# Burlington Distribution System Sustainability Plan

June 19, 2024

## Table of Contents

## List of Acronyms

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|---|---|
| APO | Annual Planning Outlook, which is completed by the IESO. |
| BEC | Burlington Enterprises Corporation, for the purpose of this report, BEC is used to refer to both BEC and Burlington Hydro |
| DC | Direct Current |
| EV | Electric Vehicle |
| IESO | Independent Electricity System Operator |
| LDC | Local Distribution Company |
| LNA | Land Needs Assessment |
| MURB | Multiple-Unit Residential Building |
| OEB | Ontario Energy Board |
| TS | Transformer Station |

# List of Figures



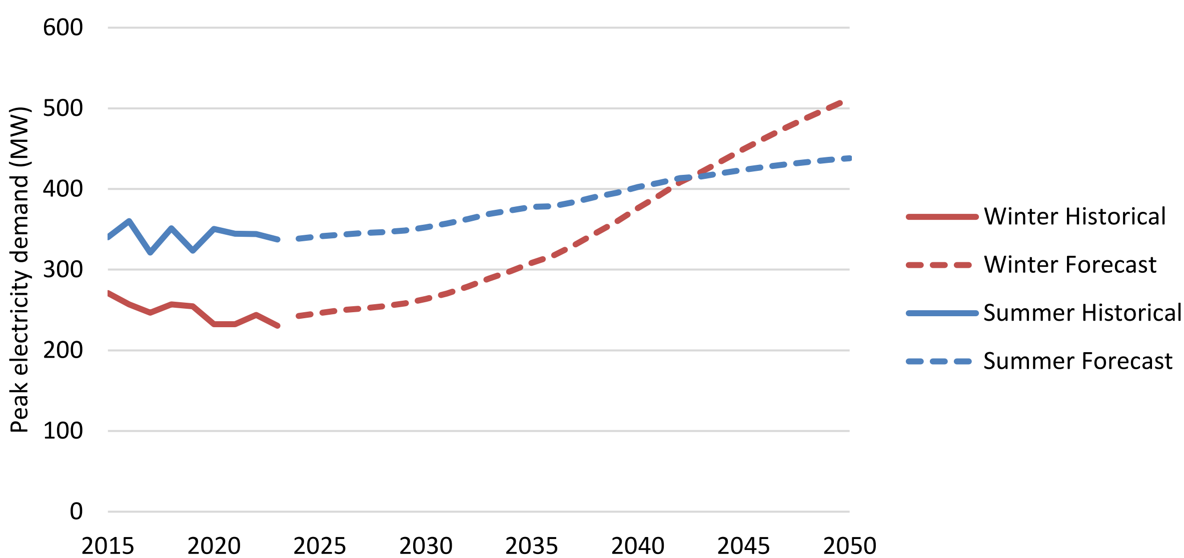
# List of Tables

# EXECUTIVE SUMMARY

Burlington Enterprises Corporation (BEC) is committed to supporting climate action, by ensuring it is well-positioned to address changes driven by electrification, decarbonization, climate change, growth and clean energy technology initiatives. This Sustainability Plan outlines how BEC is preparing its distribution system and operations for the future, identifying new infrastructure needs, adopting climate adaptation measures to improve resilience, and supporting community climate action. To prepare this Sustainability Plan, BEC defined a **Climate Action Scenario** for the purpose of developing a long-term electricity demand forecast. This scenario specifies a set of assumptions and conditions that influence electricity demand and is used to explore the effects of growth and electrification over time. The long-term electricity demand forecast predicts the timing, location, and magnitude of distribution system needs.

The Climate Action Scenario includes assumptions consistent with the City of Burlington's 2020 Climate Action Plan, the 2020 City of Burlington Official Plan, the 2022 Halton Region Land Needs Assessment, the Independent Electricity System Operator's (IESO) Annual Planning Outlook, and other studies.

**Seasonal Peak Electricity Demand Forecast for BEC's Distribution System per Climate Action Scenario**




As shown in the figure above, under the Climate Action Scenario summer electricity peak demand grows slowly in the near term at less than 1% per year. Electricity demand growth accelerates after 2030. Population and employment growth are largely offset by energy efficiency efforts in the near term, with electric vehicles (EVs) and fuel switching to electric heat (i.e., heat pumps) leading to incremental electricity usage in the longer term. By the 2040s, winter peak electricity demand surpasses summer peak electricity demand. Overall, summer peak electricity demand is expected to grow from approximately 337 MW in 2023 to 438 MW in 2050, while winter peak electricity demand is projected to increase from approximately 231 MW in 2023 to 512 MW in 2050.

This Sustainability Plan also discusses the important role BEC has in ensuring a climate resilient distribution system. Climate change is causing profound changes to seasonal and annual weather patterns in terms of precipitation, temperature, and numerous other variables. It is also increasing the frequency, intensity, and duration of extreme weather events. These changes can pose significant operational risks to distribution systems, potentially damaging infrastructure and disrupting service delivery. The extreme events have ramifications throughout the economy, disrupting businesses and incurring costs for repairs and added insurance. BEC has undertaken actions to improve the resilience of the grid, including investing in grid hardening and updating emergency action plans.

In addition to the range of initiatives BEC has undertaken to enable climate action, it has developed plans and associated actions, informed by the results of its analysis, to continue to support customers as they adopt clean energy technologies.

**Near-Term Plan (2025-2030)**

*Action 1: Address Existing Overloading and Aldershot Growth Centre*

To meet forecasted electricity demand through 2030, two near-term investments are required for parts of the distribution system that are currently at or above their planning capacity:

- Expanding 27.6 kV feeders south from Tremaine Transformer Station (TS) to relieve constraints on the 280M8 feeder, Palermo TS feeders, and Bronte TS.

- Extending feeders from Burlington TS to address growth in Aldershot, with tie points and switches to transfer load.

*Action 2: Enhance Electricity Demand Forecasting and Analytics for Future Planning Cycles*

To prepare for EV adoption and other electricity demand growth, BEC will enhance its data analytics capabilities and improve system visibility, using granular analytics on historical data to track electrification trends and improve investment planning. BEC will explore voltage conversion, long-term investment strategies, and regularly update its electricity demand forecast to address the integration of EVs and electric space heating, ensuring infrastructure investments support demand growth. In addition, BEC will continue to implement best practices related to distribution sector resilience.

*Action 3: Continue Enhancing Distribution Operations with Grid Modernization Technology*

BEC will replace its current Outage Management Systems later in 2024 and has included in its capital plan additional investments in distribution automation and sensing technologies. Grid modernization solutions will continue to be evaluated to improve system resilience, reduce outage time, and enable operational flexibility.

*Action 4: Enable Electric Vehicle Charging*

BEC will develop partnerships and educational programs to facilitate EV charger installations, collaborate with Burlington Transit and large commercial customers on fleet electrification, and implement best practices from the Ontario Energy Board’s (OEB’s) Electric Vehicle Integration Initiative.

*Action 5: Continue Engaging with Stakeholders*

BEC will continue to engage with stakeholders to identify and satisfy customer needs, ensuring the connection of EV chargers and other clean energy technologies, and exploring options for customer-facing programs and non-wires solutions.

**Medium- and Long-Term Plan (Years 2030-2050)**

In the 2030s, electricity demand growth, attributed largely to EV charging, will necessitate further investment in distribution infrastructure. The 27.6 kV system will need upgrades, including feeder extensions. Continued management of residential electricity demand on the 4.16 kV and 13.8 kV systems will be necessary, with voltage conversion to 27.6 kV anticipated for some feeders. Additional feeders from Tremaine TS to load centers south of the QEW, reinforcement of 27.6 kV feeders in Aldershot and downtown Burlington, and load transfers from Burlington TS to Cumberland TS will likely be required.

In the 2040s, increased demand from space heating electrification may lead to winter peaks and electricity demand growth exceeding 3% per year. During this period BEC may require more high-voltage transformer station capacity. Collaborating with Hydro One and the IESO, BEC aims to align with the City of Burlington's Climate Action Plan. Feeder investments would continue, with new 27.6 kV feeders for dense areas and areas near transit stations (i.e., mobility hubs) and continued upgrade and voltage conversion in the 4.16 kV and 13.8 kV networks.

BEC must consider regulatory funding mechanisms to address these required investments, including recovery in between rebasing applications, which typically occurs every 5 years. The OEB allows "incremental capital module" applications for large interim projects, though recovery is uncertain. In addition, BEC must evaluate non-wires solutions and demonstrate cost-effective system planning.

**Conclusion**

BEC is well-positioned for the community's transition to a low-carbon future, supporting clean choices and reducing greenhouse gas emissions through continuous grid modernization and long-term sustainability efforts. Engaging with the City of Burlington and community members has provided invaluable insights, helping BEC to shape its strategies and fostering ongoing collaboration as it implements the plan's actions. BEC remains committed to adapting to new challenges, leveraging innovative technologies, and ensuring a resilient, efficient, and environmentally friendly energy system for the City of Burlington.

# 1. INTRODUCTION

Burlington Enterprises Corporation (BEC)[1] recognizes it has a pivotal role in the energy transition and supporting customers as they take action to reduce their carbon emissions. The energy transition involves electrifying the economy, integrating clean energy sources such as solar energy, and adopting energy-efficient technologies and practices.

BEC is responsible for delivering electricity safely, reliably, and affordably to customers. BEC achieves this by prudently planning, investing in, and maintaining distribution system assets to meet peak electricity demand. Additionally, BEC ensures that there is sufficient distribution system capacity to connect new homes and businesses, oversees the management of connection requests for new electric vehicle (EV) charging stations, solar energy systems, and battery systems, and supports the delivery of energy efficiency programs. Furthermore, with the increasing frequency and impact of extreme weather events due to climate change, BEC must also ensure that its distribution infrastructure and services are climate resilient.

The City of Burlington has committed to being a net carbon-neutral community by 2050 in its Climate Action Plan. BEC is dedicated to supporting the City of Burlington's climate goals and ensuring it is prepared for these changes.

To address changing needs as a result of the energy transition, climate goals and climate change, BEC developed a Sustainability Plan to:

- Study electricity supply and electricity demand up to 2050 and develop strategies to continue evolving its electricity distribution infrastructure to meet electrification needs.
- Ensure continued resilience in the face of more frequent extreme weather events.

BEC engaged Power Advisory[2] to assist in developing this Sustainability Plan. This includes:

- creating a Climate Action Scenario and accompanying electricity demand forecast aligned with the climate action initiatives outlined in the City of Burlington's Climate Action Plan,
- identifying distribution system requirements to accommodate anticipated electricity demand growth (from both climate action and population growth), and
- outlining planned actions and next steps. These actions encompass measures aimed at improving climate resilience and supporting customers through the energy transition.

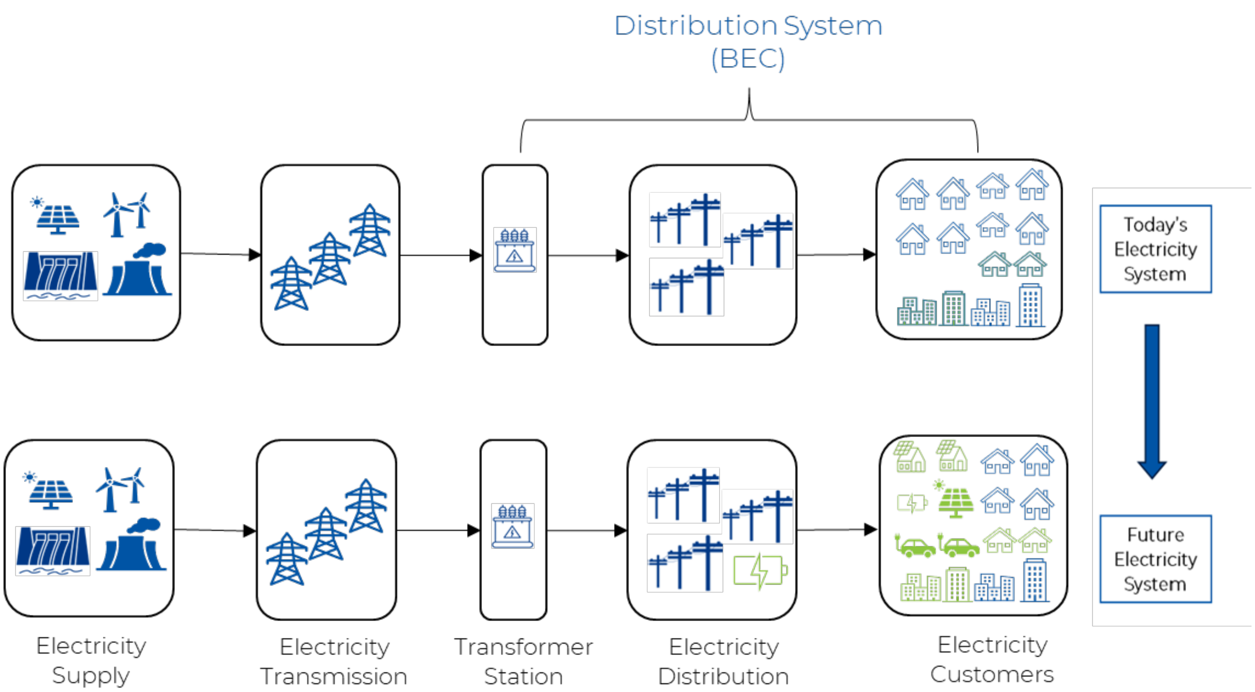
[1] Throughout this report, BEC will refer to BEC and Burlington Hydro.

[2] Power Advisory Website. https://www.poweradvisoryllc.com/

# 2. OVERVIEW OF SCOPE AND APPROACH

Electricity is generated across the province and transmitted across the bulk system to local distribution systems, shown in the figure below. Each community has a local distribution company (LDC) that delivers electricity from the bulk system through the distribution system to homes and businesses. This study is focused on the impacts of climate action initiatives on the distribution system that is owned and operated by BEC.

**Figure 1. Impact of Climate Action on the Distribution System**




Many climate action initiatives impact how, and how much, electricity is used by customers. For example, customers can increase their electricity usage if they charge EVs at home or convert their natural gas heating systems to electric or dual fuel heat pumps. On the other hand, customers can potentially decrease their electricity usage from the distribution system if they install solar energy systems or use energy more efficiently. Furthermore, battery energy storage systems are becoming increasingly available to customers and LDCs, offering many benefits, including the ability to store electricity for use during peak periods and support the reliability and resilience of the electricity supply. However, as this is new technology, its deployment on the distribution system needs to be thoughtfully integrated.

As electricity usage increases, BEC must ensure that grid infrastructure is scaled to meet customer electricity demands. In addition to electrification, potential changes that would increase electricity demand include population growth and climate change impacts on weather (i.e., more extreme heat). Moreover, climate change is leading to an increase in extreme weather events, making the distribution system more vulnerable to damage and customers more likely to experience outages. The complexity of these changes will require an evolution in the day-to-day operations of the distribution system.

Studying the impacts on the distribution system consists of scenario development, electricity demand forecasting, determining system needs, considering options to meet system needs, and making investment decisions. Each of these elements are considered within this report. To complete this analysis, BEC developed a ***Climate Action Scenario*** that is used for the purpose of creating an electricity demand forecast consistent with the implementation of expected climate action initiatives in the City of Burlington. This scenario specifies a set of assumptions and conditions that influence electricity demand and is used to explore the effects of growth and electrification over time. The long-term electricity demand forecast predicts the timing, location, and magnitude of distribution system needs. (See Section 4 for more details on the Climate Action Scenario).

In addition to the impact from the adoption of climate initiatives, this Sustainability Plan considers changes in electricity usage due to population and employment growth. It describes how BEC is preparing the distribution system for the future, including identifying new electricity infrastructure, adopting and investigating climate adaptation measures, and supporting climate action in the community.

BEC recognizes that this Sustainability Plan is set within the broader context of Ontario's energy sector which is preparing for economy-wide decarbonization and the transition away from fossil fuels. Ontario's electricity demand is expected to increase across all sectors; residential, commercial, industrial, agricultural, and transportation over the next 25 years. According to the IESO's 2024 Annual Planning Outlook (APO), Ontario's net annual energy electricity demand is projected to grow from 154 terawatt-hours (TWh) in 2025 to 245 TWh in 2050; a 59% increase, with an average annual growth rate of 1.9%. The most rapid growth is expected in the transportation sector due to electrification, with net annual energy electricity demand projected to rise from 2 TWh in 2025 to 44 TWh in 2050. The number of light-duty EVs on Ontario's roads is projected to increase from nearly 400,000 in 2025 to 11.5 million in 2050, driven largely by the Government of Canada's 2023 regulations requiring manufacturers and importers to meet annual zero-emission vehicle sales targets.

# 3. STAKEHOLDER ENGAGEMENT

Involving BEC's customers, community members, and other stakeholders in the development of this Sustainability Plan was an essential part of the process. BEC's stakeholder engagement included:

- Coordinating with City of Burlington's staff to ensure alignment with scenario development.
- Delivering a presentation to Burlington Climate Action Stakeholder Team[3] members and seeking their feedback on the proposed approach.
- Engaging with a group of electricity sector representatives to receive additional advice on climate action and its impacts on the distribution sector.
- Conducting a survey with the community to solicit feedback and determine their priorities, and held a public webinar on April 25, 2024, to inform community members about the process and development of the Sustainability Plan.

The City of Burlington's staff provided guidance to BEC regarding the development of the Climate Action Scenario, including key assumptions pertaining to the Climate Action Plan, population growth, housing development, and economic development. The staff also participated in the presentation to the Burlington Climate Action Stakeholder Team members. Feedback from the Burlington Climate Action Stakeholder Team confirmed the growing momentum within the City of Burlington for the adoption of EVs and heat pumps. Current initiatives, such as the Better Homes Burlington pilot, were referenced as examples.

BEC engaged with representatives from the electricity sector, including the IESO, Electricity Distributors Association, Electrical Safety Authority, Plug'n Drive, and the Advanced Energy Management Alliance. Key findings from the discussions with these representatives include:

- **Data challenges:** Installations of EV chargers and heat pumps without permits make it difficult to track installations; reliable data on electrification is needed to inform system planning and ensure capacity is available for future growth.
- **Education needs:** There is a significant effort required to educate customers so that they feel comfortable switching to electric options Informing and educating customers will be instrumental in meeting climate action goals and implementing BEC's sustainability plan.
- **Collaboration opportunities:** There is a significant opportunity to collaborate to support customers in the energy transition, and BEC is viewed as a potential enabler and partner of customer endeavors and initiatives supporting the energy transition.

[3] The Burlington Climate Action Stakeholder Team consists of representatives from BOMA Canada, BOMA Toronto, Burlington Green, Burlington Hydro, the City of Burlington, Enbridge Gas, Halton Catholic District School Board, Halton District School Board, Halton Region, McMaster University, Mohawk College, Realtors Association of Hamilton-Burlington, Sustainability Leadership, and West End Home Builders' Association.

- **Non-wires solutions:** Underscored the emerging and innovative solutions that could be leveraged by BEC, such as demand response programs, to offset or defer the need for traditional distribution system assets.

- **Climate Resilience:** Reaffirmed the need to ensure climate resilience, with a particular emphasis on the possibility of flooding damage and severe storms.

Feedback from this group of electricity sector representatives informed the near-term action items of this plan, including BEC's role in enabling climate action in the community (i.e., address gaps in customer awareness related to electrification), and the need for ongoing partnerships with the community (i.e., addressing data gaps.)

Residents of the City of Burlington also provided meaningful input through their survey responses. While the results are not statistically significant, and as such are not necessarily representative of BEC's customer base, most who did participate indicated that climate action and clean energy initiatives were very important to them.

Additionally, most respondents indicated that they were at least somewhat familiar with carbon neutrality and were taking some actions to support it. The installation of thermostats and other energy-saving devices were the most common engagement in climate action initiatives, while the purchase of EVs (either already or soon) was the next most common. Few respondents are currently considering solar and energy storage. The largest barrier to participation in climate action initiatives is cost, followed by a lack of information and too many requirements or effort. In terms of priorities for BEC's Sustainability Plan, maintaining reliability and resilience of the distribution system was rated as a top priority by respondents. Secondary priorities were enabling renewable energy connections, enabling electrification, and supporting energy efficiency programs. The main advice provided by respondents was a desire to accelerate the implementation of climate action initiatives and reduce barriers. Furthermore, respondents advised continued transparency and engagement with the community during the implementation of the Sustainability Plan.

Participation and feedback received from community members and electricity sector stakeholders supported BEC's scenario development, assumptions, and proposed next steps discussed in this plan.

# 4. DEVELOPING THE CLIMATE ACTION SCENARIO

To produce an electricity demand forecast, the first step is to establish a forecast scenario that defines a set of assumptions about future conditions affecting electricity usage. For this Sustainability Plan, BEC developed a Climate Action Scenario that describes assumptions resulting from various climate action initiatives over time, including an increase in EV charging, the installation of heat pumps, and improvements in energy efficiency.

The assumptions within the Climate Action Scenario are informed primarily by the City of Burlington's 2020 Climate Action Plan,[4] the 2020 City of Burlington Official Plan,[5] and the 2022 Halton Region Land Needs Assessment (LNA).[6]

The Climate Action Plan outlines a low-emissions future scenario and the City of Burlington's efforts to become a net carbon neutral community by 2050. The Climate Action Plan identifies a low-carbon energy pathway, and it includes community member interests and stakeholder engagement. Further, it builds on the Climate Emergency Declaration to set direction for the City of Burlington to mitigate greenhouse gas emissions and reduce energy consumption.

Using a "reduce, improve and switch" framework, the Climate Action Plan focuses first on reducing energy consumption, then improving energy efficiency, and finally switching remaining fossil fuel end uses to alternative energy sources like electricity. BEC adopted the same framework when developing assumptions for the Climate Action Scenario.

While there are no specific energy efficiency targets in the Climate Action Plan, three programs are outlined targeting new buildings, deep energy retrofits, and industrial energy efficiency. To reflect the ambitious energy efficiency goals in the Climate Action Plan, future energy efficiency in the Climate Action Scenario is consistent with the full achievable potential from Scenario B of the 2022 Refresh of the IESO's 2019 Achievable Potential Study.[7] Achievable potential refers to the amount of energy efficiency that is technically feasible, cost-effective, and likely to be implemented given non-financial factors like consumer behaviour.

Several other assumptions in the Climate Action Plan have significant effects on electricity demand growth and informed the Climate Action Scenario. A shift to denser neighbourhoods and greater use of transit, cycling, and walking as alternatives to personal vehicles affects residential demand and, later in

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[4] City of Burlington. (February 2022). Climate Action Plan. https://burlingtonpublishing.escribemeetings.com/filestream.ashx?DocumentId=39597

[5] City of Burlington. (2020-09-30). Burlington's Official Plan. https://www.burlington.ca/en/planning-and-development/resources/Official-Plan/Burlington-Official-Plan-2020-Full.pdf

[6] Halton Region. (February 2022). Land Needs Assessment. https://www.halton.ca/getmedia/c4bc5320-ca9a-42c0-9d78-50e73d6ad504/LPS-ROPR-PGC-Report-Appendix-A-Land-Needs-Assessment.aspx

[7] IESO. (2022-09-14). Aggregated Potential Data Sheets. https://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/APS/APPENDIX-1-Forecast-Potential-and-Consumption-2022.xlsx

the forecast, EV charging demand. Rapid fuel switching to EVs and heat pumps towards the 2050 net carbon neutral target adds significant new sources of electricity demand. The Climate Action Plan contemplated a mix of heating sources including solar heating, so electric heat pumps are not used for 100% of heating needs.

While the Climate Action Plan includes substantial growth of solar generation and use of electricity storage, due to relatively low rates of adoption and limited programs currently supporting widespread adoption of solar, the Climate Action Scenario did not emphasize solar and storage. That said, solar, storage, and other distributed energy resources (DERs) are considered as options to meet power system needs. Further, this Sustainability Plan also addresses the measures to support customer adoption of solar and storage technologies.

The Climate Action Scenario also includes assumptions on the pace of future population, housing, and employment growth. Based on recommendations from City of Burlington's staff, BEC referred to the most recent Halton Region LNA to develop annual housing and employment forecasts. The City of Burlington's Official Plan and other sources such as development applications also informed the spatial distribution of future growth.

# 5. ELECTRICITY DEMAND FORECAST UNDER THE CLIMATE ACTION SCENARIO

A long-term electricity demand forecast is used to anticipate the timing, location, and magnitude of needs in the distribution system that would emerge under the Climate Action Scenario, described in Section 4. Proactively forecasting distribution system needs under such Climate Action Scenario helps BEC plan system investments which enable electrification-driven growth. The forecast methodology adds estimates of expected electricity demand growth in residential, commercial, and transportation sectors to historical electricity demand in a process that is comparable to the electricity demand forecast methodology used for the IESO's APOs. In addition to preparing a system-wide electricity demand forecast, BEC prepared demand forecasts for each of the 34 feeders operating at 27.6 kV that serve the City of Burlington to identify any localized capacity constraints.

## 5.1 Electricity Demand Forecast Methodology

The "bottom-up" forecast estimates energy consumption and peak electricity demand for the residential, commercial, and transportation sectors separately.

- Residential consumption is based on forecasts for household growth, household type (e.g. single family vs. multi-family), and consumption per household.

- Commercial consumption is based on forecasts for employment and consumption per employee. In this forecast, manufacturing and other industrial end uses are considered part of the commercial sector.

- For both the residential and commercial sectors, heating-specific consumption is modelled separately from all other electrical consumption to account for fuel switching from fossil fuels to heat pumps.

- The transportation sector accounts for the electricity required for personal light-duty EVs, medium- and heavy-duty vehicles primarily for commercial use, and transit electrification.

Forecasts for population growth, employment growth, and transportation needs for the City of Burlington are downscaled to the 34 areas normally served by each 27.6 kV feeder, enabling feeder-specific electricity demand forecasts. The downscaling process accounts for the unique characteristics of different parts of the City of Burlington and plans for future urban development.

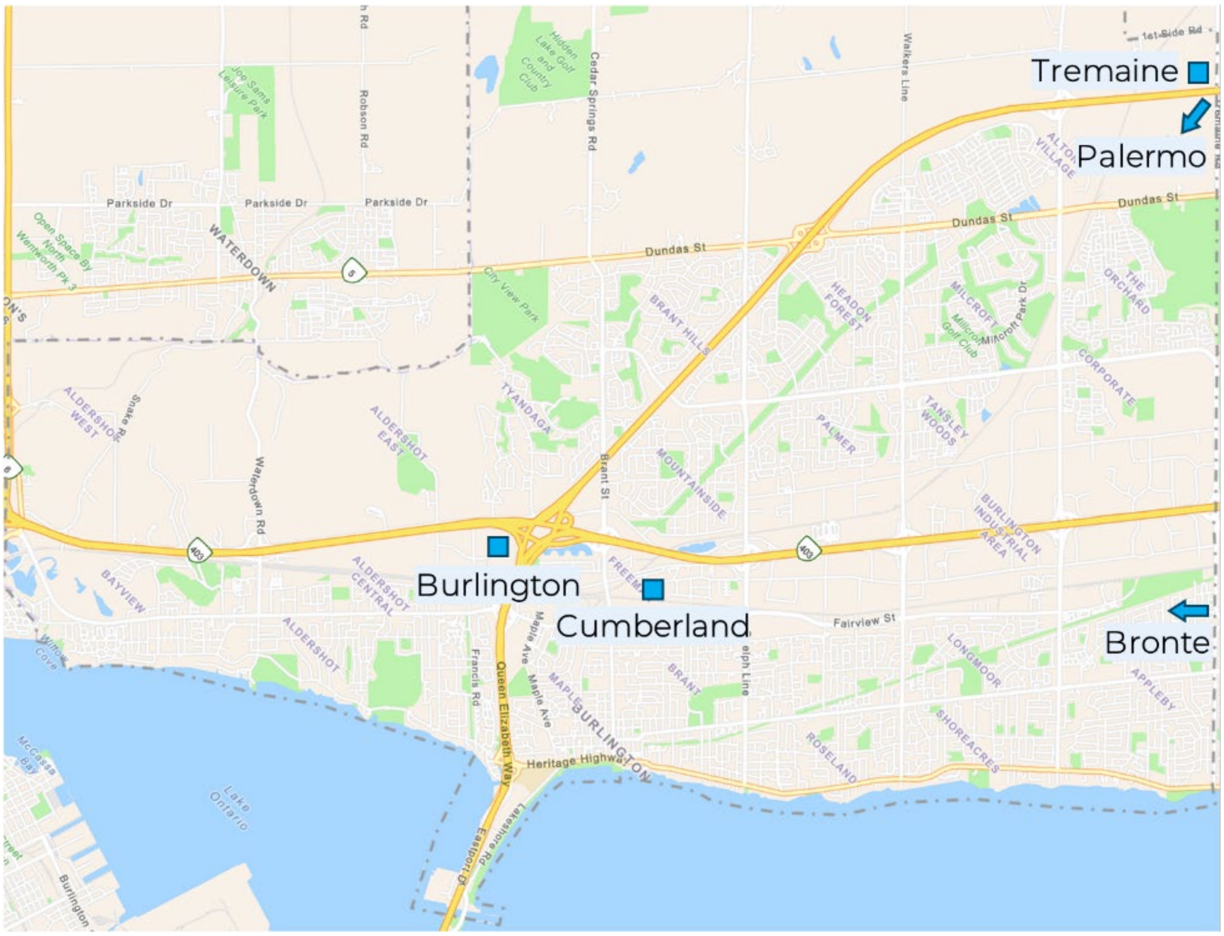
Energy consumption forecasts for the residential and commercial sectors are converted to peak electricity demand using historical peak electricity demand to energy ratios. Peak electricity demand to energy ratios for EVs and space heating are derived from a review of electricity planning studies.

For a historical base year, feeder electricity demand at the coincident peak hour for BEC's system is used as the starting point of the forecast. The base year selected for this forecast was 2022. The absolute growth in the "bottom-up" electricity demand forecast each year is then added to this starting point.

## 5.2 Distribution System Overview

BEC's distribution system is supplied by five transformer stations owned by Hydro One (Figure 2)[8]. Supply from Burlington TS and Cumberland TS is used exclusively by BEC, while supply from Tremaine TS, Palermo TS, and Bronte TS is shared with neighbouring LDCs. Palermo TS and Bronte TS are not physically located in the City of Burlington.

**Figure 2. Transformer Stations Supplying BEC's Distribution System**

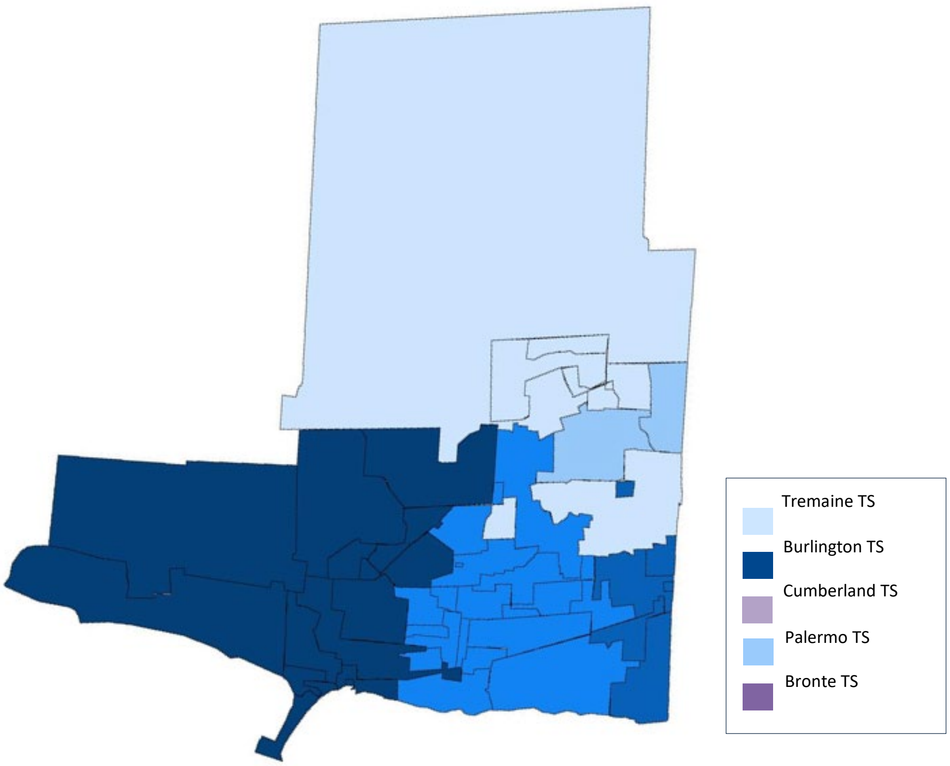



BEC owns and maintains 34 distribution feeders which operate at 27.6 kV and emanate from the five Hydro One-owned transformer stations. Some customers are served directly at this voltage, while others are connected to the lower primary voltage systems operating at 13.8 kV and 4.16 kV. To step voltage down to these lower primary voltages, BEC owns 32 municipal stations.

[8] City of Burlington. (2022). Map of Hydro One Transformer Stations. https://burlington.maps.arcgis.com/home/index.html

Energy consumption and peak electricity demand is forecasted for each of the 27.6 kV feeders (Figure 3), assuming the same system configuration as the 2022 base year.

**Figure 3. Service Areas by Transformer Station and 27.6 kV Feeder**




## 5.3 Modeling Assumptions for the Climate Action Scenario

The following sub-sections provide additional detail regarding the modeling assumptions for housing and employment growth, energy efficiency, and electrification per the Climate Action Scenario used by BEC to develop the electricity demand forecast. These assumptions are the main drivers of change in electricity demand, impacting the long-term forecast and include:

- Household and employment growth
- Energy intensity
- Electrification (EVs and heat pumps)

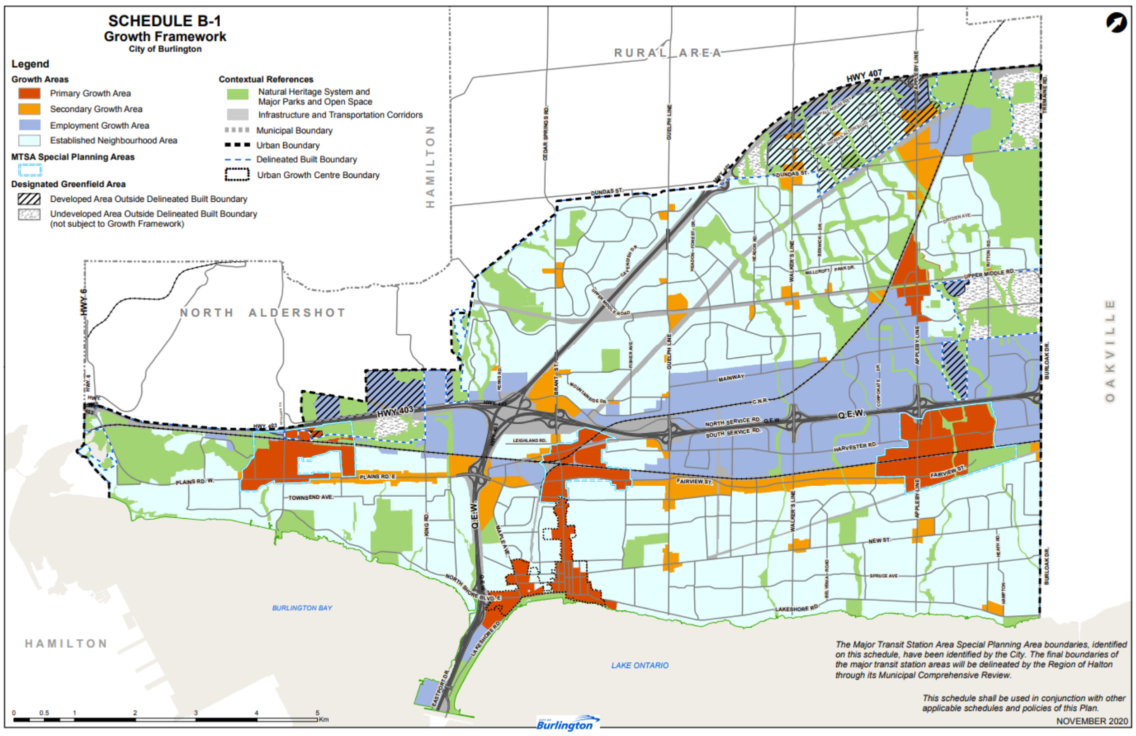
### 5.3.1 Household and Employment Growth

Data from the 2021 census was used to characterize the current housing mix served by each 27.6 kV feeder. Current employment for each feeder was estimated based on historical non-residential electricity demand. As discussed in Section 4, household and employment growth forecasts are based on the Halton Region LNA from February 2022.

**Table 1. Population and Employment Forecasts for the City of Burlington**

| Year | Population | Multi-Unit Residential Buildings (MURBs)[9] | Other Households | Employment |
|---|---|---|---|---|
| 2021 | 193,500 | 19,214 | 54,911 | 98,500 |
| 2031 | 216,800 | 27,826 | 57,262 | 106,800 |
| 2041 | 240,500 | 37,075 | 59,535 | 115,300 |
| 2051 | 265,000 | 45,979 | 61,784 | 124,900 |

**Figure 4. Growth Framework for City of Burlington**




Forecasted growth was downscaled to feeders based on planned urban development. Short-term growth was informed by active development applications and connection requests received by BEC for housing developments and commercial buildings. The geographic pattern in current development

[9] In the LNA, the term "apartment" is used to refer any households (condominium or purpose-built rental) that are stacked vertically, other than accessory units. This household type is described as a MURB in this report.

applications was generally consistent with the long-term growth framework in the City of Burlington's Official Plan (Figure 4).

Employment growth (blue areas in Figure 4) is expected mainly in the corridor adjacent to the Queen Elizabeth Way (QEW) and east of Guelph Line. There is also vacant land at Bronte Creek Meadows and along Highway 403 west of Highway 407 that is designated for employment growth.

Approximately 80% of household growth is expected to be from MURBs. There are very few sites available for greenfield housing development in the City of Burlington. New high-density housing will be concentrated mostly in Primary Growth Areas (red areas in Figure 4). The Primary Growth Areas include three Major Transit Station areas near Aldershot, Burlington, and Appleby GO transit rail stations, the downtown centre along Lake Ontario, and the uptown centre at Appleby Line and Upper Middle Road.

Table 2 shows the resulting growth expectations to 2050 by TS. Employment growth is expected to align with the existing distribution of electricity demand between stations. Household growth is more concentrated in the downtown and Aldershot areas currently served by Burlington TS.

**Table 2. Current Electricity Demand and Growth to 2050 per the Climate Action Scenario, by Station**

| Parameter | Burlington TS | Cumberland TS | Palermo TS | Bronte TS | Tremaine TS |
|---|---|---|---|---|---|
| **Share of 2022 Electricity demand** | 36% | 27% | 7% | 10% | 19% |
| **Share of 2022 Population** | 42% | 27% | 6% | 8% | 18% |
| **Share of Household Growth** | 58% | 20% | 7% | 5% | 10% |
| **Share of Employment Growth** | 37% | 28% | 7% | 9% | 18% |

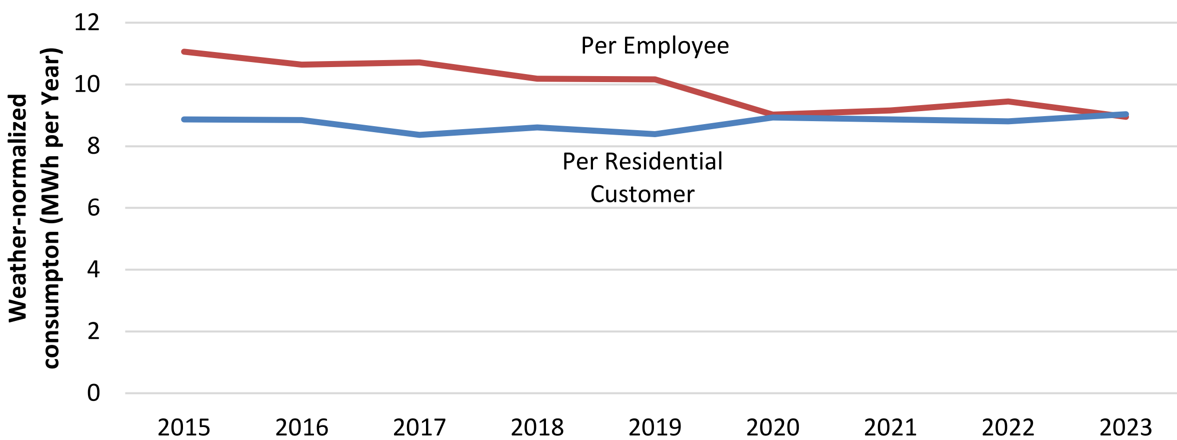
### 5.3.2 Energy Efficiency

Energy intensity is the amount of electricity demand per household or per employee; efficiency improvements reduce energy intensity, enabling the same population to be served with less energy. Historical energy intensity (kWh and kW per household and per employee) is calculated based on historical consumption data. Energy intensity is forecasted using assumptions on future energy efficiency improvement and, for heating, future climate change.

Residential or per household electricity demand for single-family and row houses was based on weather-normalized consumption of residential customers.[10] Residential consumption was assumed to vary by housing type (single-family, row house, and MURB) according to the same ratios included in the IESO's 2021 APO.[11] On average, each MURB household consumes about half as much electricity as a single-family home.

Commercial electricity demand is defined as electricity demand for all consumers other than households and EV charging. Employment is used as an indicator of commercial electricity demand. The seasonal peak demand and total energy consumption for non-residential General Service customers is used to develop per-employee energy intensity for the base year. Historical residential and commercial electricity demand is further disaggregated into heating and non-heating subsectors using historical temperature-dependence.

**Figure 5. Historical Energy Intensity**




As discussed in Section 4, the 2022 Refresh of the IESO's 2019 Achievable Potential Study is used to forecast future energy efficiency improvement per household and per employee relative to the 2022 base year (Figure 6).

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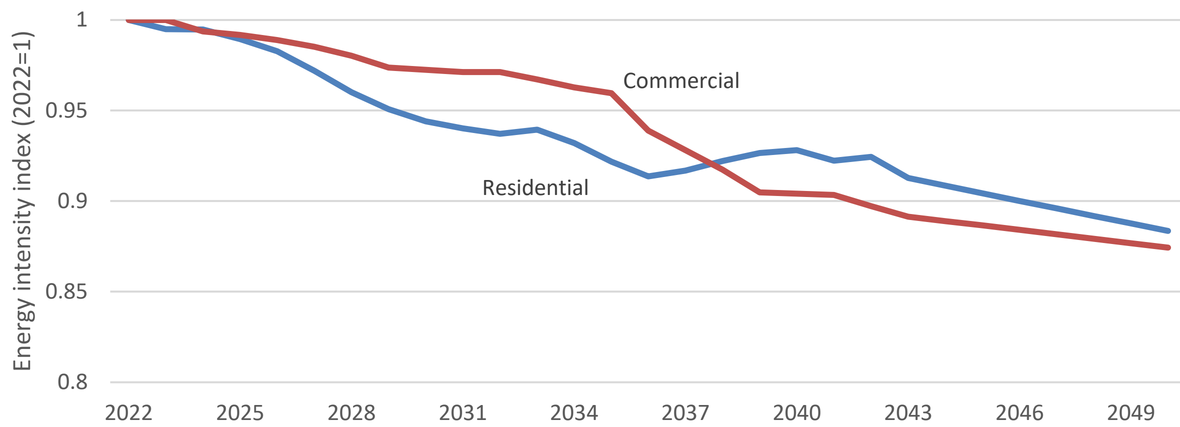
[10] Electricity consumption for heating and cooling can vary substantially from year to year depending on the weather. Weather-normalization is a process to estimate the electricity that would have been consumed if weather had been consistent with a long-term average.

[11] IESO. (December 2021). Annual Planning Outlook. https://www.ieso.ca/-/media/Files/IESO/Document-Library/planning-forecasts/apo/Dec2021/Demand-Forecast-Module-Data.ashx

**Figure 6. Energy Intensity Forecast**




A steady reduction in heating electricity demand due to climate change – approximately 8% by 2050 compared to current levels – is also modelled, consistent with the SSP2-4.5 climate scenario.[12]

### 5.3.3 Electrification

Electrification considered as part of the Climate Action Scenario includes adoption of EVs and heat pumps, as described below.

**Electric Vehicles**

Assumptions for future EV market share are consistent with federal EV sales share targets, including 100% of new personal vehicle sales being zero-emissions by 2035. This is slightly slower than the 100% of sales by 2030 adoption rate assumed in the Climate Action Plan. Different neighbourhoods of the City of Burlington are adopting EVs at different rates; these differences are considered when forecasting future EV sales. Feeder areas are sorted into four categories based on current level of EV adoption, and a separate EV forecast was produced for each. Areas that currently have a higher penetration of EVs are projected to continue to have faster adoption of EVs.

The light-duty EV forecast includes a reduction in number of personal vehicles per person consistent with mode share targets in the City of Burlington Integrated Mobility Plan, September 2023.[13]

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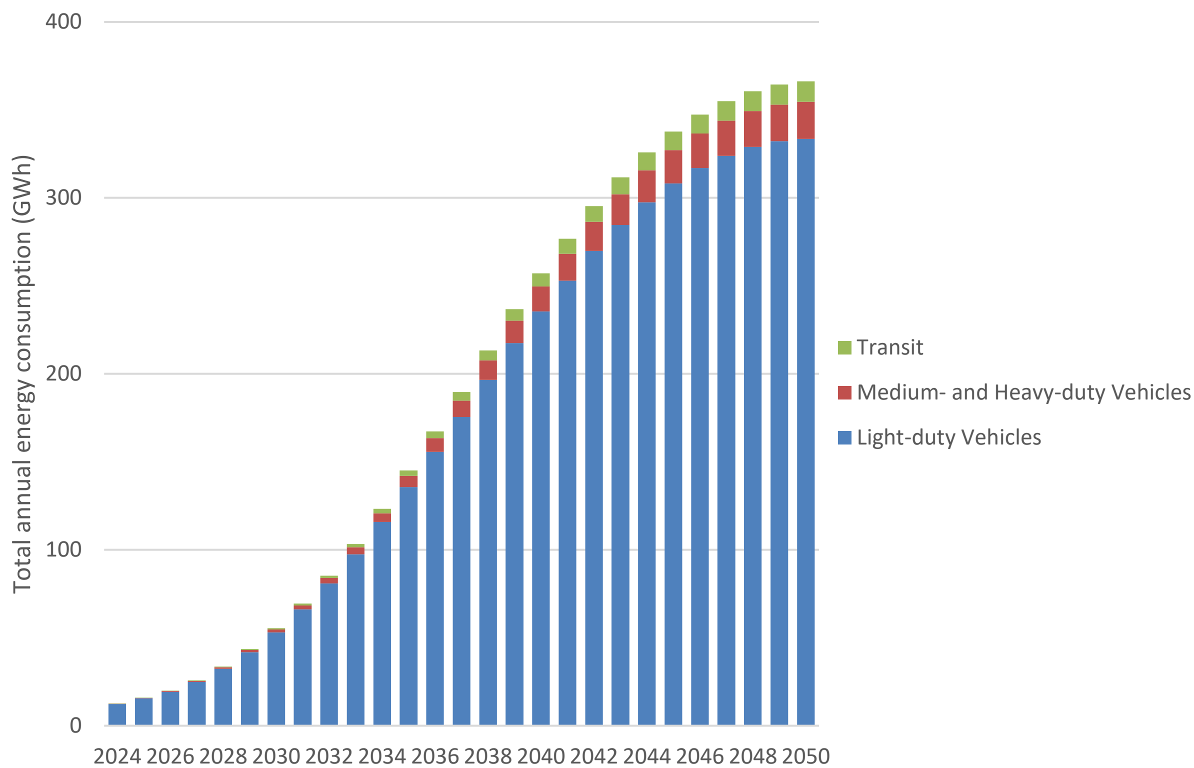
[12] Shared Socio-economic Pathways, Scenario 2, 4.5 W/m$^2$ of radiative forcing by 2100. Climate Data for a Resilient Canada: https://climatedata.ca/

[13] City of Burlington. (September 2023). Integrated Mobility Plan. https://www.getinvolvedburlington.ca/imp

The number of EVs currently in use is grounded in registration data by forward sortation area published by Ontario's Ministry of Transportation,[14] and current market share is derived from historical sales data.[15]

Light-duty vehicle energy consumption was estimated based on vehicle population data from Statistics Canada, vehicle kilometers travelled data from the Transportation Tomorrow Survey,[16] and a vehicle efficiency assumption consistent with IESO forecasts. Total electricity demand from medium-and-heavy-duty vehicles is assumed to be 5% of electricity demand from light-duty vehicles, which is consistent with the assumption used in the IESO's 2022 APO for electric mobility other than light-duty vehicles. The forecast also includes gradual conversion of Burlington Transit's fleet of buses to electric at the same pace as other medium-and-heavy-duty vehicles, and a greater number of buses per capita to support an increasing mode share for transit.

**Figure 7. Electric Vehicle Forecast per Climate Action Scenario**




[14] Government of Ontario. (Data from 2022-24). Electric Vehicles in Ontario. https://data.ontario.ca/dataset/electric-vehicles-in-ontario-by-forward-sortation-area

[15] Statistics Canada. (2024-03-12). New Zero-Emissions Vehicle Registrations Quarterly. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002501

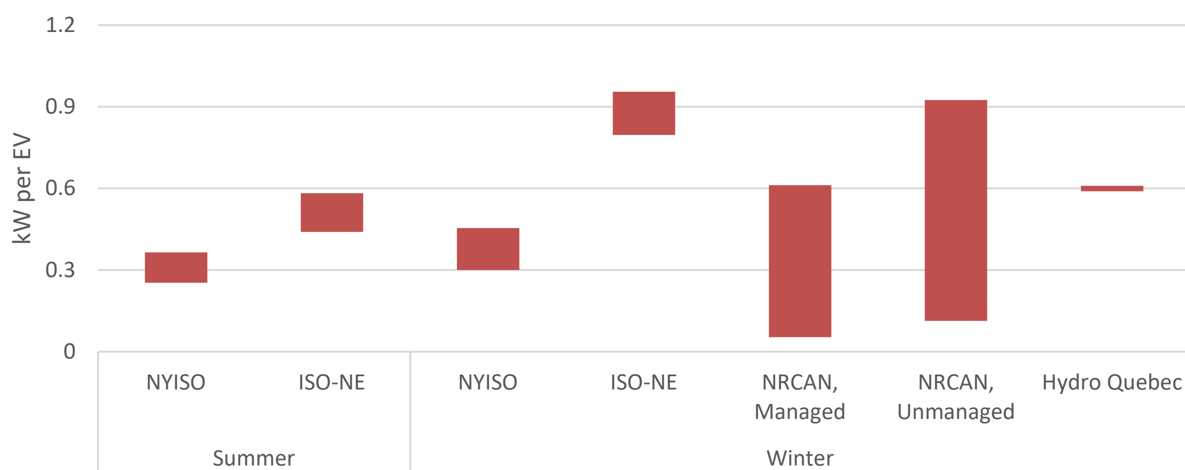
[16] University of Toronto. (2024) Transportation Tomorrow Survey Introduction (TTS). https://dmg.utoronto.ca/tts-introduction/

The peak electricity demand impact of EV charging is informed by a review of planning studies in other jurisdictions.[17, 18, 19, 20] There is a broad range of estimated demand per vehicle across studies, from 0.2 to nearly 1.0 kW per vehicle, although studies agree that charging needs and peak electricity demand impacts are higher for the winter peak and there is potential to reduce the peak impact of EVs through time-of-use rates and active charging management. For this forecast, assumptions from New England's Independent System Operator (ISO-NE) are adopted because they provide the greatest level of detail. Figure 8 outlines the variation in kW per vehicle across several studies, for both winter and summer.

The peak electricity demand impact of public, direct current (DC) fast EV chargers on the 27.6 kV system is expected to be mitigated by diversity between types of EV charging. While the peak electricity demand impact of an individual DC fast EV charger is significant, they are used infrequently, and it is unlikely that multiple charging stations on the same feeder will be used at the same time.

Public fast EV chargers and commercial EV fleet depots have high power requirements which can exceed the capability of lower-voltage parts of the system (i.e. 13.8 kV and below). Coordination with charging networks and commercial customers, particularly in the warehouse sector, is essential to ensure that the distribution system is prepared for different and expanding commercial uses.

**Figure 8. Electric Vehicle Impact by Study**




**Heat Pumps**

Long-term heat pump adoption assumptions are presented in Figure 9. Space heating assumptions for 2050 are consistent with the Climate Action Plan which has air source heat pumps in 40% of residential

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[17] NYISO. (2022). Load and Capacity Data. https://www.nyiso.com/documents/20142/2226333/2022-Gold-Book-Final-Public.pdf

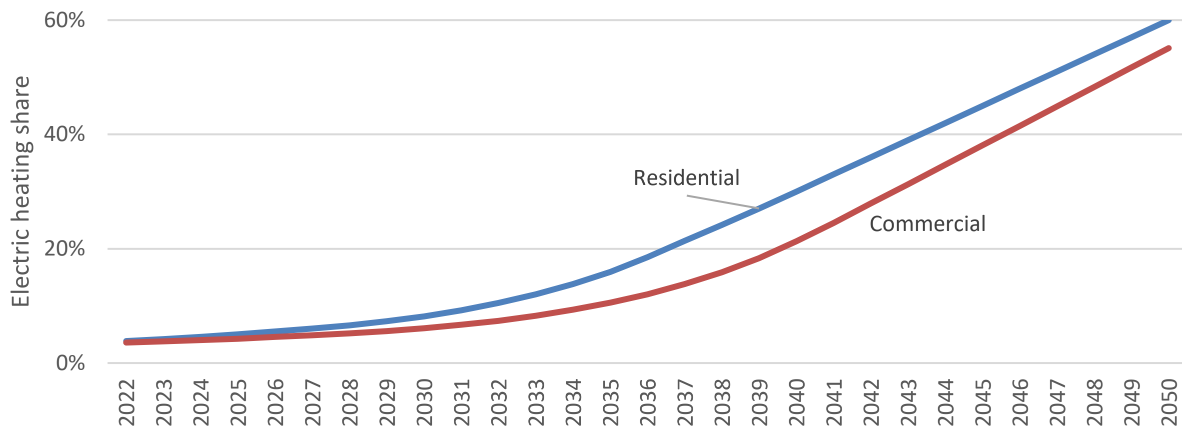
[18] ISO-NE. (2023). Capacity, Energy, Load and Transmission (CELT) Report. https://www.iso-ne.com/static-assets/documents/2023/05/2023_celt_report.xlsx

[19] NRCAN. (2020) Zero Emissions Vehicles. https://natural-resources.canada.ca/sites/nrcan/files/Executive%20Summary%20ICF_English.pdf

[20] Hydro Quebec. (2018). Demand Forecast. https://www.regie-energie.qc.ca/fr/participants/dossiers/R-4057-2018/doc/R-4057-2018-B-0012-Demande-Piece-2018_07_27.pdf

buildings and 30% of commercial buildings by 2050, and ground source heat pumps in 20% of residential and 25% of commercial buildings by 2050.

**Figure 9. Heating Electrification Assumptions per Climate Action Scenario**




Peak electricity demand-to-energy ratios for electrified heating are sourced from ISO-NE's 2023 Capacity, Energy, Load and Transmission planning report. The peak electricity demand-to-energy ratio implicitly accounts for load diversity.[21]

## 5.4 Climate Action Scenario Electricity Demand Forecast Results

Electricity demand by sector per the Climate Action Scenario is presented in Figure 10. Much of the population- and employment-driven growth is offset by sustained energy efficiency efforts, resulting in minimal growth in the residential and commercial non-heating sectors. Incremental electricity demand growth is largely driven by EVs and fuel switching to electric heat. Since EVs are charged primarily at or near the owner's residence, energy consumption and electricity demand growth is expected to be higher in the areas with the most housing development.

Summer peak electricity demand grows slowly, at a rate of less than 1% per year, in the near term and accelerates after 2030. By the 2040s, system-wide winter peak electricity demand exceeds summer peak (Figure 9).

[21] Load diversity describes the difference between peak demand for an individual customer (noncoincident demand) and peak demand for a group of customers (coincident demand). Because different customers reach their peak demand at different times, coincident demand from a group of customers is always less than or equal to the total noncoincident demand.

**Figure 10. Energy Consumption by Sector per Climate Action Scenario**

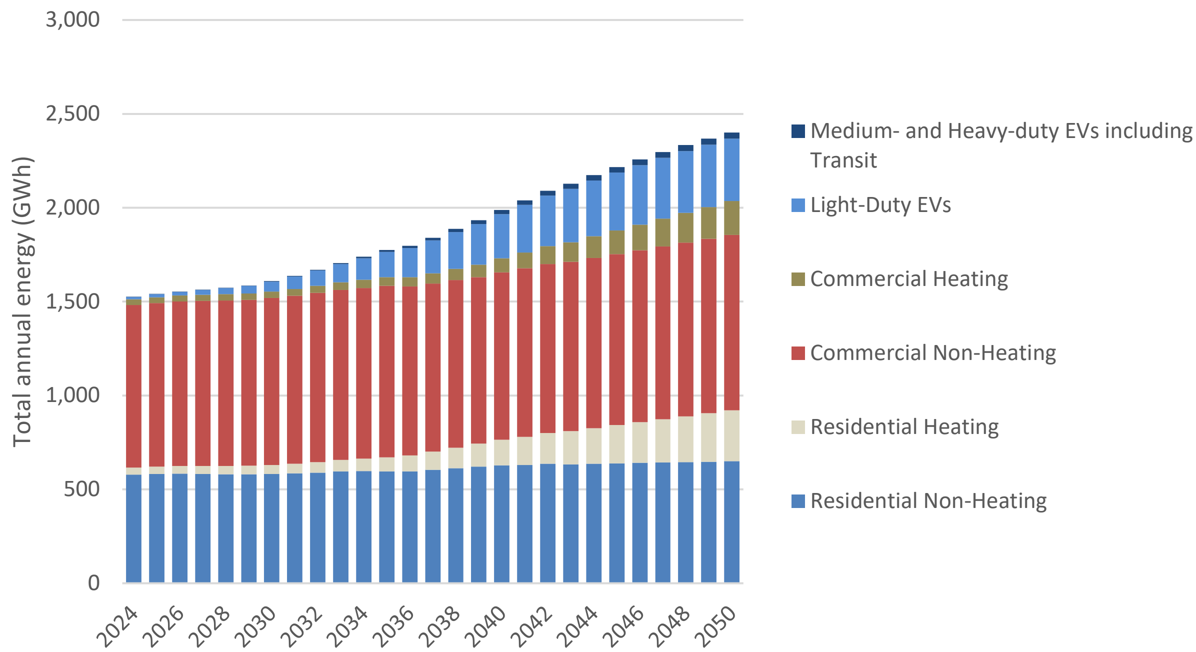
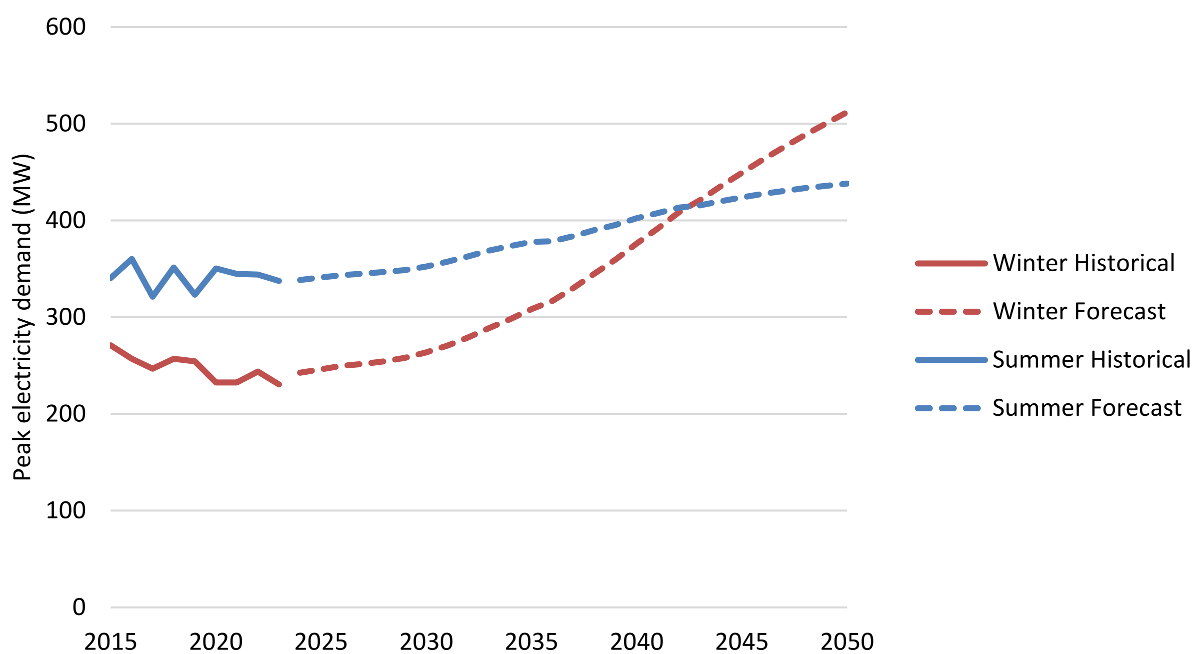



**Figure 11. Seasonal Peak Electricity Demand Forecast for BEC's Distribution System per Climate Action Scenario**



The highest growth in both absolute and relative terms is in the area served by Burlington TS, caused by a higher concentration of housing development. Tremaine TS also has significant forecasted winter peak electricity demand growth due to electrification of existing residences (Table 3). Feeder-level growth rates are more variable, with some neighbourhoods like Aldershot and downtown Burlington reaching 2% annualized growth in the summer and some highly residential neighbourhoods reaching 5% annualized growth in the winter.

**Table 3. Seasonal Electricity demand Growth Rates per Climate Action Scenario (Annualized)**

| Season | Burlington TS | Cumberland TS | Palermo TS | Bronte TS | Tremaine TS | Service Area |
|---|---|---|---|---|---|---|
| Summer | 1.2% | 0.7% | 0.9% | 0.5% | 0.7% | 0.9% |
| Winter | 2.8% | 2.6% | 2.5% | 2.1% | 3.2% | 2.7% |

## 5.5 Electricity Demand Forecast Uncertainty

Long-term electricity demand forecasts include inherent uncertainties about future events, including population and economic growth, changing customer preferences and a rapidly evolving policy environment. The uncertainties associated with forecasts will naturally increase with the length of an outlook period. For future investment decisions it will be important to revisit the electricity demand forecast to determine if there have been any significant changes.

- **Residential Growth:** In the residential sector, there is uncertainty on the pace of housing growth.

- **Commercial Activity:** Commercial and employment-related electricity demand was assumed to be proportional to total employment, but this assumption may need to be revisited if the composition and/or space needs of employment change. For example, data centres and manufacturing have significantly higher energy consumption per employee than offices and retail, and an increase in employees working from home has reduced the amount of space and energy consumption per employee for many offices (refer to the steep decrease in overall consumption per employee after 2020 in Figure 5).

- **Energy Efficiency Funding:** The electricity demand forecast scenario assumes that additional funding for energy efficiency becomes available. Future energy efficiency budgets are uncertain and are currently being established by the IESO and Ministry of Energy, in consultation with LDCs and other stakeholders, as part of a new Conservation and Demand Management Framework.

- **Pace of Electrification:** Future electrification-related electricity demand growth is uncertain. The pace of electrification is dependent on government policy, customer adoption of new technology, and technological improvements. Electrification-related impacts on the electricity system is an active area of research, and more field data is needed particularly for heat pumps.

# 6. CLIMATE ACTION SCENARIO DISTRIBUTION SYSTEM NEEDS

This section describes the existing distribution system in greater detail and identifies anticipated system needs based on the electricity demand outlook, system capability, and application of distribution planning criteria established under the Climate Action Scenario.

## 6.1 Station Capacity

The first step of the distribution needs assessment is determining the availability of bulk transformer station capacity. Table 4 presents the peak electricity demand forecast for each station and the capacity currently assigned to BEC's distribution system. Shaded cells illustrate years where electricity demand is forecasted to exceed assigned capacity. Table 4 describes the forecasted state of the system before any mitigating actions such as electricity load transfers, additional infrastructure, or non-wires solutions such as electricity demand response or battery storage.

**Table 4. Transformer Station Electricity Demand Forecast and Assigned Capacity (MW)**

| Station | Assigned Capacity | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| **Burlington TS** | 156 | 124 | 129 | 141 | 163 | 195 | 222 |
| **Cumberland TS** | 148 | 91 | 94 | 101 | 106 | 121 | 137 |
| **Palermo TS** | 30 | 25 | 26 | 27 | 29 | 32 | 36 |
| **Bronte TS** | 30 | 35 | 36 | 37 | 39 | 41 | 45 |
| **Tremaine TS** | 115 | 66 | 68 | 72 | 76 | 79 | 81 |
| **Burlington and Cumberland** | 304 | 215 | 223 | 242 | 269 | 315 | 359 |
| **Palermo, Bronte, and Tremaine** | 175 | 126 | 129 | 136 | 143 | 151 | 162 |
| **Total** | 479 | 341 | 353 | 378 | 412 | 466 | 521 |

Bronte TS has recently been exceeding its normal capacity, and without mitigation this is expected to continue, restricting BEC's ability to connect new customers. Therefore, there is a near-term need to reduce electricity demand at Bronte TS. The solution will require the construction of new feeders to Tremaine TS for more interconnection to accommodate electricity load transfers.

Overall, BEC's distribution system has adequate total station capacity to meet electricity demand through the 2020s and 2030s, largely due to available capacity at Cumberland TS and Tremaine TS. By the 2040s, Burlington TS is forecasted to reach capacity. Electricity load transfers are unlikely to be a feasible solution and a solution will need to be developed through the regional planning process with IESO and Hydro One.

## 6.2 27.6 kV Feeders

Although BEC will have adequate near-term capacity at the transformer station level after resolving the capacity constraints at Bronte TS, there are near-term capacity limitations at the 27.6 kV feeder level. Each transformer station has multiple 27.6 kV feeders which extend to different areas of the City of Burlington. As electricity demand grows, these feeders may reach their planning capacity and require mitigation. A detailed capacity assessment of the 27.6 kV voltage system was performed using feeder-specific electricity demand forecasts.

BEC's planning capacity for 27.6 kV feeders is 300 Amps (A). This design decision adds resilience to the system by enabling each feeder to be backed up by a neighbouring feeder. While feeder loading can exceed the planning capacity for short periods, BEC plans investments to maintain peak feeder loading below 300 A.

BEC proactively manages capacity on its feeders via electricity load transfers between neighbouring feeders. Transferring electricity load is based on proximity between feeders and existing tie points; additional switches or feeder extensions may be needed to implement the electricity load transfers assumed for long-term planning. If a need exceeds reasonable electricity load transfer capability, a new feeder or resource (such as a non-wire solution) is required.

A non-wires solution is an alternative approach to addressing distribution system constraints or meeting increased electricity demand without solely relying on traditional investments in new wires or infrastructure. Instead of building new feeders or transformer stations, non-wires solutions typically involve implementing innovative technologies or strategies such as demand response, DERs like energy storage systems, voltage optimization, or other grid modernization initiatives. These solutions aim to optimize the distribution system, reduce system stress, improve reliability, and defer the need for other electricity infrastructure upgrades.

Table 5 presents results of the feeder capacity assessment, comparing the greater of summer and winter peak electricity demand against the 300A planning capacity. Table 5 is not a forecast of long-term feeder utilization, but rather an indication of how electricity demand on different feeders is forecasted to grow in the absence of any mitigations such as load transfers, additional infrastructure, or non-wires solutions.

At Burlington TS, the key concern in the 2025 to 2030 period is growth in the Aldershot area (39M31 and 39M32). There are currently limited options to transfer electricity load from that area, so expansion of existing feeders will be needed.

There is considerable spare capacity at Cumberland TS. While some feeders are near or exceeding their planning capacity, there are opportunities to address these needs using load transfers to other Cumberland TS feeders, enabled by relatively small investments. For much of the forecast period, load transfers to Cumberland TS are also assumed to be used when feasible to relieve adjacent feeders from other TSs.

Feeders at Palermo TS are at capacity, and incremental growth must be transferred to the neighbouring Tremaine TS or managed with a non-wire solution. Bronte TS is limited by transformer station capacity (discussed above), not feeder capacity.

Finally, Tremaine TS currently has two feeders (280M6 and 280M8) which are above their planning capacity. Tremaine TS has adequate capacity to connect new electricity demand growth within the planning horizon, however, new feeders from Tremaine TS are required to relieve existing feeders and accommodate demand growth in areas currently serviced by Palermo TS and Bronte TS.

**Table 5. 27.6 kV Feeder Capacity Assessment**

| Station | Feeder | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Burlington TS | 39M1 | 82% | 87% | 95% | 115% | 136% | 154% |
| | 39M2 | 96% | 96% | 97% | 97% | 98% | 98% |
| | 39M3 | 44% | 46% | 52% | 61% | 70% | 76% |
| | 39M4 | 48% | 51% | 67% | 93% | 118% | 137% |
| | 39M5 | 91% | 96% | 105% | 115% | 132% | 149% |
| | 39M6 | 41% | 41% | 42% | 44% | 49% | 54% |
| | 39M31 | 90% | 96% | 104% | 115% | 135% | 154% |
| | 39M32 | 105% | 117% | 135% | 169% | 209% | 243% |
| | 39M33 | 71% | 70% | 71% | 78% | 89% | 98% |
| | 39M34 | 58% | 58% | 63% | 78% | 94% | 106% |
| | 39M35 | 88% | 95% | 106% | 128% | 153% | 176% |
| | 39M36 | 69% | 75% | 84% | 96% | 117% | 137% |
| Cumberland TS | 76M21 | 70% | 73% | 76% | 76% | 79% | 82% |
| | 76M23 | 9% | 11% | 16% | 23% | 31% | 37% |
| | 76M25 | 73% | 72% | 73% | 76% | 88% | 100% |
| | 76M27 | 52% | 56% | 62% | 65% | 70% | 83% |
| | 76M29 | 31% | 32% | 35% | 38% | 44% | 49% |
| | 76M22 | 78% | 83% | 91% | 96% | 107% | 124% |
| | 76M24 | 32% | 33% | 34% | 34% | 35% | 38% |
| | 76M26 | 114% | 114% | 119% | 122% | 124% | 136% |
| | 76M28 | 92% | 93% | 99% | 107% | 124% | 136% |
| | 76M30 | 88% | 93% | 105% | 132% | 158% | 178% |
| Palermo TS | A4M5 | 86% | 87% | 91% | 101% | 111% | 120% |
| | A4M6 | 112% | 117% | 126% | 137% | 146% | 153% |
| Tremaine TS | 280M3 | 93% | 94% | 97% | 100% | 102% | 104% |
| | 280M5 | 16% | 17% | 17% | 18% | 19% | 21% |
| | 280M4 | 81% | 84% | 89% | 93% | 98% | 101% |
| | 280M6 | 130% | 131% | 137% | 145% | 148% | 148% |
| | 280M7 | 0% | 0% | 0% | 0% | 0% | 0% |
| | 280M8 | 144% | 150% | 162% | 175% | 185% | 192% |
| Bronte TS | 13M25 | 39% | 39% | 40% | 43% | 49% | 54% |
| | 13M26 | 79% | 82% | 89% | 99% | 116% | 131% |
| | 13M27 | 70% | 71% | 73% | 72% | 74% | 76% |
| | 13M28 | 56% | 57% | 58% | 58% | 59% | 61% |

## 6.3 13.8 kV and 4.16 kV Systems

The stations and feeders in the lower voltage primary systems (i.e. 4.16 kV and 13.8 kV) generally serve fewer customers in smaller areas compared to a 27.6 kV system. A different approach is needed for these lower voltage parts of the distribution system because electrification-driven needs are more unpredictable at smaller scale.

In demand forecasting, load diversity benefits are lower when serving fewer customers because it is more likely that all customers will be at or near their peak demand at the same time. The expected peak electricity demand per EV charger is about twice as high for a group of 10 chargers compared to a group of 100 because fewer chargers are more likely to be used simultaneously.[22] As a result, relatively low peak electricity demand assumptions can be used to forecast electricity demand on a 27.6kV feeder

[22] Energy Systems Integration Group. (January 2024). Grid Planning for Vehicle Electrification. https://www.esig.energy/wp-content/uploads/2024/01/ESIG-Grid-Planning-Vehicle-Electrification-report-2024.pdf

which may supply thousands of customers, but higher peak electricity demand assumptions are needed for 4.16 kV feeders and other lower-voltage infrastructure.

A single large commercial EV customer such as a public fast charger or EV fleet depot can have comparable peak demand to an apartment building, but BEC has limited insight into the timing and location of planned commercial EV chargers. Direct coordination with these customers will be needed as early as possible to ensure that timely investments in lower voltage systems are made.

Smaller customers such as single-family homes do not go through a formal connection process to install EV chargers, but the combined, uncoordinated impact of many residential EV chargers and/or heat pumps in the same area can exceed the capability of the existing system. A data-driven approach, including more geographically granular demand monitoring and forecasting, can improve visibility on emerging needs in the lower voltage parts of the system. EV charger management, such as demand response and time-of-use rates, can also reduce the peak impact of residential EV charging.

## 6.4 Summary of Climate Action Scenario Distribution System Needs

Overall, based on the Climate Action Scenario developed by BEC, there are three actions required to meet the forecasted electricity demand requirements in the near-term period through 2030. These actions will address existing capacity constraints in the system and accommodate localized electricity demand growth like housing development.

- Completing planned work to address over-loading on feeder 280M6 at the Tremaine TS
- Expanding 27.6 kV feeders south from Tremaine TS to relieve capacity constraints on the 280M8 feeder, Palermo TS feeders, and Bronte TS.
- Addressing growth in the Aldershot area by extending existing feeders from Burlington TS, with associated tie points and switches to transfer load.

Electricity demand growth is forecasted to accelerate in the 2030s, largely due to EVs. Provided that the near-term issues above are addressed, the 27.6 kV system is well-positioned to meet this growth. Investments will be needed on the lower voltage primary system (i.e. 4.16 kV and 13.8 kV) to enable EV charging which could include additional feeder upgrades and voltage conversion to 27.6 kV.

In the 2040s, feeder and station needs are forecasted to be driven increasingly by space heating electrification and a growing winter peak electricity demand. Efforts to manage residential demand on the 4.16 kV and 13.8 kV systems will need to continue. During this period, two additional feeders from Tremaine TS to load centres south of the QEW will likely be needed, along with greater reinforcement of 27.6 kV feeders in Aldershot and downtown Burlington, and ongoing load transfers from Burlington TS to Cumberland TS. If extending feeders from Tremaine TS to Burlington TS is not feasible or cost-effective, new station capacity may be needed by the mid-2040s.

# 7. CLIMATE RESILIENCE

Climate change is significantly impacting infrastructure, including electricity systems. Particularly, climate change is causing unprecedented changes to seasonal and annual weather patterns in terms of precipitation, temperature, wind speed, and numerous other variables. It is also increasing the frequency, intensity, and duration of extreme weather events. The Intergovernmental Panel on Climate Change (IPCC) suggests that the electricity sector is one of the sectors most at risk of disruption from climate change. The risks are expected to be greater in the future given the increasing rates of warming climate in Canada.[23]

Natural Resources Canada (NRCan) reported in August 2022 that "Canada's climate is warming at a rate about twice that of the global average. Ontario's mean annual temperature increased by 1.3 degrees Celsius between 1948 and 2016, with mean annual precipitation increasing by 9.7 per cent over the same period. Climate model projections indicate these changes will continue." [24]

Extreme events also have ramifications throughout the economy, disrupting businesses and incurring costs for repairs and added insurance. In 2022, the Insurance Board of Canada highlighted that "in Canada, insured catastrophic losses, most of which is due to water-related damage, have risen from around $456 million per year on average over the late 1900s and early 2000s to 'routinely exceeding' $2 billion per year.'"[25] They further report that "in Ontario, insured losses related to severe weather climbed to $1.2 billion in 2022 from $400 million in 2021."[26]

The changes in weather patterns and increase in extreme weather events can pose significant operational risks to distribution systems, potentially damaging infrastructure and disrupting service delivery. Examples of direct impacts to the distribution system include "ice accretion and lightning strikes on overhead conductors, wind damage, premature aging, and conductor sag and annealing and indirect impacts include changes to vegetation management, ice road integrity, vector-borne disease, and supply chain issues, as well as precipitation overwhelming riverine and urban drainage systems, resulting in flooding and potentially straining submersible equipment."[27]

Over the last 10 years, BEC, in addition to other Ontario LDCs, has been experiencing the impacts of climate change on its distribution system including increased incidence of extreme weather events

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[23] IPCC. (2023). AR6 Synthesis Report (SYR). https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf

[24] NRCan. (2022). Chapter 3: Ontario (in Canada in a Changing Climate: Regional Perspectives Report). https://changingclim ate.ca/site/assets/uploads/sites/4/2020/11/Ontario-Chapter-Regional-Perspectives-Report.pdf

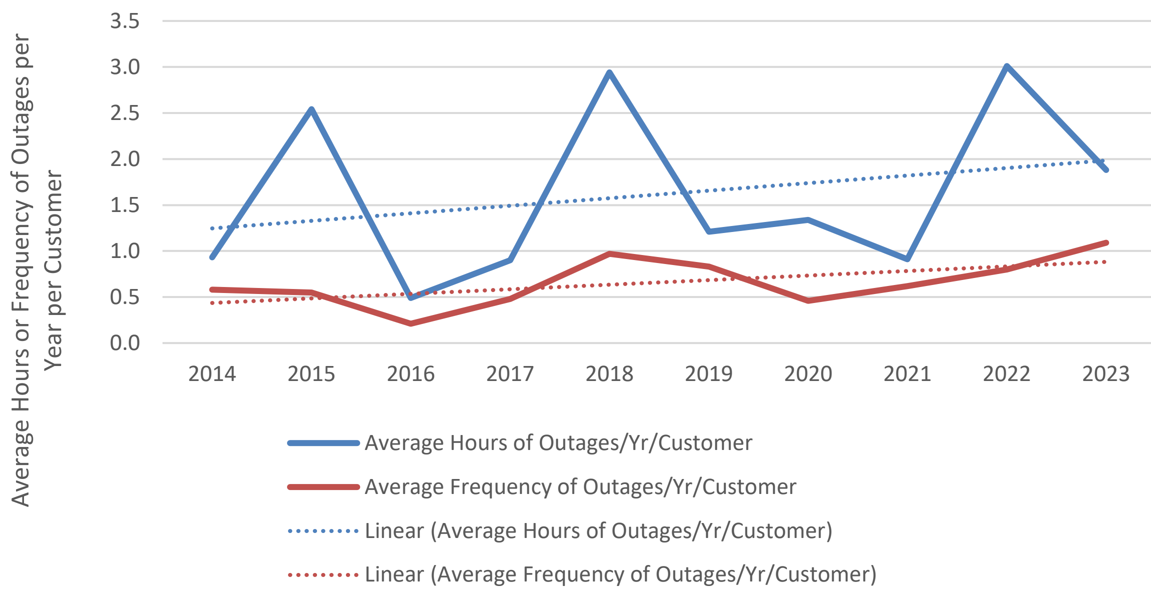
[25] Insurance Bureau of Canada. (January 2023). News and Insights Report. https://www.ibc.ca/news-insights/news/severe-weather-in-2022-caused-3-1-billion-in-insured-damage-making-it-the-3rd-worst-year-for-insured-damage-in-canadian-history

[26] Insurance Bureau of Canada. (January 2022). News and Insights Report. https://www.ibc.ca/news-insights/news/severe-weather-in-2021-caused-2-1-billion-in-insured-damage

[27] OEB. Improving Distribution Sector Resilience, Responsiveness and Cost Efficiency. Page 12. (2023-06-09). https://www.rds.oeb.ca/CMWebDrawer/Record/837682/File/document

which have negatively impacted reliability. Evident in the figures below[28], BEC has seen an increasing trend in the duration and frequency of outages caused by adverse weather/environment. In addition, there is variability and unpredictability in when these events occur and their sizeable impact on customers.

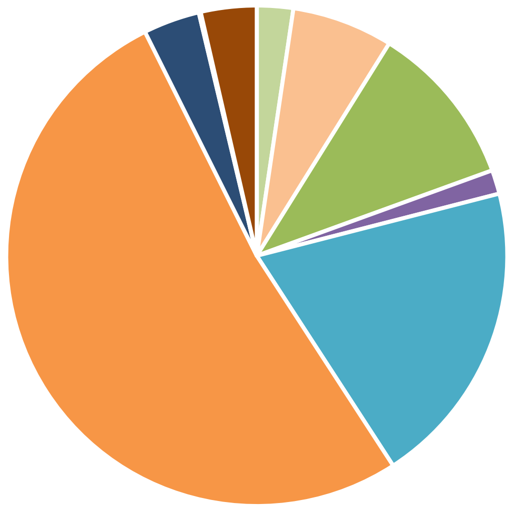
**Figure 12. Number of Outages from Adverse Weather/Environment/Tree Contact Events in BEC's Service Area**




Similarly, as identified in the Figure below, adverse weather (which captures extreme weather events) is a leading contributor of outages, accounting for 50% of outages on average. This demonstrates the increasing importance of LDCs, including BEC, to ensure it is continuously adapting to be climate resilient through process improvements and infrastructure investments.

[28] Figures uses BEC's internal reliability data for SAIDI/SAIFI by cause code.

**Figure 13. 2014-2023 Average Hours of Outages per Customer by Cause (excluding "Loss of Supply")**




In response to a request from the Minister of Energy, the OEB recently issued a report titled "Improving Distribution Sector Resilience, Responsiveness and Cost Efficiency," which made recommendations to improve distribution sector resilience to extreme weather and climate change. The OEB defines resilience as "the ability of the electricity distribution network to respond to high-impact/low-frequency disruptions by adequate preparing for, withstanding, and rapidly recovering from, and adapting to these events." [29] The OEB has set out multiple proposals to address resilience, including integrating resilience into distribution system planning, engaging in data-driven empirical assessments of vulnerabilities to the distribution system, prioritizing value for customer when investing in system enhancements for resilience purposes, and measuring and reporting on restorations following severe events.

Recognizing the increasingly unpredictable climate, it is appropriate for BEC to consider a range of climate adaptation measures to improve resilience. Climate adaptation refers to the process of adjusting to current or expected changes in climate to minimize harm and reduce vulnerabilities.

Examples of climate adaptation measures include:

- **Asset Design and Hardening:** Revise design criteria for critical components (like certain substations) to prepare for climate risks such as floods by raising elevation of structures, relocating structures during major project upgrades out of high climate-risk zones or

[29] OEB. Improving Distribution Sector Resilience, Responsiveness and Cost Efficiency. Page 15. (2023-06-09). https://www.rds.oeb.ca/CMWebDrawer/Record/837682/File/document

underground, use of submersible transformers. Some LDCs are also strengthening poles and lines or undergrounding circuits to improve resilience to extreme wind and ice.

- **Resilient Distribution Planning:** Distribution planning criteria and design choices can support resilience during extreme weather. Redundancy between feeders (e.g., 300A planning capacity for 27.6 kV feeders) ensures that operators have multiple options to quickly restore load after a single-element outage. Adding additional switches and tie points between feeders improves flexibility and can reduce the area affected by faults.

- **Grid Modernization:** New technologies such as enhanced sensors and distribution automation are increasingly being implemented in distribution systems to improve visibility of system operations and outage response. These technologies can provide customer benefits throughout distribution operations, including climate resilience.

- **Modifying Operations:** Operational improvements are often the lowest-cost option to substantially improve climate resilience. Emergency response planning is another consideration. Plans should clarify roles and lines of communication with partners and stakeholders, including transmitters, system operators, and municipal authorities. Regular drills and training on emergency response are also recommended. Maintaining spare equipment and/or crew and equipment sharing agreements with neighbouring LDCs should also be considered. Operational changes for climate adaptation can also include increased investment in vegetation management and innovative technologies, like drone inspection.

- **Others:** Redundancy and backup systems, climate-informed planning, emergency response and recovery plans, community engagement and communications, regulatory/standards compliance, and training and capacity building initiatives.

BEC currently has adaptation measures in place. These measures and future near-term actions identified by BEC to continue to address climate resilience are discussed in the next section.

# 8. SUSTAINABILITY PLAN NEXT STEPS

In the preceding sections of this report, BEC has detailed how climate action and clean energy initiatives will impact its distribution system in the City of Burlington. BEC has prepared a Climate Action Scenario and an associated electricity demand forecast to determine future distribution system investments required. This section provides a summary of existing activities currently underway at BEC, new near-term action items between 2025 and 2030, and considerations for the medium and longer term.

## 8.1 Near-Term Plan (Years 2025-2030)

BEC is well-positioned to support climate action and electrification within the City of Burlington. With minimal near-term electricity demand growth, the focus over 2025-2030 is enabling electrification, addressing a limited number of existing distribution system needs, and improving climate resilience.

### 8.1.1 Climate-Informed Planning and Maintenance

BEC has developed preventative maintenance and asset management practices which support resilience to extreme weather, including:

- Conducting annual asset maintenance and testing for critical assets to mitigate impacts of climate change and unplanned failures.
- Embedding resilience in asset management planning processes and targeting replacement of deteriorated assets in Poor and Very Poor condition.
- Grid hardening measures, including replacement of submersible transformers with pad-mounted transformers. This change is a result of updates to a Canadian Standards Association Standard referenced in O. Reg 22/04 (Electrical Distribution Safety) which LDCs must comply with and the increasing failures that have been occurring with existing submersible transformers.
- Implementing a vegetation management program which is completed on a proactive three-year cycle to mitigate outages due to tree contacts.
- Recent updates to emergency response plans to prioritize clear, simple and frequent communications during outage events. The emergency response will be coordinated with the City of Burlington to identify points of contact and critical loads that should be prioritized for restoration.

In addition, BEC is currently undertaking two studies to better integrate new technology in distribution planning:

- Engaging in research in partnership with McMaster University to understand distribution system impacts of EV charging and heating electrification.
- Completing a study on the technical and financial feasibility of battery energy storage solutions as a non-wire alternative

Additional actions considered as part of this Sustainability Plan include:

**Action 1: Address Existing Overloading and Aldershot Growth Centre**

To manage existing and near-term needs on the 27.6 kV system, BEC will maximize the use of load transfers and non-wires options before committing to the construction of new feeders. When evaluating new investments in distribution infrastructure, BEC will consider the OEB's recently updated guidelines on including non-wires solutions in planning and rate filings, noting that the updated guidelines come into effect for new applications submitted in 2026 and thereafter.[30]

Using non-wires solutions like storage and demand response requires new capabilities to forecast and dispatch these resources in real time. BEC may consider pilot programs to develop internal capabilities and integrate non-wires solutions into routine operations. Given the capacity constraint on the 280M8 Feeder and at Bronte TS, a local electricity demand response program for the area between Appleby Line and Burloak Drive may be a cost-effective solution to defer feeder expansion or improve operational flexibility. The initial steps to launch this program include targeted outreach to large customers in the area and major demand response aggregators active in Ontario to gauge interest, and better understand the demand response potential in this region.

Even with these measures, two major feeder expansion projects are likely needed before 2030.

- Expanding 27.6 kV feeders south from Tremaine TS to relieve capacity constraints on the 280M8 feeder, Palermo TS feeders, and Bronte TS.
- Extending existing feeders from Burlington TS to the Aldershot area to relieve 39M31 and 39M32, with associated tie points and switches to transfer load.

BEC will continue to work closely with IESO and Hydro One as part of the regional planning process.

**Action 2: Enhance Electricity Demand Forecasting and Analytics for Future Planning Cycles**

To prepare for EV adoption and other sources of electricity demand growth, BEC can enhance its data and analytics capabilities, and improve its visibility on the existing system. Continuous monitoring and more granular analytics on historical, customer-level electricity demand data can be used to track electrification trends and improve investment planning. There is potential to gain greater insight from historical electricity demand data to complement and improve electricity demand forecasts. Improved analytics would help to support granular modelling of lower-voltage feeders and identify needs as early as possible. Electricity demand analytics can also enable BEC to estimate location-specific adoption of EVs and electric space heating to update forecast assumptions.

Many LDCs are responding to expected EV electricity demand by gradually upgrading the voltage class of their system. Strategies include upgrading voltage when 4.16 kV assets reach end of life and connecting most new customers to the higher voltage system. LDCs are also intentionally oversizing new service

[30] Ontario Energy Board. (2024-03-08). Non-Wires Solution Guidelines for Electricity Distributors. https://www.oeb.ca/sites/default/files/uploads/documents/regulatorycodes/2024-03/OEB_2024%20NWS%20Guidelines_20240328.pdf

transformers in residential neighbourhoods to anticipate future EV electricity demand. BEC will explore voltage conversion and pre-investment for EV growth in parallel with evolving guidance from the OEB.

Integrating electric space heating later in the forecast presents similar challenges to the more immediate issue of integrating EVs. Load shapes, peak contribution, and location of the new load is currently uncertain and will depend on the degree that new technology is developed and adopted.

For both EV and electric space heating, meeting needs on the lower voltage parts of the system requires BEC to conduct regular forecast updates to account for new meter data, large new customers, and policy change. BEC will regularly update its electricity demand forecast to ensure future infrastructure investments enable electrification-driven demand growth.

In addition, BEC will continue to implement best practices related to distribution sector resilience. For example, the OEB is developing new policies requiring LDCs to report on storm preparation, customer communication during outages, and incorporating climate resilience in planning.[31] Additional grid hardening measures will be identified pending clarity from the OEB with respect to assessment methodology for resilience investments.

### 8.1.2 Grid Modernization

BEC's grid modernization strategy focuses on using field-proven solutions to automate circuit protection and switching while laying the groundwork for future advances. BEC has already undertaken several actions, including:

- Installing of distribution automation and sensor technology in parts of the system
- Implementing automated fault isolation and restoration with smart devices to reconfigure distribution feeders after a fault, reducing customer interruption time.
- Enhancing cybersecurity measures
- Partnering with Grid Smart City to evaluate benefits of next-generation advanced metering infrastructure to meet future operational challenges and opportunities.

Additional actions considered as part of this Sustainability Plan include:

**Action 3: Continue Enhancing Distribution Operations with Grid Modernization Technology**

BEC will replace its current Outage Management Systems later in 2024 and has included in its capital plan additional investments in distribution automation and sensing technologies. Grid modernization solutions will continue to be evaluated to improve system resilience, reduce outage time, and enable operational flexibility.

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[31] Minister of Energy. (2023-11-29). Renewed Letter of Direction and Updates for the Government's Priorities in the Energy Sector. https://www.oeb.ca/sites/default/files/letter-of-direction-from-the-Minister-of-Energy-20231129.pdf

### 8.1.3 Enabling Climate Action

BEC has recently completed and is currently undertaking several actions, including:

- Developing a comprehensive Carbon Inventory and Decarbonization Roadmap for its operations to reduce greenhouse gas emissions.
- Implementing Green Button and a new customer portal to help customers manage and control their energy usage.
- Implementing best practices related to simplifying DER connections and connections for EV charging infrastructure, as recently established by the OEB.

BEC is prepared to connect additional DERs such as rooftop solar to the system, noting that there may be technical limitations on the amount of capacity that can be accommodated in some parts of the city such as the area served by Palermo TS.

Additional actions considered as part of this Sustainability Plan include:

**Action 4: Enable Electric Vehicle Charging**

BEC will focus on developing partnerships with customers to enable EV charger installations. BEC can open dialogue with Burlington Transit and large commercial customers on planning for fleet electrification to enable quick and cost-effective service upgrades. For the residential sector, including new high-density housing developments, BEC can develop educational programs to facilitate the upgrade process and encourage use of managed charging technologies. BEC will continue to monitor and participate in the OEB's Electric Vehicle Integration Initiative[32] and will implement emerging best practices related to facilitating EV connections.

### 8.1.4 Partnerships and Collaborations

BEC is currently undertaking several actions, including:

- Staying apprised of industry trends and best practices as members of the Electricity Distributors Associations councils for Conservation and Sustainability Issues, and Electrification.
- Engaging with Grid Smart City to prepare a readiness strategy for future Distribution System Operators.

Additional actions considered as part of this Sustainability Plan include:

[32] Ontario Energy Board. (2024-05-23). Electric Vehicle Integration. https://engagewithus.oeb.ca/ev-integration

**Action 5: Continue Engaging with Stakeholders**

BEC recognizes that stakeholders are critical partners in addressing the upcoming changes to the system. BEC will enhance stakeholder engagement to identify and satisfy more complex customer needs and to facilitate the connection of distributed solar, EV chargers, and other clean energy technologies. BEC will also explore options for customer-facing programs and non-wires solutions.

BEC is open to working more closely with city staff to develop and expand climate action programs, building on foundational efforts like the Better Homes Burlington pilot program. Closer collaboration and data sharing with the city could also better inform demand forecasting and support the business case for distribution system investments.

## 8.2 Medium- and Long-Term Plan (Years 2030-2050)

The medium- and long-term plan focuses on managing accelerating electricity demand growth and emerging distribution system capacity needs.

Through the 2030s, there is an opportunity to build on data analytics and the distribution automation investments identified in the near-term plan and further integrate advanced software tools into distribution operations. Needs could be reduced or deferred through volt-var optimization, enhanced phase balancing, and more routine use of non-wires solutions on peak electricity demand days.

By the 2040s, according to the Climate Action Scenario, BEC is expected to require additional transformer station capacity to manage electricity demand growth. BEC will need to work collaboratively with Hydro One and the IESO to ensure that Burlington's Climate Action Plan and its distribution needs are reflected in the regional planning and bulk transmission planning processes.

Rapid and widespread space heating electrification as envisioned in the City of Burlington's Climate Action Plan would also cause BEC's distribution system to become winter-peaking in the 2040s with rates of electricity demand growth exceeding 3% per year. Supporting this demand would require upgrading the voltage of parts of the existing 4.16 kV and 13.8 kV networks and extending new 27.6 kV feeders. Additional feeders would be needed to fully utilize existing capacity at Tremaine TS, and the new station and feeder capacity would generally be used to address continuing electricity demand growth in the dense residential areas in downtown Burlington and near GO transit stations.

BEC must consider the investments needed to meet accelerating electricity demand growth within the context of regulatory funding mechanisms available to finance the investments. BEC is scheduled to reset its electricity distribution rates in 2026 and 2031. Investments made pursuant to those applications can be included in rates in the standard rate-setting process, but other mechanisms are needed to recover costs in interim years. The OEB permits "incremental capital module"[33] applications in interim years for relatively large discrete projects, however, there is uncertainty with respect to the

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[33] Incremental Capital Module (ICM) and Advanced Capital Module (ACM) mechanism are set out in the OEB's New Policy Options for the Funding of Capital Investments: Supplemental Report. (2016-01-22). https://www.oeb.ca/sites/default/files/uploads/Report_of_the_OEB_Capital_Funding_Suppl_20160122.pdf

amount of capital that can be recovered depending on inflation factors and BEC's electricity demand growth.

LDCs are required to consider non-wires solutions in system planning processes for investments greater than $2 million. Evaluations of non-wires solutions are required to be submitted in order to demonstrate that the selected option is the most cost-effective. More recently, the OEB has allowed LDCs to apply for interim-year rate increases to fund non-wires solutions. Increased electrification is creating the need for large investments in interim years for LDCs across the province so the OEB may consider introducing other cost recovery mechanisms before the need arises for BEC.

BEC is actively monitoring and tracking applicable regulatory proceedings pursuant to non-wires solutions. In the meantime, BEC will continue to monitor electricity demand growth within its service territory and will continue to adopt best practices and solutions that are cost-effective for customers.

## 8.3 Financial Implications

BEC will consider the above actions and plans in the context of affordability, in addition to reliability and sustainability. As part of its planning process and next steps, BEC will evaluate the investment options associated with this Sustainability Plan including costs, customer outcomes, and impact to the distribution service rates charged by Burlington Hydro. Investments and rates are approved by the Ontario Energy Board during a full review of Burlington Hydro's rates every five years. Burlington Hydro's next full review of its rates occurs in 2025, which requires Burlington Hydro to file a 5-year Distribution System Plan (DSP). The DSP will outline Burlington Hydro's investments and plans for distribution grid expansion and modernization to continue to address climate change and support electrification.

# 9. CONCLUSION

BEC is well-positioned to meet the needs of the community as it transitions to a low carbon future and is committed to supporting and enabling customers to make clean choices, adopt new technologies, and reduce overall greenhouse gas emissions. BEC has detailed how the distribution system must evolve to accommodate both near-term and long-term electricity demand growth and must continuously monitor and evaluate these needs as new data becomes available.

In summary, BEC's near-term plan (2025-2030) includes the following actions:

*Action 1: Address Existing Overloading and Aldershot Growth Centre*

*Action 2: Enhance Electricity Demand Forecasting and Analytics for Future Planning Cycles*

*Action 3: Continue Enhancing Distribution Operations with Grid Modernization Technology*

*Action 4: Enable Electric Vehicle Charging*

*Action 5: Continue Engaging with Stakeholders*

In the medium- and long-term (2030-2050), BEC's plan is to address rising electricity demand and distribution capacity needs. Through the 2030s, BEC will continue enhancing data analytics, investing in distribution automation, expanding the 27.6 kV system, and performing upgrades and voltage conversions in the 4.16 kV and 13.8 kV networks as needed. In the 2040s, increased electricity demand may necessitate more high-voltage transformer station capacity and continued collaboration with Hydro One and the IESO to align with Burlington's Climate Action Plan.

In addition to reliability and sustainability, BEC will consider the financial implications of the above actions and plans, particularly in the context of affordability. As part of its planning process and next steps, BEC will evaluate the investment options associated with this Sustainability Plan including costs, customer outcomes, and impact to the distribution service rates charged by Burlington Hydro.

Throughout the development of this Sustainability Plan, BEC engaged with the City of Burlington and other community members. Their insights were invaluable and informed the report and recommendations. This collaborative approach ensures that BEC's strategies are aligned with the community's needs and expectations, fostering a stronger partnership as BEC moves forward.

BEC is dedicated to long-term sustainability and to modernizing its electricity grid. Recently, the Electricity Distributors Association released their vision paper, "Solving Grid-Lock: Our Vision for a Customer-Centric Energy Transition."[34] This report highlights the crucial role that LDCs play in enabling the energy transition and outlines a framework for necessary investments in grid expansion and modernization. These investments are essential to prepare the grid for increased electrification and the integration of clean energy sources. BEC continues to coordinate closely with the Electricity Distributors

[34]Electricity Distributors Association. (2024-04). "Solving Grid-Lock: Our Vision for a Customer-Centric Energy Transition. https://www.eda-on.ca/Advocacy/Research-and-Reports

Association, pursuing the policy and regulatory enablers described in the paper to ensure that its grid is ready for future demands.

BEC looks forward to continuing this journey with the community, adapting to new challenges, and seizing opportunities to build a resilient, efficient, and environmentally friendly energy system. By working together, BEC can ensure that the City of Burlington is prepared for the future and a leader in sustainable energy practices.