.g., water and sewage treatment), law enforcement challenges, and public safety, among other societal impacts.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED 69KV - 138KV CONVERSION PROJECTS RESILIENCY MEASURE.

A. Guidehouse concludes that CenterPoint Houston 's 69kV - 138kV Conversion Projects resiliency measure is reasonable and beneficial for inclusion in CenterPoint Houston's Resiliency Plan for the following reasons:

1. The replacement of 69kV wood poles with steel or concrete poles will meet CenterPoint Houston's current wind loading design standard for 138kV transmission structures

2. It will result in fewer pole failures and interruption of critical load during resiliency events. CenterPoint Houston has targeted 69kV transmission line sections serving the Houston area with a high percentage of poles that do not meet its current design standard and that are susceptible to outages during high winds
3. The 1.9 BCA ratio confirms the measure is cost effective
4. Further, the installation of more robust steel or concrete monopoles also is consistent with practices deployed at other utilities as outlined in Section VI.
5. The measure increases load carrying capacity, thus meeting transmission supply needs to serve future loads
6. Lastly, the measure will result in a more reliable transmission network serving the Houston area

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several of the electric utilities surveyed include conversion projects in their resiliency plans. Figure ELS-4 indicates that four of the nine utilities that responded to the question regarding types of investments are deploying voltage conversion projects. Additionally, Figure ELS-3 indicates that 8 of the 10 utilities surveyed prioritize transmission lines for resiliency investments. Further, Figure ELS-1 shows that 7 of the utilities address aging infrastructure through their resiliency programs, while all 10 direct their focus towards mitigating extreme windstorm hazards.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) indicates that transmission programs are commonly included in electric utility resiliency investments for the jurisdictions examined. Seven of the fifteen jurisdictions have either proposed investments or generally consider transmission investments to be within scope. For example, DTE's Distribution Grid Plan includes 4.8kV Hardening in its proposed infrastructure resilience and hardening efforts. In addition, Entergy's 10-Year Resiliency Plan proposes approximately 9,600 distribution and transmission projects that collectively, will harden more than 269,000 structures over 11,000-line miles.

COASTAL RESILIENCY UPGRADES

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S COASTAL RESILIENCY UPGRADES RESILIENCY MEASURE.

A. CenterPoint Houston's Coastal Resiliency Upgrades resiliency measure is designed to prevent the loss of electric supply to coastal areas following the loss of critical transmission lines. A loss of the transmission network for a common mode failure of a transmission circuit (i.e., multiple failures due to a single cause) followed by the loss of a double circuit tower line due to high winds or corrosion could result in an extended interruption of supply to coastal areas.

CenterPoint Houston proposes to upgrade existing lines to improve resiliency of supply to coastal areas. Poles and towers that are replaced will meet CenterPoint Houston's current wind loading design standard. These initiatives are intended to avoid a loss of critical lines that could cause interruption of load due to the loss of transmission sources.

It is also intended to avoid a loss of critical lines that could cause unacceptable low voltages and overloads on radial feeds to industrial customers with up to 1,100 MW of load at risk. The cost of the project over the three-year Resiliency Plan included in the BCA ratio presented below is $259 million. Total project cost, which includes amounts outside of the three-year Resiliency Plan, is $504.5 million.[19] The total expense to inspect and maintain the new facilities is $750,000 over three years.

Additional detail on CenterPoint Houston's Coastal Transmission Improvement Projects resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S COASTAL RESILIENCY UPGRADES RESILIENCY MEASURE?

A. The Coastal Resiliency Upgrades resiliency measure should reduce the likelihood of lengthy outages for up to 1350 MW of load,[20] and reduce the risk of potential voltage collapse in the area due to shut down of generation resulting from the loss of transmission supply lines. The Coastal Resiliency Upgrades resiliency measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 21.9 million. At the end of the three-year resiliency measure in 2027, annual CMI savings is approximately 21.9 million as the project will become operational in 2027. Guidehouse's analysis produced a BCA ratio of 1.4 for this resiliency measure, which includes the three-year capital cost and annual operation and maintenance expense cited in my response to the prior question.

[19] The BCA ratio for the Coastal Island Resiliency Measure is based on the total project cost of $504.5 million.
[20] There is additional exposure due to the potential loss of underwater transmission cable due to barge anchor severing during storms.

The ability of reinforced lines to avoid failure and customer interruptions during major storms and severe weather events is significant, particularly during high wind events. Absent these upgrades, if a major storm were to cause the loss of two lines, the potential for a loss of electric supply to coastal areas would be high. The societal impact of outages affecting critical area load could have severe consequences, ranging from the loss of critical infrastructure (e.g., water and sewage treatment), law enforcement challenges, and public safety, among other societal impacts.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED COASTAL TRANSMISSION IMPROVEMENT PROJECTS RESILIENCY MEASURE.

A. Guidehouse concludes that CenterPoint Houston's Coastal Transmission Improvement Projects resiliency measure is reasonable and beneficial for inclusion in its Resiliency Plan for the following reasons:

1. The Coastal Transmission Improvement Projects resiliency measure mitigates the risk of an extended interruption of electric supply to coastal areas during resiliency events.
2. The installation of a new transmission lines will avoid the lengthy interruption of critical load during high wind events. It will also enhance resiliency via increased capacity to serve growing coastal area load.
3. Guidehouse's analysis of the CenterPoint Houston's Coastal Transmission Improvement Projects resiliency measure produced a BCA ratio that confirms the measure is marginally cost effective, but that we conclude should be approved by

the Commission due to the magnitude and disruption associated with a loss of coastal area load.

4. CenterPoint Houston's proposal to install new transmission to meet a N-1-1 contingency without load loss is consistent with good utility practice.
5. Lastly, the potential for lengthy sustained outages and resulting societal consequences to area residents and businesses underscores the criticality of maintaining reliable electric supply to coastal areas.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several of the electric utilities surveyed include transmission improvement projects in their resiliency plans. Figure ELS-4 indicates that nine utilities responding to the question on types of investments are deploying both Line/Circuit Rebuilds and Pole Replacements. Additionally, Figure ELS-3 indicates that 8 of the 10 utilities surveyed prioritize transmission lines as a resiliency measure. Further, decreasing the impact of major events and reducing restoration time were the most common primary goals of utility resiliency measures by those surveyed, which align with CenterPoint Houston's Resiliency Plan. Pole Replacement/Line Rebuilds was also among the most common resiliency measures selected by peer utilities.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) indicates that transmission programs are commonly included in electric utility resiliency investments for the jurisdictions examined. Seven of the 15

jurisdictions either have proposed investments or generally consider transmission investments to be within scope. For example, Entergy's 10-Year Resiliency Plan proposes approximately 9,600 distribution and transmission projects that will collectively harden more than 269,000 structures over 11,000-line miles. In addition, Hawaii identifies hardening and reinforcing critical transmission circuits as a resiliency measure, which includes upgrading structures and using enhanced construction materials.

SUBSTATION TRANSFORMER FIRE PROTECTION BARRIERS

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S SUBSTATION TRANSFORMER FIRE PROTECTION BARRIERS RESILIENCY MEASURE.

A. CenterPoint Houston's Substation Transformer Fire Protection Barriers resiliency measure will install physical fire protection barriers to protect power transformers and other equipment vulnerable to damage caused by the catastrophic failure of adjacent transformers. Although substation transformer failures are uncommon compared to other distribution equipment failures (e.g., broken poles), the consequences and impact of a catastrophic transformer failure can be severe. An enormous amount of energy is released when a transformer catastrophically fails, with the possibility of extensive damage to nearby equipment from associated fire and debris. The potential for lengthy outages and costly repairs if this were to occur is high. Extinguishing the fire also presents challenges to fire department personnel.

CenterPoint Houston proposes to install either concrete or metal barriers between substation transformers in locations where the impact of a catastrophic failure is high. CenterPoint Houston proposes to install 4 substation Transformer Fire Protection Barriers

a year for a total of 12 over the 3-year Resiliency Plan at a total measure cost of $2.4 million.

Additional detail on CenterPoint Houston's Substation Transformer Fire Protection Barriers resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S SUBSTATION TRANSFORMER FIRE PROTECTION BARRIERS RESILIENCY MEASURE?

A. The Substation Transformer Fire Protection Barriers resiliency measure will reduce the risk that a transformer fire will impact adjacent transformers or other nearby equipment. The measure also avoids the high cost of repairing damaged equipment and crew labor required to restore service. The Substation Transformer Fire Protection Barriers resiliency measure is expected to reduce total CMI over the 3-year Resiliency Plan by approximately 0.5 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 0.2 million. Guidehouse's analysis produced a BCA ratio of 3.7 for this measure.[21]

Further, the potential for nearby equipment to fail when a power transformer catastrophically fails is high. In such an event, substations serving critical loads and area industries and businesses could experience disruption in day-to-day operations, resulting in economic harm.

[21] A BCA ratio above 1.0 indicates life-cycle benefits exceed measure costs; measure costs exceeding benefits results in a BCA ratio below 1.0.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED SUBSTATION TRANSFORMER FIRE PROTECTION BARRIERS RESILIENCY MEASURE.

A. Guidehouse concludes that CenterPoint's Substation Transformer Fire Protection Barriers resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The proposed solution effectively avoids major equipment damage caused by transformer failures.
2. The installation of Transformer Fire Protection Barriers at critical substations is a responsible action to undertake given the potential consequences of a catastrophic failure.
3. The proposed measure also is consistent with practices deployed at other utilities based on Guidehouse experience and benchmark survey results.
4. Lastly, installation of firewalls at critical substations avoids potentially undesirable attention and loss of confidence in CenterPoint Houston from its customers and the general public for failures that result in major substation fires.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that substation hardening was one of the most common categories of resiliency initiatives identified by peer utilities. Additionally, Figure ELS-3 indicates that eight of the ten utilities surveyed prioritize transmission and distribution substations for resiliency investments. Further,

decreasing impact of major events and reducing restoration time were the most common primary goals of utility resiliency plans selected by those surveyed, which align with CenterPoint Houston's Resiliency Plan.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) shows that a couple electric utilities in the jurisdictions examined focus on substation and grid hardening in their resiliency plans. For example, DTE's Distribution Grid Plan includes upgrades to transformers and substation equipment in the various infrastructure resilience and hardening efforts proposed. Additionally, Virginia identifies grid hardening resiliency investments as in-scope.

DISTRIBTUION POLE REPLACEMENT/BRACING

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S DISTRIBUTION POLE REPLACEMENT/BRACING RESILIENCY MEASURE.

A. CenterPoint Houston's Distribution Pole Replacement/Bracing resiliency measure is designed to replace poles that have been identified during scheduled inspections as not meeting CenterPoint Houston's minimum remaining strength criteria. Poles will either be replaced or braced with brackets to meet CenterPoint Houston's current extreme wind and ice loading design standard. Although existing poles meet the design standard in effect at the time they were built, they may not meet changes in the design standard due to increased extreme weather severity and frequency. To improve pole resiliency strength in high wind conditions and to expand the life of new poles, CenterPoint Houston has introduced composite (fiberglass) and metal (ductile iron) poles, although wood is the preferred option

for some replacements depending on location and judgement of area engineering or operations personnel.

CenterPoint Houston proposes to replace or brace up to 6,000 poles per year for a total of 15,000 over the 3-year Resiliency Plan and a total resiliency measure cost of $99.3 million.[22]

Additional detail on CenterPoint Houston's Distribution Pole Replacement/Bracing resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S DISTRIBUTION POLE REPLACEMENT/BRACING RESILIENCY MEASURE?

A. The Pole Replacement/Bracing resiliency measure should reduce the number of sustained, storm-related interruptions on distribution main lines and laterals where poles are replaced or braced. The failure rate of existing poles where rebuilds are proposed is expected to increase based on wind speeds and event frequency forecasts described earlier in my testimony, which indicates that by 2030 there is a 2% probability of winds exceeding 70 mph inland, and 5% probability of exceeding 70 mph in coastal counties. For these forecasts, I determined that approximately 0.5% of inland poles and 1% of coastal poles are likely to fail. These forecasts are similar to information included in a Florida Power and Light filing which showed measured rate of failure for non-hardened poles during Hurricane Irma to be 0.2%. Other benefits include reduced costs for truck rolls and crew

[22] Although 5,000 poles will be targeted to be analyzed annually, CenterPoint Houston will first determine whether bracing is sufficient to meet the wind loading requirements (based on location) or if an upgraded pole is the preferred method. If a larger quantity or poles can be braced than the anticipated quantity of 5,000 (at lower cost), annual quantities may be higher.

labor to restore service absent the presence of replacement poles. The Distribution Pole Replacement/Bracing resiliency measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 41.3 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 20.8 million. Guidehouse's analysis produced a favorable BCA ratio of 6.2 for this measure.[23]

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED DISTRIBUTION POLE REPLACEMENT/BRACING RESILIENCY MEASURE.

A. Guidehouse concludes that CenterPoint's Distribution Pole Replacement/Bracing resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. It cost-effectively hardens distribution circuits as the BCA ratio is 6.2.
2. The replacement or bracing of poles to meet CenterPoint Houston's extreme wind and ice design standard will result in fewer failures and sustained interruptions during high wind events.
3. CenterPoint Houston's pole replacement criteria ensures the appropriate pole type (wood, fiberglass, or ductile iron) is selected based on locational exposure to storm events.
4. Lastly, based on my prior industry experience and peer utility benchmarking survey results, I determined that the installation of more robust poles is consistent with resiliency practices deployed at other utilities.

[23] A BCA ratio above 1.0 indicates life-cycle benefits exceed measure costs; measure costs exceeding benefits results in a BCA ratio below 1.0.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI , indicates that the majority of electric utilities surveyed include pole replacement/hardening investments in their resiliency plans. Figure ELS-4 shows that all nine utilities that responded to the question regarding types of investments are deploying and seeking to address those related to pole replacements. Additionally, Figure ELS-3 indicates that the ten utilities surveyed prioritize distribution lines for resiliency investments. Further, Figure ELS-1 indicates that seven address aging infrastructure, while ten focus on mitigating extreme windstorm hazards. Pole replacement/line rebuilds was also one of the most common categories of resiliency initiatives identified by peer utilities.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse's report (Exhibit ELS-2) shows that pole replacement/hardening programs are commonly included in electric utility resiliency investments for the jurisdictions examined. 11 of the 15 jurisdictions summarized in Table 4 either propose investments or generally consider pole replacement/hardening resiliency investments to be within scope. For example, Florida includes pole inspections and replacements as part of their resiliency efforts. Additionally, Hawaii includes upgrading wind criteria and structures as part of their hardening process. Further, Connecticut includes system hardening such as stronger wood poles and steel poles.

DISTRIBUTION RESILIENCY – CIRCUIT REBUILDS

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S DISTRIBUTION RESILIENCY – CIRCUIT REBUILDS RESILIENCY MEASURE.

A. CenterPoint Houston's Distribution Resiliency – Circuit Rebuild resiliency measure is responsive to increased frequency and severity of extreme weather events. It is designed to replace and improve pole strength by meeting current NESC design standards on circuits where a substantial number of poles were installed under the prior standard at the time of construction, but do not meet CenterPoint Houston's current and higher extreme wind and ice design standard. This measure includes utilization of non-wood engineered structures, hardening substation getaways, and removal/replacement of equipment.

The circuits that CenterPoint Houston targets for resiliency rebuild through the installation of more robust poles and associated equipment are those most susceptible to failure during major storms and other extreme weather events that do not meet current engineering design standards. Replacement poles will meet CenterPoint Houston's current extreme wind and ice design standard. Further, circuits chosen for upgrade will be prioritized according to those that serve critical facilities (e.g., hospitals, water treatment plants, police stations); support mobile generation; or serve underserved communities. Circuit selection and pole placement location will be further enhanced with the full implementation of Digital Twin technology presented later in my testimony.

CenterPoint Houston's proposes to upgrade 300 to 350 feeder miles per year over the 3-year Resiliency Plan for a total resiliency measure cost of $312.8 million included in the BCA ratio presented below.

Additional detail on CenterPoint Houston's Distribution Resiliency – Circuit Rebuild resiliency measure, including alternatives considered and metrics for evaluating effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S DISTRIBUTION RESILIENCY – CIRCUIT REBUILD RESILIENCY MEASURE?

A. The Distribution Resiliency – Circuit Rebuild resiliency measure should reduce the number of sustained, storm-related interruptions on circuits where poles and associated equipment will be replaced. The Distribution Resiliency – Circuit Rebuild Resiliency Measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 137.4 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 69.4 million. Guidehouse's analysis produced a favorable BCA ratio of 7.0 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED DISTRIBUTION RESILIENCY – CIRCUIT REBUILD RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's Distribution Resiliency – Circuit Rebuild resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The replacement of poles conforms to CenterPoint Houston's current and higher extreme wind and ice loading standard and will result in fewer failures and sustained circuit interruptions during high wind events.

2. CenterPoint Houston has targeted circuits with a high percentage of poles that do not meet its current design standard and thus are more susceptible to outages during high winds.
3. CenterPoint Houston's pole replacement criteria ensures that the appropriate pole type and size is selected based on locational factors and application.
4. Guidehouse's analysis of the Distribution Resiliency – Circuit Rebuild resiliency measure produced a BCA ratio that confirms the measure is cost effective
5. Based on my prior industry experience and peer utility benchmarking survey results, I determined that the installation of more robust poles is consistent with resiliency practices deployed at other utilities.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that the majority of electric utilities surveyed include pole replacement/hardening investments in their resiliency plans. Exhibit ELS – 4 shows that all nine utilities that responded to the question regarding types of investments are deploying and seeking to address those related to pole replacements. Additionally, Figure ELS-3 indicates that all ten of the utilities surveyed prioritize distribution lines for resiliency investments. Further, Figure ELS-1 shows that seven of the utilities address aging infrastructure through their resiliency programs, while all ten direct their focus towards mitigating extreme windstorm hazards. Pole replacement/line rebuilds was also one of the most common categories of resiliency initiatives identified by peer utilities.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) shows that pole replacement/hardening programs are commonly included in electric utility resiliency investments for the jurisdictions examined. Eleven of the fifteen jurisdictions summarized in Table 4 either propose investments or generally consider pole replacement/hardening resiliency investments to be within scope. For example, Hawaii includes upgrading wind criteria and upgrading structures as part of their hardening process. Additionally, Connecticut includes system hardening such as stronger wood poles and steel poles.

STRATEGIC UNDERGROUNDING/FREEWAY CROSSINGS

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S STRATEGIC UNDERGROUNDING/FREEWAY CROSSINGS RESILIENCY MEASURE.

A. CenterPoint Houston's Strategic Undergrounding/Freeway Crossings resiliency measure is designed to replace wood poles and accessory equipment on overhead distribution lines at freeway crossings that are at risk of failure during major storms and other extreme weather events, or which could result in significant outages if damaged. For overhead crossings, replacement poles will be concrete and meet CenterPoint Houston's extreme wind and ice design standard. For underground crossings, terminal poles will be replaced with fiberglass or concrete poles and meet CenterPoint Houston's current extreme wind and ice design standard.

CenterPoint Houston proposes to replace 10 freeway crossings per year (30 total), including 8 overhead line replacements and 2 underground cable replacements per year, respectively. Total resiliency measure cost included in the BCA ratio presented below is

$31.2 million over the 3-year Plan, at an average cost of $300,000 per overhead crossing and $1 million per underground crossing.[24]

Additional detail on CenterPoint Houston's Strategic Undergrounding/Freeway Crossings resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S STRATEGIC UNDERGROUNDING/FREEWAY CROSSINGS RESILIENCY MEASURE?

A. The Strategic Undergrounding/Freeway Crossings resiliency measure should reduce the number of sustained, storm-related interruptions on freeway crossings where poles are replaced, or lines are relocated underground. Other benefits include reduced costs for truck rolls and crew labor to restore service absent the presence of replacement poles. Further, access to freeways is needed by emergency vehicles during major storm and other extreme weather events. When a wire is down across a highway, emergency response personnel (e.g., police, fire, national guard) do not have access to respond to make life saving rescues. Line failures on major freeways are also highly visible, attracting public attention and resulting in traveler inconvenience.

The Strategic Undergrounding/Freeway Crossings resiliency measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 4.4 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are

[24] The exact number of overhead versus underground freeway crossing replacements will be determined based on site specific engineering and operational analysis. Accordingly, measure costs may vary from current estimates.

approximately 2.2 million. Guidehouse's analysis produced a BCA ratio of 3.8 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED STRATEGIC UNDERGROUNDING/FREEWAY CROSSINGS RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint's Strategic Undergrounding/Freeway Crossings resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons.

1. It cost-effectively enhances distribution resiliency and minimizes traffic and interruption of consumer travel and commerce as confirmed by the 3.8 BCA ratio calculated by Guidehouse.
2. The replacement of deteriorated poles that conform to CenterPoint Houston's current design standard will result in fewer failures and sustained interruptions during high wind events and storms.
3. CenterPoint Houston's Strategic Undergrounding/Freeway Crossings resiliency measure criteria ensures the appropriate pole type and size is selected based on locational factors and application; or when overhead lines are not suitable, will relocate lines underground below the highway.
4. The installation of more robust poles is consistent with practices deployed at other utilities to improve resiliency based on prior Guidehouse experience and peer utility benchmarking survey results.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that the majority of electric utilities surveyed include pole replacement/hardening investments in their resiliency plans. Exhibit ELS – 4 indicates that all nine utilities that responded to the question regarding types of investments are deploying and seeking to address those related to pole replacements. Additionally, Figure ELS-1 indicates that seven of the utilities address aging infrastructure through their resiliency programs, while all ten direct their focus towards mitigating extreme windstorm hazards. Further, seven of the utilities that responded selected decreasing impact of major events as a primary goal of their resiliency program.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) indicates that pole replacement/hardening programs are commonly included in electric utility resiliency investments for the jurisdictions examined. Eleven of the fifteen jurisdictions summarized in Table 4 either propose investments or generally consider pole replacement/hardening resiliency investments to be within scope. For example, Connecticut includes system hardening such as steel poles and fiberglass cross arms as part of their resiliency efforts. Additionally, Hawaii includes upgrading structures and using enhanced construction materials.

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S TRIPSAVER® RESILIENCY MEASURE.

A. CenterPoint Houston's TripSaver® resiliency measure should reduce the duration and number of sustained interruptions on distribution circuit lateral line sections for transient outage events such as those that occur during momentary tree contact. TripSaver® replaces existing fused cutouts located along the first tap from the main line distribution circuit. For momentary faults, the TripSaver® opens and recloses in an attempt to clear momentary faults. For sustained faults, the TripSaver® will open and lock out the lateral branch portion of the circuit. Distribution feeders targeted for TripSaver® installations include locations most susceptible to lateral line section outages, locations with a relatively high number of customers or load at risk.

CenterPoint Houston's proposes to install 2,500 TripSaver® per year for a total of 7,500 over 3 years, at a resiliency measure cost of $58.9 million over the three-year Resiliency Plan included in the BCA ratio presented below. The annual maintenance expense for the TripSaver® resiliency measure is $10,000 ($30,000 over 3 years).

Additional detail on CenterPoint Houston's TripSaver® resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S TRIPSAVER RESILIENCY MEASURE?

A. TripSaver devices will help avoid blown fuses and related customer interruptions during major storms and other extreme weather events, particularly during high wind conditions.

Because many lateral line sections will have lower restoration priority compared to main line outages during storms, outage duration for customers located on lateral line sections is typically longer. For systemwide storms that simultaneously impact many circuits, TripSaver® can significantly mitigate the number of customers who would sustain extended interruptions due to transient faults. Other benefits include reduced cost for truck rolls and crew labor to restore service absent the presence of the TripSaver®.

The TripSaver® measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 122.2 million. At the end of the 3-year resiliency measure in 2027, annual CMI savings are approximately 240.3 million. Guidehouse's analysis produced a BCA ratio of 61.3 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED TRIPSAVER® RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint's TripSaver® resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The ability of TripSaver® to significantly reduce frequency and duration of sustained interruptions during high wind events at low cost is high, resulting in a robust BCA ratio of 61.3.
2. Peer utility benchmarking survey results confirm the installation of TripSaver® or similar technologies is consistent with practices deployed at other utilities.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several of the electric utilities surveyed include TripSaver® in their resiliency plans. Exhibit ELS – 4 indicates that four of the nine utilities that responded to the question regarding types of investments are deploying and seeking to address resiliency investments related to TripSaver®. Additionally, Figure ELS-3 indicates that all ten of the utilities surveyed prioritize distribution lines for resiliency investments. Further, decreasing impact of major events and reducing restoration time were the most common primary goals of utility resiliency plans selected by those surveyed, which align with CenterPoint Houston's Resiliency Plan. Automation/customer resiliency was also one of the most common categories of resiliency initiatives identified by peer utilities.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) shows that grid modernization is included in electric utility resiliency investments for several of the jurisdictions examined. As shown in Table 4, New Jersey marked outage management system upgrade as part of their summary of resiliency investments and mention grid modernization communication systems as in-scope. Additionally, Virginia includes intelligent grid devices as well as operations and automated control systems as part of their resiliency efforts.

INTELLIGENT GRID SWITCHING DEVICE ("IGSD") INSTALLATION

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S IGSD INSTALLATION RESILIENCY MEASURE.

A. CenterPoint Houston's IGSD Installation resiliency measure will reduce the number of customers interrupted and reduce restoration times for faults occurring on main line sections of distribution circuits. CenterPoint Houston proposes to install up to 150 IGSD

devices per year, or alternatively stated, 50 schemes per year[25], either fully automated or remotely operated by distribution system operators, over the three-year Resiliency Plan. Distribution feeders targeted for IGSDs include locations most susceptible to main line outages with additional consideration of the magnitude of load at risk (e.g., serving greater than 4,000 customers) and those that serve critical customers or facilities (e.g., hospitals or facilities providing emergency services during storms). A complementary technology measure included in CenterPoint Houston's Resiliency Plan, also discussed in Guidehouse witness Dr. Joseph Baugh's testimony, is installing remote equipment required to enable communications between the IGSD device and the utility's control systems used by distribution controllers. The components allow for communications using the Company's 700MHz radios system, along with the LTE Cellular redundant systems, because any public carrier outages to the LTE Cellular system will also affect the redundancy of the IGSD communications package. The package is designed to include a battery back-up system.

Candidate feeders for IGSD are those that require minimum line upgrades and sufficient available capacity to accept loads from adjacent feeders or feeders from another substation following an outage on the main line section of the alternate circuit. Further, both the circuit where load will be transferred from and the circuit receiving the load (and vice-versa) should have sufficient load on the non-faulted line sections to justify the installation.

CenterPoint Houston's proposes to install 50 IGSD schemes per year. With 3 devices typically required per scheme, this results in 150 devices per year and 450 devices

[25] Each IGSD transfer schemes is assumed to require 3 switching devices, one at the midpoint of each feeder and one at the open tie point between each feeder.

(alternatively stated as 150 IGSD schemes) over 3 years at a total resiliency measure cost of $53.8 million over the three-year Resiliency Plan included in the BCA ratio presented below.[26] The total expense to inspect and maintain the new equipment is $820,000 over three years.

Additional detail on CenterPoint Houston's IGSD resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S IGSD RESILIENCY MEASURE?

A. IGSD devices will help avoid lengthy customer interruptions, either via manual or fully automated switching. For systemwide storms that impact many circuits, the number of customers that will experience sustained interruptions during major storms and other extreme weather events will be reduced through IGSD schemes. The ability of IGSD schemes to materially reduce the impact of outages during major storms and other extreme weather events, coupled with other resiliency measures, collectively reduce the economic impact of major storms and other extreme weather events within CenterPoint Houston's service territory. It should also result in faster restoration of critical loads at relatively low cost.

The IGSD measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 58.1 million. At the end of the three-year resiliency measure in

[26] The $53.8 million total cost includes $5.1 million for operational technology/communications support. Measure BCA is based on the total cost of $53.8 million.

2027, annual CMI savings are approximately 27.7 million. Guidehouse's analysis produced a BCA ratio of 15.7 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED IGSD RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint's IGSD measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The IGSD resiliency measure should significantly reduce the number of sustained customer interruptions and restoration times during severe storms and other extreme weather events at relatively low cost, resulting in a robust BCA ratio of 15.7.
2. The installation of IGSD schemes is consistent with practices deployed at other utilities based on peer utility benchmarking survey results presented later in my testimony.
3. CenterPoint Houston's proposed investment in low-cost automation also underscores its commitment to apply automation technology to enhance the resiliency of its power delivery system.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI indicates that several of the electric utilities surveyed include smart grid upgrades in their resiliency plans. Exhibit ELS – 4 shows that seven of the nine utilities that responded are deploying and seeking to address resiliency investments related to smart grid upgrades. Additionally, Figure ELS-3

indicates that the ten utilities surveyed prioritize distribution lines for resiliency investments. Further, decreasing impact of major events and reducing restoration time were the most common primary goals of utility resiliency plans selected by those surveyed, which align with CenterPoint Houston's Resiliency Plan. Automation/customer resiliency was also one of the most common categories of resiliency initiatives identified by peer utilities.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) shows that grid modernization is included in electric utility resiliency investments for several of the jurisdictions examined. As shown in Table 4, New Jersey marked outage management system upgrades as part of their summary of resiliency investments and mention grid modernization communication systems as in-scope. Additionally, Virginia includes intelligent grid devices as well as operations and automated control systems as part of their resiliency efforts.

TEXAS MEDICAL CENTER SUBSTATION

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S TEXAS MEDICAL CENTER SUBSTATION RESILIENCY MEASURE.

A. CenterPoint Houston's Texas Medical Center Substation resiliency measure will enhance resiliency, redundancy, and reliability for the Texas Medical Center ("TMC") and surrounding greater Houston area. This new substation will ultimately contain 5 transformers to supply current and future loads as well as reduce loads served by other nearby substations. CenterPoint Houston intends to leverage this new substation to reduce

loading for two other substations while supplying backup power to 22 large customers with a total of 70 MW of load located within the Medical Center area. The total cost is $102 million over the 3-year Resiliency Plan and is included in the BCA ratio presented below. The measure has a total cost of $214.6 million that includes spending that will occur outside of the three-year Plan, and a total operation and maintenance expense of $150,000 total over 3 years.[27]

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S TEXAS MEDICAL CENTER SUBSTATION RESILIENCY MEASURE?

A. The addition of the Texas Medical Center Substation should materially improve resiliency within the TMC and greater Houston area by adding additional circuits to 22 of the largest and most prestigious hospital facilities in the world. A loss of service to these key customers would have a significant societal impact to health and safety. This area has been prone to flooding in the past (e.g., during Tropical Storm Allison) and some substations are not sufficiently elevated. This project also provides the benefit of reducing overall loading for two other substations which will improve load balancing and redundancy. The reduction in duration of outages and sustained outage frequency from the addition of this substation and circuits is significant, effectively almost completely eliminating such risk for these customers by providing two sources of power within/near their vault and allowing CenterPoint Houston to reconfigure its underground distribution system in the event of an extreme weather event that compromises one (or even two) of the substations. The estimated average load at risk generally varies by measure and is dependent on the review

[27] The BCA ratio for the Medical Center Substation project is based on the total project cost of $158 million.

but is estimated to be approximately 70 MW with a minimum restoration time of 72 hours during an extreme weather event.

The new Medical Center Substation resiliency measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 4.9 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 4.9 million.[28] Guidehouse's analysis produced a BCA ratio of 0.7 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED TEXAS MEDICAL CENTER SUBSTATION RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Texas Medical Center Substation resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The addition of the substation will enhance the grid by improving the loading characteristics of substations serving the greater Houston area and the resiliency of the grid during extreme weather events. The addition of a new substation for extremely critical load is consistent with the trending of the utility industry and leverages best practices deployed at other utilities based on prior Guidehouse experience.
2. CenterPoint Houston will leverage the design of the substation to provide for greater withstand capabilities during extreme weather events.

[28] The BCA was derived based on a total cost of $158 million to construct the substation.

3. It will provide additional capacity for customers within this area as the distribution system expands due to EV adoption, building electrification, and other types of electrification.
4. Guidehouse's analysis of CenterPoint Houston's Texas Medical Center Substation Resiliency Measure produced a BCA ratio that is less than 1.0, but criticality of load served combined with the capability to serve future load justifies the project.

The potential for widespread outages and resulting societal consequences of line failures underscores the criticality of maintaining a reliable secondary network in downtown Houston.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several electric utilities have included investments similar to CenterPoint Houston's Texas Medical Center Substation Measure in their resiliency plans. For example, the most common goal of the surveyed utilities' resiliency programs was to decrease the impact of major events, which the Medical Center Substation will have a direct impact on. Additionally, Figure ELS-2 shows the top categories for most frequent occurrences of different types of resiliency investments, with undergrounding enhancements, substation hardening, and customer resiliency all highlighted. These are all aspects of the Texas Medical Center Substation resiliency measure and reinforce the impact of its construction.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) shows that 11 out of the 15 utilities cited undergrounding circuits

and other investments similar to the Texas Medical Center Substation measure in their respective resiliency plans. For example, National Grid's Climate Change Resilience Plan in-scope investments included distribution targeted undergrounding, as well as general distribution and transmission substation specification design upgrades. Additionally, the two most common metrics jurisdictions have used to determine which projects qualify is the indirect/societal impact, and the customer outage time. Hawaiian Electric evaluates their project options using a resilience solution portfolio matrix that weighs societal benefit vs resilience solution scope (point vs. community solutions). The Medical Center Substation upgrade would deliver vast benefits to the entire community as a critical facility, and these metrics commonly used by other utilities support its inclusion in the resiliency plan.

SUBSTATION FLOOD CONTROL

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S SUBSTATION FLOOD CONTROL RESILIENCY MEASURE.

A. CenterPoint Houston's Substation Flood Control resiliency measure aims to mitigate the risk of flooding at substations, which can cause loss of electricity service to a large number of customers. This effort helps address increasing flood risk in CenterPoint Houston's service area as evidenced by CenterPoint's discussion of impacts from recent flooding events, such as Hurricane Harvey, and forecasted flood risk presented in Guidehouse's analysis.

A complementary technology measure included in CenterPoint Houston's Resiliency Plan, also discussed in Guidehouse witness Dr. Joseph Baugh's testimony, will raise and/or replace substation site telecommunication huts to the same level as the

correlating control house to increase resilience of the devices transmitting substation data to systems and individuals that monitor the substation in real-time. Without this information, CenterPoint Houston would not have operational visibility into the substation, thus hindering its ability to make operational decisions during a resiliency event.

CenterPoint Houston proposes to elevate 3 substations annually for a total of 9 over 3 years at a resiliency measure cost of $27 million, with an additional $3.6 million in operational technology support over the three-year Resiliency Plan. The total cost of $30.6 million is included in the BCA ratio presented below.

Additional detail on CenterPoint Houston's Substation Flood Control resiliency measure, including alternatives considered and metrics for evaluating measure effectiveness, is included in the Company's Resiliency Plan as well as the Guidehouse report provided as Exhibit ELS-2.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S SUBSTATION FLOOD CONTROL RESILIENCY MEASURE?

A. Elevating substations at risk of flooding reduces the potential for multiple substations to fail during a major flood, avoiding lengthy outages. The resulting impact on industries and businesses served by these substations if they were to fail would be consequential. The failure of multiple substations during a major flood would result in lengthy outages that would have widespread economic and societal consequences.

The Substation Flood Control resiliency measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 14.2 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 6.7 million. Guidehouse's analysis produced a favorable BCA ratio of 7.5 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED SUBSTATION FLOOD CONTROL RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Substation Flood Control resiliency measure is reasonable and beneficial for inclusion in CenterPoint Houston's Resiliency Plan for the following reasons:

1. The proposed solution provides significant value to CenterPoint Houston customers and the general public. The likelihood of severe flooding is high at each of the substations where elevating sensitive equipment is proposed, resulting in a robust BCA ratio of 7.5.
2. The proposed measure is consistent with practices deployed at other utilities based on benchmarking.
3. Implementation of flood control measures at substations helps avoid the significant negative economic and societal impacts associated with widespread, lengthy outages.

Q. HOW DOES THE BENCHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey discussed in Section VI of Guidehouse's report (Exhibit ELS-2) identifies several electric utilities that include substation flood control investments in their resiliency plans. For example, four of the nine utilities that responded to the survey noted making investments to raise substations. Additionally, more than half of the responding utilities indicated that the primary goal of their resiliency program is to mitigate the impact of major events with six of the nine utilities identifying floods as the

primary hazard addressed through their resiliency programs. Substation hardening/flood control was also one of the most common categories of resiliency initiatives identified by survey respondents.

The jurisdictional benchmarking report provided as Appendix A in the Guidehouse report (Exhibit ELS-2) further demonstrates that flood control programs are commonly included in electric utility resiliency plans in the states examined. For example, Hawaiian Electric identifies flood mitigation and re-location of equipment outside of flood prone areas as part of their resiliency efforts. In 2022, the New Jersey Board of Public Utilities ("NJBPU") approved PSE&G's proposed investment in electric substation flood mitigation as part of their Strong Energy Program. Further, the jurisdictional benchmarking report shows that several jurisdictions plan their resiliency efforts to mitigate 100-year floodplain levels using location-based flood probabilities combined with asset elevation data, similar to the approach being taken by CenterPoint Houston for its Resiliency Plan.

CONTROL CENTER FACILITY UPGRADES

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S CONTROL CENTER FACILITY UPGRADES RESILIENCY MEASURE.

A. CenterPoint Houston's proposed upgrades to its Addicks Operations Center ("AOC") facility is designed to protect the backup control center from damage caused by major floods or storm surges. The Control Center facility is located within the Harris County floodplain and is susceptible to flooding for 500-year or greater events. The AOC is also

located downstream of an earthen dam. If the dam were to breach, the control center facility would be inundated with water.

The control center is a critical facility as it provides essential backup to CenterPoint Houston's primary operations control center. It can also function as CenterPoint Houston's primary distribution operations center for the entire CenterPoint Houston footprint when needed. Flooding would result in the loss of critical data and functionality of monitoring devices and control systems. Damage would be extensive as servers, control stations, and other facility equipment would be damaged beyond repair. Most important, a loss of the Control center facility would jeopardize CenterPoint Houston's ability to maintain continuous contingency support of critical operating systems.

To mitigate exposure to flood damage, CenterPoint Houston proposes to construct a concrete wall around the facility. Construction would be completed by 2026 and the total cost of $7 million to build the flood wall is included in the BCA ratio presented below.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S CONTROL CENTER FACILITY UPGRADES RESILIENCY MEASURE?

A. Installation of a concrete wall at the back-up control center will reduce the likelihood that future flooding events will inundate sensitive equipment to levels that will cause systems or equipment to fail. The amount of load at risk of an extended outage avoided by CenterPoint Houston's Control Center Facility Upgrade Resiliency measure is 5,000 MW, with restoration times extended by 1 day. Other benefits of this measure include avoided load loss, shorter restoration times, avoidance of the cost to repair systems and equipment at the Control center facility, avoided repairs and crew time required to restore service, and recovery of lost data from servers.

The Control Center Facility Upgrade measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 6.1 million. At the end of the 3-year resiliency measure in 2027, annual CMI savings are approximately 2.5 million. Guidehouse's analysis produced a BCA ratio of 12.5 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED CONTROL CENTER FACILITY UPGRADES RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Control Center Facility Upgrades resiliency measure is reasonable and beneficial for inclusion in CenterPoint Houston's Resiliency Plan for the following reasons:

a. The Control Center Facility has a critical role in service restoration during storms. While the likelihood of a simultaneous malfunction of the primary and back up control centers is low, the consequences would be severe. The loss of visualization and control of the transmission and distribution system would hinder operations staff, likely resulting in extended outages.

b. The low cost of preventing such an event through the proposed upgrade resulted in a robust BCA ratio of 12.5.

c. The proposed measure is also consistent with practices deployed at other utilities based on Guidehouse experience and familiarity with control center back-up facilities.

d. Implementation of Control Center Facility Upgrades resiliency measure avoids the significant negative economic and societal impacts associated with extended

outages if the AOC were to become inoperable due to flooding simultaneous with malfunction of CenterPoint Houston's primary operations control center.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORTPROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several electric utilities have included investments similar to CenterPoint Houston's Control Center Facility Upgrades resiliency measure in their plans. For example, when surveyed on the types of the investments included in their resiliency plans, four out of the nine utilities surveyed cited data center facilities upgrades and five cited monitoring of assets. Furthermore, CenterPoint Houston's investment in the Control Center Facility Upgrades measure targets mitigation of exposure to flood damage, and in Figure ELS-1 seven out of the ten respondents stated that floods were the main hazard addressed through their resiliency programs.

Similar to the findings for Substation Flood Control, the jurisdictional benchmarking report provided as Appendix A in Guidehouse's report (Exhibit ELS-2) shows that several flood control programs are commonly included in electric utility resiliency investments in the states examined. For example, Hawaiian Electric identifies hardening and upgrading structures, as well as enhanced construction methods and the re-location of equipment outside of flood prone areas as part of their resiliency efforts. Furthermore, the jurisdictional benchmarking report shows that several jurisdictions plan their resiliency efforts to mitigate 100-year floodplain levels using location-based flood

probabilities combined with asset elevation data, similar to how the Control Center Facility Upgrade was prioritized due to its susceptibility to flooding for 500-year or greater events.

ADVANCED AERIAL IMAGERY PLATFORM / DIGITAL TWIN

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S ADVANCED AERIAL IMAGERY PLATFORM / DIGITAL TWIN RESILIENCY MEASURE.

A. CenterPoint Houston's Advanced Aerial Imagery Platform / Digital Twin resiliency measure is designed to improve and enhance the visibility of the transmission, substation, and distribution systems managed by the company by digitizing a replication of the physical equipment installed. This will allow for overlay of imagery to determine vegetation management risk and analyze potential improvements to equipment to improve performance during extreme weather events. It allows for more streamlined processes, leading to a reduction in engineering design time, improvements in installation expediency and placement of equipment, resiliency to outages, and customer benefits. CenterPoint Houston intends to initially prioritize software applications to determine how existing projects are performing from a resiliency basis and then determine whether improvements could be made with respect to project location and potential weather risks.

CenterPoint Houston proposes to leverage this software in tandem with other software to "rank" improvement projects based on their value add to customers. Utilizing this software will help reduce costs over time by focusing on improvements with the greatest resiliency benefits. CenterPoint Houston will leverage the digital model to review and determine optimal placement of projects, maximizing potential benefits for future

resiliency initiatives. The software is also capable of "learning" and leveraging prior analyses to improve model performance at identifying resiliency upgrades needed to address extreme weather events, encroachments from vegetation (or other sources), and remediation of broken/leaning equipment.

Total estimated resiliency measure cost is $9.0 million over the 3-year Plan, with an additional $0.9 million in information technology support providing centralized data products to digital technologies and analytics applications to enable real-time decision making. The total expense for software maintenance and upgrades over three years is $60,000.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S ADVANCED AERIAL IMAGERY PLATFORM / DIGITAL TWIN RESILIENCY MEASURE?

A. The Advanced Aerial Imagery Platform / Digital Twin resiliency measure will improve engineering design efficiency with greater visibility into the distribution system to address extreme weather events. When leveraged with other resiliency measure measures, this advanced aerial imagery platform, coupled with the software analysis, should materially lower the cost of engineering design, enhance vegetation management, improve IGSD schemes, assist in targeting transmission tower/pole and distribution pole placement, and flooding event mitigation, among other potential applications.

The Advanced Aerial Imagery Platform / Digital Twin resiliency measure is expected to reduce total CMI over the 3-year Resiliency Plan by approximately 0.8 million. At the end of the 3-year resiliency measure in 2027, annual CMI savings are approximately 0.3 million. Guidehouse's analysis produced a BCA ratio of 3.4 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED ADVANCED AERIAL IMAGERY PLATFORM / DIGITAL TWIN RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Advanced Aerial Imagery Platform / Digital Twin resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

a. The addition of the imagery platform and digital twin resiliency measure will enhance the functionality of CenterPoint Houston's transmission and distribution system by analyzing and mitigating the risks of line failures, enhancing the resiliency of the grid during extreme weather events.

1. CenterPoint Houston will leverage the proposed software to improve the design of its transmission, substation, and distribution systems while providing for greater withstand capabilities during extreme weather events. It will also act to provide guidance for optimal location of equipment for mitigation of outages and greater customer benefit. Guidehouse's analysis of CenterPoint Houston's Advanced Aerial Imagery Platform / Digital Twin resiliency measure produced a BCA that confirms the measure is cost effective.

2. The use of advanced aerial imagery as an input to a digital twin system is consistent with trends in utility industry best practices deployed at other utilities based on benchmarking.

b. The resiliency measure contributes to CenterPoint Houston's overarching objective of increasing the resiliency of the electric grid.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several electric utilities have included investments and tools similar to what is offered in CenterPoint Houston's Advanced Aerial Imagery Platform / Digital Twin Resiliency measure. Additionally, four out of the nine utilities surveyed chose cloud-based data handling improvements, and five highlighted monitoring of assets as the types of resiliency investments included in their plans, which are both key facets of the Digital Twin investment. Furthermore, Figure ELS-5 captures the top categories of hazards addressed through resiliency programs, and CenterPoint Houston's Advanced Aerial Imagery Platform has the capability to identify improvements for the prevention of all the listed natural hazards, as well as the aging of infrastructure.

The jurisdictional benchmarking report provided as Appendix A in Guidehouse's report (Exhibit ELS-2) shows that some of the key applications of the Advanced Aerial Imagery Platform are commonly included in electric utility resiliency investments in the states examined. For example, seven of the 15 jurisdictions analyzed include vegetation management investments, 11 include pole replacement, and eight include substation flood control. Further, the jurisdictional benchmarking report shows that several jurisdictions include magnitude thresholds and criteria to identify the criteria for additional investments and upkeep, which supports the approach being taken by CenterPoint Houston by including Digital Twin in its resiliency plan.

ADVANCED DISTRIBUTION TECHNOLOGY

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S ADVANCED DISTRIBUTION TECHNOLOGY RESILIENCY MEASURE.

A. CenterPoint Houston's Advanced Distribution Technology resiliency measure will deploy next generation electric meters and associated hardware infrastructure, along with the development of software and Distributed Intelligent Applications ("DI Apps"). The primary technologies the measure will deploy include: (1) next generation of advanced meters ("AMS"); (2) Pole Mounted Router ("PMR") firmware upgrades; (3) deployment of mesh network or similar network solutions; (4) DI App Licensing; and (5) Headend Software compatible with next generation meters. Key capabilities include enhanced fault detection, local load management and premise-level under-frequency load shedding ("UFLS").

The total cost of the measure over the three years from 2025 through 2027 is $225.8 million for capital investment, plus $15 million of operation and maintenance expense. The total three-year capital cost and maintenance expense is included in the BCA ratio presented below. This measure is expected to carry over through to completion by 2029.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S ADVANCED DISTRIBUTION TECHNOLOGY RESILIENCY MEASURE?

A. CenterPoint Houston proposes to leverage the capabilities of advanced distribution technology ("ADT") along with other tools to increase resiliency during extreme weather-related outage events, accomplished by improving fault location detection accuracy, managing cold load pick-up and phase imbalances, enabling premise-level UFLS which

will reduce outage duration for customers during load shed by expanding load shed capability, reducing the need for mobile generation through load shed capability, and allowing local load management and monitoring to accommodate distributed generation and electric vehicles and reduce the risk of transformer failures.

CenterPoint Houston's ADT resiliency measure will create a more resilient and reliable system by modernizing the functionality of the electric grid and improving quality of service and operational efficiency through deployment of next generation electric meters. Use cases and resiliency benefits enabled by installation of next generation meters includes premise-level UFLS, local load management, advanced fault detection, and improved service restoration capability.

The ADT resiliency measure is expected to reduce total CMI over the 3-year Resiliency Plan by approximately 61.1 million. At the end of the 3-year resiliency measure in 2027, annual CMI savings are approximately 40.6 million. Guidehouse's analysis produced a BCA ratio of 4.8 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED ADVANCED DISTRIBUTION TECHNOLOGY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed ADT resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The replacement of existing meters with next generation electric meters will expand automation capabilities by allowing incorporation of DI Apps and improved transformer loading measurements through the availability of time-synchronized data.

2. CenterPoint Houston's plan to deploy the ADT resiliency measure is consistent with practices deployed at other utilities based on benchmarking. The potential for widespread outages and resulting societal consequences of transformer failures and load shed events underscores the criticality of maintaining a robust, modern, and versatile metering system.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, shows how other utilities are categorizing resiliency investments. For example, when surveyed on the types of investments included in their resiliency plans seven of the nine indicate smart grid upgrades as a resiliency investment. This supports including CenterPoint Houston's Advanced Distribution Technology resiliency measure as once successfully deployed it will modernize and enhance the functionality of the electric grid.

In the jurisdictional benchmarking report provided as Appendix A of Guidehouse's report (Exhibit ELS-2) there are several grid modernization efforts and metering upgrades included in resiliency plans. For example, Dominion Energy's Phase 3 Electric Grid Transformation Projects were just approved by the Virginia regulator in 2023 and include investments in advanced metering infrastructure.

DIGITAL SUBSTATION

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S DIGITAL SUBSTATION RESILIENCY MEASURE.

A. CenterPoint Houston's proposed Digital Substation resiliency measure is in the early stages of design and development. In support of this investment, CenterPoint Houston is evaluating the benefits of adopting increased digitization and automation in accordance with the International Electrotechnical Committee's ("IEC") 61850 communications protocol. The 61850 standard promotes use of digital equipment, adoption of cybersecurity measures, and large amounts of data capture to enhance reliability and real-time monitoring of critical substation equipment. Key features of CenterPoint Houston's Digital Substation measure include the replacement of copper wiring with less costly fiber optics for easier conversion to digital communications, enhanced situational awareness for better and faster operational decisions, adoption of compact digital protective relays allowing for a more compact substation control facility, standardized configurations for increased speed of installation, centralized communications/data collection busses (i.e., via merging units), and proactive detection of equipment abnormalities and incipient failure with an overall smaller substation design footprint. These features will help drive down O&M costs, collectively enhance reliability and resiliency, and, over time, lower the cost of constructing new substations.

The proposed number of digital substations is 4 to 5 per year, and 12 to 15 over three years, with a cost of $25 million for substation equipment and $13 million for Operational Technology ("OT") systems. The total savings in operation and maintenance expense for the Digital Substations measure is $600,000. The total cost of $38 million for

capital investment and $600,000 reduction in operation and maintenance expense is included in the BCA ratio presented below.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S DIGITAL SUBSTATION RESILIENCY MEAUSURE?

A. CenterPoint Houston's Digital Substation resiliency measure will contribute to modernizing CenterPoint Houston's electric delivery system through technology adoption and automation. The measure will achieve resiliency benefits by improving system performance during major storms and other extreme weather events through the use of real-time monitoring and visualization. Over the long-term, a more compact design with fewer equipment components should lower the cost of new substations, particularly in urban areas with space constraints. It also provides greater flexibility to site new substations due to the smaller amount of space needed to build a substation using digital equipment.

The Digital Substation measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 1.3 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 0.8 million. Guidehouse's analysis produced a BCA ratio of 1.9 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED DIGITAL SUBSTATION RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Digital Substation resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The introduction of grid modernization initiatives such as those associated with digitization and automation is consistent with leading utility practices based on Guidehouse's experience advising clients in North America and worldwide.
2. As implementation proceeds, CenterPoint Houston's Digital Substation measure should enhance reliability and resiliency of CenterPoint Houston's system while lowering the cost of constructing new substations over the long term.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates that several electric utilities have included investments similar to CenterPoint Houston's Digital Substation measure in their resiliency plans. For example, when surveyed on the types of investments included in their resiliency plans, five of the nine utilities surveyed included digital substation OT systems in their resiliency plans, and seven included smart grid upgrades that deliver similar benefits to that of this resiliency measure. Furthermore, most respondents indicated that the primary goal of their resiliency measure is to decrease the impact of major events, which aligns with the purpose and benefits of the Digital Substation resiliency measure, increasing performance during major storms and reducing customer minutes interrupted.

The jurisdictional benchmarking report did not identify specific examples of this type of resiliency measure, however, based on our industry knowledge we expect that many other utilities are making similar types of investments.

SUBSTATION PHYSICAL SECURITY FENCING

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S SUBSTATION PHYSICAL SECURITY FENCING RESILIENCY MEASURE.

A. CenterPoint Houston's Substation Physical Security Fencing resiliency measure will replace chain link fences with more resilient and less permeable wire mesh fences at critical substations to thwart unauthorized access and equipment damage from vandals (stealing copper wire) or terrorists. Substations targeted for enhanced fencing will be chosen based on network vulnerability, load criticality, and location (e.g., those located in remote or hidden areas). Substation security in locations targeted for enhanced fencing will typically be supplemented with mobile cameras to monitor and detect intrusions.

The number of substations targeted for fencing upgrades is 5 annually and 15 total over the three-year resiliency measure. The total measure cost of $15 million is included in the BCA ratio presented below.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S SUBSTATION PHYSICAL SECURITY FENCING RESILIENCY MEASURE?

A. CenterPoint Houston's Substation Physical Security Fencing resiliency measure will reduce the likelihood of vandal or terrorist activity causing equipment damage and outages. Although the likelihood of terrorist activity is low, the consequences of such actions can be significant, causing lengthy outages and major load interruption across CenterPoint Houston's service territory. Such an event could result in widespread economic and societal harm. Critical loads and industries and businesses served by impacted substations could experience severe inconvenience and economic harm. Further, terrorist activity on the grid would bring forth adverse attention and heightened community awareness and concern.

The Substation Physical Security Fencing resiliency measure is expected to reduce total CMI over the three-year Resiliency Plan by approximately 14.7 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 7.3 million. Guidehouse's analysis produced a BCA ratio of 15.6 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED SUBSTATION PHYSICAL SECURITY FENCING RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Substation Physical Security Fencing Resiliency Measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The measure should result in a reduction in damage to substation equipment and avoidance of widespread concern that terrorist actions would bring to the region.
2. While the likelihood of unauthorized substation access and major damage is low, the modest cost of resilient fencing supports the proposed resiliency measure. Despite the low probability of a major event, the measure produces a robust BCA.
3. Wire mesh fencing proposed at existing substations meets CenterPoint Houston's current design standard for new substations.
4. Implementation of security measures avoids potential highly undesirable economic and societal impacts associated with widespread, lengthy outages.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, shows that several electric utilities include substation security upgrades in their plans. For example, five of the nine respondents indicated substation physical security upgrades are included in their resiliency plans. Four utilities also noted threat intelligence and management investments, which are often undertaken to ensure the safety of substations. Additionally, 6 of the 10 utilities indicated physical attacks as a hazard addressed through resiliency program.

The jurisdictional benchmarking report provided as Appendix A in Guidehouse's report (Exhibit ELS-2) shows that substation physical security investments have been identified in resiliency programs in both New York and Virginia. Additionally, Hawaiian Electric's Resiliency Working Group Meeting included several human threat magnitude thresholds in their threat scenarios, with examples such as physical substation attacks from rifles or explosives. These metrics and repair times follow a similar methodology that CenterPoint Houston has adopted in evaluating their Substation Physical Security Fencing Resiliency measure.

SUBSTATION SECURITY UPGRADES

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S SUBSTATION SECURITY UPGRADES RESILIENCY MEASURE.

A. CenterPoint Houston proposes to upgrade existing security monitoring systems at critical transmission substations to detect unauthorized access from individuals committing vandalism or terroristic activities. Substation security includes unauthorized entry detection systems, video surveillance cameras, and associated communications that link to CenterPoint Houston's control center. These systems will enable operating center staff to

rapidly notify law enforcement of an effort at or active intrusion to reduce potential equipment damage and customer outages caused by vandals or individuals with terroristic intentions. Substations targeted for security will be chosen based on network vulnerability, load criticality, and location (e.g., those located in remote or hidden areas). Enhanced security in some substations will include upgraded perimeter fencing.

The number of substations targeted for upgrades is 12 per year and 36 total over the three-year resiliency measure at a total measure cost of $19.5 million. The total operation and maintenance expense is $90,000 over three years. The total cost, including capital and expense, is included in the BCA ratio presented below.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S SUBSTATION SECURITY UPGRADES RESILIENCY MEASURE?

A. CenterPoint Houston's Substation Security Upgrades resiliency measure will reduce the likelihood of vandal or terrorist activity causing equipment damage and outages. Although the likelihood of terrorist activity is low, the consequences of such actions can be significant, with lengthy outages and major customer load interruption across CenterPoint Houston's service territory. Such an event could result in widespread socio-economic impact, have national security implications, and create societal harm. If only single substations were impacted, those serving critical loads and industries and businesses served would be severely impacted. If several substations fed by the transmission network were to fail, it would result in even greater inconvenience and economic harm. Further, terrorist or vandal activity on the grid would invariably bring forth adverse attention, public safety concern, and heightened political and community concern.

The Substation Security Upgrades resiliency measure is expected to reduce total CMI over the 3-year Resiliency Plan by approximately 25.1 million. At the end of the three-year resiliency measure in 2027, annual CMI savings are approximately 12.5 million. Guidehouse's analysis produced a BCA ratio of 19.9 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED SUBSTATION SECURITY UPGRADES RESILIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Substation Security Upgrades resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

1. The measure should reduce potential damage to substation equipment, possible public safety implications, and widespread concern that terrorist actions or major vandalism would bring to the region, state, and nation.
2. While the likelihood of unauthorized substation access and major damage is low, the cost of resilient fencing supports the proposed investments. Despite the low probability of a major event, the measure also produces a robust BCA.
3. The installation of security measures at existing transmission substations meets CenterPoint Houston's current practice for new substations.
4. Implementation of security measures avoids highly undesirable potential national security, economic, and societal impacts associated with widespread, lengthy outages.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI of this report, indicates that several electric utilities include substation security upgrades in their plans. For example, five of nine respondents indicated substation physical security upgrades included in their resiliency plans. Four utilities also noted threat intelligence and management investments, which are often undertaken to ensure the safety of substations. Additionally, 6 of the 10 utilities indicated physical attacks as a hazard addressed through resiliency programs.

The jurisdictional benchmarking report provided as Appendix A in Guidehouse's report (Exhibit ELS-2) shows that substation physical security investments have been identified in resiliency programs in both New York and Virginia. Additionally, Hawaiian Electric's Resiliency Working Group Meeting included several human threat magnitude thresholds in their threat scenarios, with examples such as physical substation attacks from rifles or explosives. These metrics and repair times follow a similar methodology that CenterPoint Houston has adopted in evaluating their Substation Security Upgrades resiliency measure.

TARGETED CRITICAL CIRCUIT VEGETATION MANAGEMENT

Q. PLEASE DESCRIBE CENTERPOINT HOUSTON'S TARGETED CRITICAL CIRCUIT VEGETATION MANAGEMENT RESILIENCY MEASURE.

A. CenterPoint Houston's Targeted Critical Circuit Vegetation Management ("VM") resiliency measure is designed to reduce critical load customer outages during resiliency events, as measured by SAIDI performance for critical load circuits during resiliency events (i.e., Major Events as defined by the Commission). Currently, CenterPoint Houston's proactive VM budget for the 2024 Plan is $34 million. CenterPoint Houston

proposes to increase annual spending by $8.33 million for each year of its 3-year Resiliency Plan for a total of $25 million over 3 years with the objective to reduce major event VM SAIDI for critical load circuits below its five-year historical average of 52.5 minutes (Figure ELS-5) by 33 percent. Reductions in SAIDI for critical load circuits will be achieved by targeting danger or hazard trees for removal, along with off cycle trimming on distribution main and lateral line segments where clearances have been compromised by fast growth species. Unlike the prior 18 resiliency measures that are capitalized, all spending on VM is expensed.

FIGURE ELS-5

Year	VM SAIDI Major Events
2019	13.3
2020	42.2
2021	107.1
2022	0.0
2023	99.7
Average	**52.5**

Source: CenterPoint Houston

Over the past five years, CenterPoint Houston has expended $141.5 million on proactive VM, with an average annual spend of approximately $28.3 million. All expenditures are expensed to a maintenance account.

Q. WHAT BENEFITS WILL BE REALIZED FROM CENTERPOINT HOUSTON'S TARGETED CRITICAL CIRCUIT VEGETATION MANAGEMENT RESILIENCY MEASURE?

A. The primary benefit of CenterPoint Houston's Targeted Critical Circuit Vegetation Management resiliency measure is the reduction in customer minutes of interruption as

measured by SAIDI for critical load circuits during resiliency events. Unlike other measures that focus on capital investments, Targeted VM is expensed with most benefits achieved during the year targeted VM is performed. Further, the actual reduction in SAIDI for this resiliency measure will be determined following the completion of the work for each year of the Resiliency Plan. The preliminary analysis assumes CenterPoint Houston will meet its targeted annual SAIDI reduction of 17.5 minutes by 2027 to meet the five-year average VM SAIDI target of 35 minutes. The Targeted Critical Circuit VM resiliency measure is projected to reduce cumulative CMIs over the 3-year Resiliency Plan by approximately 13.9 million and 4.2 million annually by 2027. For the three-year Targeted VM measure, Guidehouse's analysis produced a BCA ratio of 1.8 for this measure.

Q. PLEASE PROVIDE YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED TARGETED CRITICAL CIRCUIT VEGETATION MANAGEMENT RESLIENCY MEASURE.

A. My assessment resulted in a determination that CenterPoint Houston's proposed Targeted Critical Circuit Vegetation Management resiliency measure is reasonable and beneficial for inclusion in CenterPoint's Resiliency Plan for the following reasons:

- The Targeted Critical Circuit Vegetation Management measure is expected to provide significant value to CenterPoint Houston customers and the general public. The likelihood of lowering SAIDI is high on distribution line sections where targeted trimming or tree removal is proposed.
- The proposed measure is consistent with practices deployed at other utilities based on peer utility benchmarking survey results presented later in this report.

- Implementation of proactive vegetation management helps avoid the significant negative economic and societal impacts associated with widespread, lengthy outages during high wind events. Targeting additional VM spend on critical load circuits recognizes the additional value that avoided outages for critical load customers (e.g., hospitals and police, fire, and EMS stations) has for the communities they serve.

Q. HOW DOES THE BECHMARKING INCLUDED IN GUIDEHOUSE'S REPORT PROVIDE INDICATION THAT THIS TYPE OF RESILIENCY MEASURE IS A COMMON RESILIENCY PLANNING PRACTICE FOR ELECTRIC UTILITIES?

A. The peer utility benchmarking survey, discussed in Section VI, indicates vegetation management programs as a common resiliency investment for electric utilities to include in their resiliency plans. For example, Figure ELS-2 lists the most frequent occurrences of different types of resiliency investments and vegetation management was within the top eight categories, with three utilities indicating listing it as a common program. The jurisdictional benchmarking report provided as Appendix A in Guidehouse's report (Exhibit ELS-2) shows that 7 of the 15 states examined have utility resiliency investments that include vegetation management programs. For example, Hawaiian Electric identified enhanced vegetation management as one of the three top priorities items in scope of their investments, particularly in critical grid areas susceptible to damage from wind and falling debris. Additionally, in Massachusetts Eversource launched a vegetation resiliency pilot program, and in Louisiana Entergy's 10-Year Resiliency Plan designed to improve overall system resilience from 2024 to 2033 cited vegetation management as a critical priority.

WILDFIRE MITIGATION AND MICROGRID PILOT PROJECT

Q. DID GUIDEHOUSE REVIEW ANY OTHER RESILIENCY MEASURES OR PILOT PROGRAMS INCLUDED IN CENTERPOINT HOUSTON'S RESILIENCY PLAN?

A. Yes. Guidehouse reviewed one resiliency measure (wildfire mitigation) and one pilot program (microgrid pilot program) that were added to CenterPoint Houston's Resiliency Plan after Guidehouse had completed its initial review. Guidehouse conducted a high-level assessment of each measure and found that both of these measures appeared reasonable for inclusion.

Q. WHY DOES GUIDEHOUSE FIND THAT CENTERPOINT HOUSTON SHOULD INCLUDE WILDFIRE MITIGATION IN ITS RESILIENCY PLAN?

A. Wildfire mitigation is commonly included in the resiliency planning efforts for electric utilities with measurable wildfire risk, as evidenced in the peer utility benchmarking and jurisdictional benchmarking discussed later in this report. CenterPoint Houston's decision to include wildfire mitigation was informed, in part, by Guidehouse's analysis of wildfire risk in CenterPoint Houston's service area as well as Guidehouse's initial recommendation to include wildfire mitigation in its current or subsequent plans. Given the findings of Guidehouse's risk analysis and our high-level assessment of the proposed wildfire mitigation resiliency measures included in CenterPoint Houston's Resiliency Plan (e.g., undergrounding, covered conductors), I agree that wildfire mitigation is a reasonable resiliency measure to include in CenterPoint Houston's Resiliency Plan. Further, I find that the specific wildfire mitigation resiliency measures included in the Plan are similar to the types of resiliency measures found in other electric utility wildfire mitigation plans. We

validated this by reviewing three wildfire mitigation plans in different jurisdictions (PG&E in California[29], NV Energy in Nevada[30], and Xcel Energy in Colorado[31]) and found that all three utilities include almost all of these measures in their plans. Wildfire mitigation is commonly included in the resiliency planning efforts for electric utilities with measurable wildfire risk, as evidenced in the peer utility benchmarking and jurisdictional benchmarking discussed later in this report.

Q. WHY DOES GUIDEHOUSE FIND THAT CENTERPOINT HOUSTON SHOULD INCLUDE A MICROGRID PILOT PROGRAM IN ITS RESILIENCY PLAN?

A. CenterPoint Houston's decision to include a microgrid pilot was informed, in part, by results of Guidehouse benchmarking that demonstrates microgrids are commonly included in electric utility resiliency planning efforts, often initially in the form of pilot programs or projects. Guidehouse agrees, based on its high-level assessment of this resiliency measure, that a microgrid pilot program is a reasonable first step to take to determine if microgrids are a worthwhile investment to achieve resiliency benefits. Guidehouse did not complete a quantitative assessment because CenterPoint Houston is proposing this measure as a demonstration program to gain learnings and determine costs, benefits, and implementation challenges for such projects before considering greater investment. Findings from the pilot could help inform future BCA to determine if such investments are cost-effective for more broad application as part of CenterPoint Houston's future resiliency plans.

[29] Pacific Gas and Electric Company (PG&E), 2023-2025 Wildfire Mitigation Plan. https://www.pge.com/assets/pge/docs/outages-and-safety/outage-preparedness-and-support/2023-wildfire-mitigation-plan.pdf.
[30] NV Energy, Natural Disaster Protection Plan. https://pucweb1.state.nv.us/PDF/AxImages/DOCKETS_2020_THRU_PRESENT/2020-2/529.pdf#xd_co_f=YmM2NGYyYjQtM2QyNS00MDhlLWI4MmYtY2U1MDFjOTc0ZTFh~.
[31] Xcel Energy Public Service Company of Colorado, 2020 Wildfire Mitigation Plan. https://www.xcelenergywildfiremitigation.com/wp-content/uploads/2021/05/PSCo_2020-Wildfire-Mitigation-Plan_Rev-1-.pdf

VI. INDEPENDENT BENCHMARKING OF CENTERPOINT HOUSTON'S RESILIENCY PLAN INVESTMENTS TO A PEER UTILITY GROUP

Q. PLEASE DESCRIBE HOW THE PEER ELECTRIC UTILITY BENCHMARKING ANALYSIS WAS GENERATED, INCLUDING HOW THE PEER GROUP OF ELECTRIC UTILITIES WAS SELECTED.

A. The benchmarking analysis was designed to solicit responses from a peer group of electric utilities that have implemented resiliency programs. Guidehouse identified resiliency measures to include in the survey questionnaire while an independent contractor[32] prepared survey questions and selected the peer utility group. The resiliency survey included questions designed to identify the types of resiliency investments U.S. electric utilities are deploying and the types of system issues that they are seeking to address through these investments. The survey was conducted "blind," with the identities of participating utilities not disclosed to ensure confidentiality.

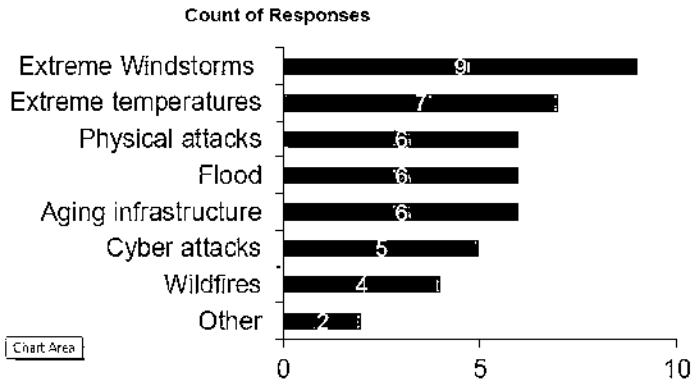
Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS PROVIDES AN INDICATOR OF GOOD UTILITY PRACTICE FOR RESILIENCY-BASED INVESTMENTS.

A. Electric utilities generally prioritize resiliency measures according to the types of resiliency events encountered on their respective systems with the greatest level of risk. Figure ELS-1 lists the types of resiliency events other electric utilities are addressing through resiliency investments. This generally aligns with the types of risks CenterPoint Houston aims to

[32] First Quartile Consulting, Inc.

mitigate through its Plan though some are less applicable (i.e., lower risk) to CenterPoint Houston's service area (e.g., wildfires).

FIGURE ELS-1



The survey also identified the types of resiliency measures deployed by survey respondents to mitigate the impact of resiliency events, with the top eight categories presented in Figure ELS-2. The three most common resiliency investments are: pole replacements / line rebuilds, automation/customer resiliency, and substation hardening / flood control. The "Other" category includes the following responses: wildfire mitigation, reliability projects budgeted but not yet executed, and capacity projects addressing preparations for data centers.

FIGURE ELS-2