ONTARIO ENERGY BOARD

Vulnerability Assessment – Draft Report

EB-2024-0199 - Vulnerability Assessment and System Hardening Project

DECEMBER 17, 2024

Ontario Energy Board

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1. INTRODUCTION

The citizens of Ontario, and society in general, are increasingly dependent on reliable delivery of electricity. To respond to extreme weather events, and the uncertainty posed by a changing climate, the Ontario Energy Board (OEB) has embarked upon a number of initiatives to help distributors assess and enhance the resilience of their distribution systems and continue to provide reliable service to their customers.

These initiatives seek to define in more detail the resiliency framework outlined in its Distribution Sector Resilience, Responsiveness and Cost Efficiency Report (**DRRCE Report**). which was submitted to the Minister of Energy in 2023.

The Minister of Energy endorsed several actions identified in the DRRCE Report and subsequently asked the OEB to develop and implement policies to improve climate resiliency within electricity distribution systems and operations.

This report focusses on setting out the OEB's expectations for the methodologies distributors should use to identify parts of their systems that are most vulnerable to extreme weather. This report is the first step in the OEB's Vulnerability Assessment and System Hardening (VASH) initiative.

The objective of this initiative is to set out how distributors should incorporate climate resiliency into their asset and investment planning to mitigate climate-related vulnerabilities. The intended outcome of this work is to support utilities decision-making such that any hardening of their physical infrastructure in response to climate change is undertaken in a manner that reflects the value of electricity service.

The determinations made regarding the final approach to the vulnerability assessment, as well as the methodology for evaluating system hardening options, will ultimately be incorporated in updates to Chapter 2 (Cost of Service) and Chapter 5 (Distribution System Plan) of the OEB's Filing Requirements for Electricity Distribution Rate Applications. Changes to the filing requirements are expected to be effective for applications filed in 2026 for 2027 distribution rates. Inclusion of this analysis into the preparation of a distributor's system plan will help to ensure that distributors are incorporating climate resiliency into their asset management processes.

1.1. Background

This project is a result of the Letters of Direction from the Ministry of Energy. The **2022 Letter of Direction** published in October 2022, among other things, called for the OEB to provide advice and proposals to improve distribution sector resiliency, responsiveness, and cost efficiency in response to anticipated extreme weather, within the context of high customer expectations and a dynamic public policy environment.

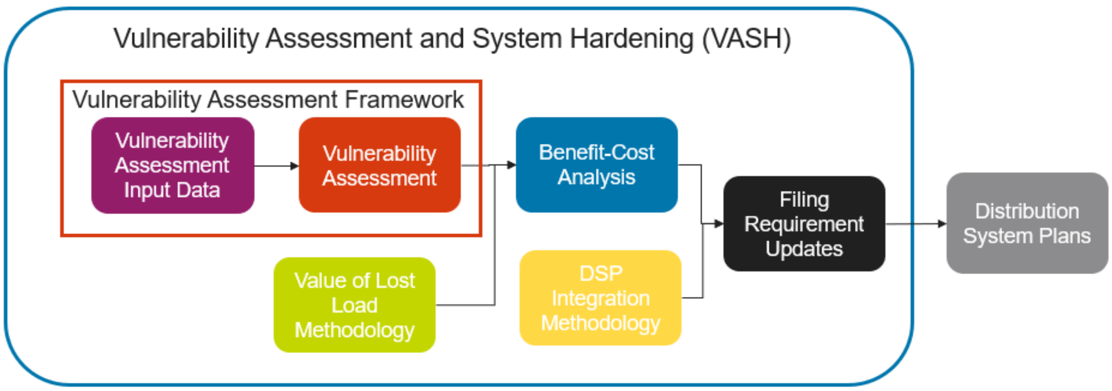
The OEB's response was encapsulated within its DRRCE Report, which was submitted to the Minister of Energy in June 2023. A subsequent Letter of Direction was published in November 2023 (**2023 Letter of Direction**) which endorsed several recommendations from the DRRCE Report and asked the OEB to develop and implement policies that require local distribution companies to:

1. provide details and report on their current storm recovery planning and preparation activities,
2. incorporate climate resiliency into their asset and investment planning,
3. engage in a regular assessment of the vulnerabilities in their distribution system and operations in the event of severe weather,
4. prioritize value of customers when investing in system enhancements for resilience purposes, and
5. satisfy minimum targets for customer communication regarding interruptions and restoration of service following major weather events and measure and report on restoration of service following such events.

To address the 2023 Letter of Direction, the OEB engaged in two parallel streams of work. The first work stream, Restoration Performance (via the Reliability and Power Quality Review), addresses 2023 Letter of Direction requirements 1 and 5 while the second, VASH, addresses requirements 2 through 4.

Figure 1 provides an overview of all elements contemplated in the VASH Framework: a Vulnerability Assessment (VA), guidance on incorporating Value of Lost Load (VoLL) into a standardized Benefit Cost Analysis (BCA), and guidance on embedding these elements into the Filing Requirements and the Distribution System Plan.

Figure 1. VASH Framework



The focus of this report, the stakeholder meetings to-date, and the development of the **Vulnerability Assessment Toolkit** (VA Toolkit) pertain to the first two components of the VASH framework: inputs and assessments.

2. VULNERABILITY ASSESSMENT DEVELOPMENT

In developing the VASH framework, the OEB considered the Ministry of Energy's Vulnerability Assessment for Ontario's Electricity Distribution Sector Report (**DVA Report**), completed a jurisdictional scan of other regulators in North America, and convened discussions with Ontario distributors, including those already doing vulnerability assessments.

The OEB also engaged intervenors, members of the reliability and power quality review working group, and other interested parties[1] by hosting three public stakeholder sessions focused on obtaining feedback on the VASH initiative and, more specifically, the VA components.

Throughout this process, the OEB has maintained consideration for the diverse size of Ontario distributors, the DVA Report, best practices in other jurisdictions, and feedback from distributors and other stakeholders. How the

[1] Canadian Association of the Club of Rome, Cornerstone Hydro Electric Concepts Association, CSA Group Electrical Safety Authority, Electricity Canada, Electricity Distributors Association, Independent Electricity System Operator, and Power Workers' Union.

OEB has taken these into consideration is further elaborated below.

2.1. Ministry of Energy's Vulnerability Assessment for Ontario's Electricity Distribution Sector Report

In 2024, the Governance, Strategy, and Analytics Branch of the Ministry of Energy published a detailed assessment of distribution sector vulnerability in Ontario. The DVA Report concluded that "climate change is already having significant impacts on the province of Ontario and is guaranteed to affect the province in years and decades to come". The document identifies a variety of climate perils relevant to distribution system performance including heat, cold, precipitation, wind, wildfire, and interrelated factors and events. It also notes that once vulnerabilities are identified, both structural and non-structural measures (e.g., procedural and response enhancements) can be made to reduce the impact of extreme weather events on system operations, therefore reducing negative outcomes for customers.

The DVA Report identifies several areas for improvement in the decision-making abilities of distributors regarding changing climate including:

- acknowledging the significant impacts of climate change and its relationship to major outage events
- improving understanding of the potential impacts at the local and regional scale
- systematically incorporating climate change data into electricity system and asset planning and management activities, and
- adopting planning and implementation practices that capture the critical importance of ongoing resilience in the electricity sector

To assist distributors in understanding potential climate impacts and systematically incorporating them into a distributor's distribution system planning the OEB has proposed the vulnerability assessment methodology outlined in this report.

2.2. Jurisdictional Scan

The OEB conducted a review of leading jurisdictions in North America requiring electricity distribution utilities to complete vulnerability assessments and incorporate system hardening measures into their rate cases. The OEB's focus was on understanding how regulators support the utilities they regulate and what kind of analysis they expect utilities to conduct. The jurisdictions summarized below illustrate how both prescriptive and open-ended approaches to vulnerability assessment methodologies and data sources have been implemented.

California: In 2018, the California Public Utility Commission issued orders to ensure utilities integrate climate change adaptation into asset investment plans. Primary data sources developed by the state for cross-cutting industry use were identified for climate input variables. Specific future climate scenarios for use in utility planning were also standardized. Vulnerability assessments targeted at utility operations, services, and assets are required and must cover the timeframes of 10-20 years, 20-30 years, and 30-50 years separately. The assessments are filed every four years alongside Risk Assessment Mitigation Phase applications[2].

Florida: In February 2020, the Florida Public Service Commission (PSC) made effective its Storm Protection Plan ruling[3] requiring utilities to file a plan covering a 0–10-year planning period that would be updated every three years. The goal of this ruling is to enhance utility infrastructure in its ability to withstand extreme weather events, therefore reducing outage and restoration costs and improving service reliability. The PSC requires descriptions of prioritization methods and locational investment targeting; however, specific data sources and methods are not prescribed.

Texas: In September 2023, the Public Utility Commission of Texas published a memorandum outlining objectives for Transmission and Distribution System Resiliency Plans[4]. This proposed rule established the expectations for electric utilities to develop and submit resiliency plans that target hardening of distribution and transmission systems. Resiliency events are defined as high impact, lower frequency occurrences that materially impact safe and reliable operation of the electric system. Hardening investments must be linked to the mitigation of one or more resiliency event types and must be supported by defensible prioritization and estimates of risk mitigation. Estimates of risk must, at a minimum, be supported by an analysis of historical frequency and severity of resilience events, however, specific data sources and methods are not prescribed.

New York: In January 2022, the State of New York passed a bill requiring each electric corporation to submit climate change vulnerability studies that evaluate infrastructure, design specifications, and procedures to climate-

[2] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/climate-change
[3] https://www.flrules.org/gateway/RuleNo.asp?id=25-6.030
[4] https://interchange.puc.texas.gov/Documents/55250_9_1329186.PDF

driven risks, including adaptation measures. The utilities are required to include an assessment of the effectiveness of mitigation plans and the estimated cost and benefits to the corporation and its customers. The plans are to be refiled on a maximum five-year cadence. Data sources and benefit-cost methods are not prescribed.

2.3. Existing Ontario Distributor Vulnerability Assessments

In June 2024, OEB surveyed Ontario distributors to understand their current practices around planning and responding to extreme weather events. The key survey findings are summarized in the Distribution Sector Resilience and Responsiveness report published on December 4, 2024.

Eight of the distributors who responded to the survey have undertaken a vulnerability assessment study within the last five years. Through the survey, interviews with seven of the eight distributors who have previously undertaken vulnerability assessment studies, and documentation on vulnerability assessments from their previous rate applications, it was found that Ontario distributors used both quantitative and qualitative approaches, weather projections, and asset-based approaches in their vulnerability assessments.

Some of these distributors relied on a structured framework such as the Public Infrastructure Engineering Vulnerability Committee Protocol (PIEVC Protocol), created by Engineers Canada[5,6], to assess infrastructure risk from climate change by reviewing historical and projected climate data. Using this approach, the interactions between climate events and distribution system assets were identified and assigned severity scores; risk profiles were developed with recommendations for adaptation.

The most common set of climate inputs that distributors included in their vulnerability assessments were extreme temperatures, precipitation patterns, freezing rain and high winds. These projections informed the likelihood and severity of climate hazards, enabling the assessment of vulnerabilities in the distribution system and their impact on infrastructure performance. Some of the distributors whose assessments were informed by forecasts used climate projection data obtained from the Intergovernmental Panel on Climate Change.

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[5] Toronto Hydro-Electric System Limited Climate Change Vulnerability Assessment, **https://pievc.ca/2015/06/21/toronto-hydro-electric-system-limited-climate-change-vulnerability-assessment/**

[6] Distribution System Climate Risk and Vulnerability Assessment – Hydro Ottawa, **https://pievc.ca/2019/09/11/distribution-system-climate-risk-and-vulnerability-assessment-hydro-ottawa/**

These evaluations of distribution system vulnerabilities focused on specific infrastructure elements, such as power lines, transformers, and substations. The distributors also confirmed that they relied on technical design standards such as those by the Canadian Standards Association (CSA Group) along with internal expert knowledge to identify the thresholds at which the climate parameters impact asset performance.

2.4. Feedback from Stakeholder Sessions

As part of this process, the OEB conducted three stakeholder meetings[7]. The initial meeting provided an overview of the proposed approach and project plan. The following two meetings focused on the vulnerability assessment methodology, presenting it in detail and soliciting feedback. In addition to these three stakeholder meetings, the OEB also received feedback from the Electricity Distributors Association (EDA).

In their feedback, stakeholders emphasized the importance of flexibility in the OEB's approach to vulnerability assessments, cautioning against a "one-size-fits-all" method that could disrupt existing planning practices and embedded expertise among engineers and planners. Some stakeholders recommended that the OEB develop a framework to account for regional differences and varying risk tolerances among LDCs and customer preferences. Some stakeholders also raised concerns about consistency in reviewing the vulnerability assessments if applicants were given too much flexibility.

While noting that flexibility is important, stakeholders also pointed out that a standardized methodology could reduce regulatory burden and help to make it feasible for the Vulnerability Assessment to be conducted internally and avoid the need to incur the cost of third-party consultants. Some stakeholders also noted that using industry accepted data inputs and methodologies would also reduce the debate during the review of rate applications. The OEB also heard that the guidelines should be clear in the filing requirements without being overly restrictive, enabling distributors to tailor their assessments as needed.

Stakeholders also called for clear criteria to evaluate vulnerability assessments and advocated that distributors should be allowed to define critical climate perils specific to their distribution systems. Overall, there was strong support for balancing flexibility and standardization in such a way that distributors receive sufficient guidance to develop a vulnerability assessment

[7] More details regarding the consultation can be found on Engage with Us webpage for Vulnerability Assessment and System Hardening, **https://engagewithus.oeb.ca/vulnerability-assessment-system-hardening**

that meets the OEB's expectations without needing to satisfy overly prescriptive or burdensome requirements.

Additionally, stakeholders underscored the importance of leveraging best practices from leading jurisdictions and harmonizing the approach with technical standards from bodies such as the CSA Group.

Concerns were raised about excessive data granularity, variability, and the burden of independently conducting climate research. Reviewing historical outage events and aligning assessments with customer perspectives and regulatory contexts were suggested as practical alternatives.

Stakeholders also highlighted the need for a carefully paced approach, allowing time for adaptation and reasonable expectations, particularly for the 2026 applications for 2027 rates. In its feedback, the EDA recommended that the OEB should consider introducing vulnerability assessment requirements for applications filed in 2027 for 2028 rates.

Vulnerability Assessment Development Considerations

In consideration of input from stakeholders, current Ontario practices, and those in other jurisdictions, the OEB has identified five key objectives for its proposed Vulnerability Assessment methodology:

- **It should be simple** and can be repeated by any distributor with the underlying data, methodology, and outputs easily understandable.
- **It should be appropriately granular** and provide specific predictions of the susceptibility of a given set of physical assets in a given location to a range of resiliency factors for the purposes of distribution system planning.
- **It must support the efficiency of its review process**. In combination with other evidence, the Vulnerability Assessment should yield sufficient and clear analysis that generates transparency, allows for efficient and effective adjudicative processes, and drives greater focus on the outcomes of vulnerability assessments rather than on the dissection of methods used to arrive at those outcomes.
- **It must support the effectiveness** of its review process by supporting appropriate consistency and generating confidence in the robustness of planning and the reasonableness of rate consequences of any actions or investments proposed in response to the

assessment. It should also appropriately balance the benefits of structuring distributors' analysis with a degree of consistency while recognizing that distributors themselves are those who bear the ultimate responsibility for managing their assets.

- **It must take into account the diversity of Ontario distributors'** size, location, and capabilities. This includes appropriately balancing the benefits of standardization while accommodating variation among distributors.

These key objectives capture the requirements and considerations from the Minister's 2022 and 2023 Letters of Direction, the DRRCE report, the DVA Report, and stakeholder feedback while reflecting best practices from other jurisdictions.

3. THE OEB'S APPROACH TO VULNERABILITY ASSESSMENT

Based on feedback from the stakeholder sessions and interviews with distributors that are already undertaking vulnerability assessments, the OEB has determined it will provide two options for distributors to conduct vulnerability assessments.

The first option permits distributors to file a customized vulnerability assessment as part of their distribution system plan (Custom Option). Applicants are free to specify and develop their VA as they see fit, but it must adhere to principles outlined by the OEB. The Custom Option may suit distributors who can leverage their experience with past vulnerability assessments and who can pursue customized analysis, perhaps using proprietary data. The OEB's criteria for the development of customized studies is outlined in Section 3.1.

The second is a structured generic option with accompanying analysis resources (Generic Option). It aims to simplify the process of analysis through the provision of a generic methodology embedded into a pre-populated assessment model. The OEB's VA Toolkit supports the development of asset class and location-specific climate peril vulnerabilities in the form of the annual probability that a climate event will exceed an asset's expected failure threshold (see Section 3.2). The OEB has also provided guidance on options for sourcing appropriate input data that underpin the toolkit.

The OEB is of the view that this dual-path approach provides a framework that optimally supports a broad spectrum of distributor vulnerability assessments.[8] Whichever option is selected, a distributor's vulnerability assessment should be filed as part of its Distribution System Plan, which is typically filed every five years with a cost-based application.

3.1. Custom Option

The Custom Option is suitable for distributors wishing to develop more customized vulnerability assessments using their own or proprietary tools (such as PIEVC Protocol) not supplied by the OEB. While this option allows for flexibility in what distributors file for a vulnerability assessment, a Custom Vulnerability Assessment (Custom VA) should nevertheless be required to meet certain criteria and, at a minimum, it must:

- Use and rely on climate forecast data
- Utilize an asset-based approach
- Be developed using a quantitative analysis (e.g., annual probability of failures)

In addition to meeting these criteria, the distributor must provide the following information to support its Custom VA.

- An explanation of how the Custom VA meets the criteria listed above.
- The input data sources used to support the Custom VA.
- The climate forecast model used, along with an explanation of the methodology, key inputs including the chosen climate perils and their applicable asset failure mode, and assumptions used.
- The asset classes included in the Custom VA.
- An explanation of how the Custom VA is used in the context of distribution system planning and how it relates to the VoLL and BCA.

This information will help the OEB and others review a distributor's Custom VA and understand how the it has been incorporated into a utility's

[8] The Custom Option could be provided by any distributor filing a Price Cap IR application. Likewise, a distributor filing a Custom IR application can use the Generic Option.

distribution system planning.

3.2. Generic Option

The Generic Option provides a generic vulnerability assessment that was designed by the OEB and may appeal to distributors who lack the resources necessary or do not wish to procure or develop customized modeling for vulnerability assessments (some of which may require proprietary data inputs and analytic tools).

The VA Toolkit sets out the Generic Option and while it still requires distributors to make choices on the inputs in order to provide flexibility, the guidance and resources provided should reduce the regulatory burden required to complete the VA. To further support distributors, the OEB is considering acquiring, on a one-time basis, a suitable dataset for the climate input data that will be included in the initial version of the VA Toolkit.

3.2.1. Vulnerability Assessment Toolkit Overview

The VA Toolkit applies a climate forecast to assess vulnerabilities using an asset-based approach, which is consistent with other jurisdictions. It also utilizes standard data tables and vulnerability calculations structured in a way that is expected to enable Ontario distributors to assess the vulnerability of asset classes to climate perils relevant to their service area without the need to retain external expertise. The output provides a vulnerability heatmap that identifies areas for further investigation and investment prioritization.

The VA Toolkit is an Excel-based model made up of three data tables. An asset’s vulnerability is defined in the model as the total forecasted annual probability of that asset experiencing a climate peril that exceeds its failure mode threshold. The model will record, for example, that a Class 4 pole may be designed to withstand 70 km/h winds and that there is a forecasted 3% chance that it will experience winds greater than 70 km/h in 2025.

The model will also tabulate vulnerability through Vulnerability Asset Annual Probability Bins (e.g., Low < 1% and Medium < 5%) whose thresholds can also be adjusted by the applicant. The higher the probability the more vulnerable the asset, the lower the probability the less vulnerable the asset. In the example above, the Class 4 pole could be considered to have medium asset vulnerability.

3.2.2. Inputs to the VA Toolkit

The VA Toolkit requires five inputs:

- **Distributor's Asset Summary** – A distributor should decide the asset classes it plans to include in its vulnerability assessment (e.g., poles, conductors, and stations transformers) and identify appropriate grid locations.
- **Utility Asset Failure Modes and Thresholds** – A distributor should decide the technical standards (e.g., CSA Group) it will rely on in understanding the technical threshold in which the asset will fail, expressed in a climate severity threshold (e.g., Class 4 pole should not exceed 70 km/h wind).
- **Climate Peril Selection** – A distributor should decide the climate perils that are relevant to its service territory and align with the asset classes identified previously (e.g., wind, snow/ice, and flooding).
- **Climate Peril Probabilities** – A distributor should decide on the source of climate input data—for example, the Canadian Centre for Climate Services (CCCS), a division of the federal Department of Environment and Climate Change—and populate the annual climate peril probabilities for varying grid locations as data allows.
- **Vulnerability Assessment Annual Probability Bin** – A distributor should decide on the cut off probability thresholds to define low, medium, high, and very high asset vulnerabilities (e.g., Low < 1%, Medium < 5%, High < 10%, and Very High >10%).

The vulnerability assessment inputs (for either the VA Toolkit or a Custom VA) may present a challenging research task for distributors, requiring the collection of installed asset data, expected failure modes (climate peril and threshold) for those assets, and the projected annual probability of those climate perils and severities at targeted locations. To reduce the complexity and resource intensity of this task, the OEB has developed guidance and standard tools to support distributors in the successful completion of vulnerability assessments at the level of rigor necessary to support system hardening investment requests.

As described above, distributors may use their discretion to determine and specify the inputs used in their vulnerability assessment. A distributor is expected to explain and justify its selection of asset classes, climate perils, and other inputs used in its vulnerability assessment process. If a distributor takes a conspicuously narrow or otherwise exceptional approach to its vulnerability assessment—for example, by excluding certain conventionally relevant asset classes or climate perils from its analysis—the distributor will be expected to provide a detailed rationale for its selected approach.

Distributor's Asset Summary

The Distributor's Asset Summary summarizes asset counts by analysis location. Locations with no assets of a specific class will have no vulnerability for that class regardless of climate projections. For locations and class combinations with higher vulnerability, a distributor may review its asset counts to understand the pervasiveness of the resiliency challenge.

The first step in the risk-based vulnerability assessment is to identify the target asset classes for inclusion in the vulnerability assessment. These should be defined by the current assets installed in a distributor's service territory. Sub-classes should be determined based on variation in failure thresholds for the assets' primary failure mode (i.e., the climate peril and severity that is most commonly associated with failure of that asset class). Example sub-classes may include material, class, height, and mounting.

Table 1 shows examples of key asset classes and sub-classes that may be analyzed in the vulnerability assessment; however, it is up to the asset owners to determine the final list that they will use in assessments. The final list should capture the key outage and cost drivers for Ontario's distributors.

Table 1 Example Asset Class and Sub-Class Variables

Example Asset Class	Example Sub-Class Variable
Pole	Material, Height
Overhead Conductor	Material, Covering
Underground Conductor	Material
Substation Transformer	Ground elevation, Presence of floodwall
Substation Breaker	Ground elevation, Presence of floodwall

Utility Asset Failure Modes and Thresholds

Failure modes and thresholds characterize the expected resilience of distributor assets identified in the Asset Summary to specific climate perils. Sub classes may be included to better estimate failure thresholds across a variety of perils. Distributors may leverage design standards to review vulnerability or refine failure thresholds with additional condition data of field equipment.

The total annual probability of failure is the summation of expected threshold exceedances across climate perils relevant to a particular asset class. Each asset class has a primary failure mode that may be identified in technical standards. However, another less common failure may exist. For example, poles and overhead conductors are primarily vulnerable to horizontal forces generated by wind gusts that may be exacerbated by ice accumulation during winter storm events. Poles in certain locations may also be vulnerable to extreme precipitation events due to permeable substrates.

Alternatively, substation equipment may be robust to wind forces and primarily vulnerable to flooding due to its ground mounted status. Each asset class should include, at a minimum, the vulnerability to its primary failure mode.

Distributors are responsible for sourcing and applying appropriate thresholds that underpin failure modes. The OEB notes that utilities may choose to rely upon the CSA Group's published guidelines for technical standards as an input to the expected failure modes for assets. Use of the CSA's guidelines would be expected not only to simplify this exercise, especially since they are already widely used in distributors' planning activities, but also help to develop consistency among disparate distributors' assessments using these tools.

Climate Peril Selection

The selected asset classes and their failure modes inform the appropriate climate perils to consider for the vulnerability assessment. For example, a study that analyzes poles and substation transformers would likely include both extreme wind and flooding; these are the primary failure modes for those asset classes. Distributors may leverage observations from historic severe events, the DVA Report, asset class technical standards, or another well-documented method to determine appropriate climate perils for consideration. Distributors should complete the model with the failure threshold (e.g., wind speed or flood depth) for each asset class and sub-class combination to be compared to climate expectations (the Asset Class Failure Mode & Threshold table).

Each type of climate peril identified for inclusion has its own primary failure mode indicators that should align with a distributor's assets. Distributors should consider various climate perils and what spatial and temporal resolutions are appropriate for risk/vulnerability assessment of the electrical grid for each. For example, certain climate perils such as flooding and wildfires are significantly affected by elevation and vegetation, and therefore show a significant variation on a sub-1 km resolution. Other perils such as temperature changes and wind gusts manifest themselves at a higher spatial resolution (e.g., ~ 5 km).

Climate Peril Probabilities

Climate Peril Probabilities project the annual probability of specific events (relevant to assets in the Distributor's Asset Summary) occurring at targeted grid locations through time. Climate perils and severity thresholds are linked to specific asset failure modes and thresholds. For example, wind gusts may be evaluated at 80, 100, and 120 km/h if these thresholds are deemed to relate to different class pole failures.

The probability of extreme weather events is often reported in terms of return intervals (e.g., a 1 in 100-year flood or wind event has a 1% probability of occurrence in any given year). The intensity of a given probability extreme weather event is reported differently for each peril (e.g., flood depth is the metric of choice for flooding; and wind gust speed is the metric of choice for wind damage).

Examples of types of relevant risk metrics by peril are shown in Table 2, however distributors should match intensity metrics with failure modes identified in the Asset Class Failure Mode & Threshold table in the vulnerability assessment model as closely as possible. Deviations should be described and supported.

Table 2: Example Climate Perils and Illustrative Metrics

Peril	Metric
Extreme Heat	Daily Max Temperature
	Daily Average Temperature
	Heating Degree Days
	Days above 30°C
Extreme Cold	Daily Min Temperature
	Cooling Degree Days
	Days below 0°C
Wind Damage	Wind Speed- 10-min sustained max
	Wind Speed- 3-second gusts
Flooding	Flood Depth
	Flood Duration
	Flood Velocity
Wildfire	Fire Weather Index
	Fire Occurrence Probability Index
Precipitation	Daily Maximum
	Annual Average
	Maximum 3 day

Distributors should complete the vulnerability assessment model with the climate perils' annual probability of exceeding key failure modes for the identified asset class and sub-class combinations (Climate Peril Probability table). The climate inputs in the model should provide base-year values and forecasts as available.

There are several key data characteristics to consider when developing inputs for differing climate perils. Below are some of the most important characteristics in determining the applicability and usefulness of climate data to vulnerability risk calculations.

- **Spatial Resolution.** Certain perils occur with greater spatial granularity than others. For example, wind gust probability or extreme heatwaves may be similar across a wide area, whereas flood depths along a river may be highly location specific. A substation sited 200 m from a river may have very different annual flood risk from one sited 100 m away in the flood plain.

- **Forecast vs Historical.** Electric distribution assets are long-lived and therefore deliver distribution service benefits decades into the future. When developing a BCA for system hardening it is important to model potential changes in climate throughout an asset's lifetime. Therefore, attention should be paid to the forecasting method used for climate perils where changes in severity or frequency are expected. Due to the non-linear and highly variable models used to forecast climates based on a variety of scenarios, the direct application or trending of historical values is not sufficient.

- **Climate Peril Intensity.** Many common data sources include summaries of mean or average weather events. Generally, all utility assets are designed to withstand these common weather events and therefore are not exposed to risk in these circumstances. It is important to utilize data on extreme event probability that match or exceed expected failure thresholds for the asset classes relevant to system hardening plans.

Distributors bear responsibility for sourcing the forecast climate inputs that underpin the VA Toolkit. While distributors may take advantage of historical data to inform, for example, their understanding of the system impacts of extreme weather, the OEB expects distributors to employ forecast data rather than historical actuals to populate the climate peril probability inputs in vulnerability assessments. In the OEB's view, this approach addresses the risk that historical experiences may not be a sufficient predictor of future weather events in a changed climate[9].This expectation is also an approach in keeping with the 2022 Letter of Direction, which identified the need to ensure policy proposals "reflect current and anticipated future extreme weather impacts".

Forecast-based climate input data is widely available on a commercial basis. The OEB has also identified that data and support are available from the CCCS. The CCCS provides access to climate data and tools and offers training and support to help use and apply data. The CCCS also operates a support desk and offers assistance for those looking for climate data.[10]

The OEB notes several advantages if the use of CCCS data were to become

[9] DRRCE Report, page 23,
[10] **Have a question? — ClimateData.ca**

common among many distributors. It would help to generate measures of consistency among distributors in the estimation of climate perils. It would simplify the exercise of gathering appropriate forecast climate data. Using publicly available sources may also lower the total cost of the undertaking by avoiding the cost of acquiring proprietary data.

Vulnerability Assessment Annual Probability

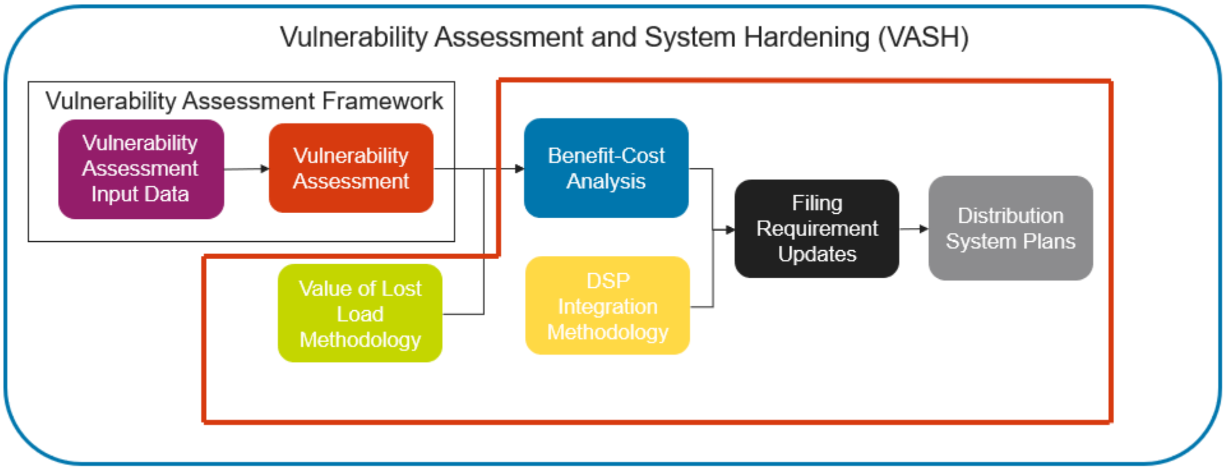
To differentiate asset classes and locations to target for mitigation review, a distributor should decide on the cut off probability thresholds to define low, medium, high, and very high asset vulnerabilities (e.g., Low < 1%, Medium < 5%, High < 10%, and Very High >10%). Commonly, annual probabilities of assets experiencing climate perils that exceed their design standards below 1% may be considered lower vulnerability. Due to the long-expected lifetimes of many common distribution assets, any annual probability above 1% implies a high likelihood that the asset will experience such an event within its expected operational life. Default annual probability bins may be adjusted at the distributor's discretion to refine targeting of asset classes. Deviations should be explained and supported by an overview of the distributor's prioritization methodology.

4. VASH NEXT STEPS

Following the completion of this report, the OEB will focus on the remaining elements of the VASH methodology and the filing requirements.
Starting in early 2025, the OEB expects to engage stakeholders on the method for assessing the cost-effectiveness of system hardening investments, specifically, how to:

- Calculate risk (Value of Lost Load Methodology)
- Evaluate adaptive actions (Benefit-Cost Analysis)

Figure 2: VASH Initiative - Areas of Focus in Early 2025



Following these steps, the OEB expects to publish a final report on the full VASH methodology and then incorporate its expectations into filing requirements for rebasing applications. An area of focus during this latter phase of work will pertain to the expectation that distributors consider addressing identified vulnerabilities on a holistic basis that incorporates climate risks alongside other planning drivers such as asset renewal.

The OEB expects that distributors' vulnerability assessment and system hardening analyses will be required in rebasing applications filed in 2026 for determination of rates effective in 2027.

The OEB acknowledges that the EDA recommended introducing vulnerability assessment requirements for applications filed in 2027 for 2028 rates.

The OEB proposes that this work should progress sooner and recognizes that this is a new approach for which Commissioners will consider the amount of time that distributors have had to prepare VASH-related aspects of their distribution system plans.

Furthermore, the OEB also plans to hold training sessions on the toolkit when the final report on the VASH methodology is published.