Extreme Temperature (Freeze)

- RM-14 – Anti-Galloping Technologies
- RM-15 – Loadshed IGSD
- PP-1 – Microgrid Pilot Program[5]

Extreme Temperature (Heat)

- RM-16 – Distribution Capacity Enhancement/Substations/Substations
- RM-17 – Major Underground (MUGS) Reconductor
- RM-18 – URD Cable Modernization
- RM-19 – Contamination Mitigation
- RM-20 – Substation Fire Barriers
- RM-21 – Digital Substation
- RM-22 – Wildfire Advanced Analytics
- RM-23 – Wildfire Strategic Undergrounding
- RM-24 – Wildfire Vegetation Management
- RM-25 – Wildfire IGSD

Physical Attack

- RM-26 – Substation Physical Security Fencing
- RM-27 – Substation Security Upgrades

Technology and Cybersecurity

- RM-28 – Spectrum Acquisition
- RM-29 – Data Center Modernization
- RM-30 – Network Security & Vulnerability Management

[5] As a proposed pilot program, Microgrids, CenterPoint Houston is not requesting Commission approval for the Microgrid Pilot as a resiliency measure.

- RM-31 – IT/OT Cybersecurity Monitoring
- RM-32 – Cloud Security, Product Security & Risk Management

Situational Awareness

- RM-33 – Advanced Aerial Imagery/Digital Twin
- RM-34 – Weather Stations
- RM-35 – Wildfire Cameras
- RM-36 – Voice & Mobile Data Radio System
- RM-37 – Backhaul Microwave Communication
- RM-38 – Emergency Operations Center
- RM-39 – Hardened Service Centers

My testimony focuses on measures associated with natural hazard and physical attack risks, which includes measures RM-1 through RM-27, RM-33 through RM-35, and RM-38 through RM-39, as well as PP-1. The testimony provided by Joseph Baugh focuses on the remaining measures, which are associated with technology and cybersecurity risks and include RM-28 through RM-32, as well as RM-36 and RM-37.

Q. ARE THERE DIFFERENCES IN GUIDEHOUSE'S APPROACHES RELATIVE TO THOSE USED IN ASSESSING CENTERPOINT HOUSTON'S PREVIOUS SYSTEM RESILIENCY PLAN FILED IN APRIL 2024 IN DOCKET 56548?

A. Yes, the primary difference is the use of more detailed climate hazard forecasts that CenterPoint Houston will use to prioritize and select individual projects within each measure. While BCA ratios for each measure were derived using a methodology comparable to the prior SRP, the current set of resiliency measures incorporates updated climate hazard forecasts. Further, CenterPoint Houston prioritization and selection of individual projects within each measure was informed by the circuit level analysis

presented in Section 6 of Exhibit ELS-2. The circuit-level analysis applies more granular individual forecasts at approximately 3,300 hexagonal plots in CenterPoint Houston's service territory.[6]

The BCA methodology also incorporates a higher Value of Loss of Load ("VoLL"), $35,000 per Megawatt-Hour, approved for use in planning studies by the Commission in August 2024.[7] Other than use of a higher VoLL, and increased cost of resiliency measures, most other assumptions and values Guidehouse used to derive BCA ratios in the April 2024 filing are unchanged. For new resiliency measures in the current SRP, Guidehouse derived BCA ratios and CMI savings based on the methods and assumptions presented in Section 5 of Exhibit ELS-2.

i. GOOD UTILITY PRACTICE

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,

[6] Guidehouse developed a grid subdividing CenterPoint Houston's service territory into approximately 3,300 hexagonal cells using the H3R7 hexagon methodology, commonly used in geospatial analysis. Jupiter Intelligence provided locational climate forecasts for each hexagonal cell's centroid and an additional set of coordinates for substation and service centers at 90 m2 resolution to augment the vulnerability analysis for these critical assets.
[7] Project No. 55837, Chairman Gleeson Memorandum, (Aug. 28, 2024).

but rather is intended to include acceptable practices, methods, and acts generally accepted in the region."[8]

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 SYSTEM 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 measures that CenterPoint Houston has proposed in its SRP. For example, Good Utility Practice helps inform CenterPoint Houston whether it 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, 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.iv of my testimony.

[8] §25.5. Definitions. (Substantive Rules Applicable to Electric Service Providers, Subchapter A)

ii. **RISK ANALYSIS**

Q. WHAT SPECIFIC TYPES OF RESILIENCY RISKS DID GUIDEHOUSE 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;
2. Flood damage driven by coastal storm surges during a hurricane and flash floods during extreme precipitation events;
3. Extreme cold during winter storms;
4. Chronic and rising high temperature events, including wildfire ignition;
5. Contamination build-up on substation and distribution circuit insulators
6. Physical attack (vandalism and terrorist threats);
7. Information Technology ("IT") and Operational Technology ("OT") Cybersecurity threats; and
8. Adequacy and need for enhancing and hardening facilities supporting emergency response activities.

Guidehouse chose these extreme weather, and physical and cybersecurity 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. My testimony addresses the first six categories while Joseph Baugh addresses seven and eight.

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.[9] 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 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.[10] Each of these findings underscores the contribution of the Houston area to the economic vitality of the region and state of Texas. As noted in Mr. Brownell's testimony, although CenterPoint Houston's service territory is small compared to other Texas utilities, its high

[9] 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

[10] 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)

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 SRP.

Guidehouse then demonstrates how CenterPoint Houston's SRP 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 SRP 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.[11] Guidehouse collected weather data for 12 major weather events over the past 15 years from 12 National Oceanic and Atmospheric Administration ("NOAA") weather

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

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 twelve 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 and Section 4 of Exhibit ELS-2, Guidehouse focused its analysis on twelve storms and extreme weather events using NOAA historical data and Jupiter forecasts 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, Hurricane Nicholas and Hurricane Beryl.[12] 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 twelve storms and extreme weather events Guidehouse analyzed using NOAA data appear below.

[12] 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
11. Houston Derecho: May 2024
12. Hurricane Beryl: July 2024

For future projections, Guidehouse applied Jupiter Intelligence's ClimateScore Global Indices model, which uses one hundred 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")[13] and land cover data to derive metrics prospectively for 2025 and 2030.

[13] 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"

i. **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)**

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 extreme temperature events, 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, will result in significant interruptions in service to CenterPoint Houston's customers absent CenterPoint Houston's proposed resiliency measures. Thus, I conclude that risk mitigation measures that CenterPoint Houston proposes in its SRP are needed to address these types of resiliency event. The potential for service interruptions is expected to rise in the future absent resiliency measures, given the results of Guidehouse's independent risk analysis. My assessment of the resiliency measures that CenterPoint Houston proposes to undertake in its SRP to address these risks is presented in the following questions on risk factors in CenterPoint Houston's service territory, and transmission and distribution system.

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 twelve 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"), but 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 wind 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.[14]

iii. BENEFITS ANALYSIS

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

A. The purpose of Guidehouse's benefits analysis was to provide CenterPoint Houston guidance on which resiliency measures produce the highest resiliency value based on the program-level BCA analysis and qualitative assessment for each measure within each risk event category. CenterPoint Houston prioritized and selected projects within each measure

[14] 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.

that produced favorable BCA ratios by targeting resiliency investments in areas of greatest risk. As I described earlier in my testimony, Guidehouse expanded its county-level weather event forecasts to include more granular individual forecasts at approximately 3,300 hexagonal plots in CenterPoint Houston's service territory. CenterPoint Houston targeted investments within these plots to maximize the benefits of resiliency measures based on reductions in Customer Minutes of Interruption ("CMI").

Guidehouse quantified net benefits by performing a life-cycle analysis of costs versus benefits (i.e., benefit-cost analysis or BCA).[15] The BCA incorporates future risk based on the wind, flood inundation, and temperature forecasts presented in Section IV.ii and Section V of my testimony. Resiliency measure costs are those projected for years 2026 through 2028, and exclude amounts spent in prior or subsequent years, except for the and Advanced Aerial Imagery Platform / Digital Twin and Coastal Resiliency Upgrades where costs are expected to be incurred prior to 2026 and are expected to occur after 2028. 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).

Quantitative benefits evaluated for each measure 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.
- **Avoided Collateral Damage** – The avoidance of the additional cost incurred

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

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 SRP measures will provide to CenterPoint Houston's customers and the Houston region.

Q. PLEASE DESCRIBE THE APPROACH AND PURPOSE OF THE CIRCUIT-LEVEL ANALYSIS.

A. The purpose of the circuit level analysis is to provide CenterPoint Houston with a granular forecast of weather-related risk and evaluation of CMI benefits at the circuit level. It also includes site-specific flood inundation forecasts for each of CenterPoint Houston's transmission and distribution substations. As described earlier, CenterPoint Houston applied Guidehouse's weather forecasts for each of the 3,300 hexagonal plots to identify projects within each measure that produced the greatest benefits as measures by reduction in CMI. Details on Guidehouse's methodology and results of the granular risk analysis is presented in Section 6 of Exhibit ELS-2.

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

A. Guidehouse's analysis for measures where benefits were quantified produced BCA ratios that appear in Table ELS-2. The BCAs were derived using a Value of Lost Load ("VOLL") of $35,000 per MWHr.[16] These results indicate that all resiliency measures where benefits are quantified achieved a BCA ratio at or above 1.0 and therefore, should be approved by the Commission, The total 3-year CMI savings is 1,309 million and 628 million annually by 2028.

TABLE ELS-2

[16] Review of Value of Lost Load in the ERCOT Market, The Brattle Group's Value of Lost Load Study for the ERCOT Region at 6, Project No. 55837 (Aug. 22, 2024).

RESILIENCY MEASURE	Resiliency Measure (RM)	3-Yr Capital Cost ($MM)	3-Yr O&M Expense	BCA	3-Yr CMI	2028 CMI
Extreme Wind						
Distribution Circuit Resiliency	RM - 1	$513.4	$0.0	12.1	263.0	133.4
Strategic Undergrounding	RM - 2	$860.0	$0.0	2.8	81.1	51.0
Restoration IGSD	RM - 3	$107.3	$0.5	19.3	97.0	48.5
Distribution Pole Replacements/Bracing	RM - 4	$251.6	$0.0	9.9	121.0	60.8
Vegetation Management	RM - 5	$0.0	$146.1	3.7	137.0	22.9
Transmission System Hardening	RM - 6	$1,467.3	$0.8	3.9	223.8	122.5
S90 Tower Replacements	RM - 7	$118.4	$0.0	9.4	59.5	23.8
69kV Conversion Projects	RM - 8	$369.3	$0.0	2.7	65.5	27.6
Coastal Transmission Resiliency	RM - 9	$177.3	$0.8	2.0	7.8	7.8
Group Subtotal		**$3,864.6**	**$148.1**	**5.5**	**1055.7**	**498.3**
Extreme Water (Flood)						
Substation Flood Control	RM - 10	$43.8	$0.0	2.1	3.9	2.0
Control Center Flood Control	RM - 11	$7.0	$0.0	15.2	2.5	2.5
MUCAMS	RM - 12	$10.8	$0.0	1.3	0.6	0.2
Mobile Substations	RM - 13	$30.0	$0.0	3.0	3.9	2.0
Group Subtotal		**$91.6**	**$0.0**	**3.3**	**11.0**	**6.6**
Extreme Temperature (Freezing)						
Anti-Galloping Technologies	RM - 14	$14.0	$1.0	7.1	5.3	2.6
Group Subtotal		**$14.0**	**$1.0**	**7.1**	**5.3**	**2.6**
Extreme Temperature (Heat)						
Distribution Capacity Enhancement/Substations	RM - 16	$579.6	$0.0	5.6	138.1	70.6
MUGS Reconductoring	RM - 17	$245.0	$0.0	1.4	13.6	7.4
URD Cable Modernization	RM - 18	$128.4	$0.0	2.2	13.0	6.5
Contamination Mitigation	RM - 19	$144.0	$6.0	2.4	15.7	7.9
Substation Transformer Fire Protection Barriers	RM - 20	$9.0	$0.0	4.0	1.5	0.7
Digital Substation	RM - 21	$31.8	$0.0	1.8	1.2	0.7
Group Subtotal		**$1,137.8**	**$6.0**	**3.8**	**183.1**	**93.8**
Physical Attack						
Substation Physical Security Fencing	RM - 26	$18.0	$0.0	21.8	17.6	8.8
Substation Security Upgrades	RM - 27	$19.4	$0.1	28.7	25.1	12.5
Group Subtotal		**$37.4**	**$0.1**	**25.4**	**42.7**	**21.3**
Situational Awareness						
Advanced Aerial Imagery/Digital Twin	RM - 33	$18.4	$2.0	4.8	10.8	5.1
Group Subtotal		**$18.4**	**$2.0**	**4.8**	**10.8**	**5.1**
Totals		**$5,163.8**	**$157.2**	**5.0**	**1,309**	**628**

iv. BENCHMARKING ANALYSIS

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

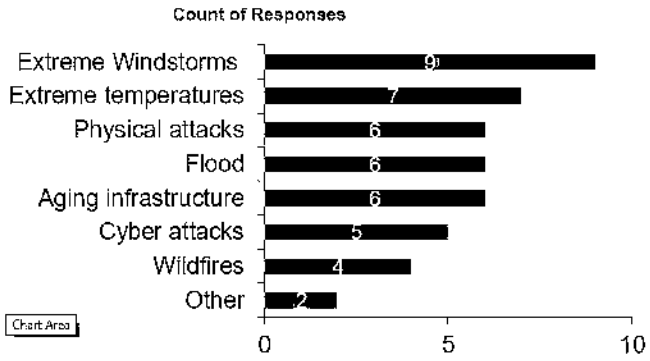
A. The benchmarking analysis was designed to solicit responses from a peer group of electric utilities that have implemented resiliency programs. Guidehouse identified resiliency

measures to include in the survey questionnaire while an independent contractor[17] 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**Error! Reference source not found.** 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 mitigate through its Plan though some are less applicable (i.e., lower risk) to CenterPoint Houston's service area (e.g., wildfires).

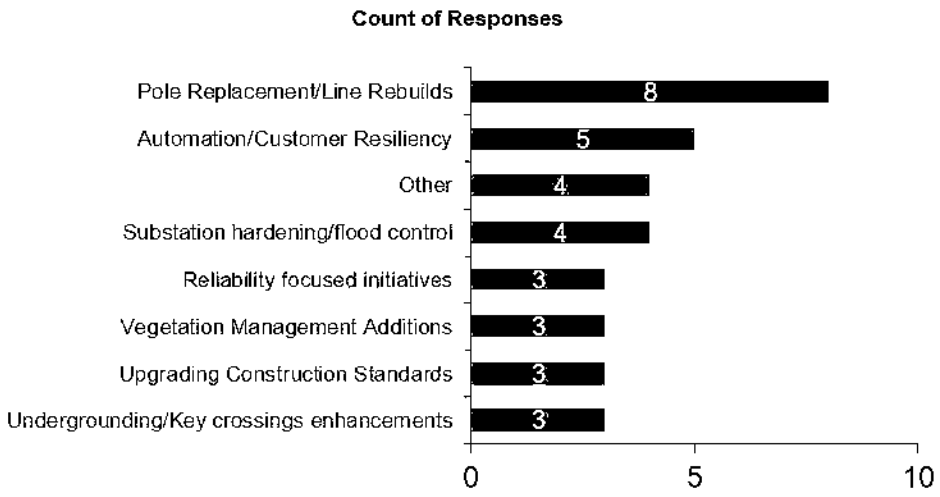
FIGURE ELS - 1



[17] First Quartile Consulting, Inc.

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 **Error! Reference source not found.**. 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



Q. PLEASE DESCRIBE GUIDEHOUSE'S JURISDICTIONAL BENCHMARKING APPROACH.

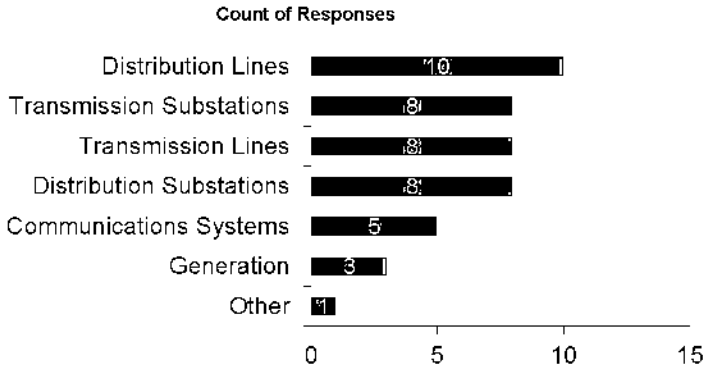
A. Guidehouse compared the CenterPoint Houston's proposed resiliency measures to those applied in other jurisdictions. Guidehouse also compared CenterPoint Houston's Wildfire Mitigation program to those included in other Texas electric utility SRP submissions to the Commission. Guidehouse's approach focused on compared on comparing CenterPoint Houston's proposed resiliency measures to those of other utilities located in areas with comparable risk profiles and weather conditions. It highlights those measures

benchmark utilities have implemented to address these risks and the extent to which these are comparable to mitigation CenterPoint Houston has proposed. Guidehouse also identified utilities in jurisdictions where resiliency plans have been mandated by statute or regulatory orders,

Q. HOW DOES CENTERPOINT HOUSTON'S SRP COMPARE TO THE TYPES OF RESILIENCY INVESTMENTS BEING MADE BY THE PEER UTILITY AND JURISDICTIONAL BENCHMARKING GROUP?

A. Survey results presented in Appendix A of Exhibit ELS – 2 and described above confirm CenterPoint's resiliency measures are similar to measures being implemented by the peer utility group. In particular, many utilities are making investments in hardening measures such as pole replacements and flood mitigation measures at substations. Notably, **Error! Reference source not found.** confirms transmission and distribution line upgrades are the most cited programs by survey participants, each of which are among the highest programmatic investment included in CenterPoint Houston's SRP.

FIGURE ELS - 3



Guidehouse's jurisdictional benchmarking analysis confirms that the measures CenterPoint Houston proposes for approval by the Commission. Appendix A and

Appendix B of Exhibit ELS-2 provide additional details and results of the peer group survey and jurisdictional benchmarking analysis, respectively.

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

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

A. The CenterPoint Houston resiliency measures I reviewed follow the categories outlined in Messrs. Tutunjian, Pryor, Easton, Mercado and Tumlinson testimony and SRP. These measures are listed below and addressed in my responses to questions that follow.

i. EXTREME WIND

Q. WHICH MEASURES THAT CENTERPOINT HOUSTON PROPOSES IN IT SYSTEM RESILIENCY PLAN ARE IMPACTED BY EXTREME WIND EVENTS?

A. The following list of measures address extreme wind events, listed separately by distribution and transmission. All transmission measures, except for Conductor Galloping Mitigation (appears under the Extreme Temperature (Freeze) event category) and protection of transmission substations from unauthorized intrusions appear in the Physical Attack category. Several measures target structures (e.g., wood poles and steel towers) that were constructed to meet design standards in effect at the date of construction, but no longer meet the higher wind speeds outlined in Guidehouse's forecasts. When cost-effective or where access is constrained, CenterPoint Houston will relocate overhead lines underground; for example, three-phase overhead main line and rear lot distribution circuit sections. In addition, CenterPoint Houston proposes automation measures such as IGSD to rapidly isolate faults and reduce their impacts on customer interruptions during extreme wind events. The Vegetation Management reduces the trim cycle from five to three years on virtually all distribution circuits. Notably, the majority of measures CenterPoint Houston proposes to mitigate resiliency events, both in terms of quantities installed and

cost - approximately 70 percent of total SRP total cost - is directed to mitigating extreme wind events. Additional details on each of these measures appear in Section 5.3 of Exhibit ELS-2.

Distribution Measures

- Distribution Circuit Resiliency
- Strategic Undergrounding
- Restoration IGSD
- Distribution Pole Replacement/Bracing
- Vegetation Management

Transmission Measures

- Transmission System Hardening
- 69kV Conversion Projects
- S90 Tower Replacements
- Coastal Resiliency Projects

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

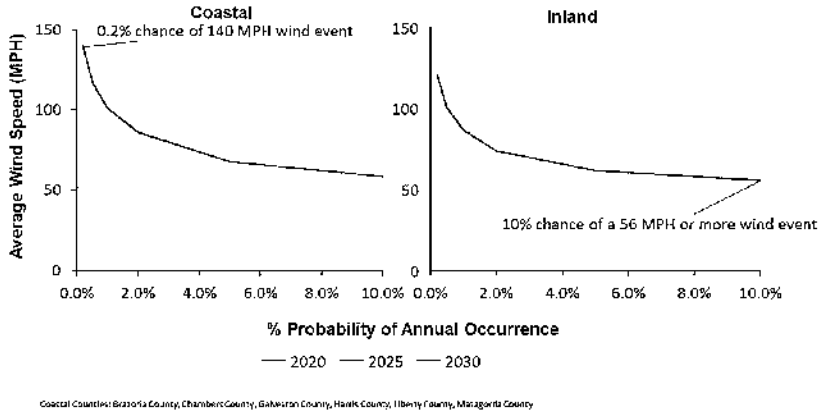
A. NOAA data indicates the frequency and intensity of hurricanes in CenterPoint Houston's service area has been rising similar to other parts of the U.S.[18] The current risk to CenterPoint Houston's T&D system is demonstrated by Hurricane Ike in 2008, where the Harris County coastal weather station captured wind measurements exceeding 130 mph, and Hurricane Nicholas in 2021 where Matagorda County and Galveston County

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

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 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 **Error! Reference source not found.**. From these curves, the 70 mph wind threshold has an annual probability of exceedance19 of 4.5% in coastal counties and 2.7% in inland counties by 2030.

FIGURE ELS - 4



Source: Guidehouse analysis

Q. WHAT BENEFITS DO YOU EXPECT CENTERPOINT HOUSTON WILL ACHIEVE FROM THE MEASURES IT PROPOSES TO MITIGATE EXTREME WIND RISKS?

A. Guidehouse's analysis and evaluation indicates each of CenterPoint Houston's proposed measures are expected to significantly reduce the impact of extreme wind events as measured by CMI. Further, each are cost-effective basis as measured by BCA ratios. Using the results of the risk analysis un the prior question, Guidehouse derived a composite 3-year CMI projected savings of 1,055.7 million with a BCA ratio of 5.5. Additional details on the derivation of these values appear in Section 5 of Exhibit ELS – 2.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS CONFIRMS THAT CENTERPOINT HOUSTON'S MEASURES TO ADDRESS EXTREME WIND EVENTS IS CONSISTENT WITH GOOD UTILITY PRACTICE.

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**Error! Reference source not found.** lists the types of resiliency events other electric utilities are addressing through resiliency investments. The focus on mitigating extreme windstorm clearly aligns with and supports the types of risks CenterPoint Houston aims to mitigate through its SRP.

Q. WHAT IS YOUR ASSESSMENT OF PROPOSED MEASURES TO ADDRESS EXTREME WIND EVENTS BASED UPON FINDINGS FROM YOUR ANALYSES?

A. Each of the measures CenterPoint Houston proposes to address high wind events will significantly reduce their impact as measured by CMI. Each measure contributes to the

overall robust BCA ratio for the extreme wind event category. Importantly, the frequency and severity of extreme wind events (e.g., hurricanes) are forecast to increase; thus underscoring the need to proactively address this risk. For these reasons, I conclude that each of the proposed extreme wind measures will provide substantive benefits to CenterPoint Houston's customers and the Houston region. For further details regarding Guidehouse's assessment of each individual Extreme Wind measure, see Section 5.3 in Exhibit ELS – 2.

ii. EXTREME WATER

Q. WHICH MEASURES THAT CENTERPOINT HOUSTON PROPOSES IN IT SYSTEM RESILIENCY PLAN ARE IMPACTED BY EXTREME WATER EVENTS?

A. The following list of measures address extreme water events. Each measure addresses flooding along coastal areas or inland areas subject to localized flooding. MUCAMS addresses extreme water conditions affecting underground communications cable and equipment for secondary and spot networks located in Downtown Houston, the Texas Medical Center and large industrial load. Mobile transformers are required for substations that not elevated experience damage due to flooding. The Control Center Facility Upgrades is needed at CenterPoint Houston's back-up control center to avoid interior damage to critical monitoring and operations technology systems from a breach of a nearby at-risk dam. Additional detail on Guidehouse's assessment of each of these measures, including quantitative and qualitative benefits, is presented in Section 5.4 of Exhibit ELS-2.

- Substation Flood Control
- Control Center Flood Control

- Major Underground Communications and Monitoring System (MUCAMS)
- Mobile Substations

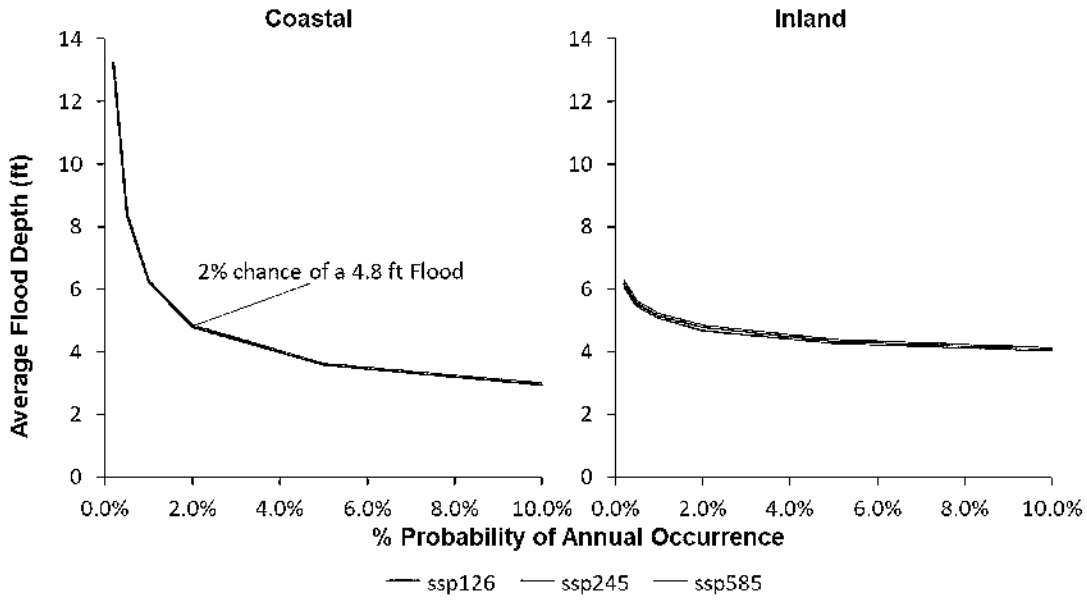
Q. WHAT IS THE HISTORICAL, CURRENT, AND FUTURE RISK TO CENTERPOINT HOUSTON'S SERVICE AREA FOR EXTREME WATER (FLOODING) EVENTS BASED ON YOUR ANALYSIS?

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.20 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 - 5. 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 - 5



Source: Guidehouse analysis

Q. WHAT BENEFITS DO YOU EXPECT CENTERPOINT HOUSTON WILL ACHIEVE FROM THE MEASURES IT PROPOSES TO MITIGATE EXTREME WATER RISKS?

A. Guidehouse's analysis and evaluation indicates each of CenterPoint Houston's measures are expected to significantly reduce the impact of extreme waters events as measured by CMI. Further, each are cost-effective basis as measured by BCA ratios. Using the results of the risk analysis in the prior question, Guidehouse derived a composite 3-year CMI projected savings of 11.0 million with a BCA ratio of 3.3. Additional details on the derivation of these values appear in Section 5 of Exhibit ELS – 2.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS CONFIRMS THAT CENTERPOINT HOUSTON'S MEASURES TO ADDRESS EXTREME WATER EVENTS IS CONSISTENT WITH GOOD UTILITY PRACTICE.

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**Error! Reference source not found.** confirms that utilities, in addition to extreme wind, utilities focus on mitigating extreme water (i.e., flooding) – addressing flood risk ranks high among utilities that responded to the survey. Accordingly, benchmark survey results align with and support the types of risks CenterPoint Houston aims to mitigate through its SRP.

Q. WHAT IS YOUR ASSESSMENT OF PROPOSED MEASURES TO ADDRESS EXTREME WATER EVENTS BASED UPON FINDINGS FROM YOUR ANALYSES?

A. Each of the measures CenterPoint Houston proposes to address extreme water events will contribute to reducing the impact of resiliency events as measured by CMI. Each measure contributes to producing a favorable BCA ratio for the extreme water event category. Importantly, the frequency and severity of extreme water events (e.g., flooding) are forecast to increase, thus underscoring the need to proactively address this risk. For these reasons, I conclude that each of the proposed extreme water measures will provide substantive benefits to CenterPoint Houston's customers and the Houston region. For further details regarding Guidehouse's assessment of each individual Extreme Water measure, see Section 5.4 in Exhibit ELS – 2.

iii. EXTREME TEMPERATURE (FREEZE)

Q. WHICH MEASURES THAT CENTERPOINT HOUSTON PROPOSES IN IT SYSTEM RESILIENCY PLAN ARE IMPACTED BY EXTREME TEMPERATURE (FREEZE) EVENTS?

A. The following list of measures address extreme temperature (freeze) events. Each are distribution measures, except for Anti-Galloping Technologies, which addresses icing on transmission lines Note that the IGSD Loadshed measure, which responds to ERCOT-mandated load shed notifications, also appears in the Extreme Wind and Extreme Temperature (Heat) event categories. The Microgrids Pilot is proposed to assess the capability of utility-scale microgrids comprised of localized and isolated generation supply to reliably supply customers during resiliency events when the Company's transmission and distribution system (or area generation) is interrupted.

- Anti-Galloping Technologies (Transmission)
- Loadshed IGSD
- Microgrids Pilot

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

A. Extreme temperatures can have a significant negative impact on utility operations. For example, extreme cold can also result in significant increase in customer demand and strain the ability of CenterPoint Houston's equipment to serve these customers during resiliency events. 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.[21]

Q. WHAT BENEFITS DO YOU EXPECT CENTERPOINT HOUSTON WILL ACHIEVE FROM THE MEASURES IT PROPOSES TO MITIGATE TEMPERATURE (FREEZE) RISKS?

A. Guidehouse's analysis and evaluation indicates each of CenterPoint Houston's proposed temperature measures are expected to significantly reduce the impact of freezing events as measured by CMI. Further, each are cost-effective basis as measured by BCA ratios. Using the results of the risk analysis in the prior question, Guidehouse derived a composite 3-year CMI projected savings of 5.3 million with a BCA ratio of 7.1. Additional details on the derivation of these values appear in Section 5 of Exhibit ELS – 2.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS CONFIRMS THAT CENTERPOINT HOUSTON'S MEASURES TO ADDRESS EXTREME TEMPERATURE (FREEZE) EVENTS IS CONSISTENT WITH GOOD UTILITY PRACTICE.

A. Figure ELS - 1**Error! Reference source not found.** indicates that of the utilities surveyed, those that targeted extreme temperature risk was among the highest that responded – only those listing extreme wind had a larger number of respondents. Accordingly, benchmark survey results align with, and support CenterPoint Houston proposed measures to mitigate extreme temperature events through its SRP.

[21] 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**

Q. WHAT IS YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED MEASURES TO ADDRESS EXTREME TEMPERATURE (FREEZE) EVENTS BASED UPON FINDINGS FROM YOUR ANALYSES?

A. Each of the measures CenterPoint Houston proposes to address extreme temperature (freezing) events will contribute to reducing the impact of resiliency events as measured by CMI. Each measure contributes to producing a favorable BCA ratio for the extreme water event category. Importantly, the frequency and severity of extreme temperatures events (e.g., freezing) are forecast to increase; thus underscoring the need to proactively address this risk. For these reasons, I conclude that each of the proposed extreme water measures will provide substantive benefits to CenterPoint Houston's customers and the Houston region. For further details regarding Guidehouse's assessment of each individual Extreme Temperature (Freeze) measure, see Section 5.5 in Exhibit ELS – 2.

iv. <u>EXTREME TEMPERATURE (HEAT)</u>

Q. WHICH MEASURES THAT CENTERPOINT HOUSTON PROPOSES IN IT SYSTEM RESILIENCY PLAN ARE IMPACTED BY EXTREME TEMPERATURE (HEAT) EVENTS?

A. The following list of measures are designed to address a wide range of Extreme Temperature (Heat) events. Each target distribution assets, except for a portion of the Contamination measure which addresses transmission substation insulators. Notably, the Distribution Capacity Enhancements measure is one of the larger proposed investments in terms of cost as it comprises almost 50 percent of the total cost of all proposed measures in the Extreme Temperature (Heat) event category. It is designed to increase load transfer capability and address islanded distribution circuits – some distribution circuits do not have back-up circuits as required under CenterPoint Houston's planning criteria – and to

mitigate the impact of increased distribution substation and circuit loadings during high temperatures events. The MUGS Reconductor and URD Cable Modernization resiliency measures each address aged distribution cables (e.g., 1970's vintage Cross-Linked Polyethylene [XLPE]) cable where deterioration of insulation has resulted in increased failures).

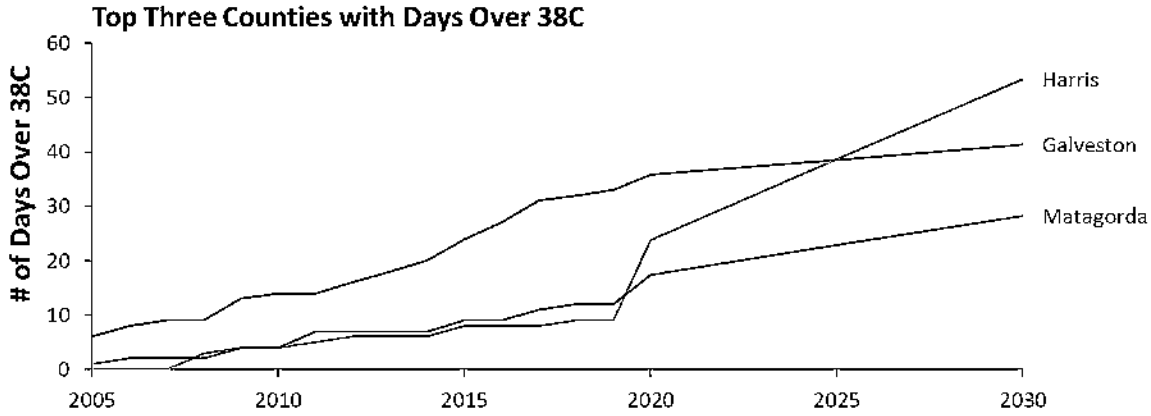
The Extreme Temperature (Heat)event category addresses several measures that, collectively, will reduce the ignition risk of electric assets as well as proactively enable CenterPoint Houston to predict potential spread of local fire events via advanced analytical models via advanced analytical models. In addition, targeted vegetation management and Restoration IGSDs designed to isolate distribution line sections outside of wildfire red zones each are included in the Extreme Temperature (Heat) event category.

- Distribution Capacity Enhancement/Substations
- Major Underground (MUGS) Reconductor
- URD Cable Modernization
- Contamination Mitigation
- Substation Fire Barriers
- Digital Substation
- Wildfire Advanced Analytics
- Wildfire Strategic Undergrounding
- Wildfire Vegetation Management
- Wildfire IGSD

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

A. Similar to freeze events described in Section V.iii, extreme temperatures (heat) 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. 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 Matagorda counties. These results, presented in **Error! Reference source not found.**, 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 - 6



Source: Guidehouse analysis

Q. WHAT BENEFITS DO YOU EXPECT CENTERPOINT HOUSTON WILL ACHIEVE FROM THE MEASURES IT PROPOSES TO MITIGATE EXTREME TEMPERATURE (HEAT) RISKS?

A. Guidehouse's analysis and evaluation indicates each of CenterPoint Houston's proposed Extreme Temperature (Heat) measures are expected to significantly reduce the impact of high temperature and drought events as measured by CMI. Further, each are cost-effective basis as measured by BCA ratios. Using the results of the risk analysis in the prior question, Guidehouse derived a composite 3-year CMI projected savings of 183.1 million with a BCA ratio of 3.8. Additional details on the derivation of these values appear in Section 5.6 of Exhibit ELS – 2.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS CONFIRMS THAT CENTERPOINT HOUSTON'S MEASURES TO ADDRESS EXTREME TEMPERATURE (HEAT) EVENTS IS CONSISTENT WITH GOOD UTILITY PRACTICE.

A. Figure ELS - 1**Error! Reference source not found.** indicates that of the utilities surveyed, those that targeted extreme temperature risk were among the highest that responded – only those listing extreme wind had a larger number of respondents. Further, some utilities, including those located within high wildfire risk areas, identified wildfire mitigation as a resiliency objective. Accordingly, benchmark survey results align with and support CenterPoint Houston's proposed measures to mitigate extreme temperature events through its SRP.

Q. WHAT IS YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED MEASURES TO ADDRESS EXTREME TEMPERATURE (HEAT) EVENTS BASED UPON FINDINGS FROM YOUR ANALYSES?

A. Each of the measures CenterPoint Houston proposes to address Extreme Temperature (Heat) events, except for Wildfire Mitigation which provides benefits beyond those measured by customer interruptions alone, will contribute to reducing the impact of resiliency events as measured by CMI. Each measure, other than wildfire mitigation which demonstrably provides benefits not measured by BCA, contributes to producing a favorable BCA ratio for the extreme temperature event category. Importantly, the frequency and severity of Extreme Temperature (Heat) events are forecast to increase; thus underscoring the need to proactively address this risk. For wildfire mitigation, which focuses on reducing the potential for ignition or spread of local fires, the benefits accrue to the public at large, and mitigation is targeted to areas at greatest risk. For these reasons, I conclude that each of the proposed extreme temperature measures will provide substantive benefits to CenterPoint Houston's customers and the Houston region. For further details regarding Guidehouse's assessment of each individual Extreme Temperature (Heat) measure, see Section 5.6 in Exhibit ELS – 2.

v. PHYSICAL ATTACK

Q. WHICH MEASURES THAT CENTERPOINT HOUSTON PROPOSES IN ITS SYSTEM RESILIENCY PLAN ARE IMPACTED BY PHYSICAL ATTACK EVENTS?

A. Two measures address physical attacks, each targeted at critical substations that if compromised, could result in significant disruption to the transmission network and loss of load. The two measures CenterPoint Houston proposes are designed to thwart unauthorized

entry and rapidly notify operations staff of attempts of or actual entry of substations, with an objective to quickly alert law enforcement. Additional detail on Guidehouse's assessment of each of these measures, including quantitative and qualitative benefits, is presented in Section 5 of Exhibit ELS-2.

- Substation Security Upgrades
- Substation Physical Security Fencing

Q. WHAT IS THE HISTORICAL, CURRENT, AND FUTURE RISK TO CENTERPOINT HOUSTON'S PHYSICAL ASSETS TO ATTACK BASED ON YOUR ANALYSIS?

A. CenterPoint Houston serves critical loads throughout its service territory, including downtown Houston, major medical complexes, and large commercial and industrial complexes. The Company's high voltage lines and substations are a critical component of ERCOT's bulk power system, and the security of transmission substations is paramount to maintaining reliability throughout the region. These enhancements are also premised on the increase in bad actors knowledgeable of critical electric power system components, thus underscoring the need for CenterPoint Houston to minimize the vulnerability of its assets to these threats,

Q. WHAT BENEFITS DO YOU EXPECT CENTERPOINT HOUSTON WILL ACHIEVE FROM THE MEASURES IT PROPOSES TO MITIGATE THE RISK OF PHYSICAL ATTACKS?

A. While the likelihood of a major physical attack at substations is low compared to other resiliency events, the impact of an attack would have major consequences in terms of damage and load at risk – extensive concurrent attacks and damage to several substations

could jeopardize the integrity of the ERCOT bulk power system. Guidehouse's analysis and evaluation indicates each of CenterPoint Houston's proposed measures are expected to significantly reduce the impact of attacks as measured by CMI. Further, each produced high BCA ratios. Guidehouse derived a composite 3-year CMI projected savings of 42.7 million with a BCA ratio of 25.4. Additional details on the derivation of these values appear in Section 5 of Exhibit ELS – 2.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS CONFIRMS THAT CENTERPOINT HOUSTON'S MEASURES TO ADDRESS PHYSICAL ATTACKS IS CONSISTENT WITH GOOD UTILITY PRACTICE.

A. Figure ELS - 1**Error! Reference source not found.** indicates that of the utilities surveyed, those that targeted risk of physical attack was third highest among those that responded. Accordingly, benchmark survey results align with and support CenterPoint Houston proposed measures to mitigate physical attacks through its SRP.

Q. WHAT IS YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED MEASURES TO ADDRESS THE RISK OF PHYSICAL ATTACKS BASED UPON FINDINGS FROM YOUR ANALYSES?

A. CenterPoint Houston proposes measures to discourage, prevent or quickly detect attacks. Despite the low likelihood of a major attacks, each measure contributes to reducing the impact of an attack as measured by CMI. The avoidance of extensive damage and loss of load results in a significant reduction in CMI and produced a robust composite BCA ratio for the physical attacks category. Further, recent events at substations elsewhere in the U.S. has heightened concern among utilities that bad actors will damage critical electric infrastructure; thus, encouraging utilities to proactively protect these assets and

underscoring the need for CenterPoint Houston to proactively address this risk. For these reasons, I conclude that each of the proposed physical attack measures will provide substantive benefits to CenterPoint Houston's customers and the Houston region. For further details regarding Guidehouse's assessment of each individual Extreme Temperature (Heat) measure, see Section 5.7 in Exhibit ELS – 2.

vi. SITUATIONAL AWARENESS

Q. WHAT AE THE MEASURES THAT CENTERPOINT HOUSTON PROPOSES IN IT SYSTEM RESILIENCY PLAN THAT ENHANCE SITUATIONAL AWARENESS?

A. Seven measures are proposed, each covering a range of applications and capabilities that CenterPoint Houston needs to enhance its selection of cost-effective resiliency measures, detect and predict conditions of wildfire spread and ignition, and support restoration of customer interruptions following a resiliency event. The first measure CenterPoint Houston proposes, Advanced Aerial Imagery/Digital Twin, is designed to target and select at risk distribution assets for improvements, while weather stations and wildfire cameras will enable CenterPoint Houston's operations staff to detect incipient wildfire events and better predicts conditions under which ignition-based wildfire events are most likely to occur. The remaining four measures enhance CenterPoint Houston's ability to rapidly restore load following a resiliency event. The Voice & Mobile Data Radio System and Backhaul Microwave Communication measures are addressed in Guidehouse witness Joseph Baugh's testimony. Additional detail on Guidehouse's assessment of each of these measures, including quantitative and qualitative benefits, is presented in Section 5.9 of Exhibit ELS-2.

- Advanced Aerial Imagery/Digital Twin
- Weather Stations
- Wildfire Cameras
- Voice & Mobile Data Radio System
- Backhaul Microwave Communication
- Emergency Operations Center
- Hardened Service Centers

Q. WHAT BENEFITS DO YOU EXPECT CENTERPOINT HOUSTON WILL ACHIEVE FROM THE MEASURES IT PROPOSES TO ENHANCE SITUALTIONAL AWARENESS?

A. CenterPoint Houston has and will continue to rely on ongoing enhancements and features of its Aerial Imagery/Digital Twin platform to identify at risk distribution assets and selection of asset locations for mitigation. Guidehouse's BCA confirms this measure is cost-effective. The two measures associated with wildfire detection and predictive analysis further enhances CenterPoint Houston's suite of wildfire mitigation strategies. Guidehouse did not derive BCAs for wildfire mitigation as the impact of wildfire events results in collateral damage to non-electric assets. Nonetheless, like other utilities in Texas and states where wildfire risk is high, CenterPoint Houston is responsibly proposing measures to reduce the risk of ignition and improve early detection of wildfires. Further, I agree with Joseph Baugh's findings that upgrades to communications systems will help CenterPoint Houston to promptly and effectively respond to resiliency events. Additional details on the value of these measures appear in Section 5.9 of Exhibit ELS – 2.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE PEER ELECTRIC UTILITY BENCHMARKING AND HOW THIS CONFIRMS THAT CENTERPOINT HOUSTON'S MEASURES TO ENHANCE SITUATIONAL AWARENESS CAPABILITIES IS CONSISTENT WITH GOOD UTILITY PRACTICE.

A. Figure ELS - 1**Error! Reference source not found.** indicates that of the utilities surveyed, several utilities, including those located within high wildfire risk areas, identified wildfire mitigation as a resiliency objective. Several respondents listed modernization of facilities and support systems as in scope with respect to resiliency investments, which includes the communication systems and emergency operations, and service centers listed above. Accordingly, benchmark survey results align with and support CenterPoint Houston's proposed measures to enhance situational awareness capabilities and facilities through its SRP.

Q. WHAT IS YOUR ASSESSMENT OF CENTERPOINT HOUSTON'S PROPOSED MEASURES TO ENHANCE SITUALTIONAL AWARENESS BASED UPON FINDINGS FROM YOUR ANALYSES?

A. The measures CenterPoint Houston proposes to improve situational awareness provides benefits beyond those measured by customer interruptions alone, as each improves the Company's ability to identify at risk assets or better predict or detect resiliency events such as wildfires. Each measure are foundational investments that collectively enhances CenterPoint Houston's growing need to relay on modernization of operation technology and support systems to address the increased variability and frequency of resiliency events outlined in Exhibit ELS - 2. For wildfire mitigation, which focuses on reducing the potential for ignition or spread of local fires, the benefits accrue to the public at large, and mitigation is designed to reduce the risk of widespread fires. For these reasons, I conclude

that each of the proposed situational awareness measures will provide substantive benefits to CenterPoint Houston's customers and the Houston region. For further details regarding Guidehouse's assessment of each individual Situational Awareness measure, see Section 5.9 in Exhibit ELS – 2.

VI. SUMMARY OF FINDINGS AND RECOMMENDATIONS

Q. HOW DID GUIDEHOUSE DETERMINE ITS FINDINGS AND RECOMMENDATIONS ON CENTERPOINT HOUSTON'S SYSTEM RESILIENCY PLAN?

A. The findings and recommendations offered in my testimony are based on the results of Guidehouse's independent analysis of resiliency risk for CenterPoint Houston's service area and potential benefits associated with CenterPoint Houston's proposed operations and physical security resiliency measures. Guidehouse's analysis included a risk assessment that forecasts an increase in extreme weather events occurring in CenterPoint Houston's service area over time. Using the results of the risk assessment and identification of benefits, costs, and industry best practice, Guidehouse conducted qualitative and quantitative analyses of CenterPoint Houston's proposed resiliency plan investments. This included benchmarking industry best practices in resiliency planning for electric systems outlined in Section IV.iv of my testimony.

Further detail on Guidehouse's independent analysis and review is provided in Exhibit ELS-2, *Guidehouse's Independent Analysis and Review of CenterPoint Energy Houston Electric's System Resiliency Plan.* This report supports my testimony and was prepared with assistance from Guidehouse staff and an outside consulting firm to conduct the peer utility benchmarking study.[22]

[22] First Quartile Consulting provided peer utility benchmarking data.

Q. PLEASE SUMMARIZE THE OVERALL FINDINGS FROM GUIDEHOUSE'S INDEPENDENT ANALYSIS AND REVIEW OF CENTERPOINT HOUSTON'S SYSTEM RESILIENCY PLAN.

A. First, Guidehouse finds that CenterPoint Houston's SRP appropriately prioritizes operations and physical security resiliency measures that help mitigate resiliency events with the highest amount of risk in CenterPoint Houston's service area. With regards to my testimony, Guidehouse's risk assessment confirms that the frequency and magnitude of extreme weather events is likely to increase over time. These include increased flood risk at substations in areas prone to flooding, and transmission and distribution lines that were built according to standards that existed at the time they were constructed, but are now susceptible to failure due to an increase in frequency and severity of hurricanes, microbursts and tornados. It includes addressing contamination build up in areas with elevated risk of failure due to flashover and islanding of distribution lines during resiliency events due to inadequate capacity. Examples of CenterPoint Houston's consideration of the findings of this risk assessment include:

- Several of CenterPoint Houston's resiliency measures target asset replacements to upgrade in locations most susceptible to outages during resiliency events. For example, CenterPoint Houston's SRP targets transmission and distribution circuits with a high percentage of poles and towers that do not meet its current design standard, making them more susceptible to outages during high wind events.
- CenterPoint Houston's SRP targets elevation of critical substation equipment to align with flood profiles and with sufficient mobile substation capability to provide alternative supply during resiliency events as outlined in Guidehouse's risk assessment.

- Transmission pole and tower replacements will be designed by CenterPoint Houston to withstand high impact hurricanes, tornados, and microbursts.
- Replaces aged cable that has deteriorated and will be replaced or modernized based on current equipment standards.
- CenterPoint Houston is applying grid modernization and capacity resiliency measures that emphasize automation and circuit ties as an efficient and cost-effective approach to improve electric transmission and distribution system performance during resiliency events.
- Hardens critical substations that are at risk of unauthorized intrusion by bad actors and increases monitoring and detection to thwart damage to its equipment.
- Improves situational awareness and response to resiliency events via enhanced support systems such as early wildfire detection, upgraded communications systems, and expansion of operations and service centers.

Similarly, the BCA analysis performed by Guidehouse indicates that each resiliency measure described above in my testimony is either cost effective (i.e., benefit-cost ratio, or BCA ratio, greater than 1.0, and each provides additional qualitative benefits that support inclusion in CenterPoint Houston's SRP. Further, the peer utility and jurisdictional benchmarking survey described in Section IV.iv of my testimony indicates that proposed natural hazard and physical security resiliency measures included in CenterPoint Houston's SRP are consistent with those deployed at other utilities.

In summation, I conclude that CenterPoint Houston's SRP is:

- appropriate for addressing the risks it faces;
- aligned with industry best practice (i.e., Good Utility Practice); and
- beneficial to customers and communities served by CenterPoint Houston.

Q. PLEASE SUMMARIZE THE RECOMMENDATIONS GUIDEHOUSE PROVIDED FOR CENTERPOINT HOUSTON'S CONSIDERATION.

A. Based upon analysis associated with the prior SRP, Guidehouse offered a variety of recommendations, which are described in Guidehouse's report that was filed with in Docket 56548. CenterPoint Houston had addressed many of the recommendations within its prior SRP.

In developing its 2026-2028 T&D SRP, CenterPoint Houston has also addressed other recommendations, most notably by increasing the resolution of locational risk analysis to help inform the prioritization of specific projects for investment. Guidehouse has also provided additional recommendations for the current SRP, with a focus on the implementation of proposed measures. See Section 7.2 in Exhibit ELS – 2 for details regarding these recommendations.

Q. PLEASE SUMMARIZE HOW CENTERPOINT HOUSTON MADE MODIFICATIONS TO ITS SYSTEM RESILIENCY PLAN BASED ON THE FINDINGS AND RECOMMENDATIONS PROVIDED BY GUIDEHOUSE REGARDING ITS RESILIENCY MEASURES.

A. CenterPoint Houston used the Guidehouse analysis to make adjustments to its plan as stated in Mr. Brownell's testimony. For example, as noted in CenterPoint Houston's SRP, CenterPoint Houston collaborated with Guidehouse to identify alternatives and metrics included in its SRP. Further, CenterPoint Houston provided additional justification targeted critical circuit vegetation management and wildfire mitigation resiliency measures (including targeted vegetation management for wildfire risk areas) after Guidehouse's prior review. This was informed in part by wildfire risk analysis included in Guidehouse's report. It is also my understanding that recommendations offered in the Guidehouse report

applicable to implementation and future resiliency plans will be considered as CenterPoint Houston works to implement and further refine its SRP.

VII. CONCLUSION

Q. PLEASE SUMMARIZE YOUR DIRECT TESTIMONY.

A. Guidehouse's independent assessment of CenterPoint Houston's SRP and my testimony finds that its proposed resiliency measure investments are expected to provide substantive benefits to its customers and the Houston region. Accordingly, I recommend the Commission approve CenterPoint Houston's SRP and the resiliency measures it proposes over the 3-year investment period spanning 2026 through 2028. My recommendation is supported by the level of rigor Guidehouse applied to evaluate and confirm the benefits associated with CenterPoint Houston's SRP. As noted in my findings, Guidehouse's risk assessment confirms that the frequency and magnitude of extreme weather events is likely to increase over time. The resiliency measures CenterPoint Houston proposed to mitigate resiliency events affirmatively address the increased exposure and vulnerability of its transmission and distribution system to such events.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.

STATE OF Texas §
§
COUNTY OF Harris §

AFFIDAVIT OF EUGENE L. SHLATZ

BEFORE ME, the undersigned authority, on this day personally appeared EUGENE L. SHLATZ who having been placed under oath by me did depose as follows:

1. "My name is EUGENE L. SHLATZ. I am of sound mind and capable of making this affidavit. The facts stated herein are true and correct based upon my personal knowledge.

2. I have prepared the foregoing Direct Testimony and the information contained in this document is true and correct to the best of my knowledge."

Further affiant sayeth not.

Eugene L. Shlatz
EUGENE L. SHLATZ

SUBSCRIBED AND SWORN TO BEFORE ME on this 6th day of January, 2025.

TERENCE GLENN RUSSELL
NOTARY ID #1093521-4
My Commission Expires
February 21, 2027

Terence Glenn Russell
Notary Public in and for the State of Texas

My commission expires: 02-21-2027

Guidehouse
Outwit Complexity

Eugene L. Shlatz

Director (Contract Worker)

eshlatz@guidehouse.com
Tampa, FL
Direct: 802.233.1890

Professional Summary

Gene has over 35 years of management consulting and supervisory experience in energy delivery, electric power generation and distributed energy systems. He has directed numerous engagements on electric system reliability, smart and renewable technologies, microgrids, asset management, electric pricing, due diligence and system adequacy. His clients have included US, Canadian, European and South American electric utilities, electricity consumers, law firms and government agencies. Gene is an expert on electric power delivery systems; and has testified before FERC, state regulatory commissions and U.S. Congress on transmission open access, DG integration, retail rates, regulatory compliance, and capital planning. He has published numerous articles and industry presentations on smart grid, distributed resources, electric reliability, asset management, energy efficiency, and electric pricing.

Professional Experience

Directs project teams and manages consulting engagements for electric utility, government and energy supply clients. Responsible for energy delivery and power production engagements in the following areas:

- **Regulatory/Legal** – capital planning, transmission and distribution program support, renewables integration and pricing, expert witness for state and federal agencies, and civil litigation
- **Operations & Planning** – transmission and distribution performance evaluation; reliability, target setting, remediation analysis, and service quality standards
- **Emerging Technologies** – renewable technology and smart grid integration, energy efficiency and technical/economic assessment of distributed resources
- **Asset Management** – implementation strategy, project prioritization, performance measurement, utilization and cost optimization, electric delivery system planning

Representative Client List and Engagements

Distributed Energy Resources & Advanced Technologies

- **Alberta Utilities Commission.** Lead investigator to evaluate impacts and costs to integrate solar PV and electric vehicles on Distribution Facility Owner distribution systems to year 2050. Conducted analytical studies of mitigation options to address performance violations.
- **American Electric Power.** Program lead to assess DER integration strategies and cost for a multi-state solar PV and electric vehicle forecast. Developed analytical approach to predict system impacts and mitigation options to address distribution system performance violations.
- **Aspen/California Energy Commission**. Conducted several independent reviews of advanced energy systems and applications for applicants seeking EPIC project funding. Technologies evaluated include integrated storage and renewables, advanced simulation software and Microgrids.

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- **NYSERDA**. Evaluated impacts of small-scale energy storage on radial and network distribution systems to assess the applicability of standby rates adjustments for New York electric utilities.
- **California Utility (Confidential)**. In response to recent fires in California, evaluated wildfire prevention mitigation strategies to reduce the hazard potential for electric transmission and distribution lines and equipment.
- **Dubai Electric and Water Authority.** Project lead for distribution automation, transmission automation, asset management, and renewables integration smart technology assessment. Conducted technical and economic studies of smart technology options and developed roadmap for implementation of recommended strategies.
- **California Energy Commission/Southern California Edison**. Project manager of DER integration studies for a major utility planning region. Predicted hosting capacity limits and options to increase DER capacity and value via advanced communications and control technologies. Assessed the capability of energy storage to increase capacity limits.
- **U.S. Department of Energy/Dominion Virginia Power.** Project manager of Solar Integration Study to identify renewable capacity impacts and integration requirements in the state of Virginia. Determined distribution hosting capacity limits and impacts of increasing amounts of solar on DVP's generation, transmission and distribution system.
- **Los Angeles Department of Water & Power.** Technical lead of a DER integration study to determine integration requirements and hosting capacity limits, and approaches to target DER and storage based on locational needs and benefits. Assessed communication and control strategies, organization structure, tariffs and rates, and strategies to achieve renewable portfolio targets.
- **Orange & Rockland Utilities.** Project manager of a DG Interconnection benchmarking analysis. Conducting studies to predict hosting capacity limits on O&R's T&D system and mitigation options in support of NY's Renewable Energy Vision initiative.
- **Pacific Gas & Electric Company.** Project manager of a Transmission and Distribution PV Impact Study. It included engineering analyses designed to facilitate the integration of DGPV into the grid. Developed PV values based on analysis across multiple scenarios and attributable to DGPV.
- **Major Southeastern U.S. Utility (Confidential).** Project manager of a Solar Integration Study to assess the technical and economic impact of increasing amounts of solar on the utilities' generation, transmission and distribution system.
- **California Energy Commission/Southern California Edison.** Project manager of a study evaluating DG impacts and integration requirements for up to 12,000 MW of DG in California by 2020. Developed a technical evaluation and costing framework applicable to all CA utilities.
- **U.S. Navy.** Evaluated on-site microgrid options for a major military shipyard, including technical assessment of renewable generation, control strategies, electric system performance and system upgrades required to operate in stand-alone and parallel modes of operation.
- **U.S. Department of Energy (DOE).** Provided technical and program management support for DOE's Smart Grid Investment Grant (SGIG) program. Responsible for impact evaluation of smart grid technologies, including program benefits and implementation strategies.

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- **PowerStream (Ontario).** Provided project management and evaluation services for an on-site microgrid comprised of a mix of wind, solar, storage and gas-fired technologies. Developing control and dispatch strategies and methods for assessing MG performance and benefits.
- **NV Energy.** Project manager of DG and large PV integration studies for southern and northern Nevada. Identified technical/capacity limits of renewable energy sources on NV Energy's T&D system. Responsible for technical and economic evaluation of power system impacts and integration costs, including intermittency. Testified before Nevada Commission to support findings.
- **Toronto Hydro.** Project manager of comprehensive evaluation of distributed energy resources versus traditional T&D alternatives for a major urban center. Included a technical assessment of DG systems impacts, technology integration and forecast of cost-effective alternatives.
- **Southern California Edison Company.** Technical support a 3-year integrated grid pilot designed to demonstrate modern grid infrastructure functionality and advance customers' ability to interconnect renewable energy sources, proactively manage customer demand, and improve the safety and reliability of the grid in a cost-effective manner.

Reliability, Benchmarking and Electric System Planning

- **Jersey Central Power & Light.** Principle investigator of a commission-mandated Operations Review of JCP&L's distribution system. The review included an assessment of reliability, storm response, preventative maintenance and budgeting processes. Navigant's report and recommendations were unanimously approved and accepted by the New Jersey Board of Public Utilities.
- **Exelon/Commonwealth Edison.** Lead consultant of an engineering and operational assessment of Exelon's system design, construction and maintenance practices. Our study was filed before the ICC in response to claims of system inadequacy for major storms. Provided expert witness testimony that confirmed ComEd's T&D practices were consistent with or exceeded industry standards
- **Government of Puerto Rico (Public Private Partnership).** Program oversight lead for long-term disaster recovery efforts for the Puerto Rico Electric Power Authority (PREPA) generation, transmission and distribution systems. Responsible for developing Grid Modernization plans to restore the electric grid to current standards, consistent with FEMA and BBA funding requirements.
- **Toronto Hydro (THESL).** Prepared an independent technical assessment of a proposed relocation of a major segment urban transmission and distribution system as evidence before a tribunal in the City of Toronto. Analyzed relocation options and impact on power system reliability and performance.
- **New York Power Authority/ Puerto Rico Electric Power Authority**. Lead investigator and subject matter expert of a study to assess damage caused by major hurricanes in 2017 and to provide recommendations to bring the power generation and delivery system to current design standards.
- **Hawaiian Electric Company**. Project manager of a technical analysis to assess the impact of capital and O&M improvement programs on electric system reliability performance during storms and major events. Demonstrated a correlation of program improvements and system resiliency during storms.
- **BC Hydro.** Lead investigator to benchmark and assess vegetation management practices and applications across the province of British Columbia. Provided recommendations on enhancing processes and VM methods to improve efficiency and cost.

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- **Saskatoon Light & Power.** Project manager of a 20-year capital development plan designed to meet reliability and performance objectives at lowest cost. Our assessment included a review and analysis of T&D engineering, maintenance and operations; and recommendations for improvement.
- **Sulphur Springs Valley Electric Cooperative (SSVEC).** Project manager of an independent Feasibility Study of delivery alternatives, including T&D, distributed generation, energy efficiency, energy storage and renewables. Successfully testified as an expert witness before AZ commission.
- **Austin Energy.** Performed a benchmarking and gap analysis of AE's engineering and operations. Prepared recommendations to enhance reliability and operations efficiency.
- **Saskatoon Light & Power.** Project manager of a 20-year capital development plan designed to meet reliability and performance objectives at lowest cost. Our assessment included a review and analysis of T&D engineering, maintenance and operations; including recommendations for improvement.
- **Toronto Hydro Electric System, Limited (THESL).** Performed a long-range planning study for THESL's radial and network downtown distribution system. Evaluated capital expansion versus CDM needed to serve downtown Toronto for 20 years.
- **Sulphur Springs Valley Electric Cooperative (SSVEC)**. Project manager of an independent Feasibility Study of delivery alternatives, including T&D, distributed generation, energy efficiency, energy storage and renewables. Successfully testified as an expert witness before AZ commission.
- **Austin Energy.** Performed a benchmarking and gap analysis of engineering and operations performance for AE's energy delivery organization.
- **Ameren Services.** Conducted a review and predictive assessment of distribution reliability. A methodology was developed to apply fact-based methods to allocate reliability expenditures.
- **American Electric Power.** Conducted a review and predictive assessment of distribution reliability. Applied fact-based methods to prioritize investment decisions and to quantify risk.
- **Potomac Electric Power Company (PHI).** Conducted an investigation and benchmarking analysis of PEPCO's T&D system, including transmission and distribution infrastructure. Prepared recommendations to enhance performance and reduce outage risk.
- **National Grid.** Conducted a system review and predictive assessment of distribution reliability. A strategic methodology was developed to predict system outage performance based on system attributes, equipment performance and historical reliability.
- **Potomac Electric Power Company (PHI).** Project manager of a benchmarking analysis of PEPCO's T&D system, including transmission and distribution infrastructure. Prepared recommendations to enhance performance and reduce outage risk.
- **Dominion – Virginia Power**. Project manager and lead investigator of a comprehensive technical review and risk assessment of secondary networks. Reviewed and analyzed engineering standards, planning criteria, operations and maintenance, and construction methods.

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Regulatory and Legal

» **Expert Witness - Civil Litigation (Various Jurisdictions).** Expert witness in personal injury cases involving electric utility assets. Conducted technical investigations, reviewed and submitted discovery, and declarations to support evidentiary hearings and agreements.

» **Duke Energy (Florida), Public Service of New Mexico & El Paso Electric.** Conducted studies to determine ancillary service requirements costs. Provided expert testimony ancillary service schedules to support OATT fillings before the U.S. Federal Energy Regulatory Commission.

» **Hydro Ottawa (Ontario).** Conducted an independent review of Hydro Ottawa's asset management and Distribution System Plan to support a rate request filing before the Ontario Energy Board (OEB). Provided recommendations to ensure compliance with OEB filing requirements for capital investments.

» **NorthWestern Energy (FERC).** Expert witness supporting ancillary services schedules and pricing for a filling before the U.S. Federal Energy Regulatory Commission.

» **NorthWestern Energy (Montana/FERC).** Expert witness for NEM Solar Integration and NERC Reliability Performance studies to comply with Montana Public Service Commission and U.S. Federal Energy Regulatory Commission requirements. Conducted technical and economic studies of solar impacts on NorthWestern's service territory and submitted expert testimony to support findings on ancillary services before the MPSC.

» **International Business Machines (IBM).** Conducted a reliability assessment of issues related to the City of Boulder, Colorado's application to the Colorado Public Utility Commission (PUC) to form a municipal electric utility. Conducted independent technical review of separation of electric assets and appeared as an expert witness before the CPSC on behalf of IBM.

» **Green Mountain Power (GMP).** Prepared independent testimony and appeared as an expert witness in a rate filing before the Vermont Public Service Commission (VPSC). Testimony supported capital investments for generation, transmission, distribution, IT/OT and physical assets.

» **NV Energy (Sierra Pacific Power Company).** Conducted a T&D avoided cost study to support an SPPC's rate filing and to determine Excess Energy Charges for net metering customers. Submitted expert testimony before the Nevada Commission on T&D marginal costs and application to NEM solar.

» **Toronto Hydro Electric System, Limited (THESL).** Prepared business case studies for major capital programs in rate filings before the Ontario Energy Board (OEB). Testified as an independent expert witness before the OEB on Distribution System Plans and renewable energy programs in Custom Incentive Rate (CIR) and Incremental Capital Module (ICM) filings.

» **Exelon (Philadelphia Electric Company).** Developed T&D avoided cost study to support PECO energy efficiency programs. Participated in a statewide stakeholder process to approve T&D avoided costs, which included the statewide EE program evaluator, the electric utility and related parties.

» **Puerto Rico Electric Power Authority (PREPA).** Conducted a T&D avoided cost analysis and prepared expert testimony to support PREPA's rate filing and avoided costs applied to net metering.

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» **Public Utility Authority (Israel).** Conducted a technical and economic review of the Israeli Electric Corporation and Palestinian Electric Authority electric generation and power delivery system on behalf of the PUA. Assessed the adequacy of electric infrastructure, power costs and investment programs.

» **Vermont Department of Public Service (VDPS).** Conducted a geo-targeted analysis of energy efficiency programs designed to defer T&D investments. Worked with electric utility stakeholders to identify cost-effective deferral opportunities and to assess processes designed to target EE programs.

» **Canadian Utility (Confidential) –** Confidential study to assess the value and strategic benefits of the acquisition of electric utility energy delivery assets. Included a technical and economic assessment of key regulatory and acquisition risk factors to support a recommendation.

» **Progress Energy.** Project manager of a best practices and compliance review of fixed asset charging practices. Reviewed methods, systems and practices used to record fixed assets for Florida and the Carolinas to support proposed changes filed with state commissions and the SEC.

» **Citizens Utilities/Vermont Electric Cooperative.** Supported numerous Certificate of Public Good (CPG) applications before the Vermont Public Service Board (VPSB). Expert witness for technical, environmental, and costing studies.

» **Vermont Department of Public Service (VDPS).** Conducted research and prepared sections of the Twenty-Year Electric Plan, including the impact of the independent system operator (ISO) and regional transmission organization (RTO) initiatives on Vermont's transmission providers.

» **Potomac Electric Power Company (PHI).** Project manager of a benchmarking study of storm hardening measures. Assessed the impact of hardening options on reliability and performance. Also assessed service quality (SQI) measures and performance-based rate (PBR) mechanisms.

» **Citizens Utilities (Vermont Electric Division).** Project manager for a T&D Audit mandated by the Vermont Public Service Board. Reviewed T&D plant accounting systems and processes, and provided recommendations for improvement.

» **Massachusetts Department of Telecommunications and Energy (MDTE).** Project manager of a stray voltage assessment of jurisdictional utilities. Identified causes of stray voltage and provided recommendations to mitigate future events, including action and improvement plans

Asset Management

» **Horizon Utilities Corporation.** Developed strategies and provided ongoing support for HU's asset management initiative. Conducted a gap analysis and implementation of asset management strategies and evaluation methods. Included an evaluation of infrastructure upgrades, operational and reliability improvement and implementation strategies using AM-based approaches.

» **First Energy**. Lead consultant of a project team that implemented asset management processes and capital prioritization models for 6 operating companies in three jurisdictions. Responsible for model development and applications, technical review and overall quality assurance.

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- **Seattle City Light**. Conducted a benchmarking and gap analysis of the power supply and energy delivery business units. It included a business case analysis to support implementation of asset management methods and new AM organization.
- **Pepco/Conectiv (PHI)**. Responsible for an asset management and prioritization assessment of capital improvement and O&M programs for three states and the District of Columbia. It included developing asset prioritization methods for transmission, distribution and IT programs.
- **Entergy**. Responsible for an asset management and prioritization assessment of Entergy's capital improvement programs for six jurisdictional utilities in 5 states. It included developing asset-specific prioritization methods for transmission and distribution programs.
- **PacifiCorp**. Responsible for an asset management and prioritization assessment of PacifiCorp's capital improvement programs for six jurisdictional utilities in 6 states. It included developing asset-specific prioritization methods for transmission and distribution and IT programs.

Work History

- Navigant Consulting, Director
- Stone & Webster Management Consultants, Executive Consultant
- Green Mountain Power Corp, Assistant Vice President, Energy Planning
- Ernst & Whinney, Supervisor
- Gilbert/Commonwealth, Senior Consulting Engineer
- Westinghouse Electric Corporation, Systems Analysis Engineer
- Boston Edison Company, Student Engineer, Cooperative Education Prog.

Certifications, Memberships, and Awards

- Professional Engineer - State of Vermont
- Institute of Electrical and Electronic Engineers, Section Chairman (Past)

Education

- M.S. Electric Power Engineering, Rensselaer Polytechnic Institute
- B.S. Electric Power Engineering, Rensselaer Polytechnic Institute

Articles, Publications and Course Instruction

- Grid Reliability and Resiliency Initiatives for the Island of Puerto Rico," Midwest Energy Solutions Conference, Chicago, February 2019.
- "Microgrid Development – Making it Work: ," Instructor: PowerGen Competitive Power College, Orlando, December 2016.
- "DG Proliferation Trends, Challenges and Solutions Addressing Interconnection Planning, Operations, Benefits & Cost Allocation," Instructor: DistribuTECH University, San Diego, Feb. 2015.

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- "Smart Grid and Distributed Energy Storage," Total Energy USA, Houston Texas, November 2012.
- "Distributed Generation: Grid Impacts and Interconnection Strategies," Rocky Mountain Electric League, 2012 Spring Management, Engineering and Operations Conference, Omaha Nebraska.
- "Energy Storage Opportunities for Integration of Large-Scale Renewable Generation," Electricity Storage Association (ESA) Annual Conference, Washington DC, May 2012.
- "Grid Integration of Renewable, Intermittent Resources," 2011 PowerGen International Conference, December 2011, Las Vegas, NV, with Vladimir Chadliev.
- "Reducing T&D Investments Through Energy Efficiency" IEPEC, August 2011, with K. Parlin & W. Poor.
- "Value of Distributed Generation and Smart Grid Applications," DistribuTECH, San Diego, Feb. 2011.
- "Prioritization Methods for Smart Grid Investments," EEI Perspectives, April-May, 2010.
- "Evaluation of Targeted Demand-Side Management at ConEd (CECONY)," ACEEE Energy Efficiency Conference, September, 2009, with Craig McDonald.
- "DER Operational & Grid Benefits" Electric Light & Power, February, 2009.
- "Benefits of Smart Grid Integration with Distributed Energy Storage Systems," Infocast Power Storage Conference, July, 2008.
- "The Rise of Distributed Energy Resources," Public Utilities Fortnightly, Feb, 2007, with S. Tobias.
- "Risk Planning & Project Prioritization: Bringing Energy Delivery to the Next Level in Asset Management," InfoCast T&D Asset Management Conference, St. Louis, MI, May 2004.
- "Valuation Methods: Estimating the Value of Avoiding the Risks Associated with T&D Reliability Failures," EEI Spring 2004 T&D Conference, Charlotte, NC, April 2004.
- "Reliability Tradeoffs," EEI Perspectives, January-February, 2004, with Daniel O'Neill.
- "What's the Outlook for Distributed Generation Interconnection Standards?" 2003 PowerGen International Conference, Las Vegas, Nevada, December 2003.
- "Federal Interconnection Standards: Putting DG in a Box," Public Utilities Fortnightly, April 2003, with Stan Blazewicz.
- "An Innovative Approach to Fact-Based Distribution Reliability Cost Optimization," Distribution 2000, Brisbane, Australia, November 1999, with Cheryl Warren.
- "System Reliability: Competitive Issues," Rethinking Electric Reliability Conf., Chicago Il, Sept 1997.
- "Reliability: Competition & Keeping the Lights On," EUCI, Denver, Colorado, October 1998.
- "System Reliability in a Restructured Environment," Electric System Reliability in a Competitive Environment Workshop, Denver, Colorado, October 1997.
- "Privatization Efforts in South America" EUCI Workshop, Denver, Colorado, January 1997.
- "Open Access Pricing Issues," Transmission Pricing Conference, Vail, Colorado, Sept. 1996.

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Testimony and Appearances as an Expert Witness

Case Description	Company	Year	Docket	Jurisdiction
Rate Cases, Resource Planning, Open Access and Regulatory Investigations				
Request for Increase in Retail Rates	Kentucky Power	2023	2023-00159	Kentucky
Wholesale Rate Filing (OATT)	NorthWestern	2019	ER-1756-000	FERC
Retail Rate Filing (Net Metering)	NorthWestern	2018	D2018.2.12	Montana
Request for Increase in Retail Rates	GMP	2017	17-3112	Vermont
Transfer of Electric Assets (Municipalization)	IBM	2017	15A-0589E	Colorado
Marginal Cost Study (NEM & Rate Filing)	NV Energy	2016	16-06006	Nevada
Custom Incentive Rate Filing	Toronto Hydro	2016	EB -2014-0116	Ontario
Incremental Capital Module (Rate Filing)	Toronto Hydro	2014	EB-2012-0064	Ontario
Summer/Winter 2011 Storm Review	Exelon/ComEd	2013	11-0588	Illinois
Distributed Generation Integration	NV Energy	2012	10-04008	Nevada
Distributed Utility Planning	CUC	2011	6290	Vermont
Power Purchase Contracts – IURC Complaint	Jay REMC	2003	9704-CP-069	Indiana
Section 205 Filing – Wholesale Rates	NISource	1998	ER96-35-000	FERC
Open Access Transmission Tariff Filing	NISource	1997	ER96-399-000	FERC
Request for Increase in Wholesale Rates	NISource	1996	ER92-330-000	FERC
Request for Increase in Retail Rates	GMP	1996	5532	Vermont
Least-Cost Planning Integrated Resource Plan	GMP	1991	5270	Vermont
Request for Increase in Retail Rates	GMP	1991	5428	Vermont
Request for Increase in Retail Rates	GMP	1990	5370	Vermont
Request for Increase in Retail Rates	GMP	1989	5282	Vermont
Request for Increase in Retail Rates	GMP	1988	5125	Vermont
Certificates of Public Good				
Transmission Line Construction Authorization	SSVEC	2010	E-01575A	Arizona
Northern Loop Transmission Upgrades	Velco/CUC	2004	6792	Vermont
Substation Reconstruction – Richford	CUC	2003	6682	Vermont
Island Pond to Bloomfield Line	CUC	2001	6044	Vermont
HK Webster Substation	CUC	1999	6045	Vermont
Burton Hill Substation	CUC	1999	6046	Vermont
Border to Richford 120/46kV Line	CUC	1998	5331A	Vermont
New Transmission Lines and Substation	IBM	1991	5549	Vermont
New Substation – Northern Vermont	GMP	1990	5459	Vermont
Gas Turbine Interconnection Facilities	IBM	1989	5347	Vermont
Dover Substation Expansion	GMP	1987	5226	Vermont
Industry Restructuring & Asset Transactions				
Purchase of Electric Assets	VEC	2004	6853	Vermont
Certificate of Consent, Sale of Distribution Assets	CUC	2004	6850	Vermont
Certificate of Consent, Sale of Transmission Assets	Velco/CUC	2004	6825	Vermont
Prudency Review and Audit Support	CUC	2003	5841/5859	Vermont
Competitive Opportunities Filing	ConEdison	1997	96-E-0897	New York

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Exhibit ELS-2: Guidehouse Independent Analysis and Review of CenterPoint Energy Houston Electric, LLC's System Resiliency Plan

Final Report

Submitted by:
Guidehouse Inc. on behalf of CenterPoint Energy Houston Electric, LLC

January 2025

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Disclaimers

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1. Executive Summary

CenterPoint Energy Houston Electric, LLC ("CenterPoint Houston" or "the Company") seeks approval from the Public Utility Commission of Texas ("PUCT" or "Commission") for approximately $5.5 billion in transmission and distribution ("T&D") investments and 211 million in expenses over the three-year period of 2026 through 2028, as described in its 2026-2028 System Resiliency Plan ("SRP"). Guidehouse Inc. ("Guidehouse") prepared this report to inform the development and refinement of CenterPoint Houston's SRP (see Exhibit BAT-2). It summarizes Guidehouse's independent analysis of resiliency risks CenterPoint Houston faces and independent review and analysis, including benefit-cost analysis ("BCA") and expected reduction in customer minutes of interruption ("CMI"), of resiliency measures included in CenterPoint Houston's SRP.

Relative to the 2025-2027 T&D SRP filed in Commission Docket No. 56548 ("prior SRP"), CenterPoint Houston proposes to increase spending from $2.3 billion to approximately $5.7 billion over the three-year period. Twelve new measures have been added, and two measures[1] have been removed relative to the prior SRP for a total of 36 measures.[2] Measure removal is due to the planned completion of these two measures by 2025, prior to the period for the 2026-2028 T&D SRP. Resiliency measures are now grouped by eight risk categories versus the asset groups presented in the prior SRP. Further, the selection of specific projects for implementation is now on a more granular level, based on climate risk hazards within 3,300 discrete areas across CenterPoint Houston's service territory.

1.1 Risk Assessment – System Resiliency Threats

Guidehouse's risk assessment (Section 4) indicates that the frequency and magnitude of extreme weather events such as high winds (*e.g.*, hurricanes), floods, extreme temperatures, as well as physical and cybersecurity events, are expected to increase over time in CenterPoint Houston's service territory as summarized below:

- **Extreme Wind Risk** – Guidehouse analysis shows maximum wind speeds increasing from 2020 to 2050 for nearly all counties served by CenterPoint Houston for 100-year, 200-year, and 500-year events. By 2030, almost all counties will begin experiencing maximum wind speeds exceeding 87 mph for a 500-year event, with coastal counties experiencing wind speeds exceeding 99 mph.
- **Extreme Water Risk (Flood)** – Flood risk varies significantly by location and elevation. Guidehouse's analysis shows that the mean flood depths, as well as flooded fractions (*i.e.*, percentage of buildings flooded), are projected to increase from 2020 to 2050 for nearly all counties served by CenterPoint Houston. Galveston and Matagorda counties are projected to experience the highest average flood depth due to their coastal

[1] TripSaver®, and Texas Medical Center Substation

[2] A total of 40 measures are included in the SRP, five of which are wildfire mitigation, for a net total of 36 measures.

proximity and lower elevation. Nearly all buildings in Galveston counties are projected to flood if a 200-year or 500-year flood were to occur in 2030. Over 30% of buildings are expected to flood in Harris and Fort Bend counties should a 200-year or 500-year flood event occur in 2030.

- **Extreme Temperature Risk (Freezing)** – Data from Jupiter Intelligence indicates that average temperatures will increase over time, and the average number of days per year with temperatures below freezing will decrease over time. However, warming temperatures contribute to destabilization of the polar vortex, which may increase the risk of extreme cold events, as occurred with Winter Storm Uri in 2021.[3]
- **Extreme Temperature Risk (Heat)** – CenterPoint Houston considers three associated weather-related risks together – heat, wildfire, and drought. Each of these risks is described below.
    - **Heat** – CenterPoint Houston's territory will also experience rising temperatures throughout this decade. The number of days exceeding 38°C (100°F) is projected to increase for all counties, but the increase for Harris County is particularly prominent, with a rise in expected days exceeding 100°F, increasing from about 20-25 today to over 50 in 2030. In addition to average temperature increases, heat wave events are also expected to rise in duration, with an average increase of 11 days between 2020 and 2030, with Colorado County projected to see an increase of 16 days. Other risks that become exacerbated with high temperatures are wildfire and drought.
    - **Wildfire** -- Although wildfire risk is currently relatively low in CenterPoint Houston's service territory, data from the Argonne National Laboratory Fire Weather Index projects fire risk to rise by 2050, with higher risk in summer months relative to other seasons. Data from Jupiter Intelligence indicates that fire risk will increase gradually in CenterPoint Houston's service territory between 2025 and 2050.
    - **Drought** – Houston has a humid subtropical climate and typically experiences a significant amount of annual rainfall. However, dry periods are expected to become longer and more severe over time. Guidehouse used the Standardized Precipitation and Evapotranspiration Index (SPEI) from global climate model output data. The SPEI captures temperature and precipitation, with low values below normal conditions indicating dry periods. The metric used is the mean months per year where the rolling 3-month average SPEI is below -2 (indicating extreme drought). In CEHE territory, the annual number of days with a rolling 3-month average SPEI below -2 is expected to increase from 3.7 in 2020 to 5.2 in 2100.
- **Physical Security Risk** – Physical Attack Risk threats and vulnerabilities for cyber systems represent major concerns from an operational perspective. CenterPoint

[3] https://www.ncei.noaa.gov/news/great-texas-freeze-february-2021

Houston technology infrastructure systems and facilities are exposed to increasing physical security risks from domestic terrorists, violent extremists, cartels, and foreign adversaries.

- **Cybersecurity Risk** – Cyber-attacks across all critical infrastructure sectors have increased over the past five years, with notable examples including the 2021 Colonial pipeline attack, numerous operating system vulnerability exploitations, and the rise of malware and ransomware attacks targeting electric system supply chains and other vulnerabilities. IT/OT cyber systems and technology infrastructure that support the CenterPoint Houston electric system are exposed to constant and increasing risk of failure to operate as designed, compromise, and misuse by foreign and domestic adversaries.

1.2 Resiliency Measure Assessment

CenterPoint Houston's proposed resiliency measures are categorized to align with the six primary risks outlined above (Extreme Wind, Extreme Water, Extreme Temperature (Freeze), Extreme Temperature (Heat), Physical Attack, Technology & Cybersecurity), as well as Situational Awareness. Situational Awareness measures represent foundational investments to support other measures and to better anticipate, react to, and recover from extreme conditions associated with the risks outlined above. Section 2.3 outlines the list of measures within each category.

For measures associated with Natural Hazards (including measures within Extreme Wind, Extreme Water, Extreme Temperature (Freeze), and Extreme Temperature (Heat)), Guidehouse's risk assessment includes quantitative analysis of historical event data and projections of future project event risk (Section 4.2). For most Natural Hazard measures, Guidehouse's assessment of the impact and value of each includes quantitative benefit-cost analysis (BCA), except for some measures for which the benefits were difficult to quantify. Sections 1.3 and 5.1 describe Guidehouse's approach to the assessment of Natural Hazard measures, while BCA results are summarized below in Table 1-1.

For Technology & Cybersecurity measures, Guidehouse applies a more qualitative approach to both risk assessment (Section 4.3.2) and measure assessment (Section 1.4 and 5.1.4).

For Physical Attack measures, Guidehouse's risk assessment methodology (Section 4.3.1) is more qualitative and similar to that for Technology & Cybersecurity measures, while the measure assessment methodology is more quantitative and similar to that for Natural Hazard measures (Section 1.3 and 5.1).

Guidehouse's risk assessment and measure assessment methodologies vary across Situational Awareness measures. Guidehouse assessed five (5) Situational Awareness measures using a methodology more aligned with that employed for Natural Hazard measures (Section 1.3 and

5.1),[4] while Guidehouse assessed two (2) Situational Awareness measures using a methodology more aligned with that employed for Technology & Cybersecurity measures (Section 1.4 and 5.1.4).[5]

Within this report, the terms "measure" and "project" have distinct meanings. The term resiliency measure encompasses all devices, costs, and impacts associated with the deployment of a measure across CenterPoint Houston's territory for its 2026-2028 T&D SRP. A project is one or more individual upgrades or additions within a measure. As explained in Section 5.1 of this report, Guidehouse derived BCAs and CMIs at the measure level, which also is referred to as a "programmatic" evaluation of a measure. Section 6 presents the results of Guidehouse's circuit-level analysis, which provides a granular, location-based analysis of measure benefits for specific distribution circuits and substations and is used to inform CenterPoint Houston's selection of individual projects within each measure in its SRP.

1.3 Analysis and Review of Natural Hazard and Physical Attack Resiliency Measures

Regarding the Natural Hazard and Physical Attack resiliency measures included in CenterPoint Houston's SRP, Guidehouse performed an independent analysis and review of each measure using quantitative and qualitative methods. Guidehouse's evaluation of these measures was also informed by the future risk profiles for wind and flooding Resiliency Events developed as part of Guidehouse's risk assessment.

Guidehouse finds that the Natural Hazard and Physical Attack resiliency measures included in CenterPoint Houston's SRP are appropriate for inclusion in CenterPoint Houston's SRP and generally follow best practices for resiliency planning for the following reasons:

- Focuses primarily on asset replacement or upgrades targeted to locations most susceptible to outages during resiliency events as well as other measures with general resiliency benefits.
- Targets circuits with a high percentage of poles that met design standards when they were installed but do not meet their current design standards and thus are more susceptible to failure resulting in outages during high winds.
- Targets elevating critical substation equipment to align with flood profiles outlined in the Guidehouse risk assessment.
- Targets transmission pole and tower replacements vulnerable to high-impact hurricanes, tornadoes, and microbursts.

[4] The five associated Situational Awareness measures include Advanced Aerial Imagery/Digital Twin (RM-33), Weather Stations (RM-34), Wildfire Cameras (RM-35), Emergency Operations Center (RM-38), and Hardened Service Centers (RM-39).

[5] The two associated Situational Awareness measures include Voice & Mobile Data Radio System (RM-36) and Backhaul Microwave Communication (RM-37).

- Upgrades underground cable and monitoring systems to reduce the likelihood of cable failure and early detection of actual or incipient equipment failure in underground networks.
- Includes grid modernization resiliency measures emphasizing automation as an efficient and cost-effective approach to improve T&D performance during resiliency events.
- Results from Guidehouse's BCA indicate that, overall, the benefits of these measures significantly outweigh the costs, and, in most cases, the benefits outweigh the costs over the life of the individual measure. In many cases, there is an additional qualitative value that further supports the inclusion of the measure in CenterPoint Houston's SRP. These findings indicate that CenterPoint Houston's SRP will provide positive value to the customers and communities it serves. Table 1-1 presents the results of Guidehouse's analysis for measures for which BCA ratios are derived. It also includes the three-year capital costs, operations and maintenance ("O&M") expenses, BCA ratios, and customer minutes of interruption ("CMI") saved for each resiliency measure, grouped by Resiliency Event category.

Table 1-1 indicates that CenterPoint Houston's proposed resiliency measures for which BCA ratios are derived are expected to provide significant savings as measured by CMI.[6] Over the 3-year Plan, cumulative CMI savings are expected to be 1,309 million. By 2028, annual CMI savings are expected to be 628 million. Guidehouse further notes that several resiliency programs are complementary, such that additional benefits are realized when resiliency measures are combined. For example, pole replacements that are proposed on distribution circuits where IGSD schemes are proposed will yield greater benefits than on a standalone basis.

Note that Table 1-1 lists only measures for which BCA ratios were derived, along with the associated costs and BCA ratios for those measures. A BCA was not performed for some measures due to benefits that do not accrue to ratepayers or are measured using different metrics. These measures include Loadshed IGSD (RM-15), Wildfire Mitigation (RM-22 through RM-25), Technology & Cybersecurity (RM-28 through RM-32), and some Situational Awareness (RM-34 through RM-39) measures, as well as the Microgrid Pilot Program (PP-1). In lieu of BCA, Guidehouse has provided other qualitative assessments as described further for each individual resiliency measure within Section 5.

Table 1-1: Resiliency Measure Costs and Benefits

Resiliency Measure	Resiliency Measure No. (RM)	3-Year Capital Cost ($MM)	3-Year O&M Expense ($MM)	BCA Ratio	3-Yr CMI 2026-2028 (million)	Annual CMI 2028 (million)
Extreme Wind						
Distribution Circuit Resiliency	RM – 1	$513.4	$0.0	12.1	263.0	133.4
Strategic Undergrounding	RM – 2	$860.0	$0.0	2.8	81.1	51.0
Restoration IGSD	RM – 3	$107.3	$0.5	19.3	97.0	48.5
Distribution Pole Replacements/Bracing	RM – 4	$251.6	$0.0	9.9	121.0	60.8
Vegetation Management	RM – 5	$0.0	$146.1	3.7	137.0	22.9
Transmission System Hardening	RM – 6	$1,467.3	$0.8	3.9	223.8	122.5
69kV Conversion Projects	RM – 7	$369.3	$0.0	2.7	65.5	27.6
S90 Tower Replacements	RM – 8	$118.4	$0.0	9.4	59.5	23.8
Coastal Transmission Resiliency	RM – 9	$177.3	$0.8	2.0	7.8	7.8
Group Subtotal		**$3,864.6**	**$148.1**	**5.5**	**1055.7**	**498.3**
Extreme Water (Flood)						
Substation Flood Control	RM – 10	$43.8	$0.0	2.1	3.9	2.0
Control Center Facility Upgrades	RM – 11	$7.0	$0.0	15.2	2.5	2.5
MUCAMS	RM – 12	$10.8	$0.0	1.3	0.6	0.2
Mobile Substations	RM – 13	$30.0	$0.0	3.0	3.9	2.0
Group Subtotal		**$91.6**	**$0.0**	**3.3**	**11.0**	**6.6**
Extreme Temperature (Freezing)						
Anti-Galloping Technologies	RM – 14	$14.0	$1.0	7.1	5.3	2.6
Group Subtotal		**$14.0**	**$1.0**	**7.1**	**5.3**	**2.6**
Extreme Temperature Heat)						
Distribution Capacity Enhancement/Substations	RM – 16	$579.6	$0.0	5.6	138.1	70.6
MUG Reconductoring	RM – 17	$245.0	$0.0	1.4	13.6	7.4
URD Cable Modernization	RM – 18	$128.4	$0.0	2.2	13.0	6.5
Contamination Mitigation	RM – 19	$144.0	$6.0	2.4	15.7	7.9
Substation Transformer Fire Barriers	RM – 20	$9.0	$0.0	4.0	1.5	0.7
Digital Substation	RM – 21	$31.8	$0.0	1.8	1.2	0.7
Group Subtotal		**$1,137.8**	**$6.0**	**3.8**	**183.1**	**93.8**
Physical Attack						
Substation Physical Security Fencing	RM - 26	$18.0	$0.0	21.8	17.6	8.8
Substation Security Upgrades	RM - 27	$19.4	$0.1	28.7	25.1	12.5
Group Subtotal		**$37.4**	**$0.1**	**25.4**	**42.7**	**21.3**
Situational Awareness						
Advanced Aerial Imagery/Digital Twin	RM - 33	$18.4	$2.0	4.8	10.8	5.1
Group Subtotal		**$18.4**	**$2.0**	**4.8**	**10.8**	**5.1**
Totals		**$5,163.8**	**$157.2**	**5.0**	**1,309**	**628**

*Average BCA weighted by resiliency measure cost.
Source: Guidehouse BCA of CenterPoint Houston's proposed resiliency measures.

To summarize, Guidehouse's risk and BCA analysis confirms that each resiliency measure is either cost-effective based on the calculated BCA ratio or provides qualitative benefits that support their inclusion in CenterPoint Houston's SRP. Further, Guidehouse's benchmarking survey of peer utility resiliency practices (Appendix A) and jurisdictional benchmarking research (Appendix B) indicates that CenterPoint Houston's proposed resiliency measures are generally consistent with those deployed at peer utilities.

Based upon analysis associated with the prior SRP, Guidehouse offered a variety of recommendations, which are described in Guidehouse's report that was filed with in Docket 56548. CenterPoint Houston had addressed many of the recommendations within its prior SRP. In developing its 2026-2028 T&D SRP, CenterPoint Houston has also addressed other recommendations, most notably by increasing the resolution of locational risk analysis to help inform the prioritization of specific projects for investment. Guidehouse has also provided additional recommendations for the current SRP, with a focus on the implementation of proposed measures. See Section 7.2 for details regarding these recommendations.

1.4 Analysis and Review of Technology & Cybersecurity Resiliency Measures

With regards to the Technology & Cybersecurity resiliency measures included in CenterPoint Houston's SRP,[7] Guidehouse performed an independent analysis and review of each measure using a qualitative assessment approach. Guidehouse reviewed CenterPoint Houston's technology resiliency measures and identified the effectiveness and benefits of each measure in a qualitative comparative analysis process that compared relevant functions and security practices in each resiliency measure with industry best practices described in the National Institute of Technology Cybersecurity Framework ("NIST CSF").

The technology resiliency measures included in CenterPoint Houston's S target centralized management of assets and data, communication and control for critical electrical systems and the personnel responsible for those systems, detection, and response to cybersecurity threats, information protection, data security, access control, and continuous monitoring for security. By targeting these areas, CenterPoint Houston should bolster its resilience against cybersecurity threats and meet its objective to enhance electric grid resilience in an increasingly digital landscape. Further, many of these resiliency measures are fundamental to CenterPoint Houston's ability to effectively manage and quickly recover from extreme weather events by enabling communication, control, and visibility during and after such events.

Guidehouse finds that CenterPoint Houston's SRP appropriately prioritizes technology resiliency measures that help mitigate cybersecurity risk. CenterPoint Houston is deploying measures that can be classified as enabling technologies per the Institute of Electrical and Electronics Engineers ("IEEE") by aiming to optimize operations, improve reliability, and ultimately ensure

[7] Includes all Technology & Cybersecurity measures (RM-28 through RM-32), as well as two Situational Awareness measures (RM-36 and RM-37)

uninterrupted service delivery. Further, findings from a peer utility benchmarking survey indicate that proposed technology resiliency measures included in CenterPoint Houston's SRP are consistent with those deployed at other utilities and are: 1) appropriate for addressing the physical security and cybersecurity risks each measure faces; 2) aligned with industry best practices; and 3) beneficial to customers and communities served by CenterPoint Houston. Based on these findings, as well as Guidehouse's analysis of the correlation between CenterPoint Houston's proposed resiliency measures and the NIST CSF framework, Guidehouse finds that CenterPoint Houston's technology resiliency measures are reasonable for inclusion in CenterPoint Houston's SRP.

Guidehouse developed several recommendations (see Section 7.2) related to CenterPoint Houston's proposed Technology & Cybersecurity resiliency measures and two Situational Awareness resiliency measures to further enhance its current and future system resiliency plans during the implementation phase.

2. Introduction and Background

2.1 Overview

Guidehouse prepared this report on behalf of CenterPoint Houston to inform the development and refinement of CenterPoint's System Resiliency Plan ("SRP"). This report summarizes Guidehouse's independent analysis of resiliency risks CenterPoint Houston faces and independent review and analysis, including BCA, of resiliency measures and projects considered for CenterPoint Houston's SRP.

The remainder of this report is organized as follows:

- **Section 2 (Introduction and Background)** – Introduces Guidehouse's understanding of resiliency risks CenterPoint Houston must manage for its electric service area and policy context for how Texas and other state jurisdictions are addressing resiliency of the electric system as an emerging topic of interest and emphasis in the electric utility industry.
- **Section 3 (Purpose of Guidehouse Analysis and Review)** – Provides an 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 SRP.
- **Section 4 (Resiliency Risk Analysis)** – Presents results and findings from Guidehouse's independent assessment of resiliency risks facing CenterPoint Houston's electric service area attributed to 1) natural hazard threats and other weather-driven events and, 2) physical and cybersecurity threats and vulnerabilities. This includes the evaluation of historical weather-driven resiliency events, discussion of human threats, and forecasting of weather-driven risk based on historical data and climate trends.
- **Section 5 (CenterPoint Houston System Resiliency Plan Review)** – Presents results and findings from Guidehouse's independent review of CenterPoint Houston's SRP, including benchmarking against best practices in resiliency planning among peer utilities. It includes an analysis of potential benefits of proposed measures included in the SRP, as well as conclusions provided to CenterPoint Houston based on this review. The updated SRP includes a circuit- and substation-level analysis to identify circuits and substations at greater risk during resiliency events for which CenterPoint Houston proposes to apply to determine specific assets for implementation over the 3-year SRP.
- **Section 6 (Circuit-Level Analysis)** – Presents the results of Guidehouse's climate hazard forecast derived for approximately 3,300 hexagonal areas with CenterPoint Houston's service territory and the prioritization of distribution circuit and substation resiliency measures used to support the selection of individual projects with each resiliency event category.
- **Section 7 (Summary of Findings and Recommendations)** – Summarizes the findings, conclusions, and recommendations from Guidehouse's independent analysis and of CenterPoint Houston's SRP review.

In addition, this report includes three appendices. Appendix A and Appendix B provide details regarding benchmarking of resiliency investments by other utilities across

jurisdictions throughout the United States, including within Texas. Appendix A describes the approach and findings associated with a survey of peer utilities regarding their resiliency programs, while Appendix B describes the approach and findings associated with the review of policy, regulation, and utility investments associated with resiliency planning efforts across a variety of jurisdictions. Appendix C includes the results of the BCA sensitivity analysis based upon varying assumptions for the value of lost load.

2.2 Revisions from the 2025-2027 T&D SRP

In its 2026-2028 T&D SRP, CenterPoint Houston proposes to spend approximately $5.7 billion over the three-year period 2026 through 2028, an increase from the $2.3 billion proposed in its 2025-2027 T&D SRP that was filed in Commission Docket No. 56548 ("prior SRP"). The increase in spending is mostly targeted toward resiliency measures included in the prior SRP, with additional spending for several new measures. The revised SRP includes twelve new measures while two measures have been removed. Measure removal is due to the planned completion by 2025, prior to the period for the 2026-2028 T&D SRP. Resiliency measures are now grouped within eight risk categories versus the asset groups presented in the prior SRP.

Similar to the prior SRP, Guidehouse evaluated measure benefits on a programmatic basis. (*i.e.*, based on total aggregate costs and impacts associated with each individual measure). However, CenterPoint Houston's selection of specific projects for implementation will be identified on a more granular level based on climate risk hazards, asset conditions, and susceptibility to failure for approximately 3,300 discrete areas within the service territory. The selection of projects based on detailed location risk evaluation increases the benefits CenterPoint Houston will achieve for proposed measures. Section 5.1.2 provides additional details regarding the scope, and Guidehouse's approach for the 2026-2028 T&D SRP relative to the prior SRP.

2.3 Proposed Resiliency Measures

The resiliency measures and projects considered for the SRP and contained in this report include the following measures (39), Pilot Programs (1) grouped within seven (7) risk categories:

Extreme Wind

- RM-1 – Distribution Circuit Resiliency
- RM-2 – Strategic Undergrounding
- RM-3 – Restoration IGSD
- RM-4 – Distribution Pole Replacement/Bracing
- RM-5 – Vegetation Management
- RM-6 – Transmission System Hardening
- RM-7 – 69kV Conversion Projects
- RM-8 – S90 Tower Replacements
- RM-9 – Coastal Resiliency Projects

Extreme Water

- RM-10 – Substation Flood Control
- RM-11 – Control Center Flood Control
- RM-12 – MUCAMS
- RM-13 – Mobile Substations

Extreme Temperature (Freeze)

- RM-14 – Anti-Galloping Technologies
- RM-15 – Loadshed IGSD
- PP-1 – Microgrid Pilot Program

Extreme Temperature (Heat)

- RM-16 – Distribution Capacity Enhancement/Substations/Substations
- RM-17 – MUG Reconductor
- RM-18 – URD Cable Modernization
- RM-19 – Contamination Mitigation
- RM-20 – Substation Fire Barriers
- RM-21 – Digital Substation
- RM-22 – Wildfire Advanced Analytics
- RM-23 – Wildfire Strategic Undergrounding
- RM-24 – Wildfire Vegetation Management
- RM-25 – Wildfire IGSD

Physical Attack

- RM-26 – Substation Physical Security Fencing
- RM-27 – Substation Security Upgrades

Technology & Cybersecurity

- RM-28 – Spectrum Acquisition
- RM-29 – Data Center Modernization
- RM-30 – Network Security & Vulnerability Management
- RM-31 – IT/OT Cybersecurity Monitoring
- RM-32 – Cloud Security, Product Security & Risk Management

Situational Awareness

- RM-33 – Advanced Aerial Imagery/Digital Twin
- RM-34 – Weather Stations
- RM-35 – Wildfire Cameras
- RM-36 – Voice & Mobile Data Radio System
- RM-37 – Backhaul Microwave Communication
- RM-38 – Emergency Operations Center
- RM-39 – Hardened Service Centers

2.4 Resiliency Risk in Texas

Resiliency refers to the ability to prevent, withstand, mitigate, respond to, and quickly recover from disruptive events. When applied to the electric sector, resiliency typically refers to the ability of the electric system to achieve one or more of these objectives when a major weather-driven event (*e.g.*, hurricanes, flooding, wildfires) impacts the area or other potential disruption occurs (*e.g.,* targeted attacks on a utility's critical physical infrastructure or cyber systems).[1]

Resiliency risk to electric utilities in Texas is demonstrated by the historical evidence and trends described in Section 4.2 and introduced below. The information included in this subsection of the report focuses on the unique characteristics of Texas and CenterPoint Houston's service area with regard to weather-driven resiliency events, with further analysis presented in Section 4, which also describes physical and cybersecurity risks for Texas and CenterPoint Houston's service area.

2.4.1 Topographic and Climatological Conditions

Texas is particularly susceptible to weather-driven resiliency events due to its large size and range of topographic and climatological conditions. In fact, the National Aeronautics and Space Administration ("NASA") states that Texas is ranked first in the U.S. in the variety and frequency of natural disasters.[2] The Texas Division of Emergency Management's ("TDEM") 2023 Texas State Hazard Mitigation Plan identifies 16 weather-related hazards applicable to Texas.[3] The most notable hazards that pose significant risks to the electric grid operation are hurricanes, floods, severe coastal flooding, severe wind, severe winter weather, and extreme heat.

Table 2-1 shows the historical impact of weather-driven hazards in Texas from 2000 to 2021, amounting to over $50 billion in total recorded property and crop damage. TDEM estimates anticipated losses over the planning cycle between 2022 and 2026 to be over $13 billion.

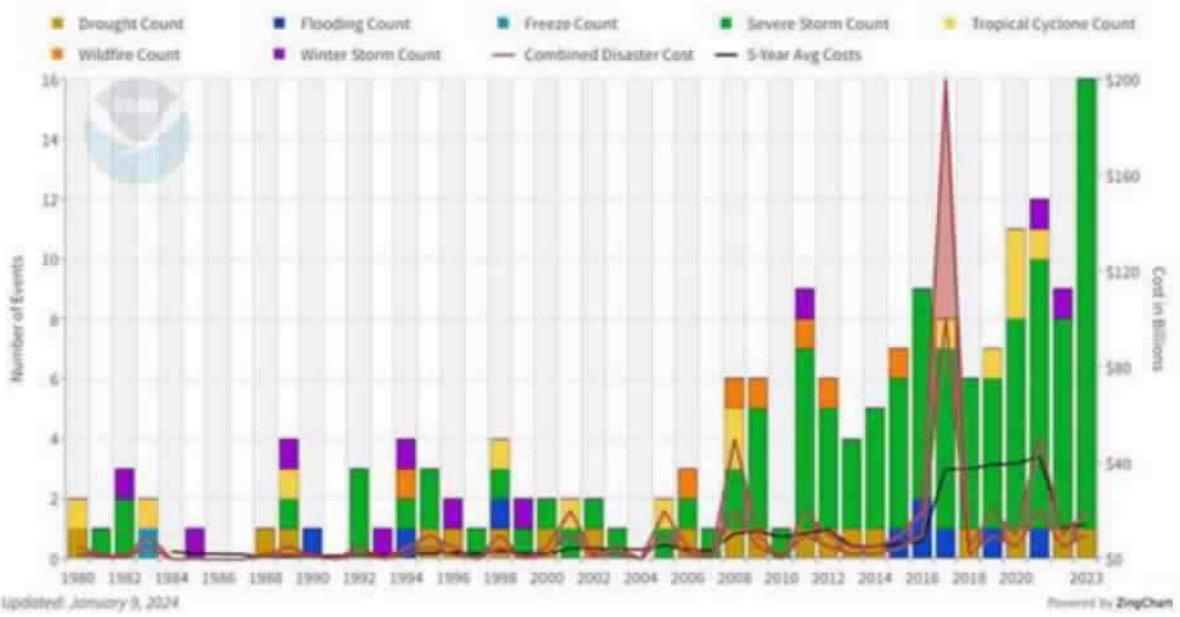
Table 2-1: Texas Historical Event Summary (2000-2021)

Hazard	Property & Crop Damages	Average Annual Events	Annualized Losses	Estimated Losses 2022–2026
Drought	$11,850,529,029	557	$538,660,410	$3,128,021,583
Hurricane	$11,320,920,805	1	$514,587,309	$2,988,228,166
Hailstorm	$11,262,699,441	1,294	$511,940,884	$2,972,860,275
Flood	$7,691,855,852	514	$349,629,811	$2,030,313,672
Tornado	$2,775,172,354	136	$126,144,198	$732,524,178
Severe Coastal Flooding	$2,451,511,967	9	$111,432,362	$647,091,984
Severe Wind	$1,478,222,789	962	$67,191,945	$390,186,192
Severe Winter Weather	$1,349,395,052	341	$61,336,139	$356,181,303
Wildfire	$1,090,393,150	55	$49,563,325	$287,816,122
Lightning	$85,796,186	35	$3,899,827	$22,646,444
Extreme Heat	$992,701	91	$45,123	$262,031
Total anticipated losses over the next five-year planning cycle				$13,556,131,950

Source: TDEM. (2023) [THMAP report, p.3.] Reference Materials (texas.gov)

Going back further in time and considering the *frequency* of major disaster events, the National Oceanic and Atmospheric Administration National Centers for Environmental Information ("NOAA-NCEI") identifies 170 confirmed weather or climate-related events in Texas for the period 1980-2023 where losses exceeded $1 Billion per event. In total, the estimated losses for these events were nearly $400 Billion. These events included 19 droughts, nine floods, one freeze, 110 severe storms, 14 tropical cyclones, seven wildfires, and 10 winter storms. The 110 severe storm events combined with the 14 tropical cyclone events represented 73% of the total events, with combined damages nearing the overall total damage cost. NOAA-NCEI also noted that the average annual frequency of such events has increased from 3.9 events per year over the 43-year period to a recent annual average of 11.0 events per year for the past five years.[4] This trend is evidenced in Figure **2-1** developed by NOAA-NCEI. These numbers represent significant threats to the communities served by the Texas electric sector, with increasing likelihoods and frequency of individual events that have a significant impact.

Figure 2-1: Texas Billion Dollar Disaster Events 1980-2023 (CPI Adjusted)



Source: NOAA-NCEI Technical Report. (2024 January). NCEI Chart

Many of these natural hazards are also expected to increase in severity over the rest of this decade. Increasingly sophisticated climate and weather models, digital elevation models, and land cover data allow Guidehouse to quantify this increase at a granular level. Additional granularity is provided later in Section 4 on the county basis and in Section 6.1 at circuit-level granularity.

2.4.2 Risks Specific to CenterPoint Energy Houston Electric Service Area

CenterPoint Houston's electric service area in Texas is particularly susceptible to severe wind, water, and temperature events, such as heavy rain, flooding, severe storms including hurricanes, tropical storms, depressions, tornadoes, other severe wind events, and winter storm events. In TDEM Region 4[8], which covers most of CenterPoint Houston's service area, many of these hazards have recorded property and crop damages from 2000 to 2021, as shown in Table 2-2.

[8] TDEM region map located here shows that all counties served by CenterPoint are in TDEM Region 4: TDEM. (n.d.). *Regions*. https://tdem.texas.gov/regions.

Table 2-2: TDEM Region 4 Hazard Ranking by Total Damages (2000-2021)

Region 4 Hazard Rankings by Total Damages

Hazard	Hazard Ranking	Total Damages
Hurricane	1	$4,084,033,024
Flood	2	$1,546,670,341
Severe Coastal Flood	3	$413,978,834
Drought	4	$171,229,891
Severe Wind	5	$79,397,008
Hailstorm	6	$65,439,927
Tornado	7	$61,350,962
Severe Winter Weather	8	$45,338,067
Lightning	9	$4,612,221
Extreme Heat	10	$0
Wildfire	11	$0
Grand Total		**$6,472,050,275**

Source: TDEM. (2023). [THMAP report, p.6]. Reference Materials (texas.gov)

CenterPoint Houston's service area is compact but diverse in terms of geography and climate risk. Common lines of demarcation used by CenterPoint Houston to address the unique risks across its electric system are Highway 59/69 and Highway 90/Interstate 10, which provide a general separation between inland and coastal counties. These lines of demarcation, which run through CenterPoint Houston's service area, are a general way to think geographically about the unique weather-driven risks to different parts of CenterPoint Houston's electric system. As shown in Section 4.2, both historical and projected wind speed and flood levels are generally higher in coastal regions than in inland regions. Guidehouse considered these distinctions in its analysis.

2.5 Policy Background

2.5.1 Electric System Resiliency Planning Precedent in Other Jurisdictions

Over the past several decades, the increased frequency and severity of extreme weather events have led to greater attention by electric utilities and their regulatory bodies on building a more resilient electric system. Many electric utilities are making operational changes to improve the resiliency of their systems during and after extreme weather events, including increasing

investment in resiliency-focused measures and projects. Further, the rising risk of physical security and cybersecurity threats has brought these emergent risks into the fold for electric utility resiliency planning and regulation.

Regarding electric sector resilience, the federal government has pursued several initiatives and executive orders, including the U.S. Department of Energy ("DOE") Partnership for Energy Sector Climate Resilience and State and Local Energy Assurance Planning initiatives, as well as the Federal Energy Regulatory Commission ("FERC") and DOE joint effort to incentivize electric utility resiliency planning.[9] The DOE has produced numerous resources related to resiliency planning for the electric sector, further demonstrating the increased emphasis on this topic at the national level.[10] Further, electric sector resiliency is a primary component of the Bipartisan Infrastructure Law that passed in late 2021. The law makes $11 billion in grants available for states, tribes, and utilities to enhance the resilience of electric infrastructure against disruptive events such as extreme weather and cyber-attacks.[11] While the Electric Reliability Council of Texas ("ERCOT") power region located solely in Texas is outside of FERC's jurisdiction, these examples provide helpful context on how the broader U.S. is considering the importance of resiliency planning.

State governments are also acting on electric utility system resiliency. While each state in the U.S. faces unique climate conditions and associated resiliency risk, the trend of increased attention on extreme weather events and cybersecurity is seen across many parts of the U.S.

Guidehouse performed benchmarking research to analyze the scope, drivers, and processes associated with electric utility system resiliency planning across a variety of US jurisdictions, including 21 states and territories (listed in Table B-1). In many jurisdictions, the growing emphasis on resiliency planning has been driven by major weather-related resiliency events, particularly coastal storms, and wildfires, which caused widespread and prolonged outages within that jurisdiction. Some examples of the context around utility resiliency planning are discussed further in Appendix B, include the following:

- **California** – Largely in response to growing wildfire risks, a series of legislative and regulatory actions have placed increasing emphasis on associated utility resiliency planning. In 2021, the Wildfire Safety Division of the California Public Utilities Commission was transitioned to a new Office of Energy Infrastructure Safety, which is responsible for reviewing utilities' Wildfire Mitigation Plans.
- **Connecticut**—In response to storms, including Tropical Storms Irene and Isaias, legislative and regulatory actions have been taken to establish metrics and

[9] MJ Bradley & Associates Issue Brief. (2020 February). *Key Considerations for Electric Sector Climate Resiliency Policy and Investments.* [MJB&A Issue Brief]. (p. 3). mjba_keyconsiderationsforclimateresiliencepolicyandinvestment.pdf (erm.com)

[10] U.S. DOE, Energy Resilience in the Public Sector. https://www.energy.gov/scep/slsc/energy-resilience-public-sector.

[11] U.S. DOE, DOE Fact Sheet: The Bipartisan Infrastructure Deal Will Deliver for American Workers, Families and User in the Clean Energy Future. https://www.energy.gov/articles/doe-fact-sheet-bipartisan-infrastructure-deal-will-deliver-american-workers-families-and-0

standards for utility resiliency planning and event responses, including within required emergency response plans.

- **Florida** – Florida has long integrated resiliency into utility planning. More recently, in 2019, legislation was passed requiring utilities to submit an electric transmission and distribution storm protection plan on an annual basis looking outward 10-years.
- **Hawaii** – Legislation was passed to help facilitate microgrid development, and several regulatory proceedings have considered resilience across topics including DER, microgrids, and integrated grid planning.
- **Illinois**—In response to associated legislation, the Illinois Commerce Commission recently ordered utilities to submit an initial Multi-Year Integrated Grid Plan (MYIGP) incorporating five years of planned investments. Resiliency and reliability are included as key objectives for the MYIGP.
- **Louisiana** – The City of New Orleans established a resolution requiring Entergy New Orleans (ENO) to file a system resiliency and storm hardening plan. In response, ENO developed a 10-year investment plan, and Entergy Louisiana similarly developed a resilience plan to address resiliency risks for infrastructure outside of the City of New Orleans.
- **Massachusetts**—At the urging of the utility regulator, Eversource Energy has pursued several climate mitigation and resilience strategies, including those in its Climate Adaptation Plan.
- **Michigan** – As part of its Distribution Grid Plan, DTE included investments aimed at improving reliability and resiliency, accelerating response to customer outages, and increasing grid capacity.
- **Nevada** – Legislation was passed requiring electric utilities to submit a Natural Disaster Protection Plan every three years to identify and mitigate resiliency risks.
- **Northeast** – In response to Superstorm Sandy, utilities across multiple states, including New Jersey and New York, made significant investments in hardening/modernizing electric and gas infrastructure.
- **Puerto Rico** – Regulatory proceedings have considered resilience associated with integrated resource plans and microgrid development. In 2019, the Puerto Rico Grid Modernization Plan proposed resiliency-related investments across transmission, distribution, generation, and microgrids.
- **South Carolina** – To address lessons learned from Winter Storm Uri in 2021, the Public Service Commission requires utilities to assess extreme cold weather threats, impacts, vulnerabilities, and resilience solutions as part of utility planning.

- **Virginia** – The Grid Transformation and Security Act, passed in 2018, established cost recovery structures for projects for grid modernization investments, facilitating investments in grid hardening and modernization to improve resiliency.

Detailed findings are described in Appendix B (Resiliency Planning Regulatory Jurisdiction Benchmarking). Key takeaways from this analysis included the following:

1. Electric resiliency planning is observed in many jurisdictions, either driven by policy and regulation or through proactive requests by investor-owned utilities to their regulator.
2. CenterPoint Energy Houston's proposed SRP aligns with the scope of resiliency measures in Texas and other jurisdictions.
3. Many resiliency measures are similar despite differences in primary risk event types.
4. Many utilities have invested in IT, OT, and communications systems to improve situational awareness and risk modeling.
5. Magnitude threshold can have different meanings depending on utility and location.
6. Metrics are commonly used to identify the need for resiliency grid investments and to measure their effectiveness.
7. Benefit-cost analysis is a commonly used measure to determine effectiveness.
8. Reporting requirements commonly accompany utility resiliency investments.
9. Equity and environmental justice are considerations that some utilities are beginning to account for in resiliency planning.
10. Protection against increasing cybersecurity threats is an emerging area for utility resiliency planning.

2.5.2 Statutory Authority in Texas for Resiliency Planning (HB 2555)

CenterPoint Houston's Resiliency Plan is responsive to state legislation passed in 2023 that recognizes the benefit to customers (*e.g.*, reduced restoration times and costs), as well as the need for electric utilities to enhance the resiliency of their systems given the state's recent experience with extreme weather events such as Winter Storm Uri in 2021 and numerous high-impact hurricanes and subsequent flooding events such as Hurricane Harvey in 2017. This legislation, referred to as House Bill ("HB") 2555, was passed by the Texas Legislature in May 2023, adding Section 38.078 to the Public Utility Regulatory Act ("PURA") titled "Transmission and Distribution System Resiliency Plan and Cost Recovery."

2.5.3 PUCT Regulatory Requirements for Resiliency Plans (16 TAC 25.62/PURA 38.078)

To implement the legislation, the Texas Legislature required the PUCT to adopt a rule allowing electric utilities to file a plan with the PUCT to enhance the resiliency of their T&D systems and

seek cost recovery treatment. The PUCT rule establishes the requirements and procedures for an electric utility to submit a System Resiliency Plan to enhance the resiliency of its T&D system.[12] As defined in the rule, a System Resiliency Plan comprises one or more measures designed to prevent, withstand, mitigate, or more promptly recover from the risks posed to the utility's system by resiliency events.

Proposed resiliency measures in the PUCT rule must fit into one or more of the following categories:

1. Hardening electric T&D facilities;
2. Modernizing electric T&D facilities;
3. Undergrounding certain electric distribution lines;
4. Lightning mitigation measures;
5. Flood mitigation measures;
6. Information technology (IT);
7. Cybersecurity measures;
8. Physical security measures;
9. Vegetation management; or
10. Wildfire mitigation and response.

Further, the plan must include the following:

- Definition of the type of resiliency events and resiliency-related risks (including magnitude threshold) each measure included in the Plan is designed to address.
- Description of how T&D systems are susceptible to the defined resiliency events included in the Plan.
- Historical evidence of the utility's experience with and forecast the risk of the identified events.
- Explanation of how proposed measures are distinct from similar measures already adopted and, if appropriate, explain how the related items work in conjunction with one another.
- Explanation of how the utility prioritized certain events, geographic areas, systems, or facilities for the proposed measures.
- Discussion of alternatives considered and why the selected measures were proposed over those alternatives.

[12] PUCT Order Adopting New 16 TAC §25.62. T&D System Resiliency Plans. Project No. 55250. https://interchange.puc.texas.gov/Documents/55250_43_1360196.PDF

- Identification of any measures that may require a transmission system outage to implement.
- Evidence of effectiveness of each proposed measure in preventing, withstanding, mitigating, or more promptly recovering from the defined resiliency events.
- Identification of benefits of the proposed resiliency measures such as reduced system restoration costs, reduction in frequency or duration of outages for customers, and any improvement in the overall service reliability for customers.
- Identification of whether any measure requires coordination with federal, state, or local government programs and funding opportunities.
- Proposed metrics or criteria for evaluating the effectiveness of measures (tying evidence of effectiveness to these metrics/criteria). For an evaluation metric or criteria that is not quantitative, the System Resiliency Plan must explain why quantitative evaluation is not possible.
- Presentation of a three-year "systematic approach" that the utility will use to carry out the plan.
- Cost estimates of capital deployment and implementation.
- An executive summary or comprehensive chart explaining the plan objectives, resiliency events, or related risks the plan is designed to address, the proposed resiliency measures, proposed metrics, costs, and benefits, and how the overall plan is in the public interest.

3. Purpose of Guidehouse Analysis and Review

3.1 Guidehouse Qualifications as Independent Expert

Guidehouse regularly consults for electric investor-owned, municipal, and cooperative utilities, as well as state and federal agencies. This includes several engagements that specifically addressed resiliency planning, such as:

- **Duke Energy Florida** – Guidehouse conducted a detailed analysis of storm hardening investment to support two successive Storm Protection Plans for approval by the Florida Public Service Commission.
- **New Jersey Board of Public Utilities** ("NJBPU")—The NJBPU engaged Guidehouse 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 Superstorm Sandy.
- **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 discussed in this report.
- **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.
- **CenterPoint Energy Houston**—Prior to this filing, CenterPoint engaged Guidehouse to assess its prior 2025-2027 T&D SRP filing under Docket 56548.

Guidehouse is committed to maintaining an independent and unbiased approach to its engagements. Specific to our analysis and review of CenterPoint Houston's SRP, we took the following steps to maintain independence:

- Our review includes a critical assessment of CenterPoint Houston's proposed resiliency measures to those adopted by other utilities that have successfully implemented resiliency programs. Recommendations are provided to further improve CenterPoint Houston's proposed resiliency measures;
- 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 measure is expected to provide in terms of mitigating the impacts of extreme weather events on CenterPoint Houston's power delivery 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 effectiveness measures that CenterPoint Houston and the Public Utility Commission of Texas (Commission) can rely on to determine if CenterPoint Houston's proposed investments deliver value to its customers over time.

3.2 Purpose and Objectives

3.2.1 Summary of CenterPoint Houston's Objectives

CenterPoint Houston's SRP is intended to enable CenterPoint Houston to take necessary actions to help prevent, withstand, mitigate, and quickly recover from disruptive events, such as extreme weather, and physical and cybersecurity attacks. A robust, targeted, and well-executed SRP has the potential to positively improve the customer experience over time by reducing the frequency and length of outages, among other potential benefits. It also improves the economic vitality of the communities the utility serves by reducing economic impacts that result from prolonged outages caused by a resiliency event. This can be demonstrated through performance measures such as quicker restoration time, improved customer communications, and reduced outage impacts on customers and communities. A primary objective of the SRP is to enhance the capabilities and strength of the electric system so that it is resilient and continues to serve electric loads during resiliency events.

3.2.2 Summary of Guidehouse's Objectives

The purpose of Guidehouse's independent analysis and review of CenterPoint Houston's SRP is to present evidence of the potential need and value of resiliency-focused measures and projects for CenterPoint Houston's service area. Guidehouse objectives included:

1. Advise CenterPoint Houston on best practices in electric utility resiliency 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.
3. Provide independent review and analysis of CenterPoint Houston's SRP, including all resiliency measures under consideration by CenterPoint Houston, to help inform CenterPoint Houston's selection and prioritization of resiliency measures to pursue.

3.3 Approach

Guidehouse worked closely with CenterPoint Houston's team developing its SRP to apply a framework for evaluating resiliency measures and projects under consideration. This included gathering and organizing data and information that would then be used to perform the BCA of CenterPoint Houston's resiliency measures and projects to the extent feasible. In addition, including where derivation of BCA was not feasible or produced low values, Guidehouse considered qualitative factors such as industry best practice informed by a review of resiliency planning efforts in other jurisdictions and peer utility benchmarking.

Further details regarding the methodologies used by Guidehouse are included within the following sections of this report:

- Section 4 includes the description of the methodological approach used by Guidehouse to perform its resiliency risk analysis.
- Sections 5.1 through 5.2 describe the methodological approach used by Guidehouse to perform its review and analysis of CenterPoint Houston's planned resiliency measures.
- Section 6.1 describes Guidehouse's circuit-level analysis approach, which helps inform CenterPoint Houston's selection of specific locations and projects for selected measures.
- Appendix Section A.1 and B.1 describe Guidehouse's methodology for the peer utility benchmarking section and jurisdictional benchmarking analysis, respectively.

4. Resiliency Risk Analysis

4.1 Analytical Approach: Assessment of Natural Hazard Threats

4.1.1 Methodology

CenterPoint Houston's service territory in Texas includes areas in the following counties: Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Waller, and Wharton. These counties, and broadly speaking, the southeast region of Texas, are at risk for several extreme weather events, including hurricanes, flooding, tornadoes, extreme heat, and extreme cold. Guidehouse used data and other information on extreme weather events found in the NOAA storm database[13] to select the following 12 events for analysis, 11 of which were from the 2013-2024 period. Hurricane Ike was more than 10 years ago but was included, given the significant damage it caused to the electrical grid.

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
11. Derecho: May 2024
12. Hurricane Beryl: July 2024

Guidehouse also used historical weather data from these events from a selection of weather stations in CenterPoint Houston's territory.[14] Weather stations were selected based on data availability during the selected events. The historical data described within this report provides valuable context to characterize risks and impacts associated with various resiliency events.

In addition, Guidehouse projected flood, wind speed, and extreme temperature risks in CenterPoint Houston's territory for 2025 and 2030 using Jupiter Intelligence's ClimateScore

[13] National Centers for Environmental Information. (2019). *Storm Events Database | National Centers for Environmental Information.* [NCEI Database] www.ncdc.noaa.gov/stormevents/.

[14] National Oceanic Atmospheric Administration, US Department of Commerce. (n.d.). *State Propagation.* [State Propagation] www.weather.gov/nwr/states_dyn?state=TX

Global Indices model, described in further detail below. For a more comprehensive risk assessment, Guidehouse performed both historical and future forecast hazard assessments. The historical hazard assessment detailed below is primarily based on NOAA data and for specific major events, while the future forecast is based on Jupiter Intelligence projections per hazard type.

4.1.2 Assumptions

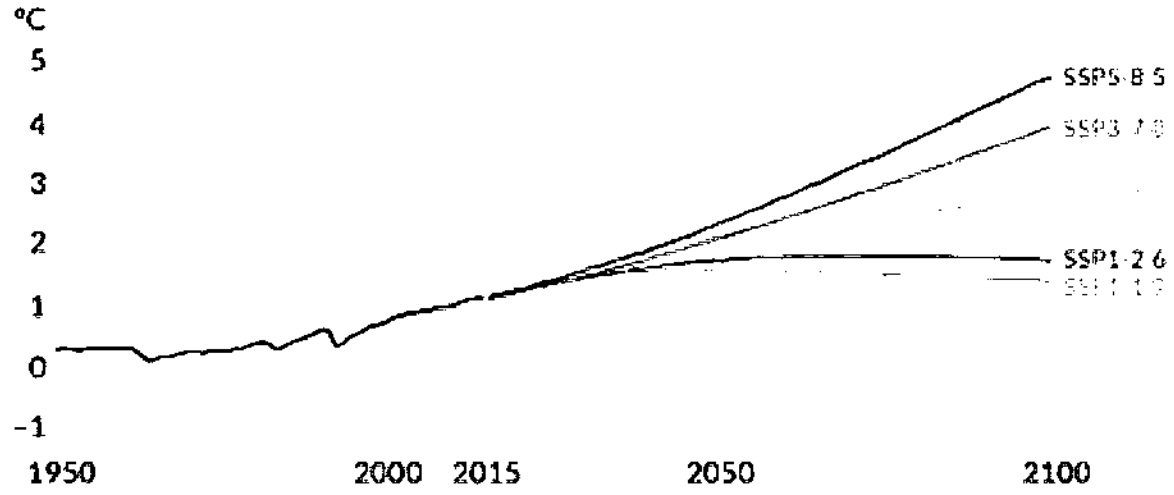
A key assumption for the historical assessment of risk presented in this report is that historical data from weather stations is representative of the conditions experienced by CenterPoint Houston's electric T&D assets in those counties. While this is broadly true for illustrating differences between larger geographies such as counties, there could be significant variations within a county that individual weather stations are not capturing. Therefore, the BCA analysis provided in this report should be viewed as an indicator of potential risk for a broader geographic area and not an assessment of risk for specific electric T&D assets in CenterPoint Houston's service territory.

A key assumption for forecasting risk is the uncertain impact of global climate change on CenterPoint Houston's service territory. Guidehouse is using three distinct Intergovernmental Panel on Climate Change ("IPCC") scenarios[15] of the future impact of climate change, as shown in Figure 4-1 and Table 4-1. The scenarios represent the impact of a certain amount of greenhouse gas emissions in a defined timeframe. They are defined in terms of social metrics or the total accumulated excess heat. Social metrics include demographics, economic growth, and the energy mix used and are summarized as shared socio-economic pathways ("SSPs").

Each SSP is closely tied to a representative concentration pathway ("RCP") that has a specific excess heat flux (Watts/square meter). A higher number for RCP represents higher accumulated heat and extent of climate change. Among the scenarios shown in Figure 4-1 RCP 8.5 presents the greatest amount of change to natural hazards, and RCP 2.6 presents the smallest amount of change. However, given our analysis's relatively near-term 10-year timeframe, the differences between the scenarios are not as large as they would be under a 20-year or 30-year timeframe.

[15] IPCC. (2003). *AR6 Synthesis Report: Climate Change 2023*. [IPCC Report]. www.ipcc.ch/report/ar6/syr/

Figure 4-1: Global Surface Temperature Change Increase Relative to the Period 1850-1900 by IPCC Scenarios



Source: IPCC. (2021). *Summary for Policymakers*. (p.22). Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

Table 4-1: Description of the Three IPCC Scenarios Used

IPCC CMIP6 Scenario	2100 Temperature Rise (°C)	Emissions Trend	Description
SSP1-2.6 (RCP 2.6)	1.8	Strong decline	Significant reduction in fossil fuels
SSP2-4.5 (RCP 4.5)	2.7	Slow decline	Middle of the Road
SSP5-8.5 (RCP 8.5)	4.4	Rising	Fossil fuel led Development

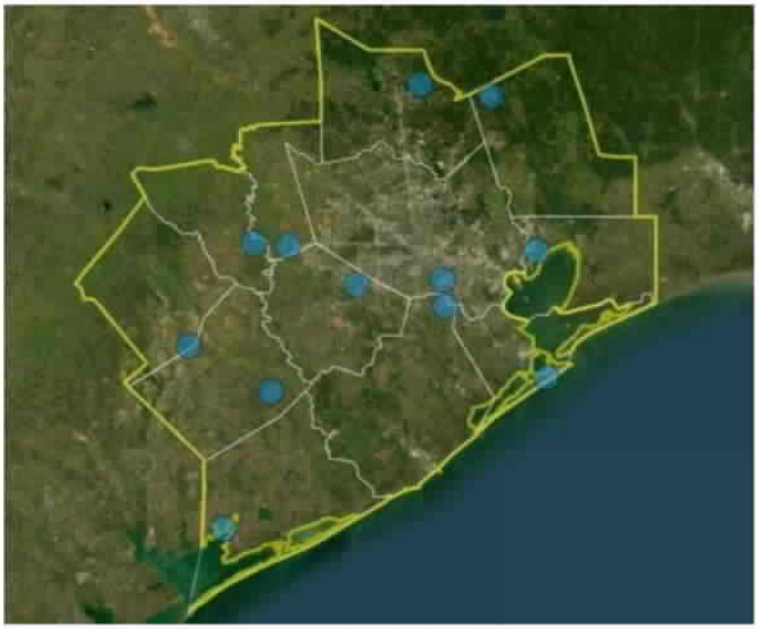
Source: IPCC. (2023). Sixth Assessment Report — IPCC.

Even with the limits imposed by these assumptions, the historical and projected future data presented later in this section of the report provide evidence of the significant risks posed by these natural hazards and the expected increase in their intensity over time. Natural hazards such as flood depths and wind speeds were projected for several return periods, which are events of varying probabilities and intensity. For example, a 10-year return period would indicate a 10% probability, and a 100-year return period would indicate a 1% probability.

4.1.3 Overview of Data and Modeling Tools Used

For historical event data, Guidehouse used data reported by 12 weather stations in CenterPoint Houston's territory identified as blue dots in Figure 4-2. Data was isolated to a period of two days before and after the selected events. Core Weather, a Guidehouse proprietary aggregation tool, was used for this purpose.

Figure 4-2: Weather Stations in CenterPoint Houston's Territory



Source: Guidehouse analysis, with inputs from Core Weather.

In addition to the weather station data, storm reports from NOAA were used for Hurricane Ike[16], Hurricane Harvey[17], Tropical Storm Imelda[18], Hurricane Nicholas[19], Hurricane Beryl, and the May 2024 Derecho. These storm reports provide key data on flood inundation and precipitation for southeast Texas and surrounding regions during these historical events.

For future projections, Guidehouse used Jupiter Intelligence's ClimateScore Global Indices model. This model uses county averages of metrics for wind, flood, wildfire, drought, and extreme temperatures. ClimateScore combines the output of downscaled general circulation models ("GCMs") with a digital elevation model ("DEM") and land cover data.

A review of the historical extreme weather events in CenterPoint Houston's service area considered for this analysis indicates that CenterPoint Houston's T&D assets are subject to:

1) Wind damage driven by hurricanes, tornadoes, and microbursts;
2) Flood damage driven by coastal storm surges during a hurricane and flash floods during extreme precipitation events;

[16] National Oceanic and Atmospheric Administration. (2009 January). *Tropical Cyclone Report Hurricane Ike*. [Hurricane Ike Report]. Tropical Cyclone Report (noaa.gov)

[17] National Oceanic and Atmospheric Administration. (2018 May). *NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT HURRICANE HARVEY*. [Hurricane Harvey Report]. Hurricane Harvey (noaa.gov)

[18] 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)

[19] National Oceanic and Atmospheric Administration. (2021 September). *NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT HURRICANE NICHOLAS*. [Hurricane Nicholas Report]. Hurricane Nicholas (noaa.gov)

3) Extreme cold during winter storms; and
4) Chronic and rising high-temperature events.

Several critical CenterPoint Houston assets such as T&D poles, conductors, transformers, switches, and breakers are subject to acute as well as chronic risks from such events as discussed in the context of specific CenterPoint Houston resiliency measures included in its SRP.

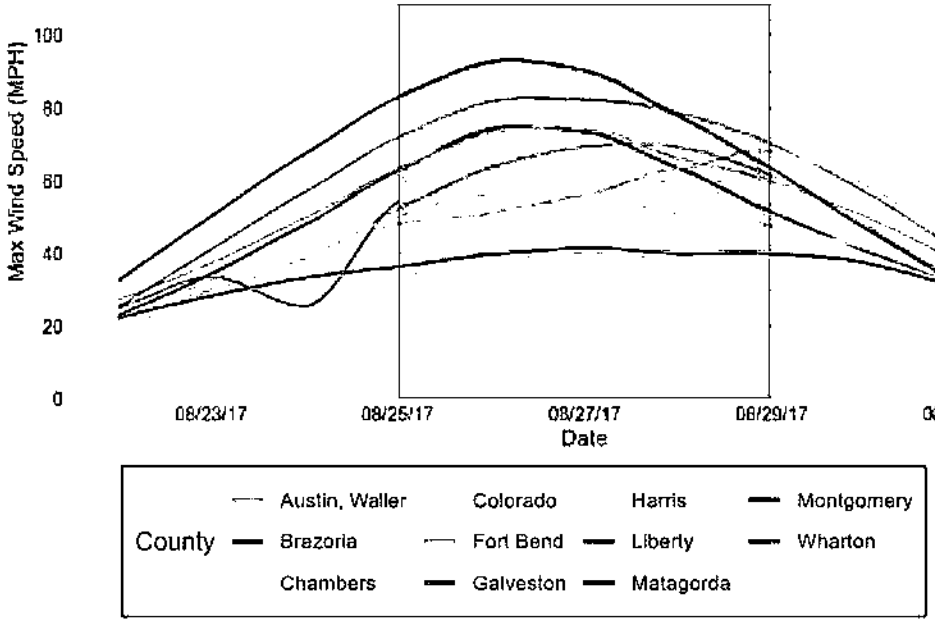
4.2 Assessment of Natural Hazard Threats

4.2.1 Hurricane Risk Profile

4.2.1.1 Historical Hazard Assessment

During Hurricane Harvey, a Category 4 hurricane, maximum hourly wind speeds exceeding 90 mph were observed for Matagorda County and exceeding 80 mph for Galveston County (see Figure 4-3).

Figure 4-3: Wind Speeds During Hurricane Harvey



The gray-shaded area highlights the peak wind period during the event.
Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.

As shown in Figure 4-4 seven counties, some as far inland as Austin and Waller counties, classify Hurricane Harvey wind speeds in their top 5% of extended windiest periods. NOAA estimated the total damage from Hurricane Harvey at $125 billion. The Texas Department of Insurance estimated 391,000 residential and commercial claims related to Hurricane Harvey across all of Texas.[20]

[20] Texas Department of Insurance. (2018 September). *Hurricane Harvey Data Call.* harvey-dc-04252019.pdf (texas.gov)

Figure 4-4: Top 5% of Storms by Counties

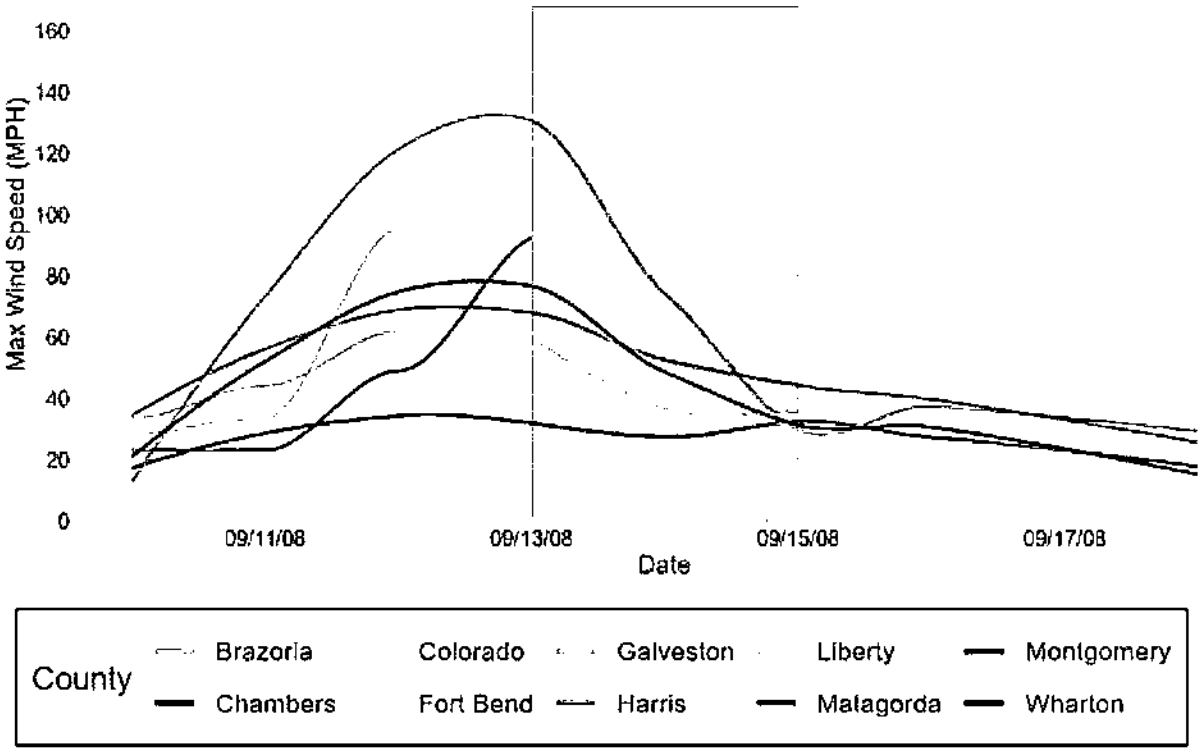
	Exceedance Model			
County	Exceedance #	Duration	Intensity Average	Intensity Max
Austin & Waller	2	4	66.4	74.5
Brazoria	4	5	67.0	92.6
Chambers	2	3	56.7	69.6
Galveston	1	3	82.4	90.1
Harris	2	3	66.9	74.5
Matagorda	2	5	85.0	110.5

Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.

Hurricane Ike, another powerful and destructive Category 4 hurricane, measured 900 miles wide and engulfed Galveston and other coastal areas, causing widespread damage and destruction estimated at $29.5 billion.[21] During Hurricane Ike, Harris Coastal Weather Station captured wind measurements exceeding 130 mph (see Figure 4-5). However, the highest wind speed experienced during Hurricane Ike may be understated because Ike's center made landfall near Galveston, but the coastal counties of Brazoria and Galveston lack data as their respective weather stations were shut off due to the extreme storm conditions.

[21] Texas Digital Library. (2011). *Hurricane Ike Impact Report*. [Hurricane Ike Impact Report]. Microsoft Word - Hurricane Ike Impact Report (tdl.org) Texas A&M University Report

Figure 4-5: Wind Speeds During Hurricane Ike

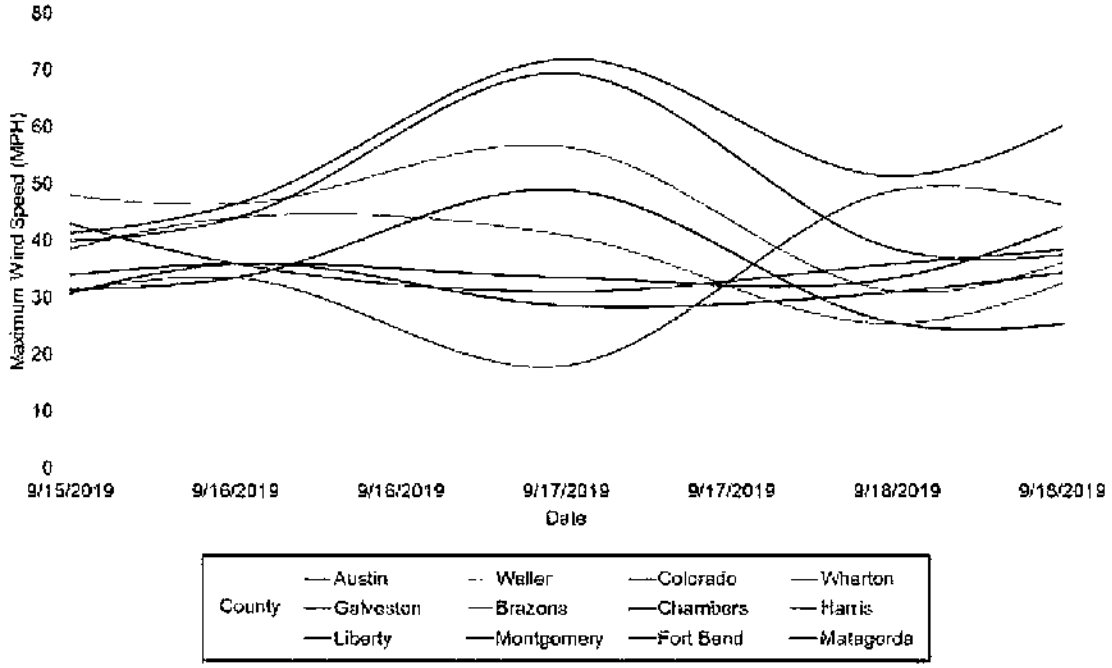


The gray-shaded area highlights the peak wind period during the event.
Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.

Tropical Storm Imelda was a relatively short-lived event that moved inland over Texas just after it developed. The storm and its remnants meandered inland for a couple of days after landfall and produced historic rainfall totals and devastating flooding over portions of southeastern Texas. NOAA estimated total damage at $5 billion.[22] Even in this relatively short-lived storm, maximum wind speeds measured in Harris County exceeded 65 mph (Figure 4-6).

[22] Tropical Storm Imelda Report. (p.6).

Figure 4-6: Wind Speeds During Tropical Storm Imelda

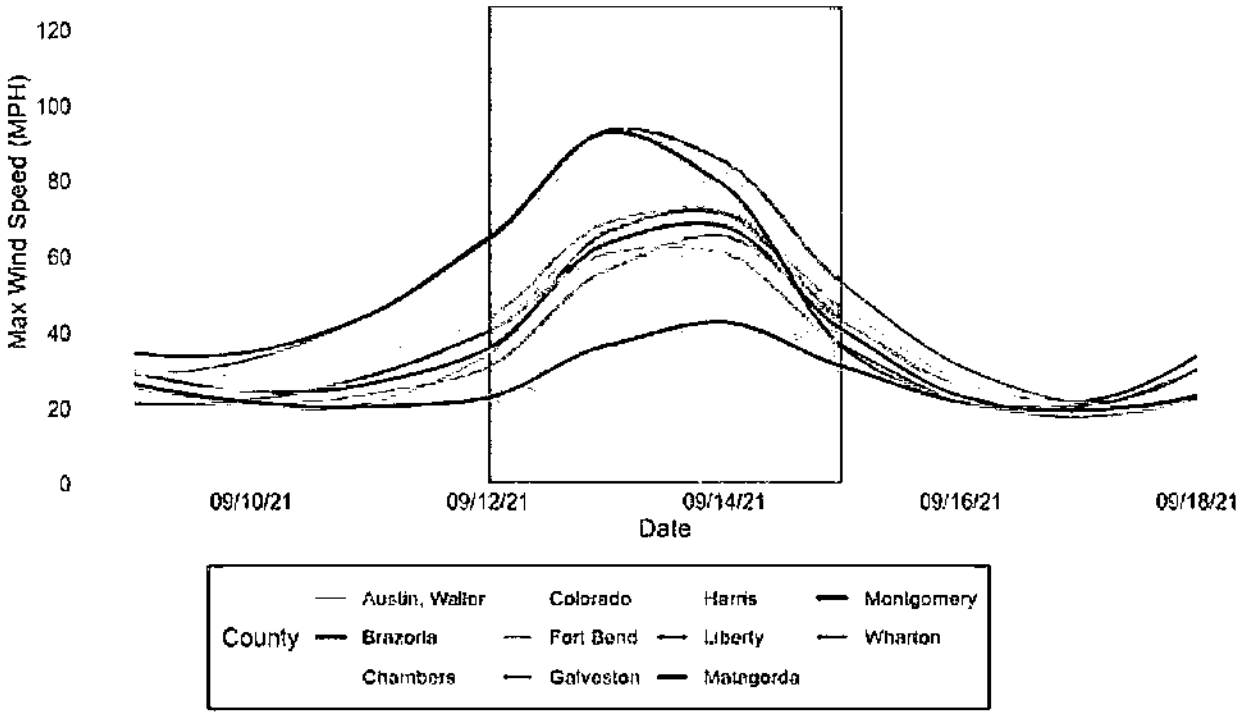


Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.

Hurricane Nicholas made landfall in Matagorda County as a Category 1 hurricane in September 2021. Wind Results for Hurricane Nicolas show that coastal stations Matagorda and Galveston experienced wind speeds over 95 mph, the highest observed. All counties in CenterPoint Houston's service area experienced high wind speeds during this event (Figure 4-7). This hurricane resulted in power losses for about half a million people.[23]

[23] Fort Bend Star (2021 September) *Hurricane Nicholas Leaves Widespread Power Outages in Wake.* [Hurricane Nicholas in Fort Bend]. Hurricane Nicholas leaves widespread power outages in wake | County News | fortbendstar.com

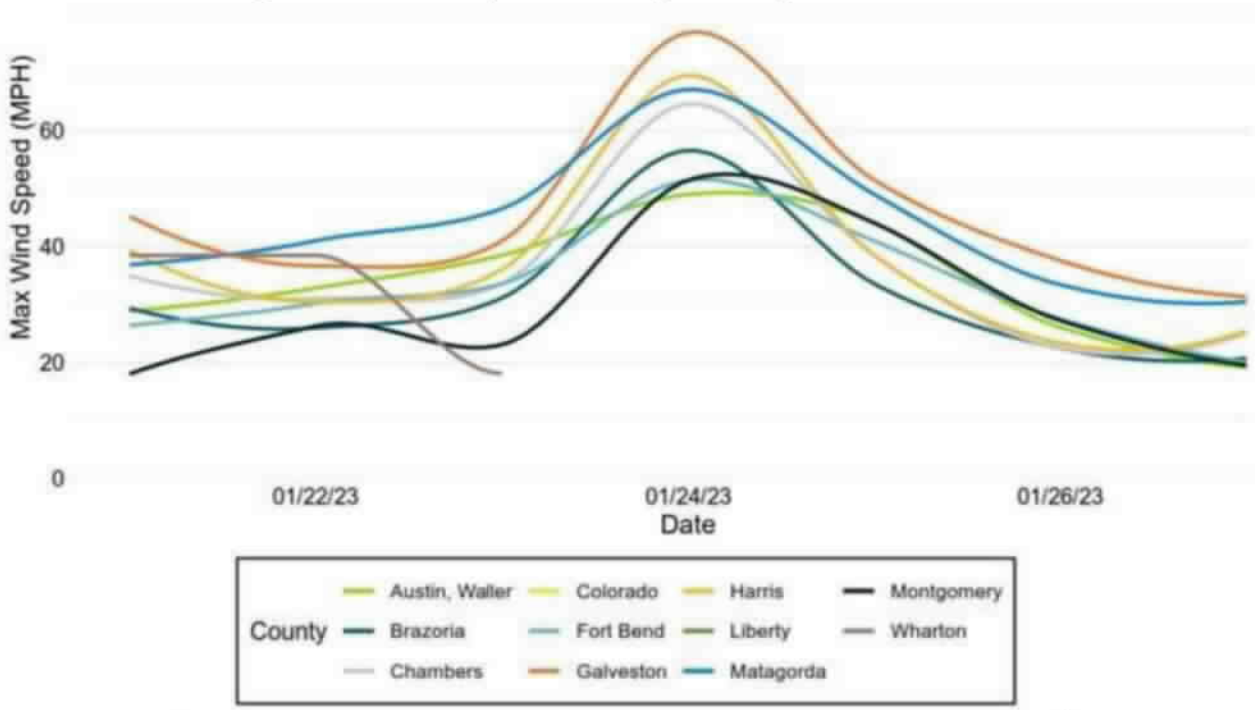
Figure 4-7: Wind Speeds During Hurricane Nicholas



The gray-shaded area highlights the peak wind period during the event.
Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.

The three tornado events Guidehouse analyzed occurred in January 2022, March 2022, and January 2023. The maximum wind speed observed during the tornado events was lower than for hurricanes. The most severe of these three events occurred in January 2022 when the coastal counties of Galveston and Matagorda experienced 60-75 mph wind (Figure 4-8).

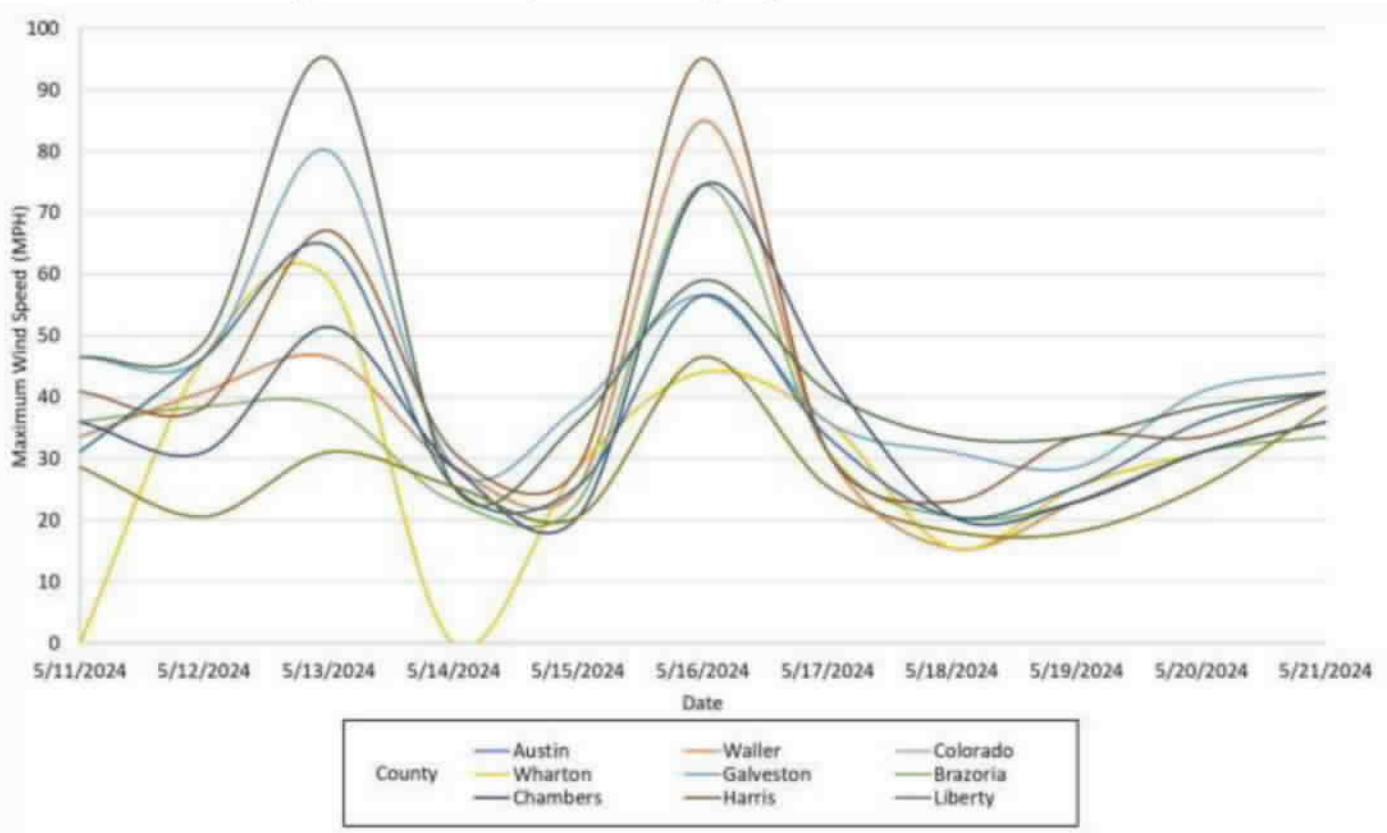
Figure 4-8: Wind Speeds During January 2023 Tornadoes



No event window (gray band) as the event occurred on the single day of January 24th.
Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.

In May 2024, a derecho event impacted southeast Texas from May 16th to May 18th with sustained high winds and damage to infrastructure in the Downtown Houston area. Figure 4-9 shows maximum winds exceeded 90 mph in Harris County, which is comparable to the wind speeds during recent hurricane and tornado events.

Figure 4-9: Wind Speeds During May 2024 Derecho



Source: Guidehouse analysis, with inputs from NOAA Weather Stations and NCEI.