ONTARIO ENERGY BOARD

Vulnerability Assessment and System Hardening Report

EB-2024-0199 - Vulnerability Assessment and System Hardening (VASH) Project

October 7, 2025

Ontario Energy Board

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1. EXECUTIVE SUMMARY

The Vulnerability Assessment and System Hardening (VASH) project stems from the **2022 Letter of Direction** published in October 2022, which asked the Ontario Energy Board (OEB) to provide advice and proposals to improve resiliency, responsiveness, and cost efficiency in the distribution sector. In response to that, the OEB provided its recommendations in its Distribution Sector Resilience, Responsiveness and Cost Efficiency Report (**DRRCE Report**) in June 2023. Through a subsequent Letter of Direction published in November 2023 (**2023 Letter of Direction**), the Ministry of Energy endorsed several recommendations from the DRRCE Report and asked the OEB to develop and implement relevant policies. This direction was further reinforced by the Minister's Integrated Energy Plan Directive (**IEP Directive**) to the OEB issued on June 11, 2025, in support of implementing the Integrated Energy Plan, *Energy for Generations: Ontario's Integrated Plan to Power the Strongest Economy in the G7*.

This report outlines how distributors are expected to integrate climate resiliency into their asset and investment planning. The objective is to support decision-making so that at-risk assets are appropriately identified and that projects proposed to improve resilience of infrastructure to climate-related vulnerabilities are cost-effective when assessed by reference to value that customers put on electricity service.

The OEB offers two options for distributors to conduct vulnerability assessments and benefit-cost analyses:

1. **Custom Option**: Allows distributors to develop tailored assessments and analyses using proprietary tools, provided they meet specific criteria, including reliance on climate projection data, asset-based approaches, and quantitative analysis of key inputs.

2. **Generic Option**: Utilizes the structured VASH Framework and Toolkit developed by the OEB, simplifying the process through standardized methodologies and guidance on sourcing input data.

This dual-path approach provided by the OEB accommodates the diversity of Ontario distributors. The OEB's expectations for vulnerability assessment and system hardening will be incorporated into the Filing Requirements for Electricity Distribution Rate Applications (Filing Requirements), effective for applications filed in 2026 for 2027 distribution rates on a best-efforts basis and will become mandatory commencing with applications for 2028 distribution rates. This integration aims to ensure that climate resiliency is embedded in the distribution system planning processes.

2. INTRODUCTION

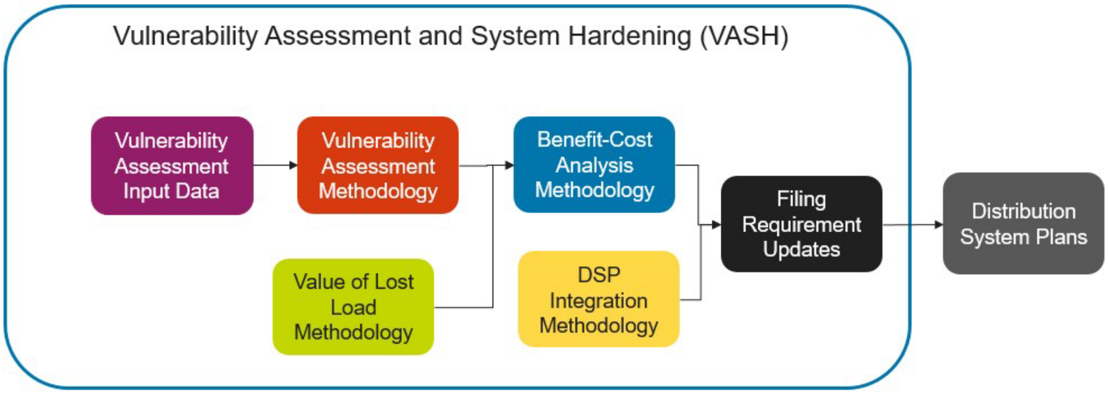
The citizens of Ontario, and society in general, are increasingly dependent on reliable delivery of electricity. To respond to extreme weather events, and the uncertainty posed by a changing climate, the Ontario Energy Board (OEB) has embarked upon a number of initiatives to help distributors assess 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 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 in their 2023 Letter of Direction to develop and implement policies to improve climate resiliency within electricity distribution systems and operations. This direction was further reinforced by the IEP Directive, which emphasized the need to “consider frequent and extreme weather impacts on energy infrastructure resilience” and encouraged electricity distributors to incorporate these considerations into their planning frameworks and processes. The VASH initiative addresses these directives by equipping distributors with tools and methodologies to identify parts of their systems that are most vulnerable to extreme weather and to evaluate system hardening options based on an objective benefit-cost framework that prioritizes value for customers. These tools and methodologies are designed to ensure that planning for climate-related risks is done proactively and integrated into distributors’ existing system planning and asset management practices.

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

Figure 1. VASH Framework



The objective of this report is to set out how distributors are expected to 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 projects undertaken to improve the resiliency of their infrastructure in response to extreme weather events, and the uncertainty posed by a changing climate is in a manner that reflects the value of electricity service to customers.

The VASH Framework is designed to serve as one of several inputs into a distributor's system planning, providing a focus on climate resilience and system hardening. By integrating VASH into the DSP, distributors ensure that climate-related vulnerabilities and mitigation strategies are considered alongside other planning drivers, supporting a holistic approach to system planning in Ontario.

The OEB's expectations for vulnerability assessment and evaluation of system hardening investments will be incorporated in 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 on a best-efforts basis and will become mandatory commencing with applications for 2028 distribution rates, aligning with the expectations set out in the IEP Directive. The inclusion of this analysis into the preparation of a distributor's DSP will help to ensure that distributors are incorporating climate resiliency into their asset management processes. The OEB also recognizes that this represents a new approach, and the OEB will take into account the time distributors have had to prepare the VASH-related components of their DSPs when reviewing applications.

2.1. 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. Subsequently the 2023 Letter of Direction published in November 2023 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.

3. VULNERABILITY ASSESSMENT AND SYSTEM HARDENING 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, that presently conduct climate vulnerability assessments and/or utilize VOLL studies in the BCA of their system hardening investment plans.

The OEB also engaged all distributors, intervenors, members of the reliability and power quality review working group, and other interested parties[1] by hosting several public stakeholder sessions focused on obtaining feedback on the components of the VASH Framework.

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 OEB has taken these into consideration is further elaborated below.

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

In 2024, 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".[2] 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

[1] Stakeholder consultation participants are listed in Appendix A: Stakeholder Consultation Participants

[2] Ontario. *Vulnerability Assessment for Ontario's Electricity Distribution Sector*. Ministry of Energy, Government of Ontario, 2024, Page 1. https://www.ontario.ca/page/vulnerability-assessment-ontarios-electricity-distribution-sector

- 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 VA and BCA methodologies outlined in this report.

3.2. Jurisdictional Scan

The OEB conducted a review of leading jurisdictions in North America requiring electricity distribution utilities to complete VAs 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 VA and BCA 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. VAs 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[3].

Florida: In February 2020, the Florida Public Service Commission (PSC) made effective its Storm Protection Plan ruling[4] 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.

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[3] https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/climate-change

[4] https://www.flrules.org/gateway/RuleNo.asp?id=25-6.030

Texas: In September 2023, the Public Utility Commission of Texas published a memorandum outlining objectives for Transmission and Distribution System Resiliency Plans[5]. 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[6] requiring each electric utility to submit climate change vulnerability studies that evaluate infrastructure, design specifications, and procedures that address climate-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 utility and its customers. The plans are to be refiled on a maximum five-year cadence. Data sources and benefit-cost methods are not prescribed.

3.3. Ontario Distributors' Existing Approach

In June 2024, the 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 VA study within the last five years. Through survey results, interviews with seven distributors, and review of documentation on VAs from their previous rate applications, it was found that Ontario distributors used both quantitative and qualitative approaches, climate projections, and asset-based approaches in their VAs.

Some of these distributors relied on a structured framework such as the Public Infrastructure Engineering Vulnerability Committee Protocol (PIEVC Protocol), created by Engineers Canada[7,8], to assess infrastructure risk from climate change by reviewing historical and projected climate data. Using this approach, the interactions between

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[5] https://interchange.puc.texas.gov/Documents/55250_9_1329186.PDF

[6] NY A08763 | 2021-2022 | General Assembly | LegiScan

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

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

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 VAs 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 projections used climate data obtained from the Intergovernmental Panel on Climate Change.

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 published by the Canadian Standards Association (CSA Group) along with internal expert knowledge to identify the thresholds at which the climate parameters impact asset performance.

Additionally, the OEB interviewed five distributors who responded to the survey and understood that these distributors incorporated VOLL in their investment planning related to resiliency. They use varying methods to develop VOLL inputs including leveraging the United States Department of Energy Interruption Cost Estimate Calculator (ICE Calculator)[9], deploying a custom survey like that underlying the ICE Calculator to a distributor's territory, relying on customer engagement through traditional feedback mechanisms, and qualitatively evaluating improvements in reliability.

These distributors do not use a uniform BCA framework to incorporate VOLL or other potential benefits of resiliency investments into decision making, however, the distributors interviewed all consider these benefits when prioritizing projects either quantitively or qualitatively. BCA methods that distributors use are evolving to include considerations of changing climates and evaluating investment alternatives for improved resiliency that are targeted based on characteristics specific to a service location.

3.4. Feedback from Stakeholders

To ensure the VASH Framework is practical and reflects stakeholder needs, the OEB conducted six stakeholder meetings and invited written feedback throughout the development process[10]. The initial meeting provided an overview of the proposed approach and project plan. The following two meetings focused on the VA methodology,

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[9] https://icecalculator.com/documentation

[10] 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

presenting it in detail and soliciting feedback. In addition to these three stakeholder meetings regarding the VA, the OEB also received written feedback from the Electricity Distributors Association (EDA). Subsequently on December 17, 2024, the OEB released a report titled Vulnerability Assessment – Draft Report and invited stakeholders to submit further feedback on VA methodology in writing. Thereafter, the final three meetings focused on the VOLL and BCA methodologies, with the OEB presenting and gathering input on proposed approaches. On July 31, 2025, the OEB released a draft of the final VASH Report and Toolkit, which encompassed the complete VASH Framework, and invited stakeholders to provide written comments.

In their feedback, stakeholders emphasized the importance of flexibility in the OEB's approach to VASH, 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 distributors and customer preferences.

While flexibility was seen as essential, stakeholders also recognized the risk of inconsistency in VA submissions if applicants were given too much flexibility. Also, while noting that flexibility is important, stakeholders pointed out that a standardized methodology and input data could reduce regulatory burden and help to make it feasible for the VA and BCA 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 expectations 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 VAs and system hardening investments proposed using the VASH Framework 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 VA that meets the OEB's expectations without needing to satisfy overly prescriptive or burdensome requirements.

Expanding on this, stakeholders noted that the VA should serve as a foundational tool—helping distributors identify and prioritize their most at-risk assets. In doing so, it would support the integration of climate resilience into planning decisions through a process that is transparent, data-driven, and cost-effective.

Stakeholders also encouraged the OEB to ensure that the VASH Framework not only supports traditional investments but also enables more modern, resilient system planning—allowing for the consideration of innovative solutions where they can demonstrate value and effectiveness.

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. Similarly, concerns about the appropriateness of publicly available VOLL resources for Ontario customers were expressed. Some stakeholders raised the fact that the research underlying these sources was not conducted on Ontario customers and, therefore, may not reflect the willingness-to-pay sentiment or economic realities of Ontarians across customer segments.

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 their feedback, the stakeholders recommended that the OEB should consider introducing VA requirements for applications filed in 2027 for 2028 rates.

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 VA and BCA methodologies:

- **It should be simple** and repeatable by any distributor, resulting in underlying data, methodologies, and outputs that are easily understandable.
- **It should be appropriately granular** and provide specific predictions of the susceptibility of a given set of physical assets to relevant climate-driven risks. Granularity should support evaluation of resiliency of those assets in a given location to a range of resiliency factors for the purposes of distribution system planning.
- **It must support the efficiency of the OEB's review process**. In combination with other evidence, the VA and BCA should yield sufficient and clear analysis that generates transparency, allows for efficient and effective adjudicative processes, and drives greater focus on the outcomes of VAs and system hardening investment plans 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 by generating confidence in the robustness of planning and in 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'** sizes, locations, 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 IEP Directive, the DVA Report, and stakeholder feedback while reflecting best practices from other jurisdictions.

4. THE OEB'S APPROACH TO VULNERABILITY ASSESSMENT AND BENEFIT-COST ANALYSIS

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 VAs and BCAs.

The first option permits distributors to file a customized VA and BCA as part of their DSP (Custom Option). Applicants are free to specify and develop their VASH Framework 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 VAs and system hardening investment cases and who can pursue customized analysis, perhaps using proprietary data. The OEB's criteria for the development of customized studies is outlined in Section 4.1.

The second option (Generic Option) is to use the structured VASH Framework developed by the OEB with the accompanying Vulnerability Assessment and System Hardening Toolkit (VASH Toolkit). The generic option aims to simplify the process of analysis through the provision of generic VA and BCA methodologies embedded into the VASH Toolkit. The OEB's VASH Toolkit enables the development of asset class and location-specific climate peril vulnerability expressed as the annual probability that a climate event will exceed an asset's expected failure threshold. Additionally, it provides for project characterization and evaluation resulting in BCA ratios and summary metrics that are valuable for asset investment planning (see Section 4.2). 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 VAs and BCAs.[11] Whichever option is selected, a distributor's VA along with evidence supporting the effectiveness of any system hardening investments proposed on the merits of a VASH BCA is expected to be filed as part of its DSP, which is typically filed every five years with a cost-based application.

4.1. Custom Option

The Custom Option is suitable for distributors wishing to develop more customized VAs, VOLL inputs, and BCAs using their own or proprietary tools not supplied by the OEB. While this option allows distributors flexibility to create their own VASH Framework (Custom VASH), it is required to meet certain criteria. At a minimum, it must:

[11] 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.

- Use and rely on climate projection data
- Utilize an asset-based approach
- Be developed using a quantitative analysis for key inputs including:
    - Annual probability of failures
    - Value of lost load
    - Project lifetime costs and benefits

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

- An explanation of how the Custom VASH meets the criteria listed above.
- The input data sources used to support the Custom VASH.
- The climate projection 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 VASH.
- The VOLL used, along with an explanation of the methodology, customer classes, and outage durations considered. Methodology explanations should include a summary and explanations of deviations from the Generic Option.
- The BCA Framework used (i.e., benefit types, cost types, discount rates, lifetimes, etc.). A distributor may choose to include benefit streams beyond those required for the Generic Option. Methodology explanations should include a summary and explanations of deviations from the Generic Option.
- An explanation of how the Custom VASH is used in the context of distribution system planning.

This information will help the OEB and others review a distributor's Custom VASH and understand how it has been incorporated into a utility's distribution system planning.

4.2. Generic Option

The Generic Option provides a generic VA and BCA framework 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 (some of which may require proprietary data inputs and analytic tools).

The VASH Toolkit sets out the Generic Option and is comprised of two main components: the VA Toolkit and the BCA Toolkit. While the VASH Toolkit still requires distributors to make choices on the inputs in order to provide flexibility, the guidance and resources provided should reduce the effort otherwise required to complete a VA and conduct a BCA for system hardening investment options. The VASH Toolkit also includes a VA Toolkit User Guide and a supporting Model Logic Diagram. To further support distributors, the OEB is 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.

4.2.1. Vulnerability Assessment Toolkit Overview

The VA Toolkit applies a climate projection 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: Asset Summary, Asset Class Failure Thresholds, and Climate Peril Probabilities. An asset's vulnerability is defined in the model as the total projected 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 projected 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 < 2% and Medium < 10%) 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. Although applicants may adjust vulnerability bin thresholds to fit their needs, the OEB has suggested standard bins: Low < 2%, Medium < 10%, High < 20%, and Very High > 20%.

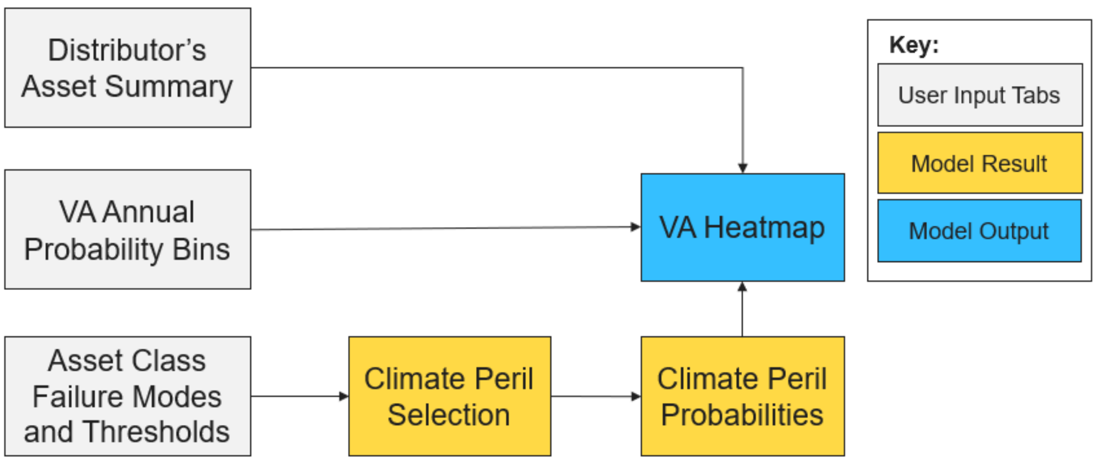
- < 2% is selected for Low as it aligns with CSA guidelines for designing to a 1-in-50–year peril design standard.
- > 20% is selected for Very High to align with the 5-year planning cycle (20% annual probability equates to a 1-in-5–year event).

- A 10% threshold is used to further disaggregate vulnerability tranches to aid in decision making and is positioned roughly midway between Low and Very High. This results in 2-10% range for Medium and 10-20% range for High.

In the example above and using the standard bins, the Class 4 pole at 3% annual probability of exceedance could be considered to have medium asset vulnerability.

Figure 2 shows the VA Toolkit flow diagram. Each toolkit core inputs component is described in the sections below.

Figure 2. VA Toolkit Flow Diagram



4.2.2. 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 VA (e.g., poles, conductors, and stations transformers) and identify appropriate grid locations.

- **Utility Asset Class 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, Environment and Climate Change Canada

(ECCC)—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 < 2%, Medium < 10%, High < 20%, and Very High > 20%).

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, in the form of the VA Toolkit, and standard climate projection datasets, on a one-time basis, to support distributors in the successful completion of VAs 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 VA. A distributor is expected to explain and justify its selection of asset classes, climate perils, and other inputs used in its VA process. If a distributor takes a conspicuously narrow or otherwise exceptional approach to its VA – 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 VA is to identify the target asset classes for inclusion in the VA. 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 asset classes and sub-classes that may be analyzed in the VA; 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 VA. 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 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 VA Toolkit 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
	Cooling Degree Days
	Days above 30°C
Extreme Cold	Daily Min Temperature
	Heating 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 VA Toolkit 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 projection method used for climate perils where changes in severity or frequency are expected. Due to the non-linear and highly variable models used to project 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.

The OEB has provided in the VA Toolkit, on a one-time basis, climate peril projections for wind and ice accretion at locations across Ontario, derived from CSA and ECCC data. These inputs are acceptable for use in a distributor's VA. However, the distributors bear responsibility for sourcing the projected climate inputs beyond these perils that may be applicable to the distributor's VA. For these additional perils, the distributor should ensure that a common climate projection scenario is employed (i.e., match additional peril projections to the climate scenario selected from the VA Toolkit data).

The Intergovernmental Panel on Climate Change (IPCC) uses global emissions scenarios to explore future climate outcomes. These scenarios model possible futures with no probability assignments (i.e., each may be as likely as another). ECCC and CSA use Representative Concentration Pathway (RCP) scenarios to consider potential futures in alignment with these generally accepted projections.

The OEB recommends aligning with the CSA approach of using RCP 8.5 for asset classes with expected useful lives less than 60 years and RCP 6.0 for asset classes with expected useful lives greater than 60 years. Climate projections for these RCP scenarios are provided in the VA Toolkit.

Distributors may choose other RCP or generally accepted climate projection scenarios (e.g., Shared Socioeconomic Pathway (SSPs)) to model failure projections and should provide rationale if they choose to do so. This will meet the IEP directive's requirement to consider frequent and extreme weather impacts on energy infrastructure resilience and ensure future average, minimum and maximum temperatures are incorporated into demand modelling.

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 projection data rather than historical actuals to populate the climate peril probability inputs in VAs. 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[12].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". It is further supported by the IEP Directive, which emphasizes the importance of planning for infrastructure resilience in light of increasingly frequent and severe weather events.

Projection-based climate input data is widely available on a commercial basis. The OEB notes several advantages if the use of ECCC data were to become 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 projected 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 < 2%, Medium < 10%, High < 20%, and Very High > 20%). As discussed above, standard annual probability bins have been provided by the OEB. However, these 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.

4.2.3. Benefit-Cost Analysis Toolkit Overview

The BCA Toolkit is designed to support the evaluation of targeted system hardening projects at specific grid locations evaluated in the VA. The BCA Toolkit provides a generic framework for calculating the lifetime present value of benefits and costs of a project, a benefit-cost ratio (BCR), and the expected annual and lifetime reduction in customer minutes of interruption (CMI). These metrics may support the decision to include or exclude a system hardening project from a distributor's Capital Plan. However, a distributor retains responsibility for defining specific thresholds for investment decision making.

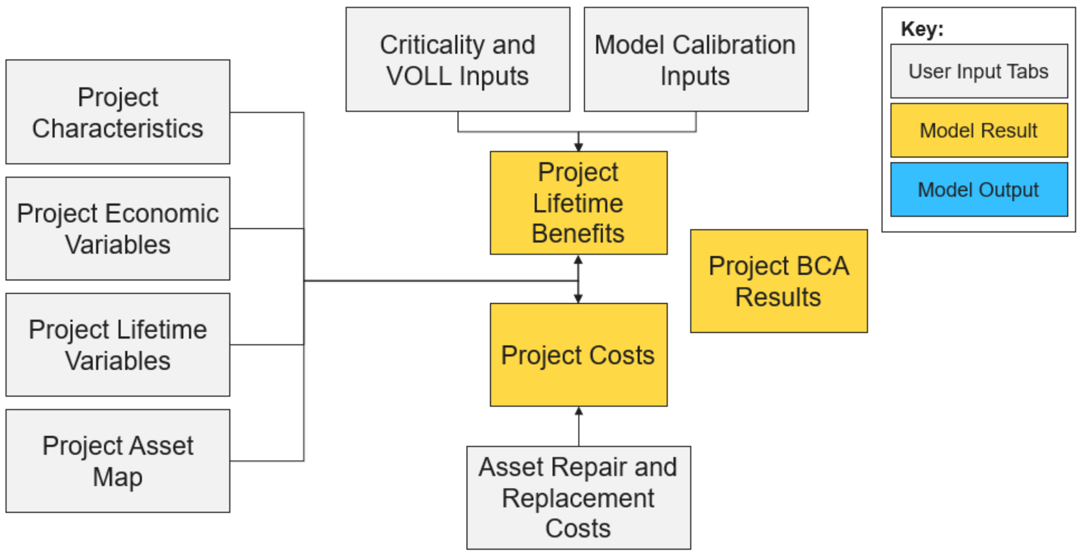
The BCA toolkit contains two tabs with several categories of data requirements. Information on asset costs, project characteristics, economic variables, and project asset definitions are required to calculate expected outcomes for a baseline and a

[12] DRRCE Report, page 23,

project scenario. Details on these inputs and the appropriate application of project characteristic selections are provided in the next section.

Figure 3 shows the BCA Toolkit flow diagram. Each toolkit core inputs component is described in the sections below.

Figure 3. BCA Toolkit Flow Diagram



4.2.4. Inputs to the BCA Toolkit

The BCA Toolkit requires several sets of inputs that build on the existing VA Toolkit.

Asset Repair and Replacement Costs

To accurately inform project costs and benefits from avoided repairs and replacements through hardening investments, it is essential to develop expected costs to repair or replace assets matching the failures modeled in the VA. The cost to repair or replace an asset in the event of failure should include all attributable costs, such as material, equipment, and labor.

The expected replacement percentage should be estimated based on climate perils and failure thresholds incorporated into the VA. For instance, if a specific replacement failure threshold was used to analyze vulnerability, this should be set to 100%. If a failure threshold based on historical asset class outages was used, an estimate of actual repair versus replacement expectations may be appropriate.

Project Characteristics

System hardening opportunities may be applicable to assets throughout their lifetime. To support flexible project definitions, a project type selection that is determined based on the status of the distributor's existing assets is included in the BCA Toolkit. Identifying the project type is critical for the correct application of BCA methods. There are three potential options:

- **End-of-Life.** If the project will replace assets that would have otherwise been replaced due to age or condition in the absence of resiliency planning.
- **Early Retirement.** If the project will replace assets that were expected to remain in service beyond the start date of the project.
- **Retrofit.** If the project will not impact existing assets, such as in cases of sectionalizing or enhanced emergency response.

There are multiple ways that a system hardening project can reduce the impact of extreme weather events on a distributor's system. To provide the flexibility to accommodate these variations and allow distributors to define projects that are best suited for their systems, the BCA Toolkit contains three potential options for impact type:

- **Frequency.** If the project increases the robustness of assets to climate perils, changing the expected failure threshold without impacting the duration or number of customers affected by remaining outages.
- **Criticality.** If the project reduces the expected outages' durations and/or the number of customers impacted by an outage without reducing the expected frequency of these events.
- **Both.** If the project will reduce both the frequency and criticality of outages.

Correct project characterization provides a thorough understanding of the project's scope and impact, facilitating effective application of BCA methods.

Project Economic Variables

Common economic analysis inputs are essential for calculating the present value of costs and benefits to customers, aligning the VASH BCA to the Distribution System Test (DST) Framework[13].

The expected annual inflation rate for the duration of the project lifetime adjusts base-year inputs allowing for flexibility in the project start year. The nominal discount rate, often the Weighted Average Cost of Capital (WACC), is used for present value

[13] OEB, Benefit-Cost Analysis Framework for Addressing Electricity System Needs, May 2024, Available: BCA Framework for Addressing Electricity System Needs EB-2023-0125

calculations. Additionally, the 4% social discount rate, provided by the Independent Electricity System Operator (IESO), baseline and scenario O&M costs, expressed as a percentage of total asset costs in each case, as well as the combined federal and provincial tax rate are used to calculate the present value of customer rate impacts for the lifetime of the project.

Project non-asset costs, which are one-time costs that do not scale by the number of assets in the project, must be added to the total asset costs to estimate the full cost of a system hardening project. Examples of these costs include engineering expenses, administrative fees, overhead burden, and any other measurable changes in costs incurred that are attributable to the implementation of the system hardening project. For retrofit projects, this field should be used to estimate the entire project cost.

Project Lifetime Variables

Resiliency investments are designed to mitigate risk over the lifetime of installed assets, making it essential to analyze the lifetime benefits of a project. For modeling, a project start year indicates when the project will be in-service, and the expected lifetime of the project refers to the anticipated field life of the assets being invested in. If the project includes multiple asset classes, a weighted average lifetime may be used to provide a reasonable estimate while reducing modeling effort.

For early retirement projects, it is necessary to determine the remaining useful life (RUL) of the existing assets. This represents the number of years these assets would have continued to be in service if the resiliency project had not been implemented. This input is specific to early retirement projects and may be omitted for end-of-life and retrofit project types.

By considering these factors, the analysis ensures a comprehensive understanding of the long-term benefits of resiliency investments.

Criticality and Value of Lost Load Inputs

Criticality inputs are essential for accounting for differences in the Value of Lost Load (VOLL) by customer segment and outage duration. Therefore, the expected duration of outages impacted by a project and the expected number of customers, categorized by class, who will be affected by the project is required for both the baseline and scenario case as applicable to the project's impact type. For projects with a frequency impact type, the project VOLL should equal the baseline VOLL, on a per-event basis, as there is no change in the criticality of remaining outages after project implementation. For projects with criticality and both impact types, the resulting duration and customer counts should be evaluated as a separate scenario to determine the post-project implementation VOLL.

The OEB explored several methods for developing VOLL estimates to support system hardening project BCAs. The OEB determined that the research effort and development time required to procure Ontario-specific VOLLs that are applicable to its diverse distributors using industry standard survey instruments would not align with the timelines and investment expectation for VASH. In lieu of conducting a provincial custom study, a publicly available source widely used across North America, the ICE Calculator[14], which provides VOLL estimates in $/outage by outage duration and customer class, was reviewed for adequacy of its application to Ontario.

Before the release of the ICE Calculator 2.0, the OEB compared ICE Calculator 1.0[15] VOLL outputs for various customer classes and outage durations after customizing the underlying model inputs to resemble those of a 2018 Toronto Hydro Value of Service Study that leveraged the same survey instrument as the ICE Calculator. While results from the ICE Calculator 1.0 outputs did not show an exact match to the 2018 Toronto Hydro Study, the relative comparability across these studies supported the use of the ICE Calculator as a low-cost and efficient option for many distributors.

In May 2025, Lawrence Berkeley National Laboratory released ICE Calculator 2.0, which incorporates enhancements to the underlying survey methodology and econometric modeling for estimating the VOLL across customer classes and outage durations. ICE Calculator 2.0 offers improved data inputs, updated modeling, and greater flexibility in customizing outage scenarios to reflect distributor-specific system characteristics, providing more robust and representative VOLL estimates in comparison with ICE Calculator 1.0 – particularly for longer-duration outages and a broader range of customer segments.[16]

Based on this research, the OEB expects that distributors will derive project and baseline VOLLs from the ICE Calculator 2.0, in the absence of custom distributor-specific VOLL studies. The ICE Calculator provides the ability to customize inputs to distributor-specific variables such as outage history and customer characteristics. However, it is important to note that while these inputs can be customized, the underlying econometric model itself – based on survey data from several U.S. utilities – remains fixed and cannot be altered.

[14] Lawrence Berkeley National Laboratory (LBNL) and Resource Innovations, Inc, ICE Calculator, 2025, Available: https://icecalculator.com/interruption-cost/config/select-states

[15] The OEB used the ICE Calculator 1.0 to conduct its comparison analysis to maintain consistency across survey instruments. In May 2025, Lawrence Berkeley National Laboratory published an ICE Calculator 2.0 containing updates to its survey model. The OEB requires distributors to use ICE Calculator 2.0 for developing VOLL estimates in the BCA.

[16] ICE Calculator 1.0 vs. 2.0: A Comparison of Estimated Customer Power Interruption Costs. Available: https://eta-publications.lbl.gov/sites/default/files/2025-06/ice_2.0_vs_1.0_comparison_may2025.pdf

The OEB establishes an acceptable starting point of using an ICE composite value based on input variables from the following states: New York, Michigan, Ohio, and Iowa. However, a distributor may choose any single or combination of states that they consider comparable to their own service territory as a starting point. Since the econometric model does not change with the selected state(s), the initial choice becomes irrelevant once a distributor customizes all the input variables to reflect its own characteristics. Therefore, distributors are expected to modify as many input variables as possible, depending on data availability, to ensure the results are representative of their specific context.

The ICE Calculator resource is free to access and provides an acceptable estimate while significantly reducing research effort on distributors. Other sources may be used, but they must be specified as dollars per outage, scaled for the total number of customers impacted for appropriate use, and account for variations in outage duration and customer class.

Model Calibration Inputs

An estimate of the benefits of any enhancement project requires an understanding of the historical outage frequency of existing plant to estimate the relative improvement in reliability to be gained. This variable is often developed from outage management system (OMS) data analysis. Calibration to historic outage data accounts for the likelihood that two or more assets will fail during the same weather event. For example, if a single windstorm damages 10 consecutive poles and their associated conductor, customers impacted by this event will experience a single outage. This modeling step aligns asset-specific annual failure frequency estimates from climate projections to a VOLL that is scaled by $/outage.

As historic annual outage events provide a baseline value necessary for all projects and are used to calibrate model results to a distributor's system observations, these inputs should reflect historical values for outage durations and the number of customers impacted by the climate perils that the project will address.

There are three primary considerations for the development of this BCA model input:

Historic years for average:

- Goal: Reduce variability in observed historic events to reasonably set starting point for projections.
- Ideal: Use most recent 5 years.
- Acceptable: Use most recent 3 years.

Applicable Cause Codes:

- Goal: Match modeled outages from climate perils in toolkit to observed historic outage subset.
- Ideal: Filter OMS to cause codes specifically related to the climate peril(s) targeted for mitigation.
- Acceptable: Filter OMS to available resiliency-related cause codes.

Project Locational Granularity:

- Goal: Match modeled outages from assets in project characterization to observed historic outage subset.
- Ideal: Use historic outages for the grid location being targeted for mitigation (substation, feeder, section, etc.).
- Acceptable: Use system wide value.

Project Asset Map

Projects are defined by the assets currently installed, what would have occurred in the absence of a resiliency project, and the proposed resilient asset alternative. These three categories are referred to as: baseline, code, and replacement.

- **Baseline assets.** The currently installed assets being considered for resiliency upgrades. For example, a utility might be evaluating a feeder with 100 Class 4 poles.
- **Code assets.** The asset class that would have been installed in the absence of resiliency considerations. This may differ from baseline assets in situations where the baseline assets would not be replaced like-for-like in a normal replacement. For instance, if a utility's standards have changed since the installation of the baseline assets, the new standard might be to build Class 3 poles instead of Class 4.
- **Replacement assets.** The resilient asset class that will be installed through the project. The replacement assets may be of a more robust type than baseline or code or be the same as code but be installed before the natural retirement of the existing assets (i.e., early retirement project type).

5. CHAPTER 5 FILING REQUIREMENTS - DISTRIBUTION SYSTEM PLAN INTEGRATION

The VASH Framework is an OEB policy that outlines the OEB's expectations for the methodologies distributors use to identify parts of their systems that are most vulnerable to extreme weather and evaluate system hardening options based on an objective benefit-cost framework.

Distributors will be required to include vulnerability assessment and system hardening analyses in their rebasing applications submitted in 2026 for 2027 rates. Changes to the filing requirements are expected to be effective for these applications on a best-efforts basis and will become mandatory commencing with applications for 2028 distribution rates, aligning with the expectations set out in the IEP Directive.

The OEB also recognizes that this is a new approach, and that Commissioners will take into account the time distributors have had to prepare the VASH-related components of their DSPs. This section delineates the expectations for integrating the results of the VASH Framework into the DSPs of distributors.

The OEB expects to adjust its filing requirements to align with the VASH Framework, ensuring that applications filed in 2026 for 2027 distribution rates are inclusive of this Framework. The following sections outline the Chapter 5 filing requirements for a Distribution System Plan.

5.1. VASH Applicability

The VASH Framework is intended to complement distributors' existing planning processes pertaining to the development of their DSP. As proposed in the DRRCE Report and endorsed by the 2023 Letter of Direction, the OEB expects that the "vulnerability assessments should be integrated into distributors' existing system planning and asset management practices." Integrating resilience considerations into these established processes should allow distributors to align resilience efforts with existing planning drivers such as asset renewal. This approach could help identify new options for dealing with end-of-life infrastructure while simultaneously creating additional value for customers by enhancing system resiliency. Ultimately, this approach further improves the holistic nature of a distributor's system planning.

The Filing Requirements state that, "a project or program involving two or more drivers associated with different categories should be placed in the category corresponding to the trigger driver." This same principle should be applied to system hardening projects. For projects that are only driven by system hardening, it should be categorized under System Service.

If any discrepancies occur between the VASH Framework and the OEB's Filing Requirements, the Filing Requirements will take precedence to ensure compliance and regulatory consistency.

5.2. Planning Process

This section outlines how the OEB expects distributors to integrate the VA and BCA of system hardening investments into their DSP. Distributors can choose between two approaches to conduct VA and BCA: Generic and Custom. The Generic Option, detailed in section 4.2, uses the structured VASH Framework and Toolkit developed by the OEB, offering standardized methodologies and guidance for sourcing input data. The Custom Option, described in section 4.1, allows distributors to use proprietary tools to develop tailored assessments, provided they meet specific criteria—such as using climate projection data, asset-based methodologies, and quantitative analysis of key inputs.

Distributors are expected to perform vulnerability assessments using either the Generic Option or the Custom Option provided by the OEB throughout their service area. The assessments should identify parts of the distribution system (i.e., locations and asset classes) that are most vulnerable to extreme weather and other climate-related events. Refer to Section 4 on how to perform this assessment.

The OEB expects distributors to identify the sources of data leveraged in the analysis as indicated in Section 4. For the Generic Option, if a distributor decides to use different or additional input data, it should discuss its choice of input data.

Distributors using the Generic Option are expected to upload, alongside the discussion of vulnerability assessment results in their DSP, a completed version of the VA Toolkit. Distributors using the Custom Option are also expected to file their custom vulnerability assessment study including the detailed calculations along with the discussion of results in their DSP.

After completing the VA, a distributor should conduct a pre-assessment to determine whether technically and economically feasible system hardening investments exist.

For example, as a part of the pre-assessment, distributors may:

- **Prioritize their analysis on the most significant vulnerabilities** identified in the VA—those with the highest probability of failure or greatest potential impact on customers—while applying professional judgment and operational experience to focus effort where it is most likely to yield actionable solutions. Distributors must document their prioritization method and how the distributor has chosen to define significant vulnerabilities (e.g., top 10% of vulnerable locations or top 10 projects). This ensures the analysis is targeted and manageable, while still allowing flexibility to examine additional areas where warranted.

- **Leverage historical data and operational experience** to identify areas of the system that have experienced repeated or severe impacts from extreme weather events.

- **Assess the results of the VA in conjunction with other relevant information**, such as asset condition assessments, historical performance, and alignment with other capital plans (e.g., system renewal or grid modernization). Distributors should consider resilience as a complementary planning driver – factoring in potential resilience benefits when evaluating investment options triggered by non-resilience drivers. This ensures resilience is proactively embedded in broader planning decisions.

- **Consider geographic and environmental factors**, such as vegetation density, terrain, or location that may influence the feasibility or urgency of hardening measures.

- **Evaluate the technical feasibility of system hardening solutions** to address the identified vulnerabilities, guided by a detailed understanding of the distribution system.

- **Document the rationale for project selection or exclusion**, including why certain vulnerabilities may not be addressed (e.g., no viable solution, cost-prohibitive).

Regardless of whether the pre-assessment identifies projects requiring a BCA, distributors are expected to document and explain their pre-assessment approach and submit it as part of their application to the OEB. This ensures transparency and demonstrates that vulnerabilities in the distribution system—particularly in the context of severe weather—have been thoroughly considered.

If a pre-assessment does not identify any economically plausible investments, the distributor doesn't need to complete a BCA. However, if the pre-assessment identifies economically plausible system hardening investments, a distributor must include the completed BCAs for those projects in their application. The BCAs must be filed along with the pre-assessment results. BCAs are to be prepared for each specific system need. BCAs are not to be applied on a system-wide basis. However, a single BCA may be used to support a program intended to address multiple, similar needs that may exist at different locations within the distribution system.

Distributors should also recognize that incorporating resilience considerations may shift the evaluation of investment options. Projects that may have previously been dismissed under traditional planning criteria could merit renewed analysis if they offer resilience benefits, potentially revealing more effective or forward-looking solutions to address system vulnerabilities.

Distributors using the Generic Option are expected to use the BCA Toolkit (Section 4.2.3) to demonstrate that the proposed system hardening investments are beneficial and they provide value to their customers. Distributors choosing to pursue Custom Option should ensure that the benefit-cost analysis methodology they use meets the criteria outlined in Section 4.1.

While the proposed benefit-cost analysis (BCA) methodology is primarily designed to evaluate capital investments in system hardening, it can also be applied to assess the cost-effectiveness of operational expenditures. Although the current version of the VASH Toolkit does not offer a plug-and-play solution for evaluating operational projects, distributors may choose to do so under the Custom Option. This flexibility allows for a broader application of the BCA framework, particularly where operational measures may offer meaningful resilience benefits.

5.3. Conclusion

The VASH Framework represents a significant step forward in embedding climate resiliency into electricity distribution planning in Ontario. The methodologies and expectations outlined in this report will be incorporated into Chapter 2 (Cost of Service) and Chapter 5 (Distribution System Plan) of the OEB's Filing Requirements for Electricity Distribution Rate Applications. These requirements will apply on a best-efforts basis for applications filed in 2026 for 2027 rates and will become mandatory for applications filed in 2027 for 2028 rates.

The OEB recognizes that the application of the VASH Framework may be refined over time. The OEB will monitor the implementation of these requirements and may amend the Framework as needed, based on experience gained through the review of distributor applications. This adaptive approach will ensure that the VASH Framework remains practical, effective, and aligned with the broader goals of system resilience and customer value.

6. APPENDIX A: STAKEHOLDER CONSULTATION PARTICIPANTS

Electricity Distributors
Alectra Utilities Corporation
Burlington Hydro Inc.
Canadian Niagara Power Inc.
Elexicon Energy Inc.
Entegrus Powerlines Inc.
ENWIN Energy Ltd.
Essex Powerlines Corporation
GrandBridge Energy Inc.
Hydro One Networks Inc.
Hydro Ottawa Capital Corporation
InnPower Corporation
London Hydro Inc.
Niagara-on-the-Lake Hydro Inc.
Oakville Hydro Electricity Distribution Inc.
PUC Distribution Inc.
Toronto Hydro-Electric System Limited
Utilities Kingston

Intervenors
Association of Major Power Consumers in Ontario
Building Owners and Managers Association
Coalition of Concerned Manufacturers and Businesses of Canada
Consumers Council of Canada
Energy Probe Research Foundation
Pollution Probe
School Energy Coalition, Toronto: Corporation
Vulnerable Energy Consumers Coalition, Toronto:

Other Organizations
Canadian Association of the Club of Rome
City of Toronto
Cornerstone Hydro Electric Concepts Association
CSA Group
Electrical Safety Authority
Electricity Canada
Electricity Distributors Association
Independent Electricity System Operator
Ministry of Energy and Mines
Power Workers' Union