newfoundland labrador hydro

Newfoundland and Labrador Hydro
Hydro Place. 500 Columbus Drive
P.O. Box 12400. St. John's. NL
Canada A1B 4K7
t. 709.737.1400 I f. 709.737.1800
nlhydro.com

March 28, 2024

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Jo-Anne Galarneau
Executive Director and Board Secretary

Re: *Reliability and Resource Adequacy Study Review* – Long-Term Load Forecast Report – 2023

In correspondence dated May 5, 2023, the Board of Commissioners of Public Utilities ("Board") directed Newfoundland and Labrador Hydro ("Hydro") to file a number of updates regarding the studies and analyses ongoing within the Reliability and Resource Adequacy Study Review ("RRA Study Review"). In particular:

1) Hydro shall file by May 19, 2023 a comprehensive list of all reports, studies and analyses it has currently underway or planned with respect to the reliability of the LIL, potential alternative generation resources, the load forecast, and any other issues raised in the 2022 RRAS Update and the May 1-2, 2023 technical conference. This list shall include a description of the scope of each study, report and analysis, the consultant or group undertaking the work and the schedule for completion.

2) Hydro shall file with the Board a copy of each report, study or analysis listed in response to number 1 above as it is completed.

Subsequent to the May 25, 2023 submission of the Planned Reports, Studies and Analyses, the Board directed Hydro ". . . to file the assumptions for each load forecast scenario as soon as possible and by the end of the first quarter of 2024 at the latest."[1] Hydro updated the listing of Planned Reports, Studies and Analyses as part of its correspondence to the Board's further comments and directions on January 19, 2024.[2]

Enclosed with this letter is an overview of the 2023 Long-Term Load Forecast Report, including an attachment containing the study "R&RA 2024: Independent Load Forecasting Process Review," completed by Daymark Energy Advisors.

[1] "Reliability and Resource Adequacy Study Review – Planned Reports, Studies, and Analyses – Response to Further Comments and Directions," Board of Commissioners of Public Utilities, October 12, 2023, p. 3.
[2] Please refer to "*Reliability and Resource Adequacy Study Review* – Planned Reports, Studies, and Analyses – Response to Further Comments and Directions," Newfoundland and Labrador Hydro, January 19, 2024, p. 4, Table 1.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/sk

Encl.

ecc:

Board of Commissioners of Public Utilities
Jacqui H. Glynn
Maureen Greene, KC
Board General

Island Industrial Customer Group
Paul L. Coxworthy, Stewart McKelvey
Denis J. Fleming, Cox & Palmer
Dean A. Porter, Poole Althouse

Labrador Interconnected Group
Senwung F. Luk, Olthuis Kleer Townshend LLP
Nicholas E. Kennedy, Olthuis Kleer Townshend LLP

Consumer Advocate
Dennis M. Browne, KC, Browne Fitzgerald Morgan & Avis
Stephen F. Fitzgerald, KC, Browne Fitzgerald Morgan & Avis
Sarah G. Fitzgerald, Browne Fitzgerald Morgan & Avis
Bernice Bailey, Browne Fitzgerald Morgan & Avis

Newfoundland Power Inc.
Dominic J. Foley
Lindsay S.A. Hollett
Regulatory Email

Long-Term Load Forecast Report

2023

March 28, 2024

A report to the Board of Commissioners of Public Utilities

Executive Summary

Newfoundland and Labrador Hydro ("Hydro") annually develops a Reference Case forecast of firm electric power demand and energy requirements to assess the impacts of customer, demographic, and economic factors on the future provincial electricity load requirements. The resultant load forecast is a critical primary input to Hydro's overall planning, budgeting, and operating activities. The forecast was produced in the third quarter of 2023; it covers the period from 2023 through 2034 and is the basis for Hydro's 2024 Resource Adequacy Plan,[1,2] which covers the same period.

Overall, the 2023 load forecast is showing growth across the provincial system, stemming from several factors including:

- Increasing population growth when compared to prior forecasts utilizing Government of Newfoundland and Labrador forecasts;
- Ongoing electrification[3] activities, primarily resulting from actions taken by the Provincial and Federal governments to mitigate climate change and where possible, utilizing third-party expert input such as Dunsky Energy + Climate Advisors ("Dunsky") for electric vehicle ("EV") adoption rates; and
- Existing Industrial customers firm requests looking to expand and decarbonize their operations.

Hydro engaged Daymark Energy Advisors ("Daymark") to provide a third-party independent assessment of the strength of its load forecasting process, including a review of the underlying methodologies used to produce the 2023 load forecast and the accuracy of Hydro's historical forecasts. Industry changes, as well as policy changes in response to concerns about climate change, have accelerated compared to what has been seen in recent years, and there remains uncertainty regarding timing and adoption rates for new technology. This uncertainty is captured by developing alternate forecast scenarios. Historically, for years one through ten of the load forecast, Hydro's forecast accuracy is within the industry norm.[4] As

[1] Filed as part of the ongoing Reliability and Resource Adequacy Study Review proceeding ("*RRA Study Review*").
[2] For clarity, within Attachment 1, Daymark refers to the 2024 Resource Adequacy Plan as the "2024 R&RA."
[3] Electrification is decarbonization that results in replacing processes or technologies that use fossil fuels with an electrically powered equivalent.
[4] Hydro assesses the accuracy of its forecasts using the mean absolute percent error with respect to Newfoundland Power Inc. ("Newfoundland Power") domestic customer sales and general service sales. Newfoundland Power requirements represented 78% of the 2022 Island Interconnected System requirements, exclusive of transmission losses and station service.

the time horizon in any forecast increases, the level of error is expected to increase, which supports Hydro's use of alternative scenarios to support system planning assessments. A copy of Daymark's report is included as Attachment 1 to this report, which states that "Hydro's current load forecasting methodology reflects standard industry approaches for assessing potential growth. The approach and data are grounded in the realities Hydro and the industry must face."[5] The report provides recommendations for continuous improvement in Hydro's forecasting process, which are intended to generate efficiency in the process, and concludes that these efficiencies ". . . does not detract from the general efficacy of Hydro's forecasting approach in this current proceeding."[6]

All forecasts have inherent uncertainty. As a rule, in any utility, system-planning activities require consideration of a broad range of potential future outcomes to reflect uncertainty in the load forecast model input data and the relationships estimated in the model. This enables sound decision-making by demonstrating the resiliency of plans against a range of input considerations, allowing for increased certainty when making recommendations. From a load forecast perspective, this process requires the establishment of an appropriate Reference Case, previously referred to as the Base Case. The Reference Case reflects the expected or most likely future scenario based on current information, as well as the analysis of several scenarios, which capture the breadth of potential future outcomes, highlighting the sensitivity of the load forecast to changes in key drivers.

To reflect the potential for variability in the model input data and the relationships estimated in the load forecast, Hydro develops scenarios to capture a broad variation from the Reference Case. Developed scenarios tend to focus on possible alternate future outcomes for macroeconomic drivers of the load forecast and government policies. Examples can include decarbonization,[7] population growth, and industrial expansion or contraction. By developing alternative scenarios, Hydro can assess the sensitivity of its expectations with respect to demand and energy requirements to changes in macroeconomic conditions and validate the robustness of its resource planning activities against the same. This methodology enables Hydro to better manage the inherent uncertainty in forecasting demand and

[5] "R&RA 2024: Independent Load Forecasting Process Review," Daymark Energy Advisors, March 22, 2024, sec. II(C), p. 15.
[6] *Supra*, f.n. 5, sec. IV. p. 19.
[7] Decarbonization refers to the reduction of greenhouse gas emissions.

energy requirements during a period of significant industry change that could impact resource planning analyses.

For this planning exercise, a range of load forecasts was developed independently for the Island Interconnected System and the Labrador Interconnected System. For the 2024 Resource Adequacy Plan, three forecasts were developed to reflect the range of forecasted Island Interconnected System load requirements, as summarized in Figure 1.

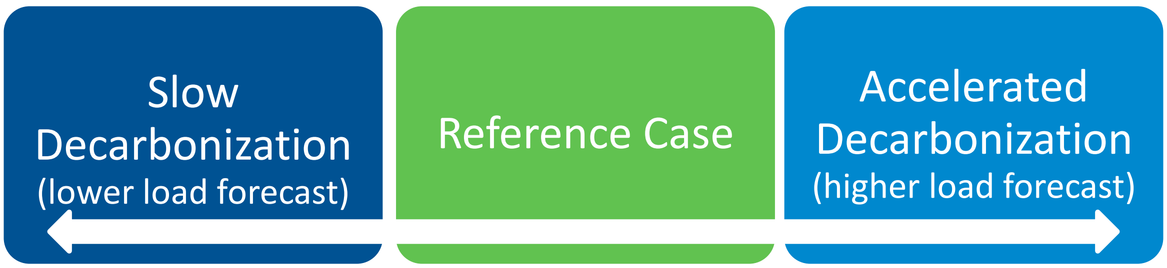

Figure 1: Island Interconnected System Forecast Scenarios

- **Slow Decarbonization Path Scenario ("Slow Decarbonization"):** Considers more moderate decarbonization efforts and electrification of the transportation sector, lower population and housing starts, as well as increased electricity rates, resulting in a lower load forecast as compared to the Reference Case;
- **Reference Case:** Based upon the continuation of a steady level of decarbonization, driven primarily through government policy and programs, anticipated electrification of the transportation sector, and steady increase in population and housing starts; and
- **Accelerated Decarbonization Path Scenario ("Accelerated Decarbonization"):** Assumes accelerated decarbonization and electrification of the transportation sector, electricity rate assumptions consistent with the Reference Case, as well as higher population and housing starts, and an increase in industrial demand, resulting in a higher load forecast as compared to the Reference Case.

Similarly, three forecast scenarios were developed for the Labrador Interconnected System to reflect the potential range of load forecast requirements for that system. Considering the current customer service requests from existing Industrial customers asking to significantly increase load in this area, Hydro has chosen to develop sensitivity cases to assess how industrial growth could affect system demand and energy requirements. As a result, the Reference Case, which includes no new industrial load, reflects the low side of the potential future outcomes. The three forecasts are summarized in Figure 2.

Figure 2: Labrador Interconnected System Forecast Scenarios

- **Reference Case:** Reflective of current decarbonization and consistent industrial loads;
- **Medium Growth Scenario:** Primarily reflective of increased industrial requirements, resulting in a higher load forecast than the Reference Case; and
- **High Growth Scenario:** Reflective of accelerated decarbonization through electrification and increased industrial requirements, resulting in a higher load forecast than both the Reference Case and Medium Growth Scenario.

The resulting interconnected customer electricity demand requirements that were developed for both the Island and Labrador Interconnected Systems are presented in Chart 1 and Chart 2, respectively.

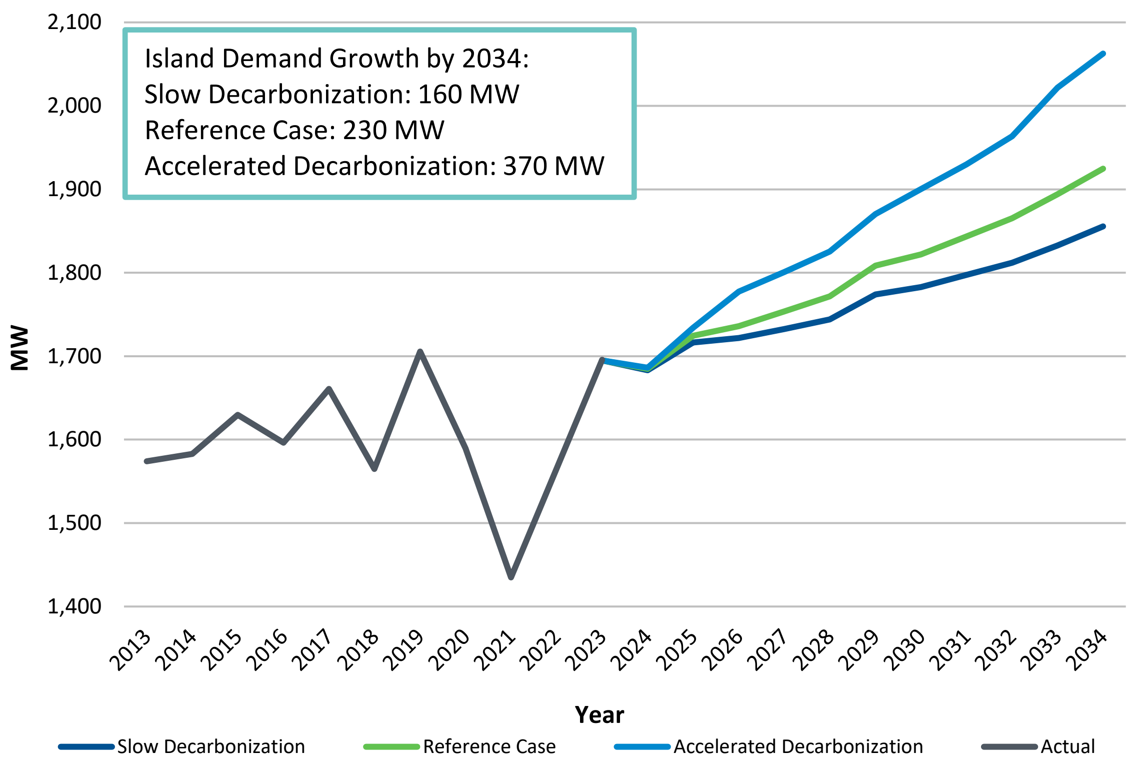

Chart 1: Island Interconnected System Annual Customer Coincident Demand Requirements[8,9,10]

1 The results of the three long-term planning forecast scenarios for the Island Interconnected System project overall load growth for the Island in every scenario across the forecast horizon. The compound annual growth rate[11] ranges from 0.8% in the Slow Decarbonization Scenario to 1.8% in the Accelerated Decarbonization Scenario.

[8] The Island Interconnected System annual customer coincident demand is reflective of the total Island Interconnected System demand less transmission losses and station service load.
[9] Historical values are not weather normalized.
[10] The significant decline in demand in 2020 and 2021 was due to the effects of the COVID-19 pandemic.
[11] The compound annual growth rates are based on the forecast load increases from 2023 to 2034.

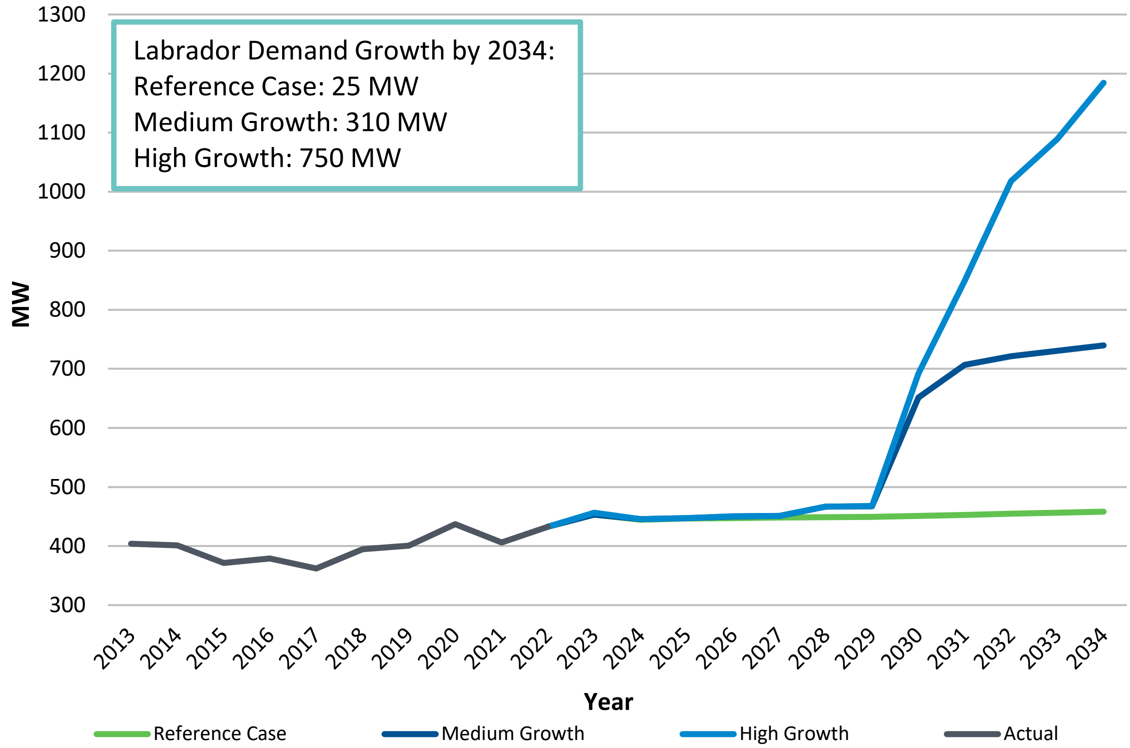

Chart 2: Labrador Interconnected System Annual Customer Coincident Demand Requirements[12,13]

The three Labrador Interconnected System forecast scenarios also project overall load growth for Labrador. The compound annual growth rate ranges from 0.1% in the Reference Case to 9.1% in the High Growth Scenario, highlighting the potential for significant load growth on that system stemming from existing Industrial customers.

[12] Excludes transmission losses.
[13] Historical values are not weather normalized.

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1.0 Introduction

Each year Hydro generates independent load forecasts for the Island and Labrador Interconnected Systems. These forecasts are then used company-wide as the basis for many of Hydro's key business activities, including general rate applications, financial budgeting and forecasting, transmission planning analyses, rate analyses, long-term financial planning, and reliability and resource adequacy assessments.[14]

While Hydro has always included a discussion of its load forecast as part of its *RRA Study Review* filings, the Board of Commissioners of Public Utilities ("Board") has directed Hydro to ". . . file the assumptions for each load forecast scenario as soon as possible and by the end of the first quarter of 2024 at the latest" to assist in the Board's and the parties' understanding of the various load forecasts.[15]

To facilitate an increased understanding of the load forecast that will form the basis of Hydro's 2024 Resource Adequacy Plan filing by the end of the second quarter, this document is intended to provide:

- An overview of Hydro's load forecast philosophy;
- A description of the development of and methodology behind Hydro's load forecast;
- A description of the inputs used to generate the load forecast;
- A summary of Hydro's 2023 Load Forecast results;
- A listing of underlying assumptions for each of Hydro's load forecast scenarios; and
- A discussion of key drivers that influence the outcomes of the load forecast, including the influence of the same on the 2023 Load Forecast.

2.0 Load Forecast Philosophy

The purpose of load forecasting is to project electric power demand and energy requirements for future periods.[16] The objective of the load forecast process is to characterize and understand the range of

[14] Hydro also produces a forecast for the Isolated System; however, this report focuses on the forecasts for the Interconnected Systems only.
[15] "Newfoundland and Labrador Hydro - Reliability and Resource Adequacy Study Review Planned Reports, Studies and Analyses - Further Comments and Directions," Board of Commissioners of Public Utilities, October 12, 2023, item 4, p. 3.
[16] Demand is the rate at which electric energy is delivered to or by a system, generally expressed in kilowatts or megawatts, at a given instant or averaged over any designated interval of time.

possible system demand and energy requirements arising from the inherent uncertainty in the load forecast model inputs, to ensure that Hydro is prepared to serve its customers' needs in the near and long term. As a result, the load forecast is a key input to the resource planning process, which recommends what resources should be made available to meet projected demand within the province, consistent with applied reliability standards.

As is generally the case in utility system planning, Hydro uses the Reference Case plus alternative scenarios approach to its load forecast development. The Reference Case is developed to represent Hydro's expectation of the demand and energy requirements that would materialize based on the use of baseline expectations for economic growth and existing government policies and programs. Alternatives to the Reference Case are developed to determine the sensitivity of system requirements to changes in key inputs, both in terms of magnitude of change and timing of requirements.

Consideration of a range of alternatives is a critical component of Hydro's planning activities as it allows for the impact of uncertainty in input parameters on the overall forecast. This enables Hydro and its stakeholders to understand the impact of key parameters like policy adoption rates and differing economic conditions when assessing options and timing of resource additions to meet future customer requirements.

3.0 Load Forecast Methodology

For the Newfoundland and Labrador Interconnected System, the load forecast is segmented into the Island Interconnected System and Labrador Interconnected System, as well as utility load (i.e., Domestic and General Service loads of Newfoundland Power and Hydro) and industrial load.

The load forecast process for the Island Interconnected System translates the long-term economic outlook and energy price forecast for the Island into corresponding utility demand and energy requirements for the electric power systems.

For the Labrador Interconnected System, utility requirements are primarily forecasted using historical growth trends. This method is used because the utility forecast is broken down into two relatively small service areas, with the primary driver for economic activity being changes to industrial activity in the area.

The forecast process for both systems also involves the development and analysis of potential new loads associated with electrification (e.g., EV adoption and conversions of heating systems to electric heat).

For Hydro's large Industrial customers, direct input from those customers forms the basis for Hydro's forecast of their firm electric power requirements.[17] Hydro does not include non-firm power requests in the development of the annual load forecast.

3.1 Development of the Island Interconnected System Forecast[18]

The Island Interconnected System load, exclusive of transmission losses and station service, is the summation of interconnected utility load, Industrial customer loads, and the distribution losses incurred serving the customer load requirements on the system.

The load forecast for the Island Interconnected system results from the combination of forecasts prepared for:

- Load served by Newfoundland Power;
- Industrial customers' load served by Hydro; and
- Rural load served by Hydro.

The forecast for transmission losses and station service load is then modelled using the Island Interconnected System forecast results and assumptions surrounding existing and potential generation resources.

Each of the forecasts for the Island Interconnected System is prepared using a set of inputs that form the basis for determining peak demand and energy requirements over the term of the forecast. Key inputs to the Island Interconnected System forecast include:

- Government of Newfoundland and Labrador economic forecast:
    - Hydro relies on the annual Government of Newfoundland and Labrador ("Government") long-term economic forecast for economic and other provincial variable assumptions in its

[17] Firm demand is the portion of the demand that a power supplier is obligated to provide, except when system reliability is threatened or during emergency conditions. Firm energy refers to the actual energy guaranteed to be available to meet customer requirements on an annual basis.
[18] The regression equations used to develop the Island Interconnected System load forecast can be found in Appendix B.

load forecast. This forecast provides a provincial perspective and appropriately considers local projects and demographics.

- Newfoundland Power load requirements:
  - Newfoundland Power provides service to the majority of customers on the Island portion of the province. In 2022, its requirements represented 85% of the Island Interconnected System demand requirements and 78% of the Island Interconnected System energy requirements.[19] Newfoundland Power's historical billing data and information contained within its five-year load forecast are used by Hydro as inputs into its long-term load forecast.
- EV adoption:
  - Considers the impact of EV adoption on demand and energy requirements. Hydro engaged an external consultant, Dunsky, to develop various forecast scenarios for EV adoption in the province. A forecast scenario was chosen for the Reference Case that considers the expected trajectory of EV adoption in the region, while sensitivities consider the potential impacts of both a slower and a more accelerated adoption rate to assess impacts on load requirements in the future. All scenarios assume utility management of EV home charging will be a part of demand response programming.
- Government policies and programs:
  - Considers the impact of provincial and federal policies on demand and energy requirements. The Reference Case forecast considers the impacts of established and committed programs on system requirements (e.g., oil-to-electric home heating conversions), while sensitivity forecasts consider the implications of changes in policy or programs as well as changes in the uptake or adoption of such policies or programs.

[19] Exclusive of transmission losses and station service.

- Electricity rates:[20]
    - The underlying electricity rate used in developing the 2023 load forecast aligns with the Government's publically announced[21] rate mitigation target of 14.7¢/kWh, escalating by 2.25% per year. While the Government's rate mitigation plan has not been finalized and communicated, for the purposes of completing a load forecast this forecast update assumes rates continue to escalate at 2.25% annually. This rate forecast was used in both the Reference Case and the Accelerated Decarbonization Scenario. For the Slow Decarbonization Scenario, Hydro created an assumed rate sensitivity forecast considering the underlying mitigated electricity rate forecast and added a 0.7% adjustment based on the historical rate impact for distribution upgrades on the Newfoundland Power System, resulting in an annual escalation of approximately 3% per year.
- Industrial customer load requirements
    - Hydro works closely with its Industrial customers to forecast the demand and energy requirements associated with each customer's business activities and future potential plans. The potential for new Industrial customers is also considered in forecast development scenarios. The various projections for existing and new customers are then combined to form the basis of Hydro's load forecast of Industrial customer requirements.

Hydro engaged Daymark to provide a third-party independent assessment of the strength of its load forecasting process including a review of the underlying methodologies used to produce the 2023 load forecast. In its report, Daymark states, "Hydro's current load forecasting methodology reflects standard industry approaches for assessing potential growth. The approach and data are grounded in the realities Hydro and the industry must face."[22] The report provides recommendations for continuous improvement in Hydro's forecasting process, which are intended to generate efficiency in the process, and concludes that these efficiencies ". . . does not detract from the general efficacy of Hydro's

[20] The rate forecast underlying the Reference Case and load forecast scenarios can be found in Appendix A.
[21] "Protecting You from the Cost Impacts of Muskrat Falls," Government of Newfoundland and Labrador, April 2019. https://www.gov.nl.ca/iet/files/Framework.pdf
[22] *Supra*, f.n. 5, sec. II(C). p. 15.

forecasting approach in this current proceeding."[23] For additional information on Daymark's independent review of the load forecast methodology, please refer to Attachment 1.

3.2 Development of the Labrador Interconnected System Forecast

The Labrador Interconnected System load, exclusive of transmission losses and station service, is the summation of interconnected utility load and Industrial customer loads, as well as the distribution losses incurred serving the customer load requirements on the system.

The load forecast for the Labrador Interconnected System results from the combination of forecasts prepared for:

- Industrial customers served by Hydro;
- Rural load served by Hydro; and
- EV requirements forecast.

Each of the Labrador Interconnected System forecasts is prepared using a set of inputs that form the basis for determining demand and energy requirements over the term of the forecast. Key inputs to the Labrador Interconnected System forecast include:

- Industrial customer forecast load requirements
    - Hydro works closely with its Industrial customers it serves directly to forecast the demand and energy requirements associated with each customer's business activities and potential future plans. The potential for new Industrial customers is also considered in forecast development scenarios. The different projections are then combined to form the basis of Hydro's forecast scenarios for Industrial customer requirements.
- Rural economic growth:
    - Considers historical economic growth in each region, information available on regional economic plans and provincial budgets that allocate funding for residential and commercial development. For the development of alternative future outcomes, the primary

[23] *Supra*, f.n. 5, sec. IV. P. 19.

consideration for increased economic activity is the changes in industrial activity, with the expansion of industrial work historically driving residential and commercial growth.

- EV requirements forecast:
  - Hydro considers the impact of the adoption of EVs on demand and energy requirements. A forecast scenario was chosen for the Reference Case and Medium Growth Scenario that considers the expected trajectory of EV adoption in the region, while a sensitivity that considers the potential impacts of a more accelerated adoption rate was used in the High Growth Scenario.

3.3 Discussion of Major Inputs to the 2023 Load Forecast

Major inputs discussed here are those variables identified as inputs to the modelling and analysis that have the most potential to impact (or be impacted by) the evolving energy landscape. Some of these major inputs are also those with the most uncertainty, making it prudent to identify a range of potential outcomes.

3.3.1 Island Interconnected System Forecast Assumptions

The major inputs driving growth in the Island Interconnected System, as well as the pace of change of each, are summarized in Table 1 and are described in further detail in the following sections.

Table 1: Major Inputs and Factors Driving Growth

Electric Vehicles	Economic Growth	Decarbonization and Electrification	Energy Efficiency	Industrial Growth
• Total cost of EV ownership • Availability of charging infrastructure • Available vehicle supply • Government policy • Available Incentives	• Population growth/immigration • Commercial development, including major projects	• Government policy, mandates and regulations • Available Incentives • Carbon pricing	• Availability of new technologies • Utility programming	• Electrification of existing and new processes/ facilities • Expansion

3.3.1.1 Electric Vehicles[24]

For the 2023 Load Forecast update, Hydro utilized a combination of the different forecasts provided by Dunsky to create three distinct forecasts; the EV Reference Case forecast, a Slower EV Adoption Forecast, and an Accelerated EV Adoption forecast that would meet the federal government's proposed regulated target of 100% of new light-duty vehicle sales being a zero-emission vehicle by 2035.[25,26]

For the Island Interconnected System forecast scenarios, the Reference Case utilized the EV Reference Forecast, the Slow Decarbonization Scenario utilized the EV forecast with slower adoption, and the Accelerated Decarbonization Scenario utilized the EV forecast with accelerated adoption.

Chart 3 shows the impact of EV charging on the Island Interconnected System demand for the three forecast scenarios. There is a total variance of approximately 50 MW between the Slow Decarbonization and the Accelerated Decarbonization Scenarios by the end of the forecast period.

[24] Information on the cumulative EV sales for the Island Interconnected System for the Reference Case and alternate scenario forecasts can be found in Appendix A.

[25] In 2022, Hydro engaged Dunsky to provide a system planning study to evaluate the potential impact of EVs on provincial load to support Hydro in its development of the load forecast.

[26] The accelerated EV adoption forecast does not assume the federal government's proposed targets for 2026 and 2030 are also met. Under the new Electric Vehicle Availability Standard, auto manufacturers and importers must meet annual zero-emission vehicle regulated sales targets of 20% in 2026 and 60% by 2030. https://www.canada.ca/en/environment-climate-change/news/2023/12/canadas-electric-vehicle-availability-standard-regulated-targets-for-zero-emission-vehicles.html

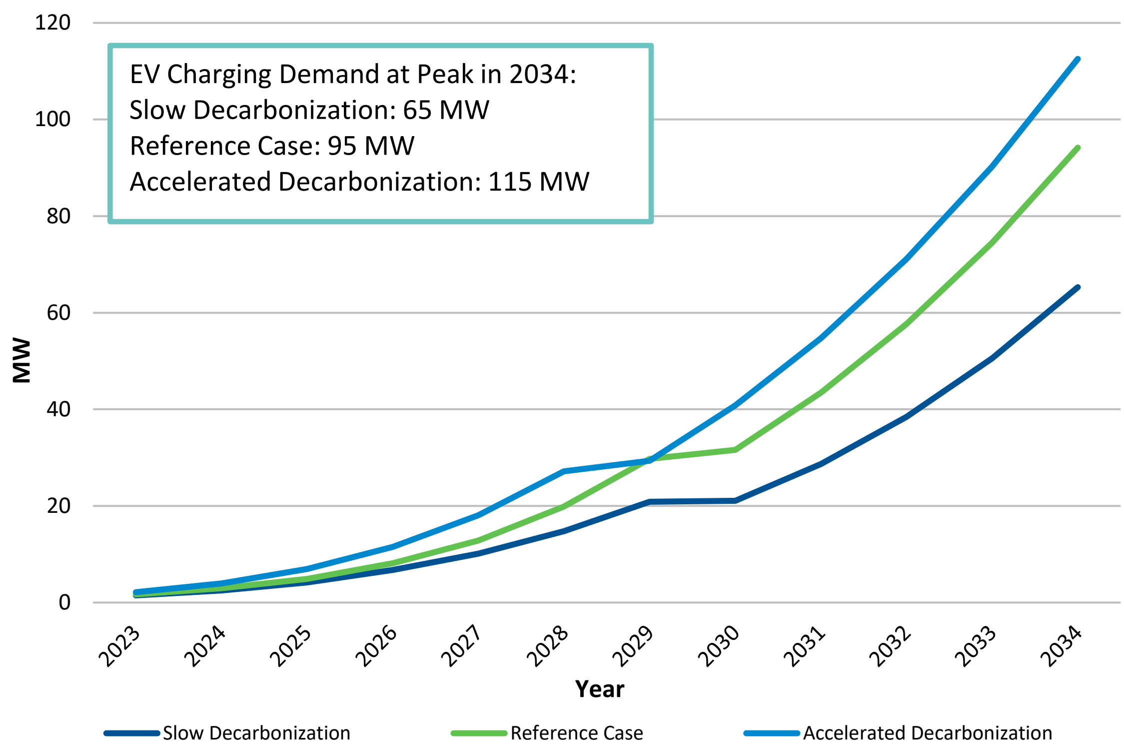

Chart 3: EV Charging Demand at Island Interconnected System Peak

Chart 4 shows the impact of EV charging on the Island Interconnected System on energy requirements for the three forecast scenarios. There is a total variance of approximately 265 GWh between the Slow Decarbonization and the Accelerated Decarbonization Scenarios by the end of the forecast period.

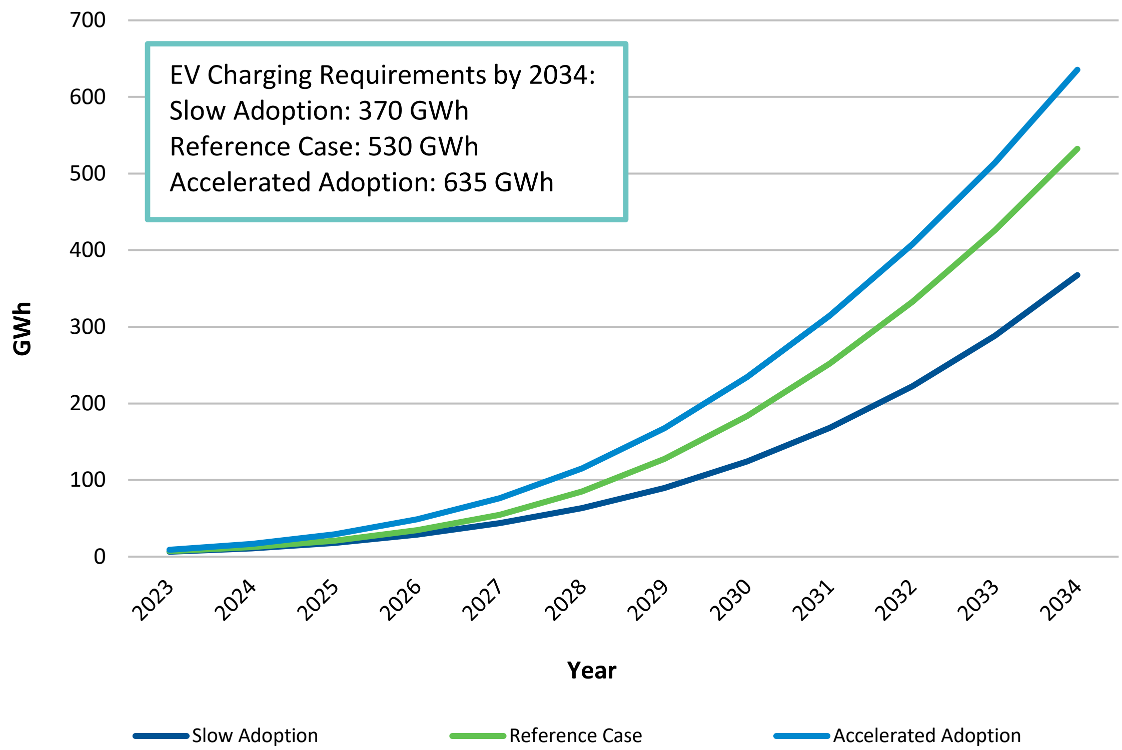

Chart 4: Island Interconnected System EV Charging Energy Requirements

It is assumed that by 2030 the system peak will include utility management of EV home charging to reduce the impact on the system peak in both the Reference Case and the Slow Decarbonization Scenario. This is assumed to be achieved through EV smart chargers. For the Accelerated Decarbonization Scenario, it is assumed that the management of EV home charging for light-duty vehicles will begin in 2029, resulting in similar demand impacts in that year when compared to the Reference Case. Medium- and heavy-duty vehicles and buses are assumed to be managed by customers to reduce demand charges and avoid equipment upgrades. In all three forecast scenarios, it is assumed approximately 50% of home charging of light-duty vehicles will be managed during peak.[27] Managed home charging can significantly reduce evening EV load by shifting the load to the overnight period. If home charging during peak demand is not managed, it is estimated to result in an additional demand of 70 MW to 150 MW by 2034.[28] Newfoundland Power is currently completing an EV load management pilot project to assess the cost-effectiveness and customer opt-in rate of different strategies to manage

[27] "EV Adoption and Impacts Study – Final Results," Dunsky Energy + Climate Advisors, August 23, 2022, Slide 19.
[28] *Supra* f.n. 26, Slide 29.

light-duty EV load.[29] Results from the pilot project may be used in the development of future load forecasts to determine the potential amount of cost-effective demand management for EV home charging.

Based on Dunsky's analysis, the potential electrical system impact from EVs could be substantial by the end of the period; however, there remains a fair degree of variance in the range of forecast requirements identified between the three EV scenarios considered.[30]

3.3.1.2 Economic Information

Hydro relies on the Government's annual long-term economic forecast for economic and other provincial variables for input assumptions in the load forecast. This forecast provides a provincial perspective and appropriately considers local projects and demographics.

Economic growth is a major input into the development of the load forecast because it captures several factors that influence energy use in both the residential and general service sectors. Increased income can result in additional demand for goods and services and increased production to meet the demand generally requires more energy.

For 2023, residential regressions underlying the forecasting model rely on a prediction of customer numbers and customer average use. New housing starts are used in generating the residential customer number forecasts while household disposable income and provincial population are used to determine average customer use. The general service model for Newfoundland Power that Hydro creates continues to use adjusted gross domestic product ("GDP") and non-residential building investment as primary inputs. Forecast future sales for Hydro's rural general service sales are generated using forecasts of household disposable income and the value of fish landings.

In the underlying economic forecast for the Reference Case, there are several major projects, including the development of resources at Bay du Nord and West White Rose as well as hydrogen developments, which will positively influence provincial economic activity leading to increased investment and employment gains. The provincial population is also forecast to continue to experience strong growth,

[29] "Application for EV Load Management Pilot Project," Newfoundland Power Inc., June 2, 2023. http://www.pub.nl.ca/applications/NP2023ElectricVehicleLoad/app/From%20NP%20-%20%20Application%20for%20Electric%20Vehicle%20Load%20Management%20Pilot%20Project%20-%202023-06-02.PDF
[30] For more information on the EV adoption and impacts provided by Dunsky, please refer to Attachment 1.

following an actual increase of approximately 7,022, or 1.3% from July 2022 to July 2023. This recent increase was the largest annual increase in population, on an actual basis, since 1972.

For the development of the Slow Decarbonization Scenario, Hydro relied on previous Governments' economic forecasts to define a future with a lower population projection and fewer housing starts, resulting in a lower level of growth in residential electricity sales. Other economic indicators were held consistent with the Reference Case.

For the Accelerated Decarbonization Scenario, Hydro relied on a high-scenario economic forecast developed by the Government. This forecast has stronger overall growth for all economic indicators as compared to the Reference Case, primarily driven by an increase in the number of major projects and mining developments and a stronger population forecast.

Table 2 shows the key economic inputs used in the forecast model for the three forecast scenarios.

Table 2: Island Interconnected System Economic Indicators

Economic Driver	Slow Decarbonization	Reference Case	Accelerated Decarbonization
Adjusted Real GDP at Basic Prices (% per year)	0.6	0.6	0.5[31]
Real Household Disposable Income (% per year)	0.9	0.9	1.2
End of Forecast Period Population (000)	533.6	542.5	553.8
Average Housing Starts Per Year	1,381	1,603	1,676
Cumulative Non-Residential Building Investment Over the Forecast Period ($000)	7,118	7,118	7,180

Chart 5 and Chart 6 provide visual representations of two of the key economic parameters driving growth on the Island Interconnected System in the 2023 Load Forecast; provincial population growth and housing starts.

[31] While the overall pattern of GDP growth is similar in both the provincial governments' Reference Case and high economic forecasts, there are a couple of years in the middle of the forecast period where the Reference Case values are higher than the high economic forecast values.

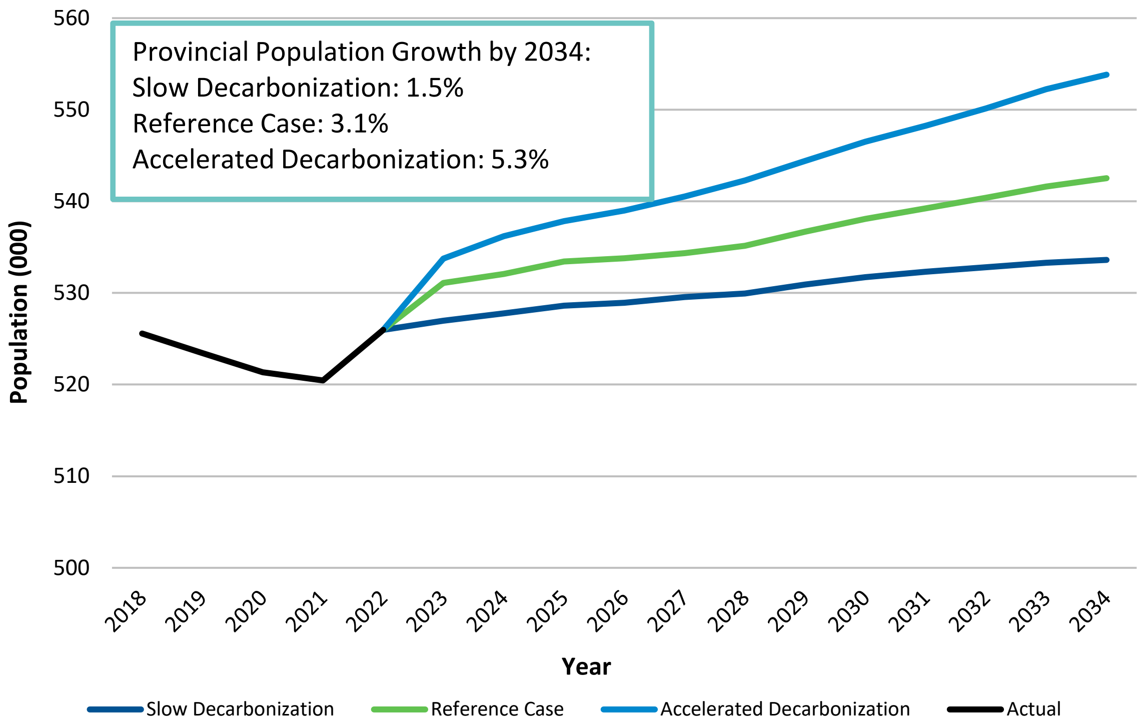

Chart 5: Actual and Forecast Provincial Population

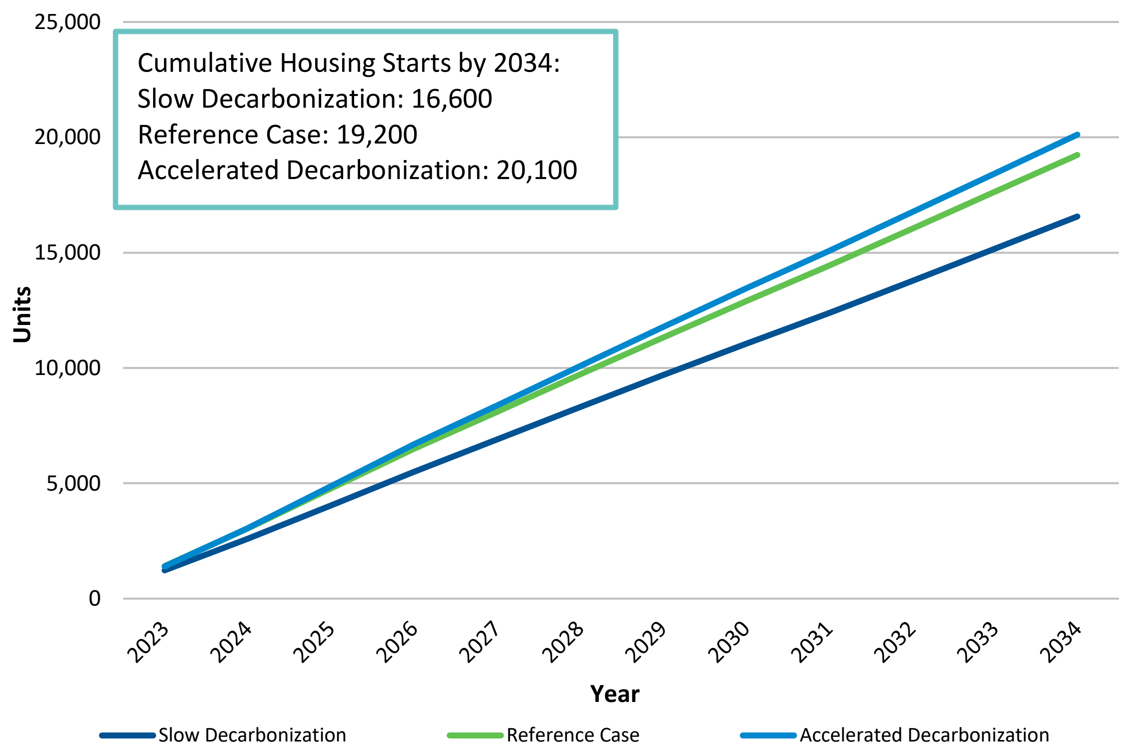

Chart 6: Cumulative Housing Starts

3.3.1.3 Decarbonization and Electrification (Utility Sales)

Government policy has the greatest potential to drive decarbonization and electrification across several sectors, such as space heating and transportation, as well as influence the overall decarbonization of the province. Electrification has the potential to change the quantity and usage pattern of electricity by customers in Newfoundland and Labrador.

All levels of government are focusing on decarbonization and electrification; however, there remains uncertainty in the timing and extent to which policies may be implemented. For the 2023 Load Forecast modelling process, decarbonization factors that were considered in the development of forecast scenarios include government policy (including mandates and regulations), available incentives,[32,33] and the price of carbon greenhouse gas emissions.[34]

The Reference Case is representative of steady electrification in the space-heating sector. For the residential space-heating sector, it is assumed that 71% of homes that are currently oil-heated but have an oil tank that will expire during the forecast period will convert to electric heat.[35] In the commercial sector, it is assumed that there will be a modest amount of Government buildings converting existing alternate fuel heating systems to electric heat, consistent with the Government's planned building conversions.[36] In forecasting the commercial sector, it is assumed that all new customers will use electric heat.

The Slow Decarbonization Scenario is representative of modest electrification. It is assumed that 59% of oil-heated homes with an oil tank expiring during the forecast period will convert to electric heat. In the commercial sector, the same assumptions were used as in the Reference Case.

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[32] In May 2021, the Government of Canada launched the Canada Greener Homes Grant to help Canadians lower their energy costs, make their homes more comfortable and contribute to Canada's climate action plan. https://natural-resources.canada.ca/energy-efficiency/homes/canada-greener-homes-initiative/canada-greener-homes-grant/canada-greener-homes-grant/23441

[33] In June 2023, Government, in collaboration with Natural Resources Canada and Environment and Climate Change Canada, announced funding towards the implementation of new fuel switching and energy efficiency incentive programs. https://www.gov.nl.ca/releases/2023/ecc/0629n03/

[34] In 2019, the Government of Canada set a national minimum price on carbon pollution starting at $20 per tonne, increasing by $10 in 2022 to $50 per tonne. Starting in 2023 through 2030, the minimum price will increase by $15 per tonne. https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/carbon-pollution-pricing-federal-benchmark-information.html

[35] Approximately 21,100 homes in Newfoundland and Labrador have oil tanks expiring during the forecast period.

[36] Consistent with Government's list of government building conversions dated February 2023.

The Accelerated Decarbonization Scenario is representative of accelerated electrification. It is assumed that all oil-heated homes with an oil tank expiring during the forecast period will convert to electric heat. It is also assumed that a portion of oil-heating customers with oil tanks expiring outside of the forecast period will convert to electric heat within the next ten years. In the commercial sector, it is assumed an additional 40% of the Government's Transportation and Infrastructure buildings and Health Facilities will convert their heating systems to electric heat in addition to the Government's planned building conversions. Consistent with the Reference Case, it is assumed that all new commercial customers will use electric heat.

Table 3 summarizes the space-heating assumptions for the Island Interconnected System included in the Reference Case and both considered alternative scenarios.

Table 3: Electrification of Space Heating

	Slow Decarbonization	Reference Case	Accelerated Decarbonization
Residential Conversions to Electric Heat During the Forecast Period (Approximate)[37]	12,400	15,100	24,400
New General Service Customers' Primary Heating Source	Electric	Electric	Electric
Government Building Conversions in 2034 (GWh)	6.5	6.5	82

Chart 7 provides a visual representation of the oil-to-electric conversions assumed through the study period.

[37] There are approximately 40,000 registered oil tanks on the Island.

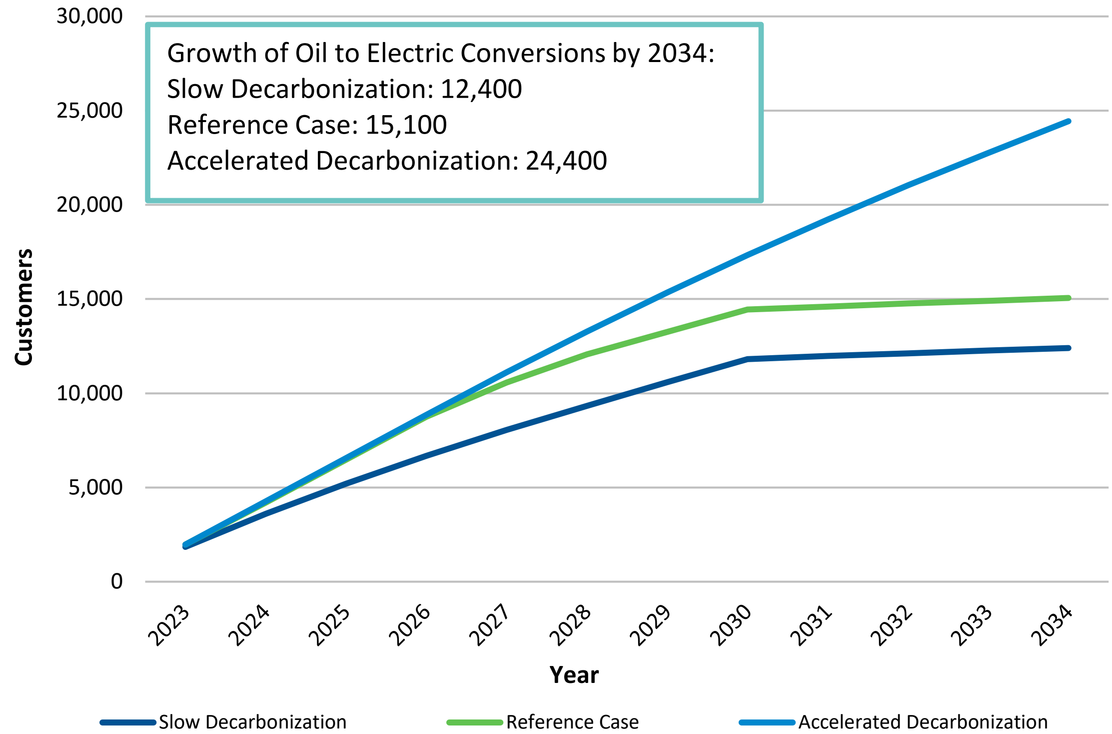

Chart 7: Cumulative Number of Residential Oil to Electric Conversions

3.3.1.4 Conservation and Energy Efficiency

Hydro and Newfoundland Power offer a variety of information and financial support options to customers to help them manage their energy usage. Since 2009, both utilities have offered customer energy conservation programs on a joint and coordinated basis under the takeCHARGE brand.

Examples of the residential programs offered include insulation and air sealing, high-performance thermostats, heat recovery ventilators, and various small technologies through the Instant Rebates Program. takeCHARGE also serves the commercial sector through the Business Efficiency Program and, in more recent years, a pilot program targeting small business customers was introduced.

For the 2023 Load Forecast update, an estimate of energy savings through utility conservation programs, as forecast by takeCHARGE, was developed. This estimate was used for all three load forecast scenarios.

Over the last decade, the installation of mini-split heat pumps ("MSHP") in residential homes has grown in popularity, with Newfoundland Power's 2022 customer survey estimating that approximately 28% of their domestic customers have an MSHP installed. In homes with electricity as the primary heating source, MSHPs are primarily being installed to reduce overall energy consumption.[38] For the 2023 Load Forecast update, forecasts were developed for the number of primarily electrically heated residential homes installing an MSHP. While non-electrically heated homes also install MSHPs, for forecast purposes it was assumed all non-electrically heated homes installing an MSHP are reflected in projections associated with the oil-to-electric conversion program.

In the Reference Case and the Accelerated Decarbonization Scenario, it is assumed that by the end of 2034 approximately 61% of Newfoundland Power's residential customers who use electricity as their primary heating source will have installed MSHPs in their homes.[39]

In the Slow Decarbonization Scenario, it is assumed that by the end of 2034, 66% of Newfoundland Power's residential customers with electric heat will have installed MSHPs in their homes, slightly more than the Reference Case and the Accelerated Decarbonization Scenario due to the increase in electricity rates underlying the load forecast driving electricity-saving measures.[40]

3.3.1.5 Industrial Customer Growth

Industrial load on the Island Interconnected System is currently comprised of six customers.[41] In recent years, Newfoundland and Labrador has seen record-setting exploration expenditures in the mining sector and there has been a noticeable advancement in wind hydrogen development projects.

In both the Reference Case and the Slow Decarbonization Scenario, it is assumed all current industrial customers will remain and business activities will continue at currently forecasted levels. In both scenarios, it is also assumed there will be an additional industrial load of 10 MW firm demand, starting in 2028 stemming from hydrogen developments.

[38] "2021 Conservation and Demand Management Report," Newfoundland Power Inc., April 1, 2022, app. B. http://www.pub.nf.ca/indexreports/conservation/From%20NP%20-%202021%20Conservation%20and%20Demand%20Management%20Report%20-%202022-04-01.PDF
[39] Based on Newfoundland Power's 2022 residential customer count.
[40] Based on Newfoundland Power's 2022 residential customer count.
[41] The sixth customer was connected to the grid in January 2024 and started drawing power from the grid late in the first quarter of 2024.

In the Accelerated Decarbonization Scenario, it is assumed all current Industrial customers will remain and business activities will continue at currently forecasted levels. This scenario also assumes that in 2025 one Industrial customer will partake in electrification initiatives, converting existing heating systems to electric heat while maintaining its existing alternate heating source as a backup. While this additional electrification load is assumed to be interruptible upon request, its impact is included in Chart 8.[42] In addition, an industrial load of 40 MW firm demand stemming from an increase in hydrogen developments is included, with 20 MW included in the years 2028, and 2032. As this industry is expected to continue to evolve, Hydro will monitor closely and adjust future scenario assumptions as required.

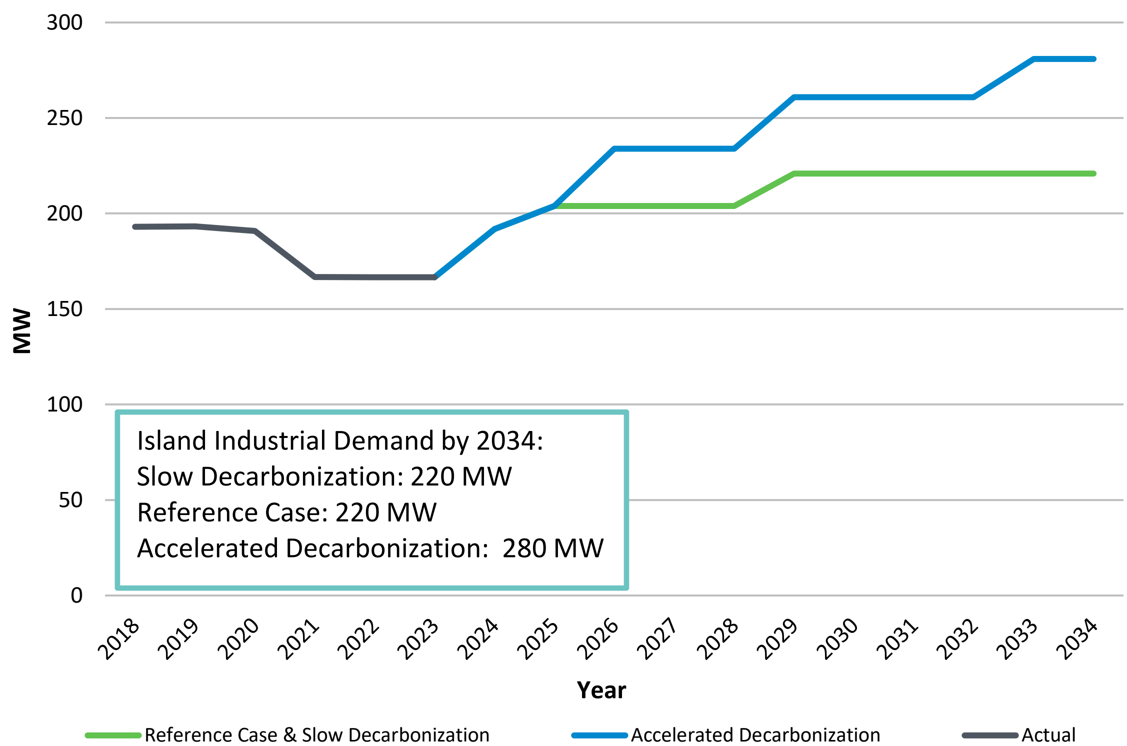

Chart 8: Island Interconnected Industrial Demand[43]

[42] Interruptible load is a load, typically commercial or industrial, that can be interrupted in the event of a capacity deficiency in the supplying system.

[43] Total industrial demand is the summation of firm requirements for industrial customers. Values are not reflective of industrial demand at the time of the Island Interconnected System peak.

3.3.1.6 Weather Data

Weather, specifically ambient temperature, is one of the largest factors affecting customer electricity usage and demand in Newfoundland and Labrador. Hydro uses weather variables in its energy and peak models, including heating degree days[44] and wind chill. For weather variables, Hydro focuses on estimating a "normal" weather year, rather than predicting what may occur in any specific year. For the Island Interconnected System energy models, Hydro uses a rolling 30-year average for the initial starting value of heating degree days and has implemented the use of a linear trend model to reflect gradual warming, resulting from climate change and reflecting recent winter weather history, over the forecast period. For the peak model, Hydro continues to use a rolling 30-year average wind chill value or P50 weather conditions as an input for peaking event conditions.[45]

At this time Hydro is not including additional forecast combinations for more extreme peak conditions in the development of its forecasts; however, continues to assess the impact that P90 conditions may have on the demand forecast and on its ability to supply customers should such conditions occur. The P90 weather condition is based on 30 years of historical wind chill values during the winter period and these assumptions increase the Island Interconnected System requirements by approximately 60 MW.[46]

3.3.2 Labrador Interconnected System Forecast Assumptions

The 2023 Labrador Interconnected System forecast is comprised of the Reference Case forecast and two alternative scenario forecasts:

- **Reference Case:** Reflective of current decarbonization Government policy and programs, and consistent industrial loads;
- **Medium Growth Scenario:** reflects significant increase in industrial loads due to growth, electrification, and health and safety related improvements; and
- **High Growth Scenario:** accelerated decarbonization through electrification and increased industrial loads due to growth, electrification, and health and safety-related improvements.

[44] Heating degree days refers to the equal number of degrees Celsius a given day's mean temperature is below 18°C.
[45] A P50 forecast is one in which the actual peak demand is expected to be below the forecast number 50% of the time and above 50% of the time (i.e., the average forecast).
[46] A P90 forecast is one in which the actual peak demand is expected to be below the forecast number 90% of the time and above 10% of the time (i.e., there is a 10% chance of the actual peak demand exceeding the forecast peak demand).

These alternative scenario forecasts cover the broader range of potential future demand above the Reference Case forecast and are primarily the result of changes in assumptions for Industrial customer load. The major inputs driving growth in the Labrador Interconnected System are described in further detail in the sections that follow.

3.3.2.1 Electric Vehicles

For the Labrador Interconnected System forecast scenarios, the Reference Case and the Medium Growth Scenario utilized the EV Reference Case forecast and the High Growth Scenario utilized the EV forecast with accelerated adoption, as described in Section 3.3.1. Chart 9 shows the forecast impact of EV charging at the Labrador Interconnected System peak. Given the relatively small number of vehicles in Labrador and the high proportion of industrial load on the system, EV charging is not anticipated to have a significant impact on the Labrador Interconnected System peak, with an overall impact between 6 MW and 8 MW in the study period.

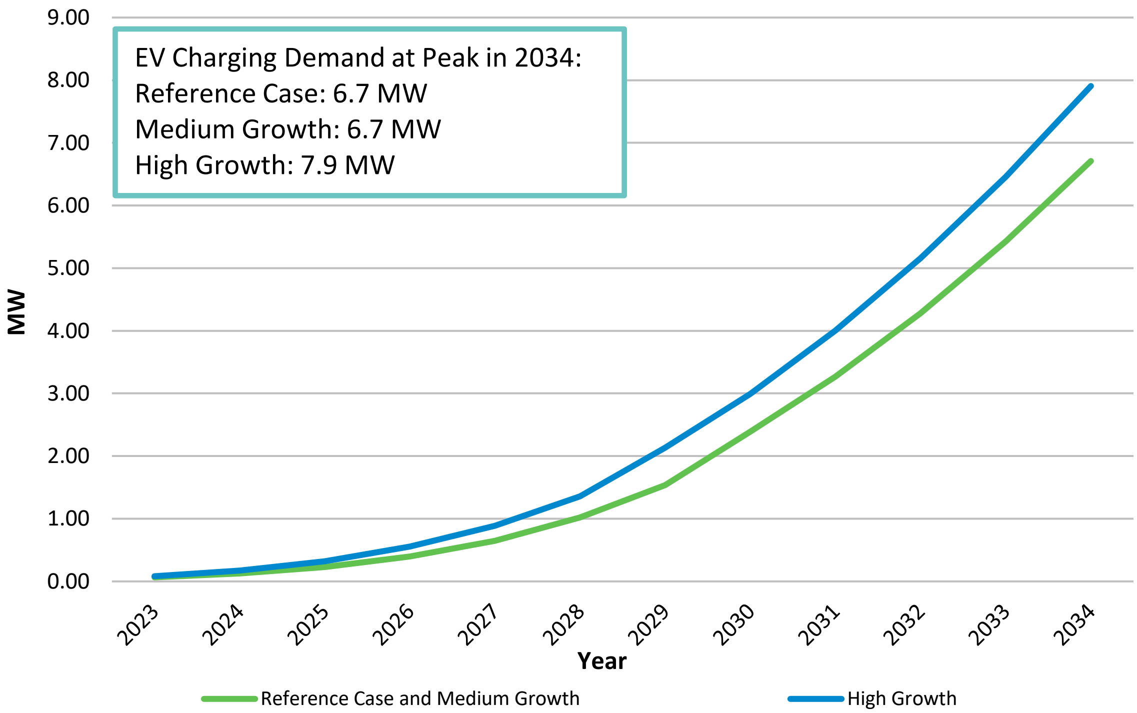

Chart 9: EV Charging Demand at Labrador Interconnected System Peak

3.3.2.2 Industrial Growth and Electrification

In recent years, Hydro has received significant requests for power in Labrador, including existing Industrial customers. The requests range from small facility upgrades to the conversion of current processes to run on electricity. In March 2021, Hydro formalized customer requests for incremental firm load in Labrador via the *Network Additions Policy – Labrador Interconnected System* ("*NAP*").[47] As requests move further through the stages of the *NAP*, sensitivity forecasts will continue to be developed for use in various planning studies.

Total industrial demand for the Labrador Interconnected System is shown in Chart 10. For the Reference Case, it is assumed that the two major Industrial customers will continue at current loads throughout the forecast period. In the Medium Growth Scenario, it is assumed that both customers will move forward with some of the projects identified and submitted through the *NAP* process. In the High Growth Scenario, it is assumed that the major Industrial customers will proceed with all potential projects that were identified and submitted through the *NAP* process.

[47] As per *Public Utilities Act*, RSNL 1990, c P-47, Board Order No. P.U. 7(2021), Board of Commissioners of Public Utilities, March 17, 2021, the Board approved a Network Additions Policy for the Labrador Interconnected System, which laid out the rules for cost allocation to customers when transmission investments are triggered by customer load on the Labrador Interconnected System. Such a policy is standard practice in utilities and protects all customers from unfair cost allocation. Newfoundland and Labrador Hydro (2020). *Network Additions Policy – Labrador Interconnected System*. https://nlhydro.com/wp-content/uploads/2021/03/Network-Additions-Policy.pdf

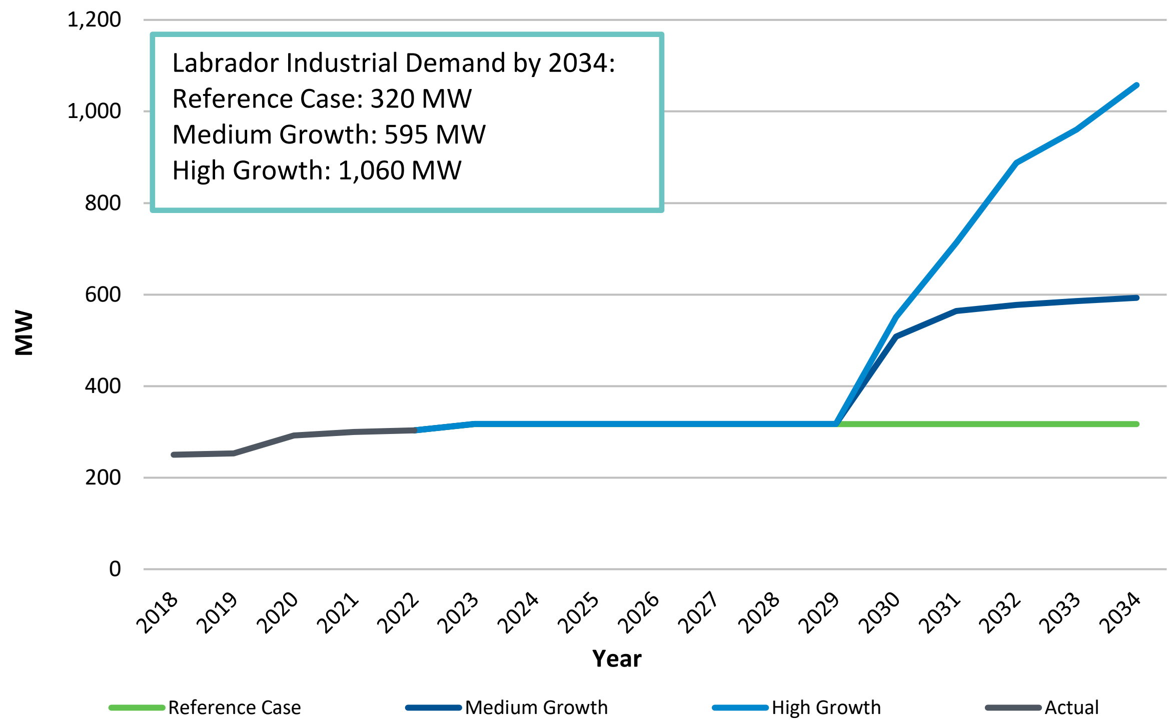

Chart 10: Labrador Interconnected Total Industrial Demand[48]

4.0 Hydro's 2023 Load Forecast[49]

The 2023 reference forecast as shown in Chart 11 resulted in accelerated growth in the medium- to long-term portion of the forecast period of 2023 to 2034 as compared to that of the previous ten years. The forecast growth is driven by sustained customer growth, electrification of the transportation and space-heating sectors, and increased industrial requirements.

[48] Total industrial demand is the summation of firm requirements for Industrial customers. Values are not reflective of industrial demand at the time of the Labrador Interconnected System peak.
[49] Tables detailing the 2023 Reference Case, Slow Decarbonization Scenario, and Accelerated Decarbonization Scenario load forecasts can be found in Appendix A.

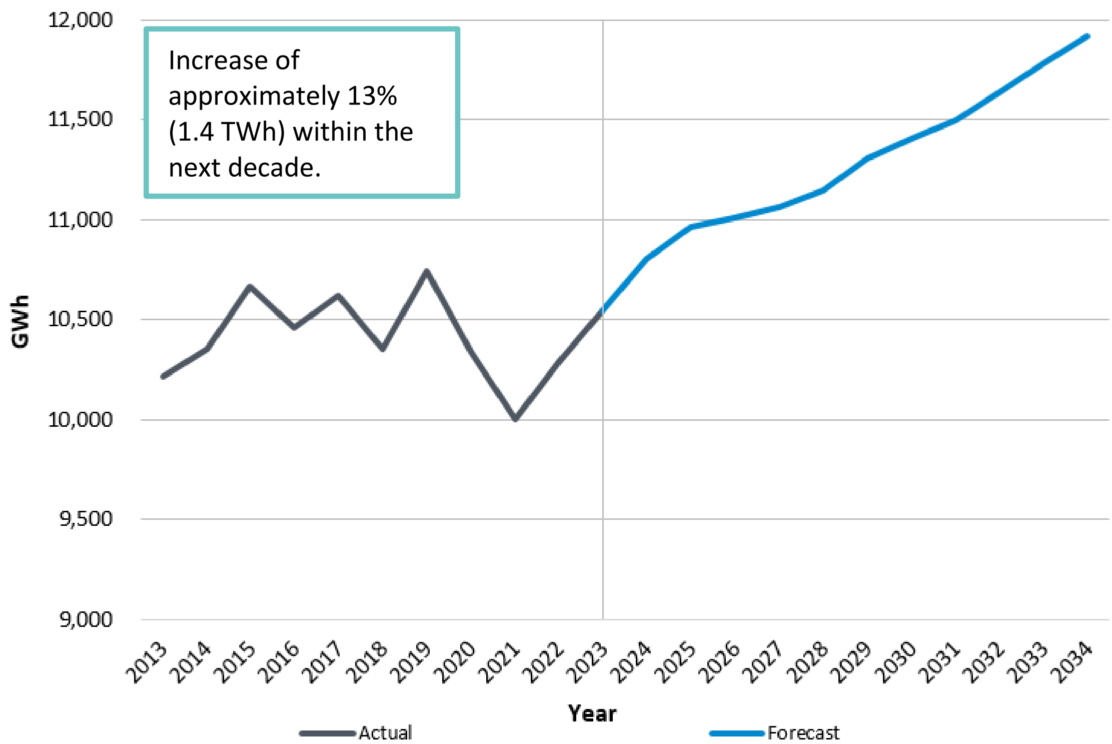

Chart 11: Newfoundland and Labrador Interconnected System Net Energy Generation: Reference Case[50,51]

The following sections present the details arising from the 2023 load forecast for the Newfoundland and Labrador Interconnected System, broken out between Island Interconnected and Labrador Interconnected Systems.

4.1 Island Interconnected System Load Forecast

For the pending 2024 Resource Adequacy Plan filing, which will use this 2023 load forecast, Hydro focused on the development of three scenarios for the Island Interconnected System. Scenarios were developed to help assess the impact of varying provincial economic growth forecasts and both the extent and timing of electrification initiatives in the heating and transportation sectors. The scenarios developed for the Island Interconnected System as part of the 2023 Load Forecast are summarized in Figure 3.

[50] Newfoundland and Labrador Interconnected System net generation is total generation requirements less transmission losses and stations service.
[51] Historical values are not weather normalized.

Slow Decarbonization

- Results in lower load growth relative to the Reference Case; reflects slower decarbonization combined with a steady, slower electrification of the transportation sector, slower population growth, lower housing starts and increased electricity rates.

Reference Case

- The expected load growth case; reflective of expected population growth and current/committed Government decarbonization policies and programs.

Accelerated Decarbonization

- Results in higher load growth relative to the Reference Case; reflects accelerated policy-driven decarbonization, combined with accelerated transportation electrification, increased population growth and higher annual housing starts, and an increase in industrial load requirements.

Figure 3: Island Interconnected System 2023 Load Forecast Scenarios

The Reference Case is reflective of a future that can be primarily defined by steady decarbonization and economic growth and favourable economics driven primarily by a strong population forecast. In the residential space-heating sector, it is assumed there will be steady conversions from oil heating systems to electric heating systems. This is driven primarily by the implementation of new fuel switching and energy efficiency incentive programs as part of a collaboration between the Government, Natural Resources Canada, and Environment and Climate Change Canada. In the transportation sector, Dunsky has estimated that EV adoption in Newfoundland and Labrador will not meet the federal government target that 100% of sales of light-duty vehicles must be zero emission. However, there is still a strong uptake of EVs forecast to occur, with approximately 78,000 zero-emission light-duty vehicles on the road in the province in 2034.[52, 53]

The first alternative scenario, Slow Decarbonization, contemplates a future with slower decarbonization efforts, as compared to the Reference Case. In the residential space-heating sector, it is assumed there will be a modest conversion from oil to electric heating as compared to the Reference Case. A steady

[52] *Supra*, f.n. 26, Slide 26.

[53] There are approximately 383,000 vehicles on the road in Newfoundland and Labrador in 2022,"EV Adoption and Impacts Study: Final Results." Dunsky Energy and Climate, August 23, 2022, Slide 9.

uptake of EVs is forecast, with approximately 54,000 zero-emissions light-duty vehicles on the road in the province in 2034.[54] This scenario also assumes slightly weaker economics driven by a reduced population growth forecast and a higher assumed forecasted electricity price.

The second alternative scenario, Accelerated Decarbonization, contemplates a future with accelerated decarbonization efforts, as compared to the Reference Case. In the residential space-heating sector, it is assumed there will be accelerated conversions from oil to electric heating. In the transportation sector, an accelerated uptake of zero-emissions light-duty vehicles is assumed, including achieving the Government of Canada's intention to set a mandatory target for sales of all new light-duty cars and passenger trucks to be zero-emission by 2035,[55] with approximately 92,000 zero-emission light-duty vehicles on the road in Newfoundland in 2034.[56] The forecast for economic growth is also stronger, driven by increased population and housing starts. This scenario also includes additional industrial load, stemming from new hydrogen production activity in the province and the electrification of existing industrial load.

Table 4 summarizes the major drivers for each of the alternative future forecasts that were described in detail in Section 3.3.

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[54] *Supra*, f.n. 26, Slide 25.
[55] "Building a green economy: Government of Canada to require 100% of car and passenger truck sales be zero-emission by 2035 in Canada," Transport Canada, June 29, 2021, https://www.canada.ca/en/transport-canada/news/2021/06/building-a-green-economy-government-of-canada-to-require-100-of-car-and-passenger-truck-sales-be-zero-emission-by-2035-in-canada.html
[56] The EV assumption is a combination of the high EV growth scenario (78,000 light-duty vehicles) as provided by Dunsky with the addition of 14,000 light-duty EVs for a total of 92,000 zero-emission light-duty vehicles to meet the 2035 Federal Zero Emission Vehicle target.

Table 4: Major Input Comparison of the Alternative Future Forecasts

Scenario	Slow Decarbonization	Reference Case	Accelerated Decarbonization
Scenario Description	Slower decarbonization and transportation electrification	Steady decarbonization and transportation electrification driven by Government policy and programs	Accelerated decarbonization and transportation electrification
Residential Rates	Increased rates	Reference	Reference
Electric Vehicles	Slower adoption	Reference	Accelerated adoption
Economic Growth	Reference Case except for lower forecasted population growth and housing starts	Reference	Higher forecasted growth across all factors
Decarbonization Policy (Government Programming)	Slower change	Reference	Accelerated change
Energy Efficiency	Accelerated change[57]	Reference	Reference
Industrial Growth	Reference	Reference	High growth

Chart 12 and Chart 13 provide a visual representation of the 2023 Load Forecast scenarios for demand and energy developed for the Island Interconnected System compared against historical system demand.

[57] Higher adoption of energy efficiency results from increased electricity rates. This forecast assumes that customers with electric heat will install heat pumps at an accelerated rate to mitigate electricity costs.

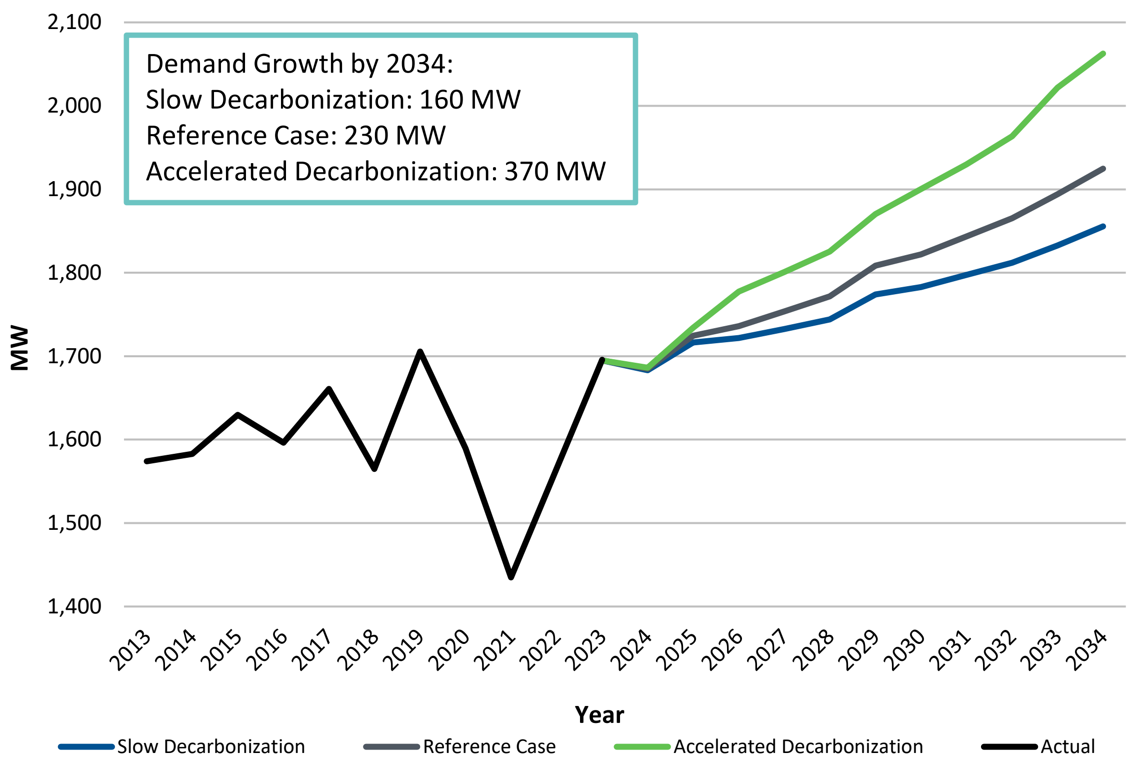

Chart 12: Island Interconnected System Customer Coincident Demand Requirements[58,59,60]

[58] Island Interconnected System demand requirements are exclusive of station service and transmission losses.
[59] Historical values are not weather normalized. Forecast values are based on normalized weather conditions.
[60] The significant decline in demand in 2020 and 2021 was due to the effects of the COVID-19 pandemic.

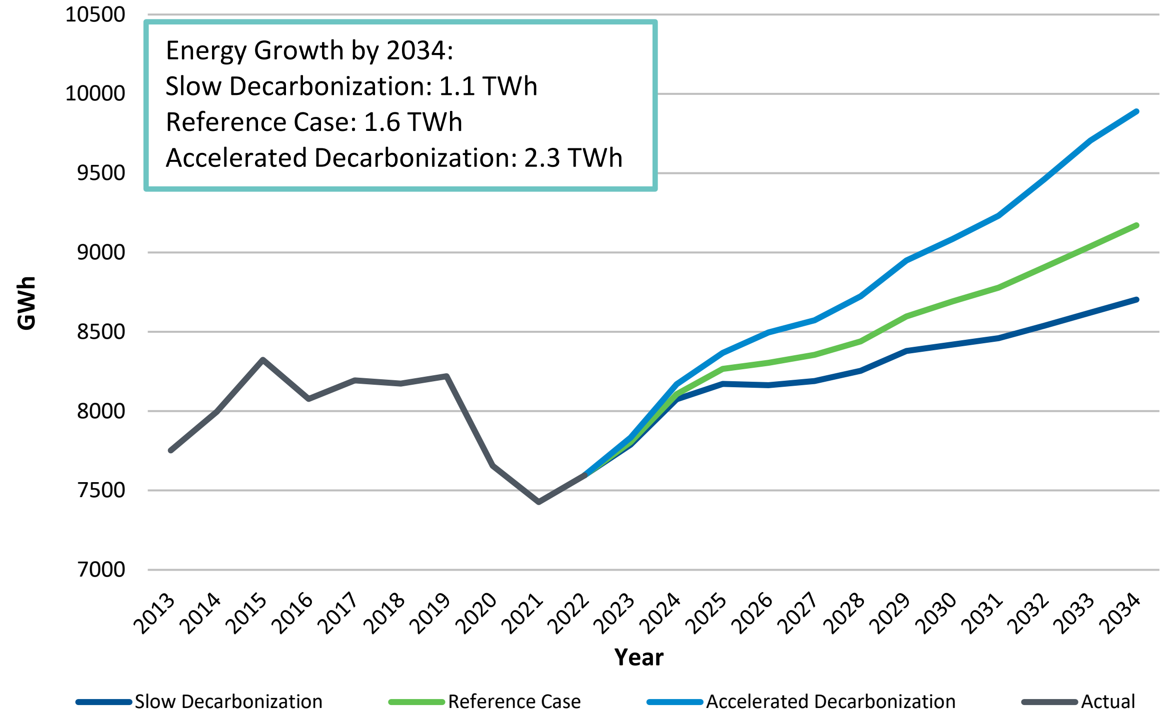

Chart 13: Island Interconnected System Energy Requirements[61,62,63]

Of note is the potential range of load possibilities between the three scenarios. As shown in Table 5, there is a total variance in 2034 of approximately 210 MW of peak demand between the Slow Decarbonization and the Accelerated Decarbonization Scenarios, with approximately 50 MW of that variance resulting from the difference in EV forecasts at peak. There is a margin of 1,190 GWh in energy requirements in 2034 between the lower and upper bounds provided by the Slow Decarbonization and the Accelerated Decarbonization Scenarios, with 280 GWh representing the variance between the EV forecasts. The disparity between forecasts at the end of the forecast period reflects both the inherent uncertainty in the later period of the forecast (an intrinsic component of load forecasting) and the uncertainty around the potential timing and extent of electrification between 2023 and 2034. Table 5 summarizes the demand and energy requirements for customers and EVs between the Reference Case and the two alternative scenarios.

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[61] Island Interconnected System energy requirements are exclusive of station service and transmission losses.
[62] Historical values are not weather normalized.
[63] The significant decline in energy requirements in 2020 and 2021 was due to the effects of the COVID-19 pandemic.

Table 5 Island Interconnected System Requirements in 2034[64]

	Customer Coincident Demand (MW)	Customer Energy Requirements (GWh)	EV Demand Component (MW)	EV Energy Consumption (GWh)
Slow Decarbonization	1,856	8,700	65	390
Reference Case	1,925	9,170	94	560
Accelerated Decarbonization	2,063	9,890	113	670

The Slow Decarbonization Scenario represents an approximate 45% decrease in demand and energy consumption compared to the Reference Case. The Accelerated Decarbonization Scenario represents an approximate 20% increase in demand and energy consumption compared to the Reference Case.

Table 6 provides a breakout of the Island Interconnected System requirements, which are subsequently discussed in detail in Sections 4.1.1 through 4.1.3.

Table 6: Breakout of Island Interconnected System Requirements[65]

	Residential	General Service	Industrial	Other
Percent Share	49	31	16	4

4.1.1 Residential Sales

In 2022, Residential sales made up 49% of the total Island Interconnected System bulk energy deliveries (46% directly by Newfoundland Power and 3% by Hydro).[66] Growth in the residential sector is driven by new customer additions, which is driven by population growth.

Residential space heating in Newfoundland is largely electrified with over 71% of customers already using electricity as their primary heating source.[67] Over the last ten years, while there has been an increase in the number of customers, average customer use has been decreasing, driven by the installation of MSHP in homes already heating with electric heat. More recently, provincial and federal government funding programs have targeted homes that do not have electricity as the primary heating

[64] Excludes transmission losses and station service.
[65] Exclusive of transmission losses and station service.
[66] Bulk energy deliveries do not include transmission losses or station service.
[67] Based on Newfoundland Power and Hydro 2022 billing data.

source to supplement or replace their existing heating source with electric heat. As space heating continues to electrify, growth in electricity use on the island, driven by switching from oil or wood to electric heat, will be partially offset by greater penetration of energy-efficient heat pumps in electrically heated homes. A large number of conversions to electric space heating will result in increased peak demand in the winter period, and the strong uptake of MSHP may result in increased demand in the summer period to meet cooling needs.

Chart 14 depicts the forecast of residential service sales under the three Island Interconnected System scenarios both including and excluding EV sales to help visualize the impact EVs are forecasted to have on sales. The variance shown between the Slow Decarbonization and the Accelerated Decarbonization Scenarios is approximately 690 GWh in 2034, with 150 GWh representing the difference in EV forecasts. The remaining variance primarily reflects the difference in economic growth and penetration levels of electric heat in the forecasts.

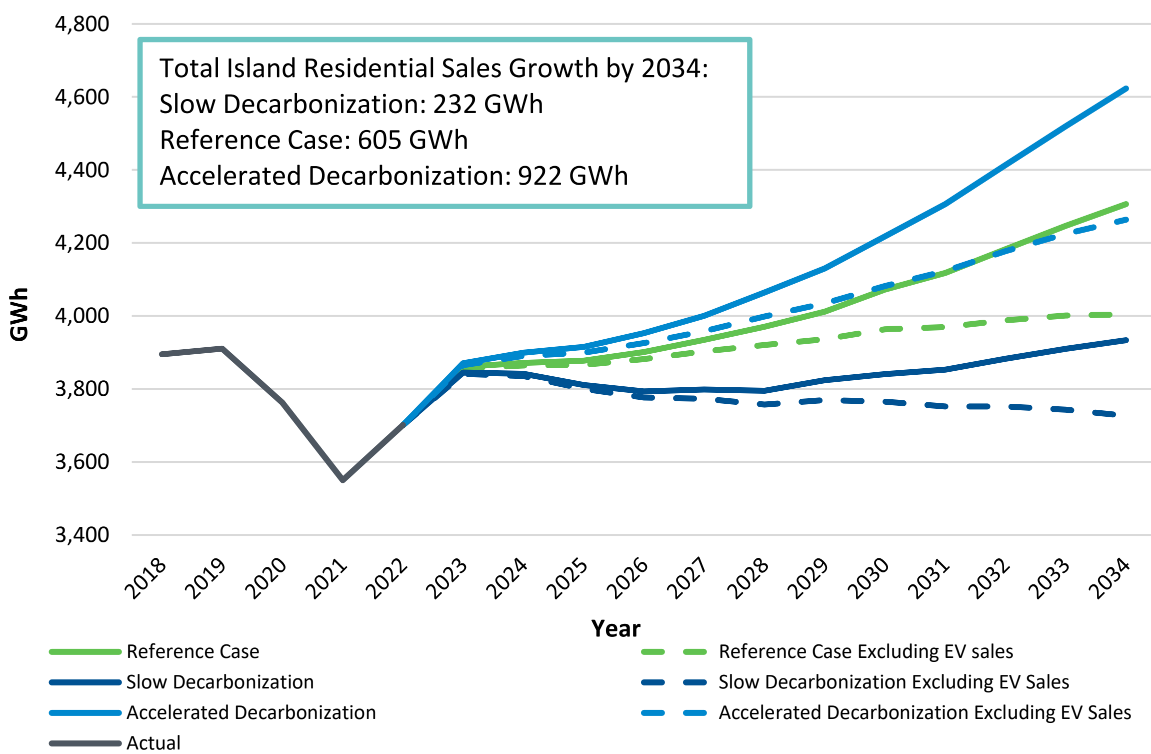

Chart 14: Island Interconnected Residential Sales[68,69]

[68] Historical values are not weather normalized.
[69] The significant decline in energy requirements in 2020 and 2021 was due to the effects of the COVID-19 pandemic.

In the Slow Decarbonization Scenario, residential sales are expected to increase by approximately 6%, including EVs; however, the change in residential sales is negligible without EV sales over the load forecast period. In the Reference Case, residential sales are expected to grow by approximately 16% including EVs, and 8% excluding EV sales. In the Accelerated Decarbonization Scenario, residential sales are expected to increase by approximately 25% with EVs and 15% without.

4.1.2 General Service Sales

The General Service classification includes commercial (e.g., retail, hospitality, offices, etc.) and institutional customers (e.g., hospitals, schools, universities, etc.). In 2022, General Service sales accounted for 31% of total Island Interconnected System bulk energy deliveries (29% Newfoundland Power, 2% Hydro).[70]

Over the last decade, General Service sales have remained relatively stable; however, General Service sales are expected to grow by approximately 20% from 2023 to 2034. The growth in the General Service sector is primarily driven by the electrification of space heating in buildings and the electrification of the transportation sector.

Chart 15 depicts the forecast of General Service sales under the three Island Interconnected System scenarios. The underlying economic forecasts affecting General Service sales are the same in both the Reference Case and the Slow Decarbonization Scenario, resulting in a negligible difference between the two forecasts when not accounting for EV charging. The higher load growth in the Accelerated Decarbonization Scenario is the result of a stronger economic growth forecast and increased electrification in the space-heating sector.

[70] Bulk energy deliveries do not include transmission losses and station service.

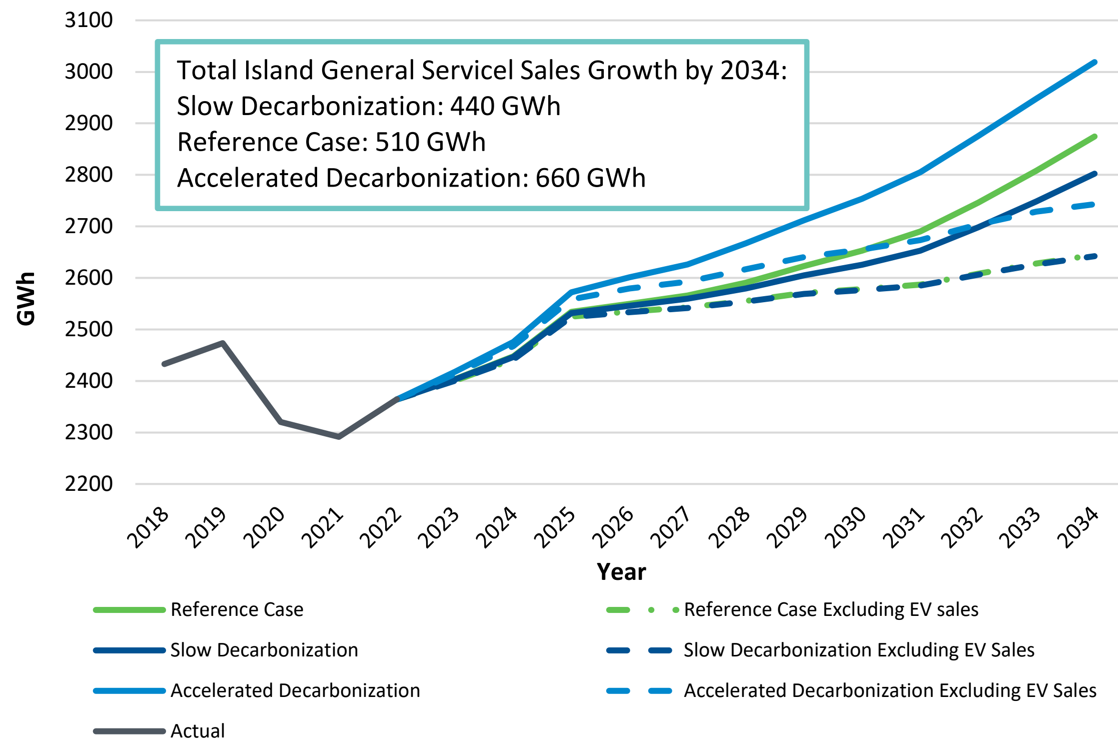

Chart 15: Island Interconnected General Service Sales[71,72]

The variance between the Slow Decarbonization and the Accelerated Decarbonization Scenarios, including EV sales is approximately 220 GWh by 2034. A sharp increase in General Service sales is observed between 2023 and 2025 as the result of the electrification of oil boilers at Memorial University of Newfoundland.

4.1.3 Industrial Sales

In 2022, sales to Industrial customers accounted for 16% of Island Interconnected bulk energy deliveries. While the makeup of Industrial customers has been consistent, the idling of the oil refinery at Come by Chance in 2020 resulted in reduced requirements in recent years. In 2021, Cresta Fund Management[73]

[71] Historical values are not weather normalized.
[72] The significant decline in energy requirements in 2020 and 2021 was due to the effects of the COVID-19 pandemic.
[73] Braya Renewable Fuels (Newfoundland) GP Inc. (“Braya”) operates the renewable fuels refinery in Come By Chance. Braya’s ownership group includes Cresta Fund Management, North Atlantic Refining Corp., which is managed by Silverpeak, and Energy Capital Partners.

acquired a controlling stake in the refinery, with plans to convert operations to renewable fuel production. As production begins, electricity requirements are forecast to increase in 2024.

The Valentine Gold mining project connected to the Island Interconnected System in January 2024; however, it did not draw power from the grid until late in the first quarter of 2024. Electricity requirements for the mine are expected to ramp up throughout 2024, with the first production from the mine expected in 2025.

Chart 16 shows the Industrial requirements for the three forecast scenarios for the Island Interconnected System. While additional Industrial growth is assumed in all three scenarios, the Accelerated Decarbonization Scenario assumes there will be higher requirements from additional new projects and that some electrification of current loads will occur.

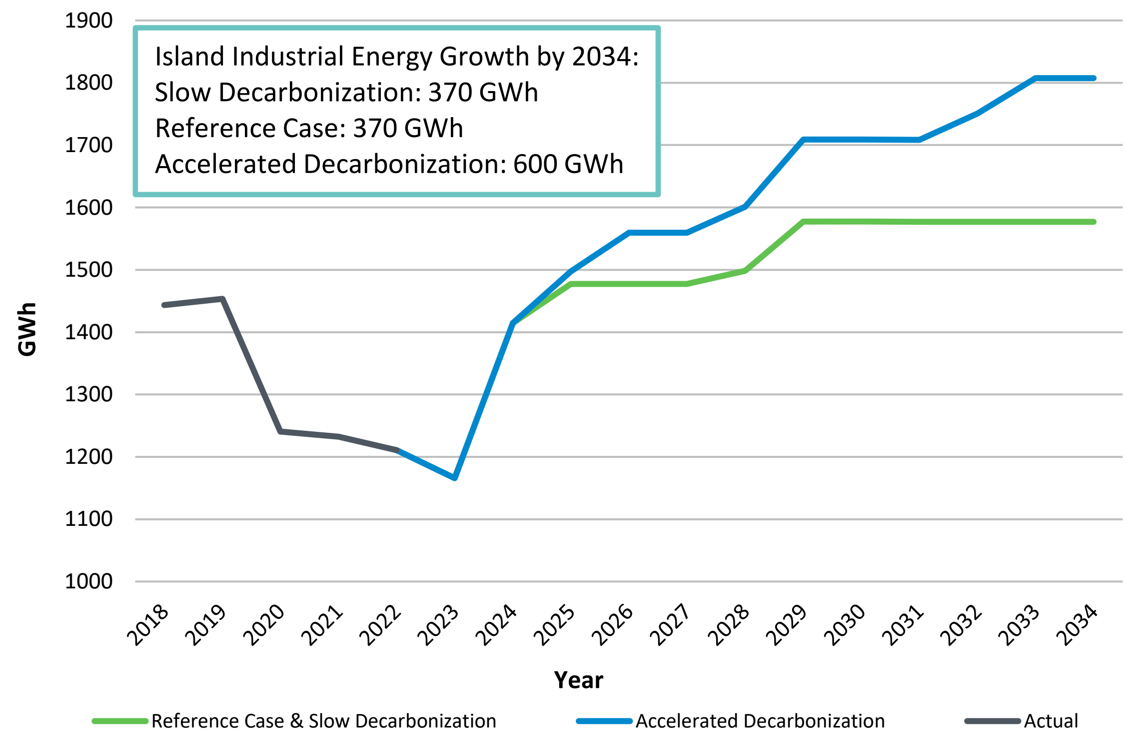

Chart 16: Island Industrial Customers Total Energy Requirements[74]

[74] Historical values are not weather normalized.

4.2 Labrador Interconnected System Load Forecast

For the pending 2024 Resource Adequacy Plan filing, which will use this 2023 load forecast, Hydro focused on the development of three scenarios for the Labrador Interconnected System. Considering the customer service requests Hydro has received from existing Industrial customers asking to significantly increase load in this area, Hydro has chosen to develop scenarios to assess how Industrial growth could affect system demand and energy requirements. As all of the Industrial growth is considered potential at this time, the Reference Case, which includes no new Industrial growth, serves as the low side of the possible future load requirements in Labrador. The scenarios developed for the Labrador Interconnected System as part of the 2023 Load Forecast are summarized in Figure 4.

Reference Case

- The expected load growth case; reflective of current/committed Government decarbonization policies and programs and consistent industrial loads.

Medium Growth Scenario

- Results in higher load growth relative to the Reference Case; primarily reflects increased Industrial requirements.

High Growth Scenario

- Results in higher load growth relative to both the Reference Case and the Medium Growth Scenario; reflects accelerated policy-driven decarbonization, combined with increased Industrial requirements.

Figure 4: Labrador Interconnected System 2023 Load Forecast Scenarios

Chart 17 and Chart 18 provide the range of potential load growth for the Labrador Interconnected System. While some uncertainty exists within the Utility sector in Labrador (i.e., due to EV penetration), the range of these forecasts primarily reflects the range in the potential for new Industrial loads in the future, which is significant in comparison to changes in the Utility sector. The variance in system demand and energy requirements between the Reference Case and the High Growth Scenario by 2034 is approximately 730 MW[75] and 5,400 GWh, respectively.

[75] Numbers may not add due to rounding.

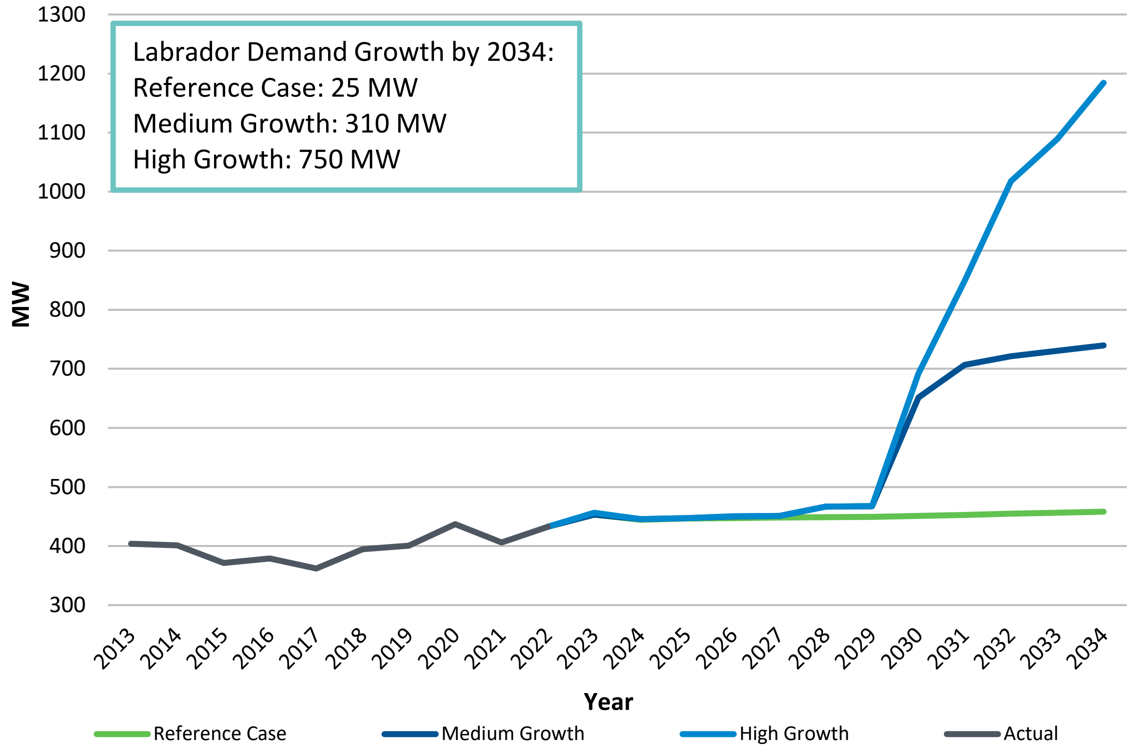

Chart 17: Labrador Interconnected System Customer Coincident Demand Requirements[76,77]

1 Labrador Interconnected System customer coincident demand grows by approximately 6% within the
2 forecast period for the Reference Case, approximately 71% in the Medium Growth Scenario, and 173%
3 in the High Growth Scenario.

[76] Excludes transmission losses.
[77] Historical values are not weather normalized.

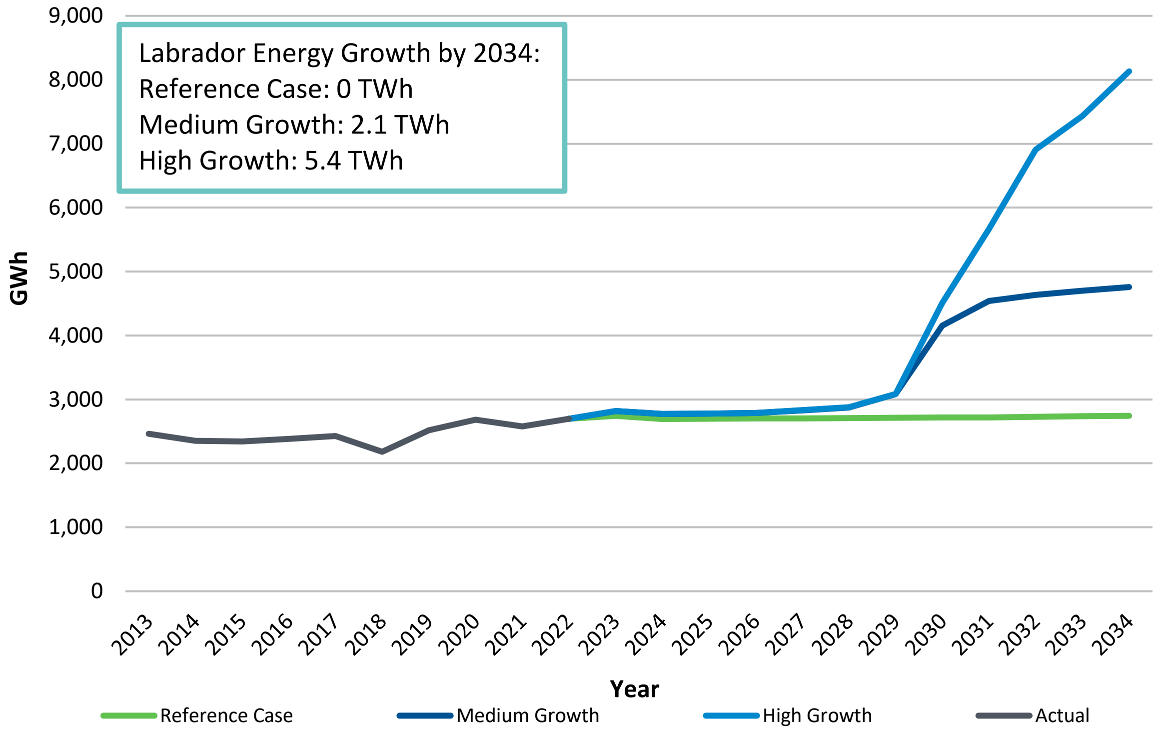

Chart 18: Labrador Interconnected System Energy Requirements[78,79]

Labrador Interconnected System energy requirements grow by approximately 2% within the forecast period for the Reference Case, approximately 76% in the Medium Growth Scenario, and 200% in the High Growth Scenario.

4.2.1 Utility Load

Chart 19 shows the range of potential utility load for the Labrador Interconnected System. The Reference Case was developed using short and long-term historical growth trends in the residential and commercial sectors. The Medium Growth and High Growth Scenarios used higher growth rates based upon the increased forecast activity stemming from the industrial projects considered in the respective cases. The primary difference between the Reference Case and the two forecast scenarios, observable from 2026 through 2028, is the increase in requirements associated with the Department of National Defense stemming from the conversion of their space-heating system to electric heat.

[78] Excludes transmission losses.
[79] Historical values are not weather normalized.

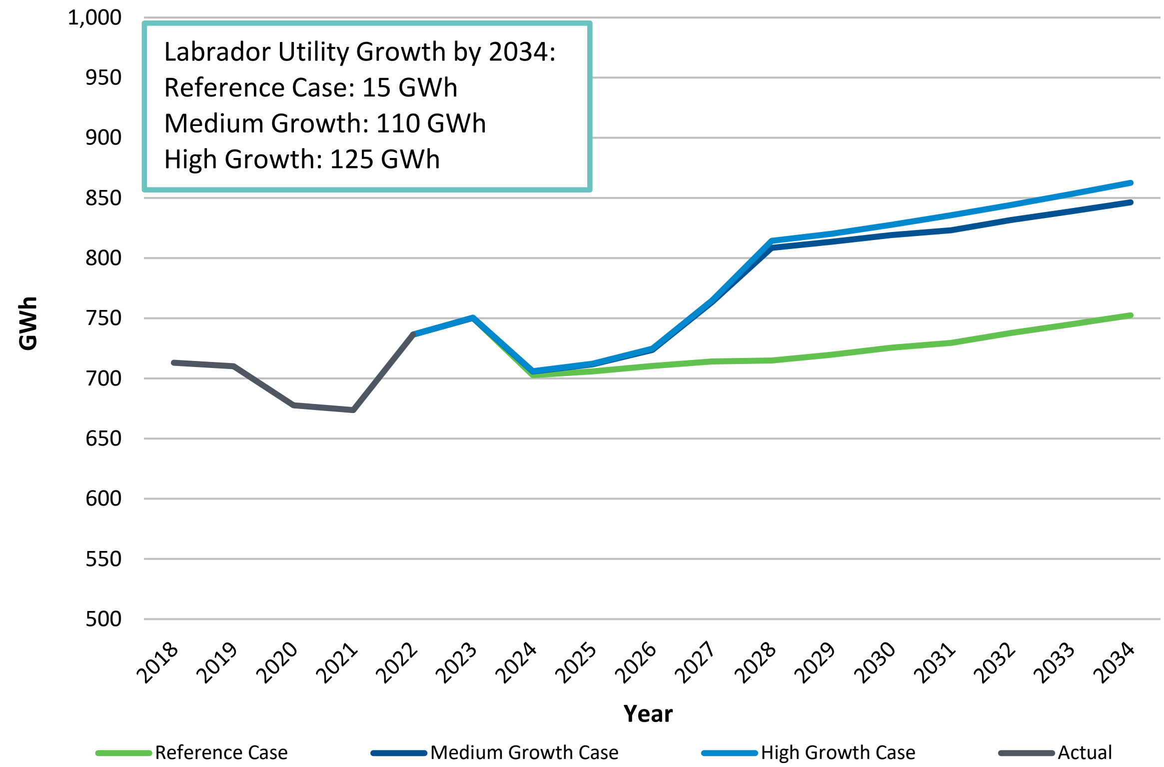

Chart 19: Labrador Interconnected Utility Load[80]

4.2.2 Industrial Load

Chart 20 shows the significant range of potential Industrial load for the Labrador Interconnected System. The Reference Case assumes business as usual for both Industrial customers, while the Medium and High Growth Scenarios assume varying degrees of electrification and growth associated with both customers. Note that the existing transmission system in Labrador is fully maximized and it has been assumed that this constraint will not be resolved at least until 2029. As such, forecast growth is anticipated to occur after 2029.

Industrial load growth in Labrador will require additional investment. Hydro is working to responsibly balance the applicants' requirements and manage bulk electrical system expansion while ensuring adherence to regulatory principles and our mandate to provide least-cost, reliable, environmentally responsible electricity. Throughout 2022 and early 2023 Hydro progressed a System Impact Study for one Industrial customer that was seeking to significantly expand their operations in Labrador. The study

[80] Historical values are not weather normalized.

was fully funded by the customer and was completed in 2023. In early 2024, Hydro contacted all existing and potential Industrial customers in Labrador West to confirm interest in participating in the next phase of the study for transmission expansion serving Labrador West. Hydro is working with these customers on their interests, confirmations, and load profiles. As customers move forward through this process, sensitivity forecasts will continue to be updated for use in various planning studies to assess the uncertainty of Industrial load growth.

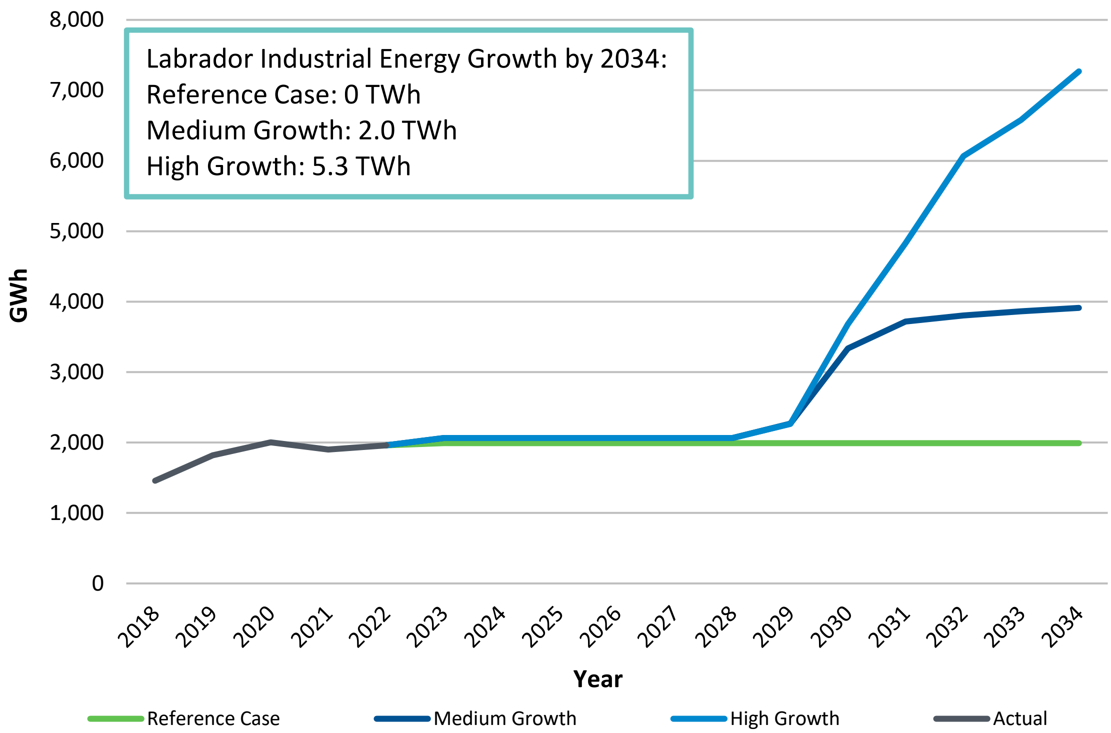

Chart 20: Labrador Industrial Customer Energy Sales[81]

5.0 Conclusion

The load forecasts presented in this report form the basis for Hydro's 2024 Resource Adequacy Plan, as they best reflect the range of potential outlooks for system planning at the time of filing. Planning is a dynamic process and requires the analysis of a variety of scenarios that reflect the range of possibilities for key drivers to better understand both the resource adequacy risks as well as the potential methods to help mitigate the risks. Hydro adheres to this aspect of resource planning practice by considering

[81] Historical values are not weather normalized.

several scenarios that address expected and potential expectations for economic growth and government decarbonization policies and programs. As noted during Daymark's independent review, Hydro's load forecast methodology reflects standard industry approaches for assessing potential growth.[82]

Government policy and programming in Canada and Newfoundland and Labrador are beginning to influence a transformation of the Newfoundland and Labrador electric power systems. The forecasts presented highlight the broad range of future alternatives, primarily based on the variation and uncertainty around decarbonization, which impacts the timing and extent of electrification activities. Combined with the recent unprecedented population growth in the province, this could drive higher economic growth.

At a minimum, the Slow Decarbonization Scenario is forecasting additional demand of 160 MW and 1.1 TWh of energy required by 2034. At the maximum, the Accelerated Decarbonization Scenario is forecasting additional demand of 370 MW and 2.3 TWh of energy required by 2034. As the Island Interconnected System is currently capacity-constrained, reliability concerns remain; given the timeframe to construct new assets, it is imperative to approve new resource options in a timely manner to maintain a reliable electricity system. Hydro is confident that its 2023 Load Forecast provides comprehensive input into the 2024 Resource Adequacy Plan to ensure appropriate planning for the future of the provincial electricity grid.

Hydro remains committed to annually updating the load forecast and creating additional scenarios to reflect changes in the planning environment to support future resource planning analysis, including the submission of build application(s) in the fourth quarter of 2024. As is the case with all forecasting analyses, improvements in the underlying methodologies are expected and planned to occur in each successive forecast update to reflect new information and industry changes. Annual updates will also address the emergence of additional information on customer adoption of policy-driven programs, responses to pricing, and the general economic climate.

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[82] *Supra*, f.n. 5, p. 15.

Appendix A

Supporting Tables

Table A-1: 2023 Planning Load Forecast – Reference Case
Primary Forecast Inputs and Island Interconnected System Utility Impacts

Economic Forecast	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Gross Domestic Product (2012$, MM)[1]	23,101	22,963	23,495	23,654	23,607	23,946	24,036	23,401	23,003	23,551	24,024	24,250
Growth Rate . . . (%)	2.2	-0.6	2.3	0.7	-0.2	1.4	0.4	-2.6	-1.7	2.4	2.0	0.9
Household Disposable Income (2012$, MM)	13,623	13,648	13,775	13,872	13,996	14,230	14,428	14,619	14,626	14,846	14,977	15,015
Growth Rate . . . (%)	0.6	0.2	0.9	0.7	0.9	1.7	1.4	1.3	0.0	1.5	0.9	0.3
Commercial Bldg. Investment (2012$, MM)	660	625	616	579	580	583	582	582	580	579	577	576
Growth Rate . . . (%)	10.2	-5.4	-1.4	-5.9	0.2	0.5	-0.1	-0.1	-0.4	-0.2	-0.3	-0.2
Housing Starts	1,412	1,619	1,743	1,709	1,606	1,614	1,602	1,581	1,542	1,593	1,611	1,602
Population (000)	531	532	533	534	534	535	537	538	539	540	542	543

Island Interconnected Utility Impacts[2]	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Domestic Customers (000's)	260	261	263	265	267	268	270	272	273	275	276	278
Domestic Sales (GWh)	3,861	3,871	3,877	3,901	3,934	3,970	4,012	4,072	4,118	4,183	4,247	4,306
Growth Rate . . . (%)	4.3	0.3	0.2	0.6	0.9	0.9	1.0	1.5	1.1	1.6	1.5	1.4
Electric Heat Market Share (%)	72	73	75	76	77	77	78	79	79	79	79	79
General Service Customer Sales (GWh)	2,404	2,448	2,534	2,550	2,566	2,591	2,623	2,653	2,690	2,746	2,808	2,875
Growth Rate . . . (%)	1.7	1.8	3.5	0.6	0.6	1.0	1.2	1.1	1.4	2.1	2.2	2.4
Street & Area Lighting Sales (GWh)	28	25	23	20	19	19	19	19	19	19	19	19
Distribution Losses (GWh)[3]	347	349	354	356	359	362	366	371	375	381	388	395
Total Utility Requirements (GWh)	6,640	6,694	6,789	6,827	6,878	6,942	7,020	7,115	7,202	7,330	7,462	7,595
Growth Rate . . . (%)	4.0	0.8	1.4	0.6	0.7	0.9	1.1	1.4	1.2	1.8	1.8	1.8

Table A-2: 2023 Planning Load Forecast – Slow Decarbonization Scenario
Primary Forecast Inputs and Island Interconnected System Utility Impacts

Economic Forecast	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Gross Domestic Product (2012$, MM)[4]	23,101	22,963	23,495	23,654	23,607	23,946	24,036	23,401	23,003	23,551	24,024	24,250
Growth Rate . . . (%)	2.2	-0.6	2.3	0.7	-0.2	1.4	0.4	-2.6	-1.7	2.4	2.0	0.9
Household Disposable Income (2012$, MM)	13,623	13,648	13,775	13,872	13,996	14,230	14,428	14,619	14,626	14,846	14,977	15,015
Growth Rate . . . (%)	0.6	0.2	0.9	0.7	0.9	1.7	1.4	1.3	0.0	1.5	0.9	0.3
Commercial Bldg. Investment (2012$, MM)	660	625	616	579	580	583	582	582	580	579	577	576
Growth Rate . . . (%)	10.2	-5.4	-1.4	-5.9	0.2	0.5	-0.1	-0.1	-0.4	-0.2	-0.3	-0.2
Housing Starts	1,226	1,361	1,449	1,453	1,402	1,405	1,383	1,360	1,339	1,376	1,402	1,410
Population (000)	527	528	529	529	530	530	531	532	532	533	533	534

Island Interconnected Utility Impacts[5]	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Domestic Customers (000)	260	261	263	264	265	267	268	270	271	273	274	275
Domestic Sales (GWh)	3,845	3,841	3,810	3,793	3,799	3,795	3,823	3,840	3,853	3,882	3,910	3,933
Growth Rate . . . (%)	3.9	-0.1	-0.8	-0.4	0.1	-0.1	0.7	0.4	0.3	0.8	0.7	0.6
Electric Heat Market Share (%)	72	73	74	75	75	76	77	77	77	78	78	78
General Service Customer Sales (GWh)	2,403	2,446	2,532	2,546	2,560	2,580	2,605	2,626	2,653	2,698	2,748	2,802
Growth Rate . . . (%)	1.7	1.8	3.5	0.6	0.5	0.8	1.0	0.8	1.0	1.7	1.9	2.0
Street & Area Lighting Sales (GWh)	28	25	23	20	19	19	19	19	19	19	19	19
Distribution Losses (GWh)[6]	346	348	351	350	351	352	355	357	359	363	367	371
Total Utility Requirements (GWh)	6,623	6,661	6,715	6,709	6,729	6,746	6,803	6,842	6,884	6,963	7,044	7,126
Growth Rate . . . (%)	3.7	0.6	0.8	-0.1	0.3	0.3	0.8	0.6	0.6	1.1	1.2	1.2

[1] Adjusted GDP excludes production related income earned by the non-resident owners of mining, oil, and gas projects.
[2] Includes Newfoundland Power and Hydro Rural.
[3] Includes company use.
[4] Adjusted GDP excludes production related income earned by the non-resident owners of mining, oil, and gas projects.
[5] Includes Newfoundland Power and Hydro Rural.
[6] Includes company use.

Table A-3: 2023 Planning Load Forecast – Accelerated Decarbonization Scenario Primary Forecast Inputs and Island Interconnected System Utility Impacts

Economic Forecast	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Gross Domestic Product (2012$, MM)[7]	23,118	23,287	23,819	23,978	23,577	24,107	24,112	23,317	22,886	23,408	23,873	23,881
Growth Rate . . . (%)	2.3	0.7	2.3	0.7	-1.7	2.2	0.0	-3.3	-1.8	2.3	2.0	0.0
Household Disposable Income (2012$, MM)	13,649	13,818	14,017	14,195	14,307	14,632	14,832	15,036	15,062	15,292	15,444	15,530
Growth Rate . . . (%)	0.8	1.2	1.4	1.3	0.8	2.3	1.4	1.4	0.2	1.5	1.0	0.6
Commercial Bldg. Investment (2012$, MM)	661	625	617	581	583	587	588	588	587	588	588	588
Growth Rate . . . (%)	10.3	-5.3	-1.3	-5.8	0.3	0.6	0.1	0.1	-0.1	0.1	0.0	0.1
Housing Starts	1,395	1,660	1,818	1,805	1,680	1,713	1,696	1,667	1,629	1,673	1,689	1,690
Population (000)	534	536	538	539	541	542	544	547	548	550	552	554

Island Interconnected Utility Impacts[8]	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Domestic Customers (000s)	260	262	263	265	267	269	270	272	274	276	277	279
Domestic Sales (GWh)	3,870	3,899	3,915	3,952	4,000	4,064	4,130	4,217	4,306	4,414	4,520	4,623
Growth Rate . . . (%)	4.6	0.7	0.4	1.0	1.2	1.6	1.6	2.1	2.1	2.5	2.4	2.3
Electric Heat Market Share (%)	72	73	75	76	77	78	79	80	81	82	82	83
General Service Customer Sales (GWh)	2,418	2,476	2,572	2,601	2,626	2,667	2,712	2,754	2,805	2,876	2,948	3,019
Growth Rate . . . (%)	2.3	2.4	3.9	1.1	1.0	1.6	1.7	1.6	1.9	2.5	2.5	2.4
Street & Area Lighting Sales (GWh)	28	25	23	20	19	19	19	19	19	19	19	19
Distribution Losses (GWh)[9]	349	353	359	362	366	372	378	384	392	401	411	420
Total Utility Requirements (GWh)	6,665	6,753	6,869	6,936	7,012	7,122	7,239	7,375	7,522	7,709	7,898	8,081
Growth Rate . . . (%)	4.4	1.3	1.7	1.0	1.1	1.6	1.6	1.9	2.0	2.5	2.4	2.3

Table A-4: 2023 Planning Load Forecasts Island Interconnected System Load Summary[10]

Slow Decarbonization Case	2023[11]	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Island Requirements (GWh)	7,790	8,075	8,172	8,164	8,191	8,254	8,380	8,419	8,461	8,540	8,622	8,703
Growth Rate . . . (%)		3.7	1.2	-0.1	0.3	0.8	1.5	0.5	0.5	0.9	1.0	0.9
Island Customer Coincident Peak Demand (MW)	1,696	1,683	1,716	1,722	1,733	1,744	1,774	1,783	1,797	1,812	1,833	1,856
Growth Rate . . . (%)		-0.8	2.0	0.3	0.6	0.7	1.7	0.5	0.8	0.8	1.2	1.2

Reference Case	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Island Requirements (GWh)	7,805	8,108	8,266	8,305	8,355	8,440	8,597	8,692	8,780	8,907	9,039	9,172
Growth Rate . . . (%)		3.9	1.9	0.5	0.6	1.0	1.9	1.1	1.0	1.5	1.5	1.5
Island Customer Coincident Peak Demand (MW)	1,696	1,685	1,725	1,736	1,753	1,772	1,809	1,822	1,843	1,865	1,894	1,925
Growth Rate . . . (%)		-0.7	2.4	0.7	1.0	1.0	2.1	0.8	1.2	1.2	1.5	1.6

Accelerated Decarbonization Case	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Island Requirements (GWh)	7,833	8,169	8,368	8,497	8,573	8,725	8,949	9,085	9,232	9,461	9,706	9,890
Growth Rate . . . (%)		4.3	2.4	1.5	0.9	1.8	2.6	1.5	1.6	2.5	2.6	1.9
Island Customer Coincident Peak Demand (MW)	1,696	1,686	1,734	1,777	1,801	1,825	1,870	1,900	1,930	1,964	2,022	2,063
Growth Rate . . . (%)		-0.6	2.8	2.5	1.3	1.4	2.5	1.6	1.6	1.8	3.0	2.0

[7] Adjusted GDP excludes production related income earned by the non-resident owners of mining, oil, and gas projects.
[8] Includes Newfoundland Power and Hydro Rural.
[9] Includes company use.
[10] Exclusive of transmission losses and station service loads.
[11] 2023 Island customer coincident peak demand is an actual.

Table A-5: 2023 Planning Load Forecasts
Labrador Interconnected System Load Summary[12]

Reference Case	2023[13]	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Labrador Requirements (GWh)	2,741	2,694	2,697	2,701	2,705	2,706	2,711	2,717	2,721	2,729	2,736	2,744
Growth Rate . . . (%)		-1.7	0.1	0.2	0.1	0.0	0.2	0.2	0.1	0.3	0.3	0.3
Labrador Customer Coincident Peak Demand (MW)	422	445	447	447	448	449	450	451	453	455	456	458
Growth Rate . . . (%)		5.3	0.4	0.1	0.2	0.2	0.2	0.3	0.5	0.4	0.4	0.4

Medium Growth Case	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Labrador Requirements (GWh)	2,816	2,772	2,778	2,790	2,829	2,875	3,081	4,155	4,539	4,637	4,700	4,758
Growth Rate . . . (%)		-1.6	0.2	0.4	1.4	1.6	7.2	34.8	9.2	2.2	1.4	1.2
Labrador Customer Coincident Peak Demand (MW)	422	446	447	450	451	467	467	651	707	721	731	740
Growth Rate . . . (%)		5.5	0.4	0.6	0.2	3.5	0.2	39.3	8.5	2.0	1.3	1.2

High Growth Case	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Labrador Requirements (GWh)	2,816	2,772	2,778	2,791	2,831	2,880	3,086	4,510	5,665	6,909	7,434	8,132
Growth Rate . . . (%)		-1.6	0.2	0.4	1.4	1.7	7.1	46.2	25.6	22.0	7.6	9.4
Labrador Customer Coincident Peak Demand (MW)	422	446	448	450	451	467	468	692	849	1,018	1,089	1,184
Growth Rate . . . (%)		5.5	0.4	0.6	0.2	3.5	0.2	48.0	22.6	19.9	7.0	8.7

Table A-6: Island Interconnected System Average Domestic Rate Forecast – Excluding HST (cents/kWh)

Year	Reference Case and Accelerated Decarbonization Scenario	Slow Decarbonization Scenario
2023	13.80	13.80
2024	14.79	14.99
2025	15.62	15.95
2026	16.07	16.52
2027	16.43	17.01
2028	16.80	17.51
2029	17.18	18.03
2030	17.56	18.57
2031	17.96	19.12
2032	18.36	19.68
2033	18.78	20.27
2034	19.20	20.87

[12] Exclusive of transmission losses and station service loads.
[13] 2023 Labrador customer coincident peak demand is an actual and excludes non-firm loads served at peak.

Table A-7: Island Interconnected System Cumulative EV Sales

	Slow Decarbonization Scenario		Reference Case		Accelerated Decarbonization Scenario	
	Light-Duty Vehicles	Medium- and Heavy-Duty Vehicles and Buses	Light-Duty Vehicles	Medium- and Heavy-Duty Vehicles and Buses	Light-Duty Vehicles	Medium- and Heavy-Duty Vehicles and Buses
2023	1,133	49	1,202	62	1,405	84
2024	1,833	86	1,989	108	2,553	150
2025	3,010	132	3,343	167	4,516	238
2026	4,857	205	5,555	261	7,568	374
2027	7,364	289	8,880	377	11,893	559
2028	10,755	402	13,857	551	18,062	802
2029	15,202	553	20,868	794	26,468	1,109
2030	20,948	753	29,982	1,120	37,179	1,502
2031	27,854	1,049	40,897	1,543	49,829	1,997
2032	36,106	1,454	53,317	2,084	64,102	2,607
2033	45,742	1,985	67,181	2,766	79,988	3,362
2034	56,819	2,662	82,383	3,613	97,435	4,289

Appendix B

Regression Equations

Newfoundland Power's Domestic Average Use Equation

This equation is the most important component of the domestic forecast. This equation is based on the market share of electric heat (percentage of customers using electric space heat), heating degree days, the marginal price of electricity, household income per customer and the provincial population.

The regression has an R-squared of 98.7%. The R-squared measures the goodness of fit or the percentage of total variation explained by the equation. The equation takes the following form:

$$Y = (0.000295 \times X1) + (10956.51 \times X2) + (-510.5399 \times X3) + (0.073854 \times X4) + (-209.4821 \times X5) + (0.010695 \times X6) + (-480.2254 \times X7) + (297.4724 \times X8)$$

WHERE: Y = Domestic Average Use per Customer in the NP Service area

X1 = Domestic Market Share of Electric Heat × Heating Degree Day Variable

X2 = Domestic Market Share of Electric Heat

X3 = Domestic Marginal Price of Electricity in the Previous Year (t-1)

X4 = Household Disposable Income per Customer in $2002

X5 = Energy Conservation Programming and Technological Change Variable

X6 = Provincial Population

X7 = Recession Dummy for 1982 (1982=1, otherwise=0)

X8 = Rate Stabilization Plan Dummy beginning in 1986.

Newfoundland Power's General Service Electric Heat Load Equation

The electrical energy requirement for Newfoundland Power General Service customers with electric heat is forecasted based on gross domestic product, commercial building investment, heating degree days and energy conservation programs.

The regression has an R-squared of 99.9% and all input (explanatory) variables are significant. The equation takes the following form:

$$Y = (0.01125 \times X1) + (0.03379 \times X2) + (0.00235 \times X3) + (-3.04676 \times X4) + (68.89012 \times X5) + (-123.525)$$

WHERE: Y = General Service Electricity Load (GWh) for Newfoundland Power Customers

X1 = Gross Domestic Product Adjusted for Income Earned by Non-Resident Owners of Mining, Oil, and Gas Projects ($2012)

X2 = Commercial Building Investment ($2012)

X3 = Heating Degree Days

X4 = Energy Conservation Programming and Technology Change Variable

X5 = Economy Shift Change Variable (<1976=0, 1976 and on=1)

Newfoundland Power's System Peak Forecast

The winter system peak forecast is prepared through the estimation of one regression equation. This regression equation is used to explain and predict the maximum hourly electricity demand requirements in a given year based on the number of Newfoundland Power Domestic non-electric heat customers, the number of Newfoundland Power Domestic electric heat customers, the Newfoundland Power weather-adjusted General Service load, wind chill, and the marginal price of electricity. The regression equation is derived from Hydro's system load data, Newfoundland Power's customer billing data, and Environment Canada's weather data. The wind chill variable is based on a 12-hour average temperature and an 8-hour average wind. The wind chill is calculated using weather station data for St. John's, Gander, and Stephenville and is weighted by the number of customers to calculate an Island wind chill figure.

The regression has an R-squared of 98.9% and has no auto-correlation effect. The equation takes the following form:

$$Y = (0.001161 \times X1) + (0.004076 \times X2) + (0.16173 \times X3) + (-25.4993 \times X4) + (0.398186 \times X5) + (-3.78459 \times X6) + (21.57706 \times X7)$$

WHERE: Y = Annual Maximum Hourly Demand (MW)

X1 = Number of Newfoundland Power Non-Electric Heat Customers

X2 = Number of Newfoundland Power Electric Heat Customers

X3 = Wind Chill Factor

X4 = Marginal Price of Electricity in the Previous Year (t-1)

X5 = Weather-Adjusted NP General Service Load (GWh)

X6 = Technological Change (<1990=0, 1990=1 increasing by 1 each year, 2022=33)

X7 = Dummy Variable for a December Peak (December=1, otherwise=0)

Hydro's Rural Domestic Average Use Forecast

This equation is based on the market share of electric heat in Hydro Rural areas, heating degree days, marginal price of electricity, household disposable income per customer, and the saturation of electric water heating.

The regression has an R-squared of 96.2%. The equation takes the following form:

$$Y = (2.2164 \times X1) + (-328.8667 \times X2) + (0.1074 \times X3) + (31.8855 \times X4) + (-47.7583 \times X5) + (13.3324 \times X6)$$

WHERE: Y = Domestic Average Use per Customer in the Hydro Service Area

X1 = Hydro Rural Domestic Market Share of Electric Heat × Degree Days Heating (Stephenville)

X2 = Domestic Marginal Price of Electricity in the Previous Year (t-1)

X3 = Household Disposable Income per Customer in $2002

X4 = Electric Hot Water Saturation Rate

X5 = Energy Conservation Programming and Technology Change Variable

X6 = Dummy Variable (2006=1, otherwise=0)

Hydro's Rural General Service Forecast

The electrical energy requirement for all Hydro General Service customers is forecasted based on household disposable income and industry variables.

The regression has an R-squared of 99.5%. The equation takes the following form:

$$Y = (0.004952 \times X1) + (0.02607 \times X2) + (0.000477 \times X3) + (23.1475 \times X4) + (6.7615 \times X5) + (-9.2484 \times X6) + (-0.7510 \times X7) + (-2.8555 \times X8)$$

WHERE: Y = General Service Electricity Load (GWh) for Hydro Customers

X1 = Household Disposable Income in $2002

X2 = Fishery Industry Variable

X3 = Domestic Market Share of Electric Heat × Heating Degree Days (Stephenville)

X4 = Variable to Account for Significant Load Interconnection.

X5 = Mining Industry Variable

X6 = Dummy Variable for 2009 (2009=1, otherwise=0)

X7 = Technological Change (<1991=0, 1991=1 increasing by 1 each year, 2022=32)

X8 = Small General Service Electricity Price

Attachment 1

R&RA 2024

Independent Load Forecasting Process Review

Daymark Energy Advisors

March 22, 2024

R&RA 2024: INDEPENDENT LOAD FORECASTING PROCESS REVIEW

MARCH 22, 2024

PREPARED FOR

Newfoundland and Labrador Hydro

PREPARED BY

Daymark Energy Advisors

DAYMARK ENERGY ADVISORS
370 MAIN STREET, SUITE 325 | WORCESTER, MA 01608
TEL: (617) 778-5515 | DAYMARKEA.COM

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I. INTRODUCTION / CURRENT SITUATION

Newfoundland and Labrador Hydro ("Hydro") engaged Daymark to provide an independent assessment of the load forecasting[1]process including a deeper review of the underlying methodologies being utilized to support the 2024 R&RA. This report is the result of numerous meetings and discussions with Hydro's load forecasting team and includes a detailed review of the process and modeling that produces the energy and peak load forecasts.

The load forecast supports a variety of important business decisions including General Rate Application (GRA) requests, evaluating alternative sources of energy and federal policies, and in planning for system adequacy and reliability, to name a few.

Hydro is expecting growth due to several potential drivers. First, there is load growth anticipated in the industrial sector, in which existing customers have expressed interest in expansion and electrifying current processes and in which new customers have explored the options around locating facilities in the province. Second, the Government of Newfoundland and Labrador (GNL), whose economic forecasts are used as an input to Hydro's load forecasting equations, has projected increasing population and housing starts. Third, the federal government is establishing climate change incentives and objectives and has implemented a carbon tax on fossil fuels to encourage electrification particularly in heating end-uses. Federal policy objectives have also been set for electric vehicles.

In addition to the new assumptions pertaining to industrial and residential economic growth and the trajectory of electrification, the load forecast process must also address the electricity rate mitigation plan to ease recovery of the investment in Muskrat Falls hydro facility and the Labrador Island Link (LIL).[2] The proposed mitigation plan sets prices at 14.7 cents per kWh and includes a 2.25% increase in prices in each year. Hydro's historical data includes periods of mitigation strategies but lacks comparative periods which mirror the proposed mitigation plan. As a result, the forecast models may not adequately address the potential price elasticity impacts of the anticipated steady price increase.

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1 "Load" generally encompasses both the energy and peak demand forecasts in this report. The energy forecast and the peak forecast are each described and assessed.

2 The corporate assumption is that some form of rate mitigation, whether it is from the Government of Newfoundland and Labrador or NLH, will continue for the longer-term.

Hydro uses a weather normalization process for the energy and peak forecasts to plan for weather impacts. This is accomplished by using heating degree days[3], a driver of electricity energy and peak needs, as an independent variable in forecast regressions. For future periods in the energy regressions, heating degree days are treated as a trendline. The process of assuming heating degree days will be in line with what was experienced in historical years serves to strip out the impact of weather on the forecast for electricity demand. This is in line with standard industry practices for weather normalization. In the peak demand forecast, rather than using heating degree days, Hydro uses a 30-year average minimum windchill at the P50 level as well as coincident factors[4] for various customer classes and geographies. Hydro also evaluates the impact of weather at the P90 level during modeling for resource adequacy to assess the capacity available to address customer peak demand during weather events.

Planning is a dynamic process and requires the analysis of a variety of scenarios or potential futures, which should provide a frame for the potential load forecast outcomes as well as reflect the range of possibilities for key drivers. The consideration of scenarios is an essential planning tool, as it allows the organization to better understand both the resource adequacy risks it faces as well as the levers it must use to help mitigate these risks. Hydro adheres to this aspect of resource planning common practices through its consideration of multiple scenarios. For the current load forecast a reference case addresses current expectations for economic growth and current government decarbonization policies and programs.

Each of these topics plays a significant role in planning and addressing uncertainty as this energy and peak forecast forms a key parameter in identifying the need for new resource options to maintain provincial reliability and economic growth.

This document is organized to provide a summary of the prior independent forecast review, a description of Daymark's scope and methodology for the review of the load forecast supporting the 2024 R&RA, Daymark's summary of Hydro's forecasting approach, and our conclusions about Hydro's process and model, including an

3 Heating Degree Days (HDD) measure the days over a year in which the ambient outdoor temperature is less than a selected base temperature. This base value in Canada is 18 °C.

HDD = (# Days Ambient Temp < Base Temp) * (Base Temperature – Ambient Temperature)

4 The customer and geographic class coincidence factors referenced here are utilized to develop a coincident peak that considers the geographic and industrial customer diversity relative to their own peak information.

assessment of its adherence to standard industry practices and our recommendations for areas for continuing improvement.

A. Previous Independent Review of Load Forecast

Daymark reviewed Hydro's load forecasting for the 2022 R&RA concluding that the forecasting process:

> "…aligns with industry standards for residential and business forecasting through their reliance on regression analysis with consideration of economic growth and price and income elasticity; and a probabilistic assessment of demand requirements is completed producing P50 and P90 projections incorporating weather extremes. Hydro's analysis is sound and reflects the state of the industry for developing long term projections. However, as is the case in the industry today, there remains significant uncertainty with respect to provincial policies particularly regarding electrification, adoption of EVs and the speed at which all of these will occur. Adding to the uncertainty is economic growth associated with provincial policies for attraction of new industries – an extremely difficult aspect to project with certainty."

In the 2022 R&RA Load Forecast Report, we noted that if the province were to adopt a more aggressive and supportive electrification policy, the current projections would not reflect that situation. Since then, Hydro has enhanced its forecast by enhancing projections for an accelerated electrification policy and evaluating the impacts of slower but steadier adoption approaches in its alternative futures approach.

B. Daymark Review Scope and Methodology

Daymark was engaged to perform an independent review of the load forecast process as undertaken by Hydro in support of the 2024 R&RA filing. Daymark's scope was expanded in comparison to prior R&RA iterations, and included review of model philosophy, variable construction, fit, predictive power, external forecast modifiers such as EV growth, and documentation. As a part of this process, Daymark reviewed the model build-up, examined the sensitivities of each linear regression, modelled how various load forecast scenarios functioned within PLEXOS, provided an overall assessment of the strength of Hydro's forecast processes, and ultimately provided suggestions for how Hydro may improve its forecasting model and process[5].

[5] Appendix I of this report addresses additional details of modeling improvements resulting from Daymark's detailed review.

In order to facilitate our analysis we met several times with Hydro's team to understand the process for forecast development, the role of the forecast information in the overall planning process for the R&RA, the approaches taken to address issues that need to be incorporated externally to the traditional load forecast approaches due to a lack of historical information (e.g., EV adoption, climate policy), and statistical approaches taken. This report summarizes Daymark's evaluation and recommendations for enhancement.

Daymark's review considered standard practices in the larger power industry as a point of reference for Hydro's forecasting approach. Hydro implements many standard practices observed across industry. There remain areas in which the modeling's theoretical construction, review of fit, and contextual documentation can be improved to reduce reliance on goodness of historical fit and better frame the basis for the projection and each are further addressed in this document.

A summary of the material Daymark reviewed throughout this process can be found in ***Appendix II: Documentation Reviewed.***

II. FORECAST PHILOSOPHY & APPROACH TO LONG-TERM PLANNING

Hydro's load forecast model comprises four groupings of customers when developing the energy and demand forecasts:

1) Newfoundland Power ("NP") customers;

2) Hydro Island rural customers;

3) Hydro Labrador rural customers; and

4) Large industrial customer use.

Both NP customers and Hydro rural customers are further broken down into residential and general use with and without electric heat with the objective of maintaining homogeneity in underlying causality. Figure 1 depicts the modeling approach Hydro relies on to forecast NP loads, which account for approximately 93% of total Hydro load, excluding industrial loads and transmission losses. Figure 2 provides a detailed look at Newfoundland Power's forecasting approach.

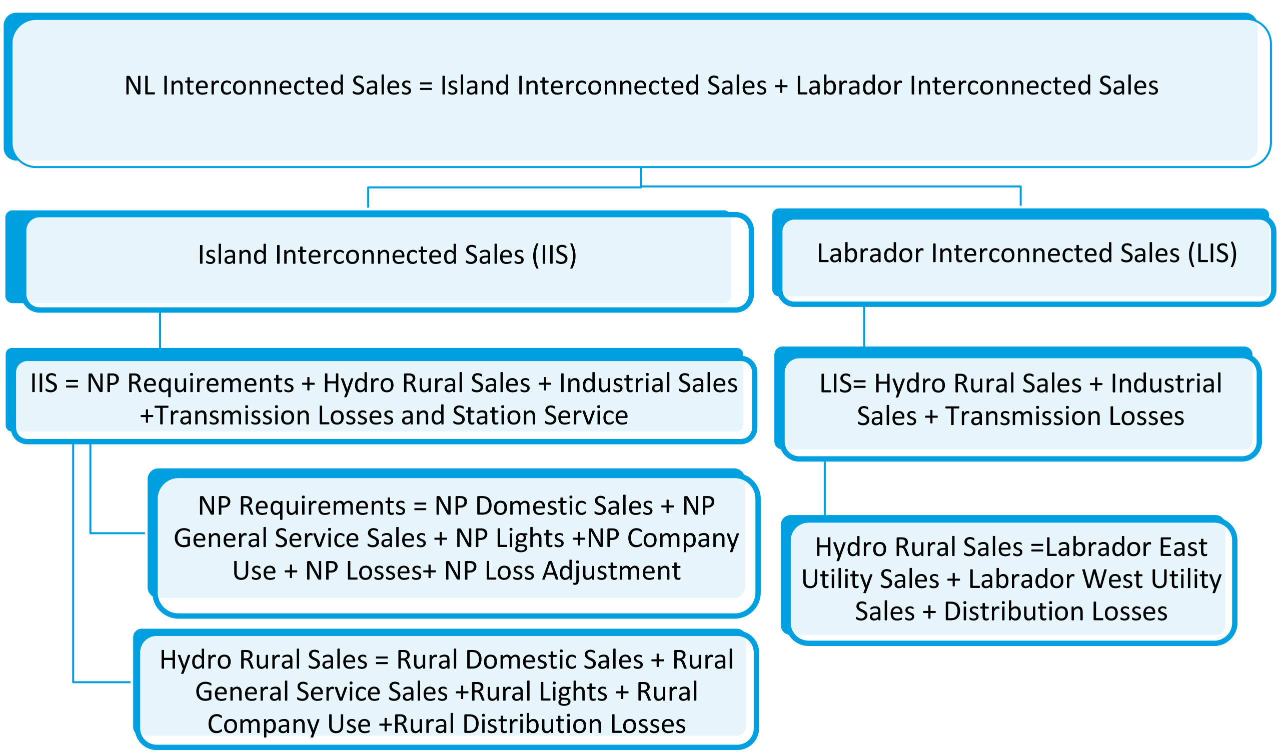

Figure 1: Hydro Forecasting Approach

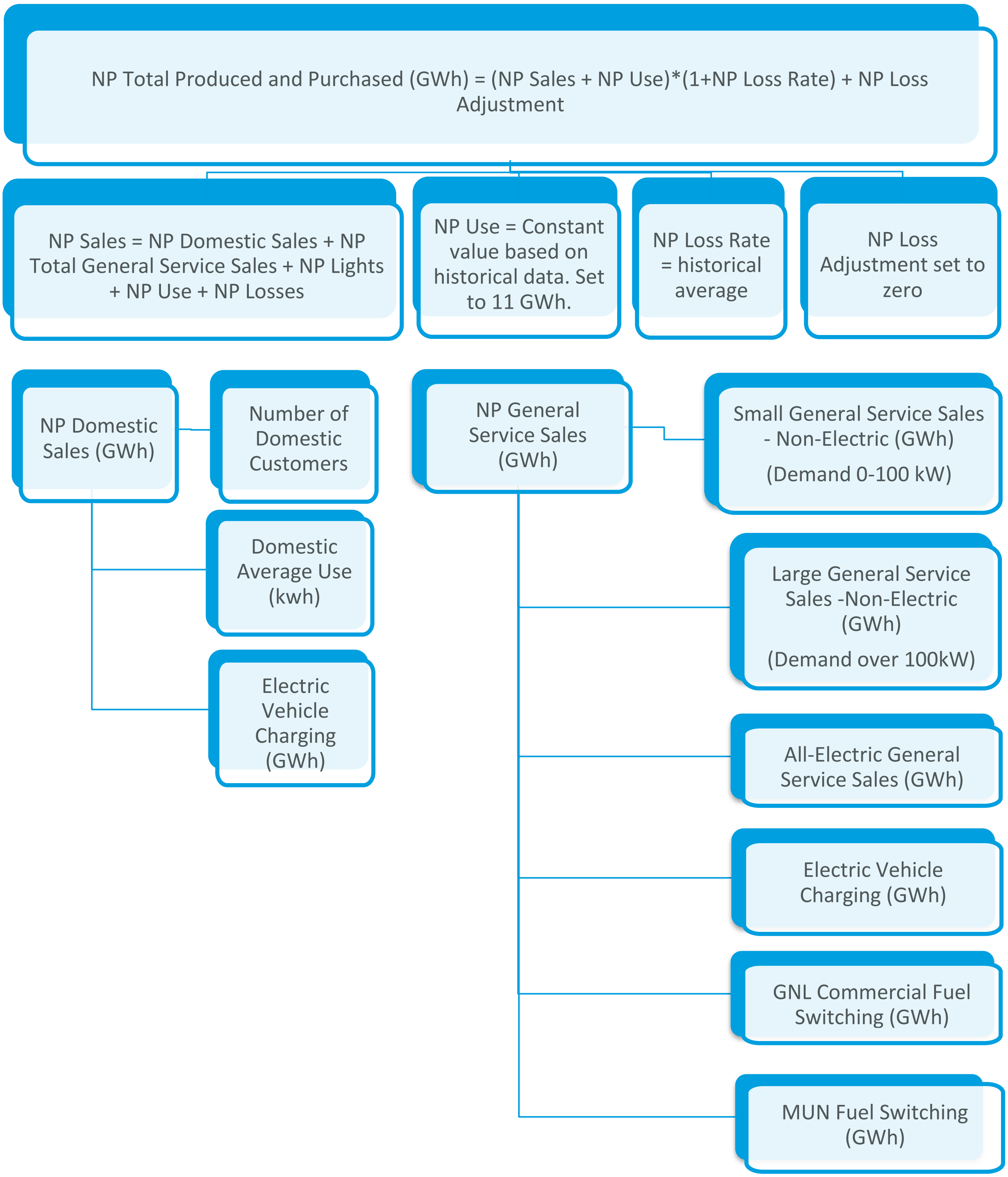

Figure 2: Newfoundland Power Load Forecasting Approach

A. Utility Industry Practices in Load Forecasting

Long-term load forecasting in the utility industry relies on a variety of standard approaches including the use of time series models, simple and complex regressions supported by theoretical underpinnings, end-use modeling which sometimes rely on adoption modeling, reliance on large customer projections, and combinations of these modeling approaches. The selection of model approach relies on the data available and the expert judgment of the forecasters. Representative independent variables that may be selected to predict future consumption include population, economic indicators, saturation level or adoption rate for existing and new technologies, weather, price of electricity, prices of fuels, and transformations of independent variables to reflect more complex relationships driving consumption. End-use models rely on data reflecting the saturation of energy-using equipment (home appliances, motors, etc.) and the trends in future adoption of newer technologies, the trend in consumption (which may be affected by household size), and prices of substitute technology (heat pumps versus resistance heating, or electric versus oil and gas).

Standard industry practice is to ensure the regression-based equations which underlie the load forecast are supported by a strong theoretical underpinning, and to incorporate alternative scenarios to improve the value of the tools for planning under uncertainty, and to inform the planners when structural changes are impacting consumption. Most uncertainty is addressed in system planning through the use of such scenarios in order to support resource adequacy assessments.[6] In the 2018 EPRI report on integrated resource planning, many investor-owned utility planning approaches were reviewed, and the report highlights several key variables influencing system planning including government policy changes, long-term economic growth, population movement and growth, technology change, and weather variability, noting that utilities typically address these through scenario analyses.

B. Hydro's Forecasting Methodology

Theoretical basis

Hydro's load forecast is developed based on theoretical underpinnings identifying factors that drive energy consumption for each homogeneous customer group. Hydro selects such factors based on a review of observed data and model fit. The basic

[6] EPRI (2018), Developing a Framework for Integrated Energy Network Planning, 10 Key Challenges for Future Electric System Resource Planning - https://www.epri.com/research/products/000000003002014154

assumption in load forecasting is that past observed relationships will help predict the future; however, there are many external factors that are expected to impact energy use in the future, and each is difficult to predict based on history. Therefore, Hydro relies on external adjustments to the models, a practice that helps Hydro track actual policy impacts such as promotion of electric vehicles and electrification objectives. This is consistent with industry practice.

Hydro develops an energy forecast for each homogenous customer group, both for Newfoundland Power and for Hydro rural customers, using regression analysis. External modifications are made to the regression model results to address provincial policy and programs. The regression models have been developed over time and are improved based on observation of predictive value and fit, based on which the load forecaster may make modifications to independent variable selection. Industry standard is to improve the regression models as each new forecast is developed and as new information is available, and Hydro also does this as forecasts are updated.

The regression equations are derived from Hydro's and Newfoundland Power's billing data, economic and investment data supplied by Statistics Canada and the Department of Finance, and furnace oil price data supplied by Platts.

For the Island Interconnected System ("IIS"), Hydro develops a peak demand forecast for each customer class, excluding EV demand. Coincident factors are then applied to each of the demands to produce the Island Interconnected System peak. Hydro then scales this peak using an hourly load shape with an evening peak to scale the values to an hourly profile. Finally, Hydro adds hourly EV demand to determine the combined peak value.

This process is slightly different for the Labrador Interconnected System ("LIS"), where peak demand forecasts are developed for each geographic area (defined as utility load for each area) and the industrial customer class: Labrador East, Labrador West, and Industrial. The coincident factors for each are applied to these peak demands. EV load is added directly to utility loads rather than added to combined peak values as a post processing step.

Scenarios analysis

Historically, Hydro developed a base case and built sensitivity cases to reflect the potential range of loads that might be required (see Table 1). Hydro has also appropriately been increasing its understanding of current emerging technologies, including mini split heat pumps and electric vehicles, to better inform its forecasting of the range of potential futures in an increasingly uncertain period for forecasting. The industry is continuing to change in response to concerns about climate change. Reflecting the policies of the government, responses of customers, and new technology adoption are key load forecasting implications of this shift. These scenarios provide a means to assess potential risks including ability to meet need, cost comparisons of alternative forecasts, and alternative resource selection implications for cost and reliability.

The 2023 annual load forecast considers a Reference Case which incorporates a representation of current decarbonization policies and adoption of a Rate Mitigation Plan. Hydro also constructed a Slow Decarbonization Path and an Accelerated Decarbonization Path to frame the range of consumption changes that may transpire, affecting the expansion decisions that Hydro must make. Table 1 summarizes the three scenarios presented in the Hydro forecast and a description of each, including the considerations as each were developed, is provided below the table.

	Reference Case Reflection of current decarbonization Government policy and programs	**Scenario 1: Slow Decarbonization Path** Slower decarbonization, steady transportation electrification, and increased rates	**Scenario 2: Accelerated Decarbonization Path** Accelerate policies for decarbonization and transportation electrification
Economic Growth	Reference	Reduced population growth	High Growth
Decarbonization Policy (Government programming)	Reference	Slower Change	Accelerated Change
Policy vs Energy Efficiency	Reference	Accelerated Change	Reference
Electric Vehicles	Reference	Slower Adoption Rate	High Adoption Rate
Demand Response Programs	Reference	Reference	Reference
Industrial Growth	Reference	Reference	High Growth
Electricity Rate	Reference	Increased rates	Reference

Table 1 Forecast Scenarios Developed for the 2024 RRA

Climate change policies – The Federal Government produced Draft Clean Electricity Regulations on August 10, 2023, which would require electric utilities to significantly phase out fossil fuels used to generate electricity starting in 2035. Final regulations are expected to be released after the comment period sometime in 2024. Ultimately, these supply-side impacts may result in a demand-side response.

Electrification of Heating – Hydro's forecast for electrification of heating took into consideration the success of the previous years' oil to electric conversions program and developed adjustments to the conversion rate in the associated models to account for program uptake.

Electric Vehicles – The Federal government of Canada issued regulations to mandate a shift to electric vehicles so that all new passenger vehicles and light trucks sold in Canada after 2035 will be electric zero-emission vehicles. This will phase in starting with a 20% requirement in 2026. Hydro engaged an external consultant, Dunsky Energy and Climate Advisors ("Dunsky") to develop an adoption plan for EVs that considers household income. As sensitivities, Hydro considers the potential impacts of a both a slower and a more accelerated adoption rate to assess impacts on load requirements in the future.[7]

Energy Efficiency– Energy efficiency or conservation programs are addressed within the regression equations used to predict general service load for Newfoundland Power customers with electric heat. In this equation, the cumulative GWh savings gained from the Conservation and Demand Management (CDM) program represent this effect, with non-zero data available from 2009 onward.

The CDM program began in 2009, with the first full year of activity in 2010, primarily to address energy efficiency opportunities with Hydro customers and internal facilities.[8] For the 2021 to 2024 period, the core focus is on delivering energy and demand savings. All cases include the same assumptions relative to program energy savings.

Alternative scenarios address differing economic growth expectations, real disposable income growth, and alternative decarbonization policies. These future scenarios include first, an *accelerated* case representing aggressive progress toward policy targets as well as higher industrial growth and second, *a slower decarbonization path* which assumes a

[7] Dunsky Energy + Climate Advisors (2023), EV Adoption and Impacts Study

[8] Newfoundland and Labrador Hydro (2010), Report on Conservation and Demand Management - https://www.muskratfallsinquiry.ca/files/P-01551.pdf

higher electricity price to consumers which is expected to modify consumption patterns. Typically, these alternative scenarios act to provide boundaries around the reference case; in Hydro's forecast the implication of electrification resulting from decarbonization policies is driving demand for both energy and peak up so the differentiation between scenarios shows a larger upside and a smaller or no downside. Hydro has informally considered additional future scenarios but has not reported or documented these scenarios in the R&RA process.

Daymark recommends that Hydro formally document these scenarios and ensure that adequate alternative futures are addressed in future forecasts as well as in the broader R&RA process.

Load forecast visualization

Hydro's peak forecasts for the Island and Labrador systems, respectively, are depicted in Figure 3 & Figure 5 and its energy forecasts for each planning region are in Figure 4 & Figure 6.

As noted above:

- *Reference* is Hydro's official forecast in the forecast model and includes current decarbonization policies and electrification.
- *Slow Decarb* refers to slower decarbonization, steady transportation electrification, and potentially higher rates on the Island Interconnected System.
- *Accelerated Decarb* refers to accelerated decarbonization and transportation electrification on the Island Interconnected System.

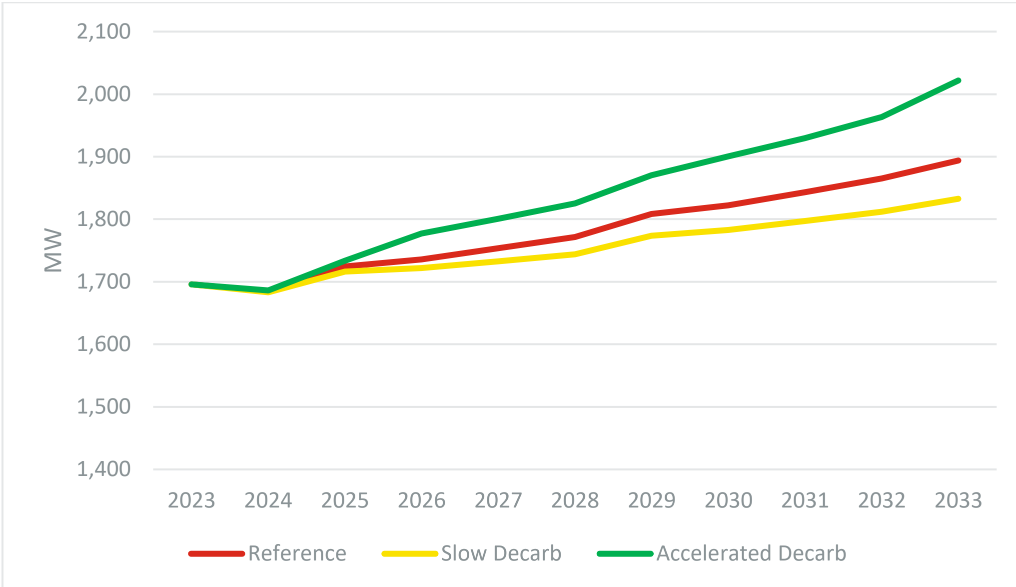

Figure 3: Island Interconnected System Peak (MW) Forecast Scenarios[9]

Note: The Y-Axis, Peak Demand, does not begin at 0 MW for Figure 3

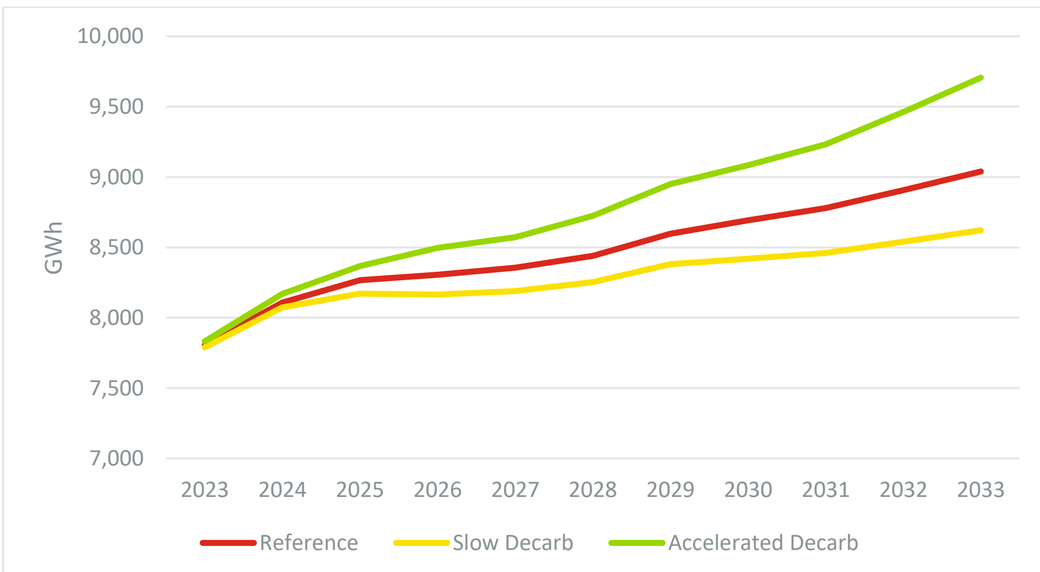

Figure 4: Island Interconnected System Energy (GWh) Forecast Scenarios

Note: The Y-Axis, Energy, does not begin at 0 GWh for Figure 4

9 Exclusive of transmission losses and station service load.

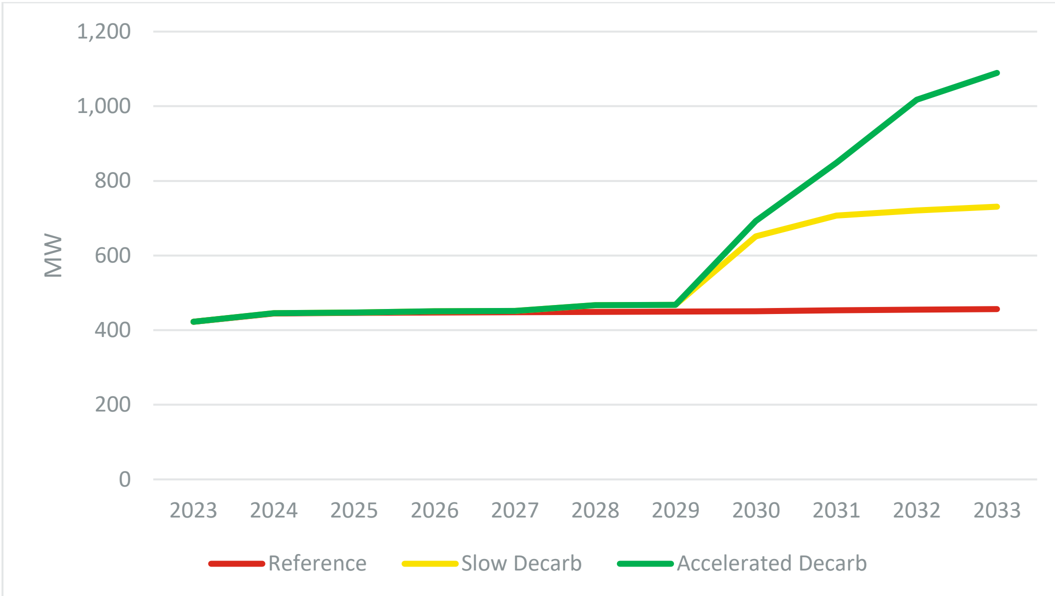

Figure 5: Labrador Interconnected System Peak (MW) Forecast Scenarios

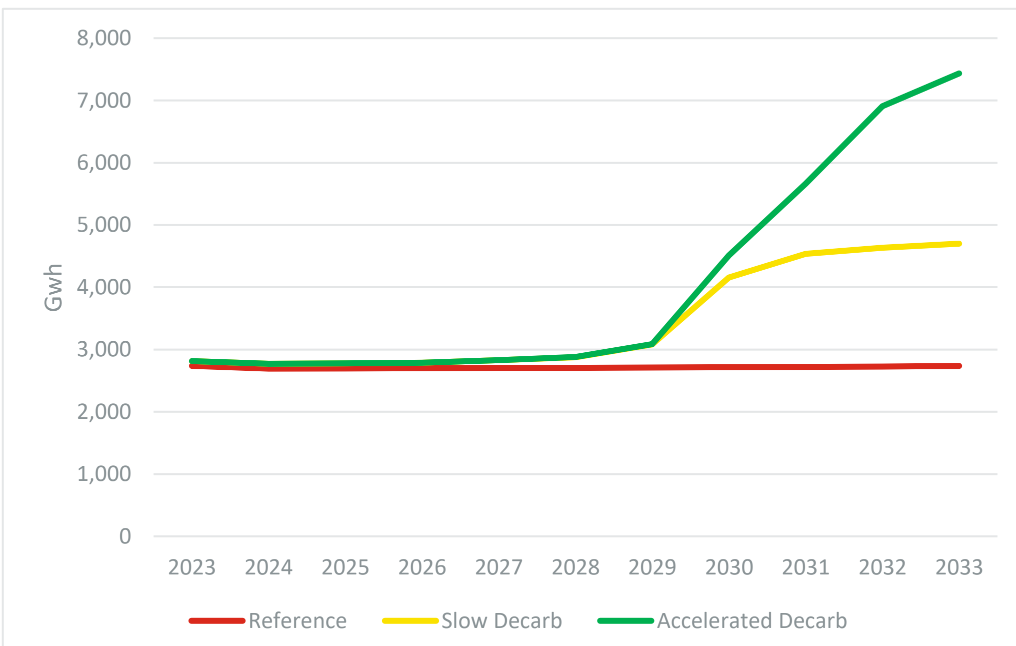

Figure 6: Labrador Interconnected System Energy (GWh) Forecast Scenarios

Review Process

Hydro assesses the accuracy of its forecasts as shown below. The review process provides a summary of mean absolute percent error with respect to NP domestic customer sales and general service sales. Industry changes, as well as policy changes, have accelerated over the time frame considered in Table 2 and the accuracy of the forecast reflects uncertainty regarding timing and adoption rates for new technology. Additionally, uncertainty is a factor in evaluating shifting consumer behavior and the timing of changes in consumer behavior.

Table 2: Forecast Accuracy (Mean Absolute Percent Error) [10,11]

Forecast Accuracy Measured in Percentage of Deviation from Actual Load										
Newfoundland Power - Domestic Customer Sales Mean Absolute Percent Error (MAPE)										
Forecast Year	**1 Yr**	**2 Yr**	**3 Yr**	**4 Yr**	**5 Yr**	**6 Yr**	**7 Yr**	**8 Yr**	**9 Yr**	**10 Yr**
NP Domestic	2.8%	2.1%	2.2%	2.8%	1.8%	2.3%	4.5%	7.3%	10.3%	15.0%
NP Domestic - Weather Normalized	1.1%	1.0%	1.1%	0.8%	1.6%	3.7%	3.8%	5.9%	6.9%	9.2%
Annual Forecasts from 2012 to 2021 inclusive.										
Newfoundland Power - General Service Sales Mean Absolute Percent Error (MAPE)										
	1 Yr	**2 Yr**	**3 Yr**	**4 Yr**	**5 Yr**	**6 Yr**	**7 Yr**	**8 Yr**	**9 Yr**	**10 Yr**
NP AEGS	19.0%	2.9%	4.4%	4.5%	3.1%	5.3%	7.0%	6.1%	6.1%	8.8%
NP TOT GS	1.3%	2.3%	3.8%	3.2%	2.7%	4.4%	6.2%	6.6%	7.8%	9.1%
NP TOT GS - Weather Normalized	0.8%	2.0%	3.4%	3.3%	3.0%	4.5%	5.8%	6.7%	7.3%	8.3%
Annual Forecasts from 2012 to 2019. 2020 and 2021 were excluded due to impacts from COVID-19.										

For years 1 through 6, on a weather normalized basis, the Mean Absolute Percent Error (MAPE) remains less than 5%, which is within industry norms. For years 7 through 10, this number fluctuates between 3.8% and 9.2% depending on load class and year. As the time horizon in a forecast increases, the level of error is expected to increase. However,

[10] Source: Forecast Accuracy for Newfoundland Power Sales Excel Worksheet

[11] "Forecast Year" refers to the number of years into the future the forecast year is, i.e., the accuracy of Hydro's forecast 10 years into the future, is only based on the 2012 forecast, as 2021 would have been that forecasts year 10, with 2012 being considered year 1.

Hydro should continue to monitor this level of error and ensure that it does not exceed 10%. The incidence of higher error rates into farther forecast horizons further supports Hydro's use of alternative futures or scenarios so that planners have increased comfort that risks of a different future are being evaluated and discussed in the process.

C. Hydro's Forecasting Approach Meets Industry Standards

Hydro's current load forecasting methodology reflects standard industry approaches for assessing potential growth. The approach and data are grounded in the realities Hydro, and the industry must face. We provide specific recommendations for enhancement in Section III. As is the case with all forecasting, improvements in the underlying methodologies are expected and planned to occur in each successive forecast to reflect new information and industry issues based on improved or new forecast methodologies. Enhancement will also address the emergence of additional information on customer adoption of programs, responses to pricing and government programs, and the general economic climate.

The conceptual basis used by Hydro for the load forecasting models is in line with industry standards. For example, in the residential class, Hydro projects consumption per customer by type of customer and then projects the number of customers over time. Use per customer is predicted based on economic considerations, disposable income and electricity prices, and weather considerations. The models utilized by Hydro rely on several independent variables which must also be projected over the forecast period and the source of such information is either provincial forecasts (economic, population) or are projected relying on additional models or simple trends.

During our review of the model construction and philosophy of the approaches used, Daymark asked Hydro to test the elimination of dummy variables intended to reflect a policy or economic occurrence that resulted in a step change that could not be predicted through a theoretically constructed independent variable. Hydro concluded that several dummy variables in use had minimal impact on the energy forecast and will consider removal from the equations in future forecasts. Daymark has recommended that Hydro continue to consider elimination of other variables that are determined to be obsolete and/or lacking predictive power as it develops future forecasts.

The next section provides a summary of suggested forecast methodology enhancements.

III. RECOMMENDATIONS

Overall, the NLH load forecasting model is generally consistent with standard industry practices. The load forecast development is typically a continuous process, and considering the ever-changing nature of the energy landscape, Daymark stresses the overarching themes of having the process be adaptive to emerging trends and transparent throughout the process to stakeholders. Daymark offers the following topics of focus for Hydro's consideration going forward:

- Establish a narrative contextual foundation for the forecast prior to setting forth forecast results and document this foundation;
- Expand on the usage of scenarios or alternative futures, documenting and communicating the purpose of each, and establish a set of milestones to monitor to track movement toward or away from the expected reference forecast and document;
- Enhance analysis of price implications including customer response to mitigation approaches and the impact of resource build on pricing and consumption in the forecast and provide contextual documentation; and
- Refine the post-model development review process to ensure fit with forecast context, evaluate independent variable predictive value, and document the continuous adaptation of the overall model.

These enhancements are intended to support continuous improvement of the Hydro load forecasting process — as stated earlier the forecast results are based on standard industry practice. Below, we provide additional detail on each of the points above.

A. Establish a Narrative Foundation

Hydro should present its load forecasting context before addressing the detailed results or implications of the analyses undertaken. Such context should address the current situation relative to energy and peak in the Province, the key forecast drivers and the drivers of changes in energy and demand, and Hydro's overall approach to addressing industry changes and policies adopted by the province and federal government. By adopting this approach, Hydro might set forth a narrative foundation that will help stakeholders assess the big picture framework in which the forecast is developed.

The definition of a reference case and alternative scenarios similarly would benefit from a clear, reported, and continually updated narrative reflecting progress towards objectives or policies and shifts in such objectives over time. The value of a reference case plus scenarios approach is that it aids the organization in understanding risks and their drivers —some of which can be influenced by the organization. For example, utilities assess the benefits and costs of planning to various probability levels such as P50, P75 or P90 which means that if planning to P90 level there is a 10% chance that load would exceed the forecast. Understanding the cost of relying on a certain level is weighted against the benefits and risks of such a decision.

B. Expand Use of Scenario Analysis

Hydro develops alternative scenarios and analyzes the details of the models so that the external adjustments are aligned with a potential future. Continued emphasis and expansion by Hydro on the scenario analysis can help to identify and assess resource risks ahead and serves to become potential milestones that planners can monitor in the data that may highlight a need for changes in the action plans such as shifting resource types or moving timing of resource options. Hydro has been moving ahead, and should continue to enhance its scenario risk analysis, with analysis of an increased number of alternative futures that can aid planners in identifying that consumption is changing differently than in the Reference case and may require modified planning. As Hydro considers a greater number of scenarios, it is important that it also maintain strong narrative bases for each scenario for internal and external usage.

A second recommendation on scenario creation is to ensure that the range resulting from the scenarios is sufficient to address the anticipated risks that Hydro must plan for. Too narrow a range of potential outcomes might lead to missing key modifications by customers and a resulting lack of resources or an inability to meet loads. While Hydro has developed multiple internal models that provide a greater array of outcomes, these additional scenarios should be documented and included as part of the standard load forecasting process and presentation of results within the R&RA process.

We also recommend that Hydro consider additional scenarios reflecting more extreme weather and reflect these in load forecast graphics demonstrating the potential implications on electricity requirements resulting from more extreme weather events. Planning for extreme weather has taken on greater importance with climate change and major weather events in North America in recent years, such as those in Texas in February 2021, the Eastern seaboard in December 2022, and Alberta in January 2024.

Hydro currently projects peak using a P50 windchill assumption in its peak model. As such, Hydro continues to monitor the likelihood of extreme weather and should consider additional scenarios to better understand its impact on resource adequacy.

C. Enhance Analysis of Prices and Price Elasticity

The current energy forecast uses historic electricity price, with dummy variables to control for historical rate mitigation, as inputs to forecast electricity demand. While it is apparent that the price of electricity will impact the overall demand for electricity, the cost of meeting future demand must be factored into the process that determines electricity prices.

Hydro's energy forecast assumes a certain price of electricity, after rate mitigation, to determine future electricity demand. This electricity demand then is used as an input to determine system requirements, which should be used to determine future electricity prices; however without this iterative approach on prices the modeling may miss the impact of resource investment on electricity consumption. This is further compounded by the fact that the price elasticity of electricity is not constant and cannot be accurately estimated for every potential price point. The interdependent and circular nature of these two forecasts mean that it would be beneficial to iterate through several load forecasts/expansion plans to capture the impact of electricity prices on overall demand.

Hydro is investigating the implications of the rate mitigation plan and resource addition costs on pricing in the future. This analysis should be incorporated into the load forecast, perhaps through scenarios, so that elasticity implications can be assessed. As is recognized throughout the industry, electricity price can be a key driver of energy demand.

D. Refine the Post-Model Review Process

Hydro should more fully document its post-model review process and enact a multi-year review period for each model to holistically evaluate its efficacy, understanding that load forecasting is an iterative process. As part of this review, Hydro should evaluate the extent to which model variables are capturing a meaningful variation and correlation between dependent and independent variables (While some variables may improve the historical fit of a model, they may not necessarily provide predictive power). Hydro should also ensure that each variable has a concise theoretical explanation maintained in the model. Further detail is provided in ***Appendix I: Principles of Model Construction and Review*** with suggestions on how Hydro might expand its post-model review.

This analysis could be made more rigorous in the future by performing in- and out-sample analysis[12] for each model along with causality testing for each independent/dependent variable relationship. Predictive power can be determined using the Adjusted R^2 values, RMSE, and the host of other statistical tests available to the modeler. Further detail on these recommended statistical approaches can be found in ***Appendix I: Principles of Model Construction and Review.***

IV. CONCLUSION

The overall modelling approach used by Hydro is generally consistent with standard industry practice. This report identifies multiple areas for continuing improvement in Hydro's load forecasting process, intended to generate further efficiencies in its modelling and identify future uncertainties that might impact model results. However, these efficiencies do not detract from the efficacy of Hydro's forecasting approach in modelling future load. The outcomes from the existing process are generally representative of the expected future load. Any recommendation identified in this report are incremental improvements to the current model, intended to ensure that Hydro is continually improving its forecasting practices as exogenous sources of uncertainty continue to grow.

[12] In-sample analysis refers to the practice of using the model to predict values within the time period of the data sample. Out-sample analysis refers to using the model to predict values outside of the time period of the data sample. Given these sets of projects, a modeler can compare actuals against predicted values to evaluate accuracy.

APPENDIX I: PRINCIPLES OF MODEL CONSTRUCTION AND REVIEW

This appendix provides greater detail of specific recommendations related to model construction and model development review to supplement the information in the body of the report.

A. Ideal Model Construction

Deterministic regression models that examine trends over time are intended to evaluate the relationship between a dependent variable and another independent variable (predictor). In more complex models, additional independent variables may be selected within a model so it might capture the impact of influences outside the base model, this is a process known as accounting for confounding variables. Load forecasting best practice is to ensure that there is a clear narrative linking the dependent, independent, and confounding variables for a set period and that each variable can be clearly defined.

When selecting the set of variables to be used in a regression, it is important that these variables capture variation that is impacting the ultimate dependent variable. In some instances, one may use binary dummy variables, which is acceptable if meaningful variation is being captured across the period of the model.

Since all data inputs in a panel data setting are observed over time there are limited reasons to include a time reason without a specific narrative. For example, a model may want to capture unobservable variables with insufficient proxy variables that might change over time (such as technological development). In this situation, it would be sufficient to include a variable for the Year or Date (essentially a linear trend). In other instances, the model may want to capture effects that vary across time but are constant across variables. In this case, you would create a dummy for each year (time fixed effects).

If there are seasonal effects, a model may include these as well. For example, rather than using data at an annual level, quarterly average data could be used in its place. For each quarter, a categorical value would be assigned from 1 through 4, allowing the model to parse through impact in each of the four seasons. This value can be adjusted for the seasonal effects relevant to the region or the situation.

Interacting a time variable (or any other linear trend) with any of the independent variables in the model would not produce a meaningful result. For example, a variable that is the product of some data series and the year, would not correctly observe how the variable is evolving over time by overstating the impact of the passage of time. In this interacted variable, there is an implicit assumption that data series would evolve linearly over time, whether this is borne in the data or not. This example is demonstrated in Table 3, where the variable continues to grow due to the linear trend coefficient resulting in a positive correlation where there is none in the original data:

Table 3: Bias Introduced by Interactions with Linear Trend Variables

	Period 1	Period 2	Period 3	Period 4
Base Trend	2	4	2	4
Linear Trend	1	2	3	4
Variable	**3**	**8**	**6**	**16**

If a variable is constant over the entire period of a given model, for example, it is a "fixed effect" and would have to be treated with a specific transformation or, more efficiently, use a different code in the software package of the modeler's choice. Essentially, the fixed effects model allows each variable (or entity) to hold a separate intercept, which is the "fixed effect" of each variable. When examining the behavior of a small sample of people, fixed effects may account for factors such as demographics, which would not change with time but might have impact on individual behavior. Additional to this purpose, fixed effects will also control for some omitted variable bias.

B. Evaluating Fit and Predictive Power

Assuming a narratively well-constructed model, there are multiple means to evaluate fit and predictive power. The most straightforward means of identifying fit is using the R2 metric. For most social science cases, an R2 can range from 0.5 to 0.99 and be a sufficient indicator of fit. However, this is not a hard and fast rule as some models with R^2 values less than 0.5 may still provide significance in their predictors and ultimately hold strong predictive power.

In addition to the R^2 metric, the p-Value of each variable will determine how significant it is. Each model will have to determine the ultimate threshold for significance, but typical references are 0.1, 0.05, and 0.01. Unfortunately, a variable may reflect false significance if the model is not sufficiently capturing the appropriate confounding variables.

C. Evaluating the Model Efficacy

It is important to robustly examine the fit and predictive power of a given model. To examine the predictive power of the model, a modeler would use the follow tests:

- In-Sample Analysis:

Given a model running across 40 years of data, apply the same model to the first 30 years of data. Measure how well the model can predict the values of the eliminated 10 years.

- Out-Sample Analysis:

For a multi-year period following the deployment of a model, measure how well the model can predict future values. There are multiple metrics to test error, such as Mean Average Percentage Error, Mean Average Error, or the Root Mean Squared Error (explained below).

- Adjusted R^2 Analysis:

The adjusted value for R^2 accounts for the number of predictors in the model, allowing a modeler to examine how individual variables impact the fit of each model. Repeating model runs with different permutations, using the adjusted R2, would help identify the utility of each individual variable.

- Root Mean Squared Error (RMSE):

The RMSE measures the average difference between values predicted by a model and the actual values (residuals). The closer this value is to zero (0), the better fit is available in the model. Interpreting RMSE will depend on the units of the ultimate dependent variable. By transforming the variables with a natural log, it is possible to interpret these values as percentages and provide a more consistent means of interpretation.

- Causality Testing:

While individual variables may improve the fit of a model and certain metrics may suggest strong predictive power, it is ultimately incumbent on the modeler to provide a clear narrative and causal link between the dependent, independent, and confounding variables.

D. Reliance on Dummy Variables

Dummy variables are of specific concern in this context. Where data is available, a modeler should tend to opt for the most amount of data variation that captures the core effect being measured. For example, if a model intends to examine the impact of a large transfusion of customers spurred by a one-time policy (refer to this as Policy A), it should be considered whether this variable is identifying the impact of some policy change or simply the impact of a change in the number of customers. If this policy change is truly a one-time occurrence, the variable will not provide any further information to the modeler regarding this policy change. If there are future policy changes (Policy B) that result in large customer transfusions, they would have to be sufficiently similar to Policy A to compare them using the results of this model.

In the example above, though the variable was intended to examine the impact of a specific policy change, it may have only succeeded at identifying the impact of customer increases and provided no real commentary on the policy impact it intended to measure. In general, Hydro should evaluate each relationship between dependent and independent variables.

APPENDIX II: DOCUMENTATION REVIEWED

Throughout the review of Hydro's load forecast, Daymark reviewed documentation including but not limited to:

- Island and Labrador Interconnected System Regression Results and Permutations (referring to regressions where specific variables may be modified or deleted to test model sensitivity),
- Island Interconnected System Electricity Prices,
- Island and Labrador Interconnected System Forecast Errors,
- Peak Forecast Coincident Factors and Windchill,
- Annual Heating Degree Days by region and station,
- Three Scenarios for Peak and Energy Forecasts for each of the Island and Labrador Interconnected Systems,
- EV Forecast assumptions, and
- Impact of weather normalization on peak forecast.

Attachment 2

EV Adoption and Impacts Study – Final Results

Dunsky Energy + Climate Advisors

August 23, 2022

newfoundland labrador hydro

EV Adoption and Impacts Study

Final Results

August 23, 2022

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EXPERTISE

Buildings + Industry

Energy

Mobility

SERVICES

Quantify Opportunities

Design Strategies

Evaluate Performance

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EXPERTISE

Buildings + Industry — **Energy** — **Mobility**

SERVICES

Quantify Opportunities

Design Strategies

Evaluate Performance

GOVERNMENTS | **UTILITIES** | **CORPORATE + NON-PROFIT**

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1. Introduction

Context: Study Scope

Dunsky Energy + Climate Advisors (Dunsky) was engaged by Newfoundland and Labrador Hydro (NLH) to assess the potential system load impacts associated with electric vehicle (EV) adoption in Newfoundland and Labrador

Scope of the study:

- Forecast EV uptake across the light-, medium-, and heavy-duty vehicle segments within the province
- Develop estimates of likely EV adoption within various geographies of the province; 2 zones (Island + Labrador)
- Assess the impacts of the forecasted EV uptake on annual energy consumption (GWh) and hourly demand (MW)

This deliverable highlights results from the study, with a focus on the forecasted EV adoption in the province under various policy, market and technology conditions. Detailed results were provided to NLH in the form of an Excel-based results dashboard.

1. Introduction

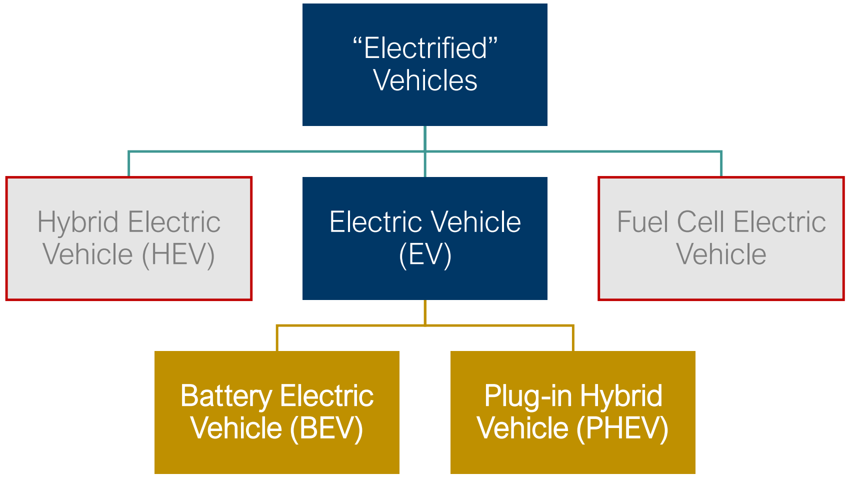
Context: Defining Electric Vehicles

The study considers plug-in EVs, specifically:

- **Battery Electric Vehicles (BEVs):** "pure" electric vehicles that have only an electric powertrain and that plug in to charge (e.g., Tesla Model 3, Chevy Bolt, Nissan Leaf)
- **Plug-in Hybrid Electric Vehicles (PHEVs):** hybrid vehicles that can plug in to charge and operate in electric mode for short distances (e.g. 30 to 80 km), but that also include a combustion powertrain for longer trips. (e.g., Chevy Volt, Toyota Prius Prime)

The following are excluded from the analysis:

- **Hybrid Electric Vehicles (HEVs)** that do not plug in to charge and are considered internal combustion engine (ICE) vehicles.
- **Fuel Cell Electric Vehicles (FCEVs)** (i.e., hydrogen vehicles): market assumed to be small within the timeframe of the study for all vehicle segments



Chevrolet Bolt, a BEV with 417 km of range.

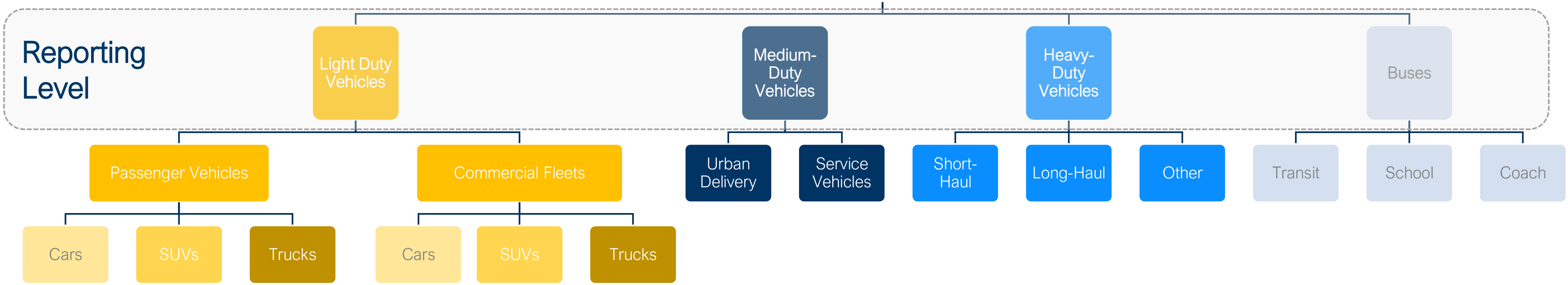
Toyota Prius Prime, a PHEV with 40 km of EV range

1. Introduction

Context: Defining Vehicle Segments

Multiple vehicle classification systems exist, however, for the purpose of this study, we break down the on-road vehicle market into several key segments that share common characteristics

- Results are broken down into for light-, medium-, heavy- duty vehicles and buses
- More granular vehicle sub-segments were used in the modeling to capture vehicle segments with distinct factors that may impact EV adoption (e.g. limited availability of EV model, unique driving patterns or technical needs, etc.)



* The study does not model commercial light-duty vehicle segment distinctly. The analysis of light-duty vehicles focuses on the personal vehicle market (the majority light-duty vehicle market) and assumes that the commercial vehicle market follows a similar trajectory,

1. Introduction

Context: Vehicle Market

Approximately 383,000 vehicles on the road in Newfoundland and Labrador

- 81% of vehicles are passenger/personal light-duty vehicles (LDVs)
- LDVs make up 90% of vehicles on the road, with the remaining 10% being medium-and heavy-duty vehicles (MHDVs)

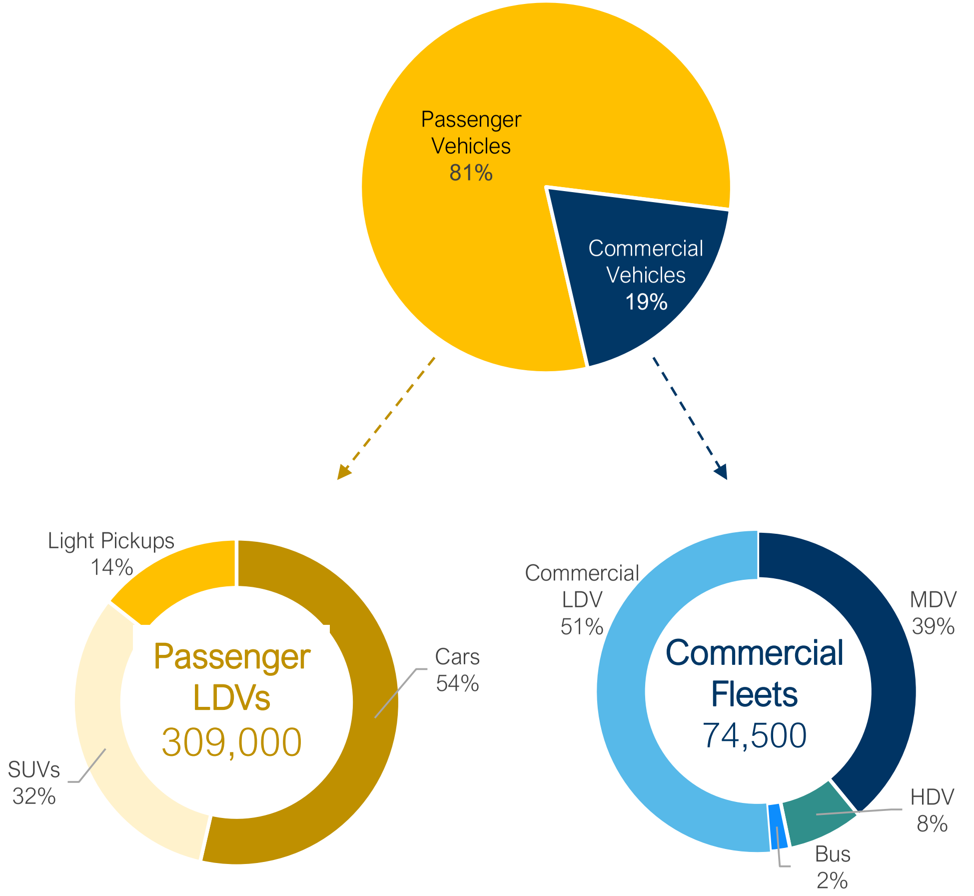
25,500 new LDVs registered annually

- Majority (89%) of LDVs predominantly passenger/personal use, with the remaining being commercial/institutional fleets
- SUVs and Trucks make up 55% of new vehicle sales, in-line with historical trends of increasing customer interest in larger vehicles

2,500 new MHDVs estimated registered annually

- Medium-Duty Vehicles make up nearly 83% of vehicles in the MHDV segment

Total Registered Vehicles (2020)



% of Total Vehicles 2020

1. Introduction

Context: Electric Vehicle Market

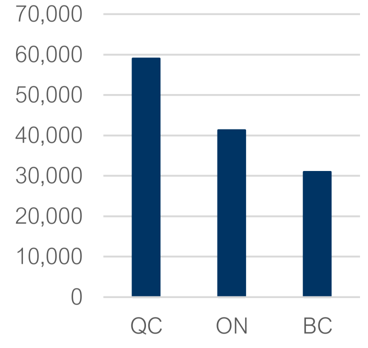
EV Adoption in Newfoundland and Labrador (NL) significantly lags behind other Canadian provinces

- Approximately 400 EVs registered (2020) in the province
- EVs represent 0.3% of new vehicle sales (2020)

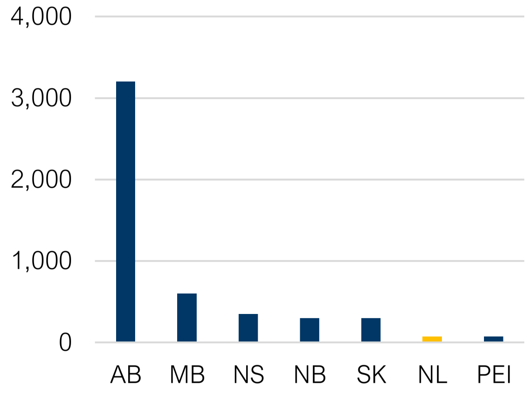
In NL, EV adoption increased starting in 2018

- A significant increase in uptake observed in 2018 (federal ZEV incentives began in 2019)
- Relatively consistent share of BEVs over the last 3 years (~50% BEV/PHEV split)
- Limited uptake of EVs within the Medium and Heavy-Duty Vehicle (MHDV) segment

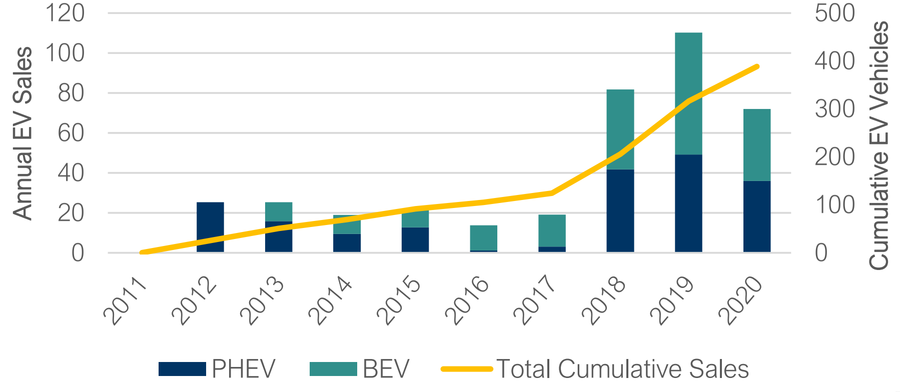
Top 3 Provinces 2019 (131,300 EVs)



Remaining Provinces - 2019 (4,900 EVs)



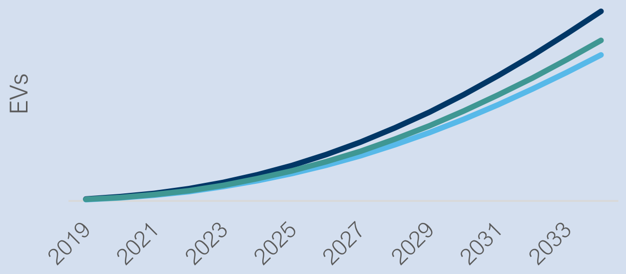
Newfoundland and Labrador EV Sales (2011 – 2020)



Approach

The study follows the following three steps to assess the potential impacts of EVs within Newfoundland and Labrador. Key aspects of the study approach are highlighted throughout the report.

Forecast EV Adoption

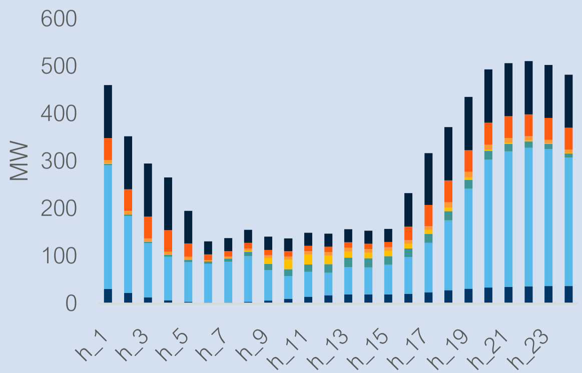


Using Dunsky's Electric Vehicle Adoption (EVA) model, forecast EV uptake within the province under various scenarios reflecting different policy, program and technology conditions.

Develop Regional Projections

Estimate EV adoption across 2 provincial zones based on high-impact factors likely to influence regional variation in EV adoption.

Assess Load Impacts



Assess the energy (GWh) and peak demand (MW) impacts associated with EV charging loads

1. Introduction

Approach: EVA Model

The study leverages Dunsky's Electric Vehicle Adoption (EVA) Model to forecast the uptake of EVs.

EVA powered by dunsky

TECHNICAL

Assess the maximum theoretical potential for deployment
- Market size and composition by vehicle class (e.g. cars, trucks, buses)
- Model availability for each vehicle powertrain (e.g. ICE, PHEV, BEV)

ECONOMIC

Calculate unconstrained economic potential uptake
- Incremental purchase cost of PHEV/BEV over ICE vehicles
- Total Cost of Ownership (TCO) (personal) or Internal Rate of Return (IRR) (commercial) based on operational and fuel costs

CONSTRAINTS

Account for jurisdiction-specific barriers and constraints
- Range anxiety or range requirements
- Public charging coverage, availability, and charging time
- Home charging access

MARKET

Incorporate market dynamics and non-quantifiable market constraints
- Use of technology diffusion theory to determine rate of adoption
- Market competition between vehicles types (PHEV vs. BEV)

Approach: Forecasted EV Adoption Overview

The EVA model was applied to forecast EV adoption using the following approach:

1. **Market Characterization:** Divide the market into vehicle segments (as depicted earlier), develop representative characteristics for each segment and collect data on annual vehicle sales, fleet size and other key market inputs.

2. **Model Calibration:** Using historical inputs on vehicle sales, energy prices, vehicle costs, incentive programs and infrastructure deployment to benchmark the model to historical adoption and calibrate key model parameters to local market conditions.

3. **Scenario Analysis:** Forecast service territory-wide EV adoption under scenarios reflecting different program/policy interventions (e.g. infrastructure deployment, incentives) as well as market and technology conditions (e.g. battery costs, energy prices).

Approach: Passenger Vehicles versus Commercial Fleets

Consideration and treatment of key barriers in the model for personal vehicles and commercial fleets reflects key differences in decision-making between the segments.

Barrier	Personal LDV	Commercial LDV	Commercial MHDV
Technical	Base vehicle assumed to be **gasoline ICEV**		Base vehicle assumed to be **diesel ICEV**
Economic	Upfront cost and Total Cost of Ownership (TCO)	Based on Internal Rate of Return (IRR) of the vehicle's upfront and operational costs over its lifetime.	
Constraints	• Range Anxiety • Charging Time • Public Charging Coverage • Public Charging Availability • Home Charging Access	• Range Requirement • Charging Time Requirement • Public Charging Coverage	• Range Requirement • Charging Time Requirement
Market	**Competition** between PHEV and BEVs		**No competition** between PHEVs and BEVs (i.e. all assumed to be BEVs)

2. Provincial Summary

2.1 Load Impact Summary

2.2 Load Management

2. Provincial Summary

Load Impact Summary: High Growth Scenario (2040)

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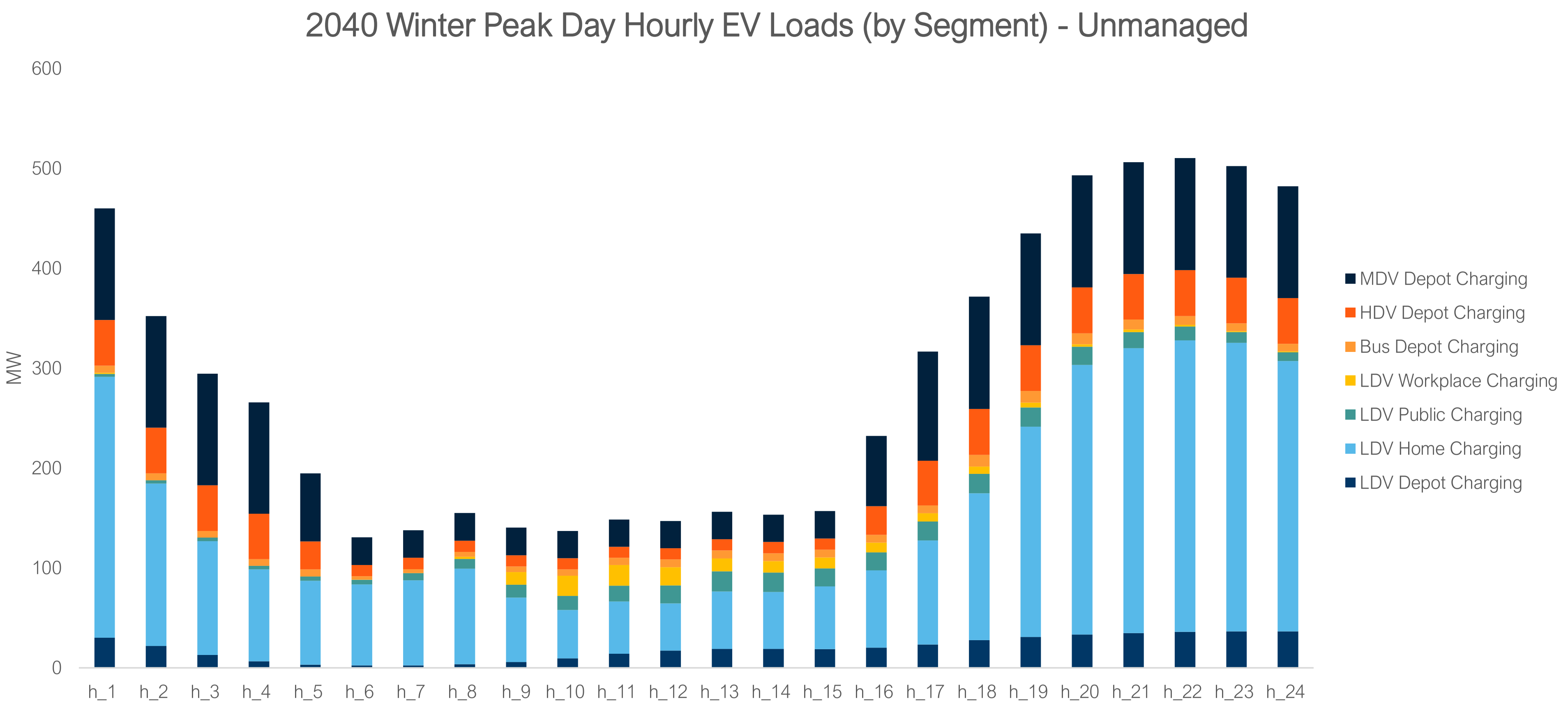
- **In 2040, if unmanaged, LDV home charging will be the primary driver of demand among EVs, contributing to a total EV load of over 500 MW at 10pm**



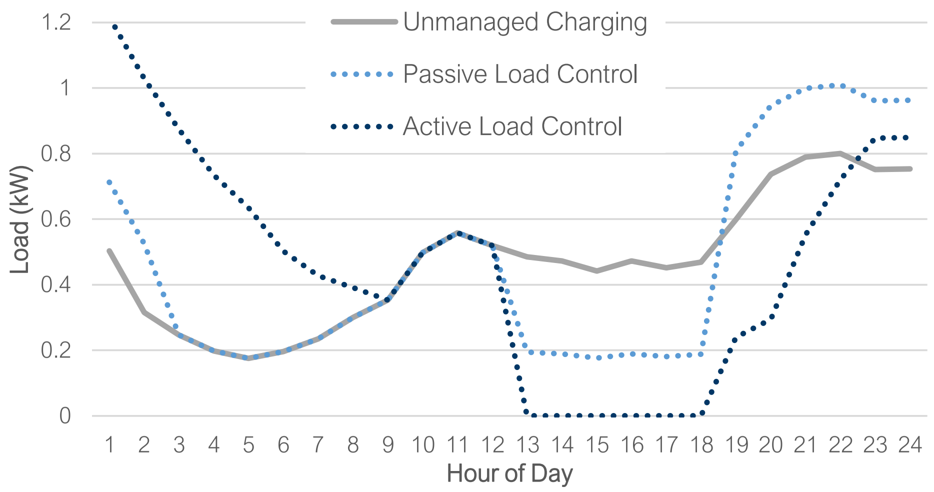
2. Provincial Summary

Key Consideration: Load Management

The inherent flexibility of EV charging loads means that they can be controlled, managed and potentially leveraged as Distributed Energy Resources (DERs) to reduce the peak demand impacts and bring additional system value

- Personal vehicles are usually connected to a charger much longer than required to obtain a full charge, therefore charging loads can be reduced or delayed with minimal disruption to drivers.
- Several EV load management strategies can be employed to shift charging loads from peak to off-peak hours, however generally they can be grouped into two categories

Illustration of the Impacts of Load Management



Strategies	Description	Examples	Impact
Passive Load Management	Rely on customer behavior and response to information, price signals or incentive from the utility	• Whole-home or EV-specific Time-of-Use (TOU) rates • Compensation for off-peak charging (e.g., “Smart Reward” program) • Utility guidance to EV drivers on setting a charge schedule	• Less certainty about customer response • Typically lower implementation costs • Risk of creating secondary peak with snapback
Active Load Management	Utility can manage charging loads through direct control, preset control strategies or other mechanisms	• Control via smart EVSE (e.g. Flo X5, ChargePoint Home, JuiceBox Pro) • Control via EV telematics (e.g. PG&E BMW Charge Forward pilot)	• Greater control over peak impacts, with ability to avoid snapback • Can help accommodate variable renewables

Key Consideration: Load Management

Managed Charging programs offer an opportunity to alleviate peak impacts of EV's

- Typically only personal LDVs are considered for these programs due to lower drive cycles and longer overnight charging periods

Managed charging programs could be considered, including **education and awareness campaigns**, **charging control using EV telematics**, or **Smart Charger programs**

- Each program type varies with respect to level of effort, peak reduction impacts, and technology certainty

Managed Charging Program	Utility Cost/Level of Effort	Peak Load Reduction Impacts	Technology certainty
Education and Awareness Campaign	**Low**	**Low**	**High**
Charging Control Using EV Telematics	**Mid**	**High**	**Low**
Charging Control Using Smart Chargers	**High**	**High**	**High**

Education and awareness: EV drivers can be encouraged to purchase smart chargers, programming them to charge overnight and reduce evening peaks. There is uncertainty around customer response/degree of peak shifting. In addition, shifts will be 'blocky', as all EV owners will be given the same targeted time period to charging. This risks creating a secondary peak.

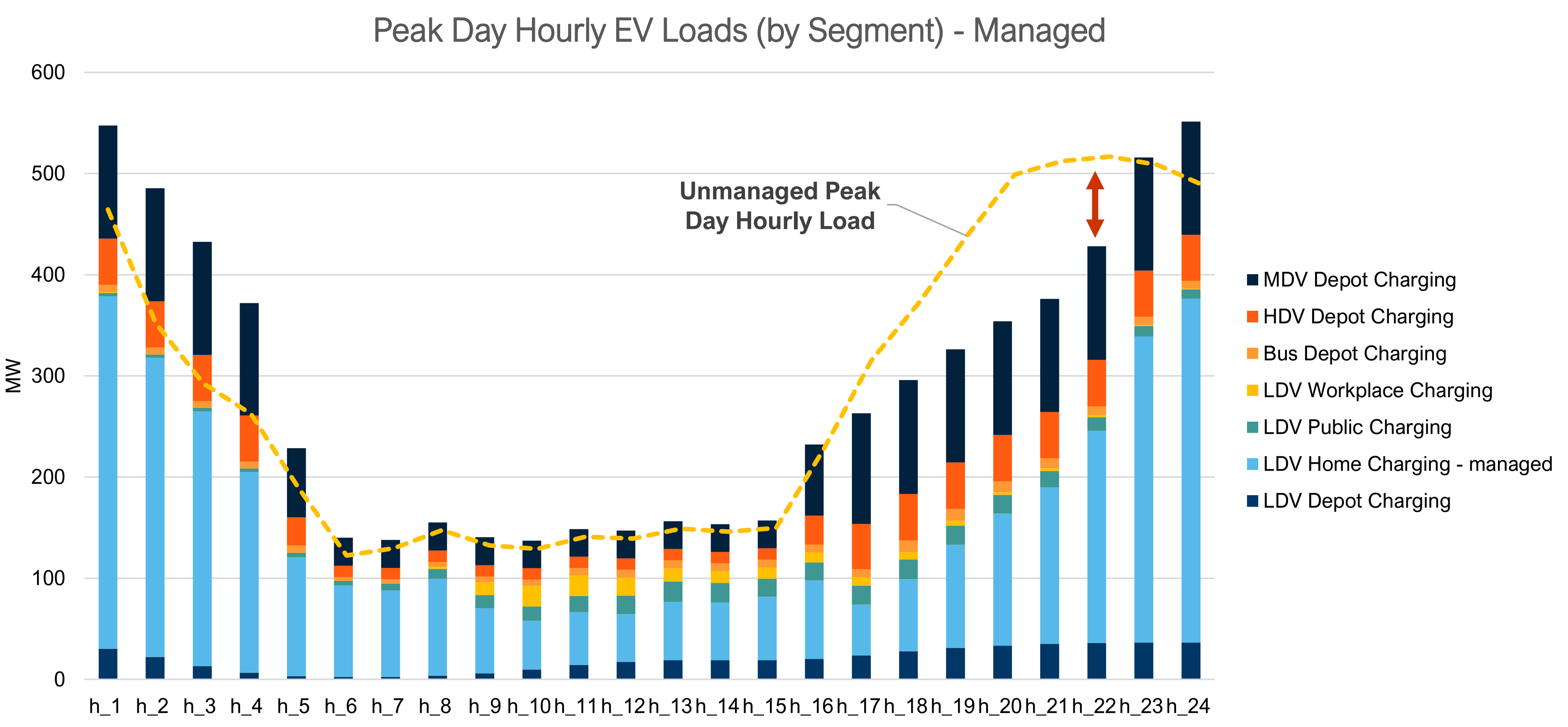
Telematics: Charging can be controlled through direct communication with vehicle telematics using a Demand Response Management System (DRMS). To-date, the communications protocols are not standardized between manufacturers; impact will depend on technological standardization moving forward.

Smart Chargers: Utilities can incentivize smart charger purchases with the expectation that participants will be willing to participate in a managed charging program in the future. Smart chargers are typically controlled through a utility DRMS.

2. Provincial Summary

Load Impact Summary: High Growth Scenario (2040)

- **Managed home charging can significantly reduce evening EV load by shifting to overnight**



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3. Light Duty Vehicles

3.1 Provincial Scenarios
3.2 Regional Impacts
3.3 Provincial Results

LDV Scenarios

	Scenario 1: Low Growth	Scenario 2: Moderate Growth	Scenario 3: High Growth
Vehicle Incentives	Current federal and provincial incentives *(Ramped down and phased-out by 2025)*	Extended federal and provincial incentive *(Ramped down and phased-out by 2030)*	Extended federal & provincial incentive *(Ramped down and phased-out by 2035)*
Public DCFC	Limited expansion of public charging network	Expansion in-line with historical trends	Significant investments in public charging deployment
Public/Workplace Level 2			
Home Charging Access in MURBs	0.2% (125 stalls) retrofitted per year	• 0.5% stalls retrofitted per year • 5% (in 2021) to 25% (2035) of new construction EV-Ready	• 1% stalls retrofitted per year • EV-Ready building codes starting 2026 (i.e. 100% of new construction)

Note: The Federal government aims to achieve 100% Zero Emission Vehicle (ZEV) market share by 2035.
While uncertainties around the specific mechanisms and pathways to achieving this target exist, it does signal continued investments and supporting programs/policies to support EV uptake.

3. Light Duty Vehicles

Sensitivities: Light-Duty Vehicles

	Low Sensitivity Scenario (Most Conservative)	Base Case	High Sensitivity Scenario (Most Aggressive)
Battery Costs	Limited cost declines	Moderate cost declines	Aggressive cost declines
EV Model Availability	Limited availability	Moderate availability	High availability
Electricity Cost Escalation	1% higher than historical	Historical levels *(≈ 3% per year)*	1% lower than historical
Fuel Price Escalation	Historical escalation	Historical escalation (≈ 2% per year) + $170/ton carbon tax by 2030	Historical escalation (≈ 2% per year) + $170/ton carbon tax by 2030
Vehicle Sales	Declining vehicle sales	No growth in vehicle sales	Increase in vehicle sales at current pace

3. Light Duty Vehicles

Regional Disaggregation

The province-wide adoption forecast is disaggregated into 2 regions to estimate the geographic distribution of EV adoption within the province, based on five high-impact factors most likely to influence regional variation in EV uptake

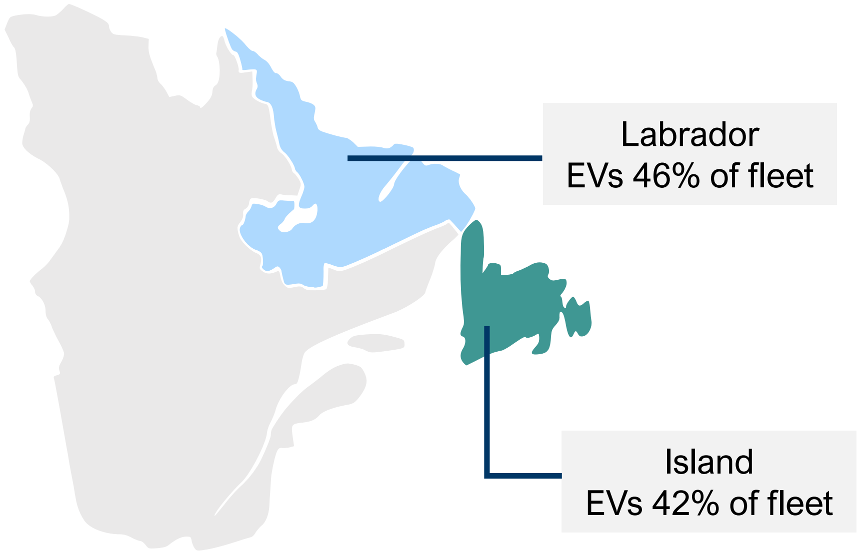
- Number of vehicles
- Historic EV sales
- Housing composition
- Income levels
- Driving distance

Regional variations in passenger EV uptake are a function of:

- The distribution of passenger vehicles across the province (higher populations = more cumulative EVs)
- Other regional differences in income levels, housing composition and typical driving distances across the province - among other factors – that will impact local penetration of EVs.
- While the vast majority of cumulative EVs will be found on the island (94%) due to population distributions, % of fleet will be slightly higher in Labrador given the lack of urban areas with additional barriers to home charging access.

The following results in the report are at the provincial level and more detailed regional outputs can be found in the Excel-based results dashboard

2040 High Scenario - LDVs



3. Light Duty Vehicles

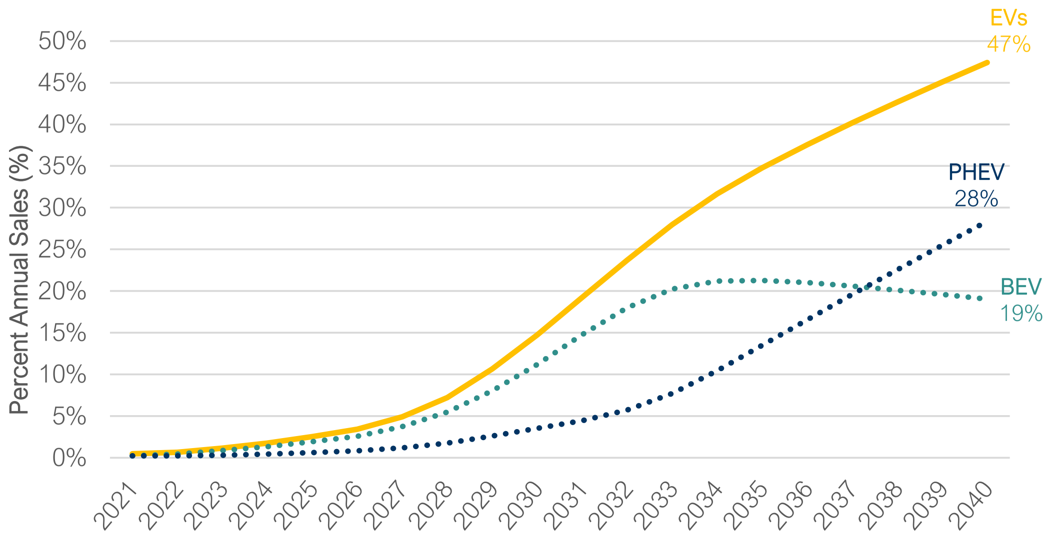
Low Growth Scenario

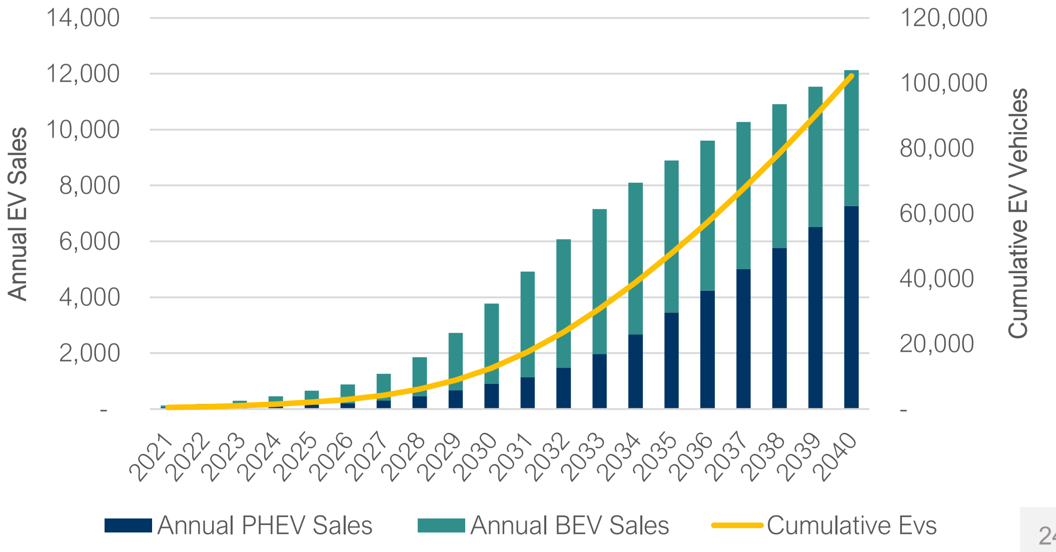
Policy/Program Interventions

Vehicle Incentives	Public DCFC (by 2040)	Public / Workplace Level 2 (by 2040)	Home Charging Access in MURBs (by 2040)
Current federal incentives (phased-out by 2025)	65 Sites (65 Ports)	100 Sites (200 ports)	6%

Under the Low Scenario, Newfoundland and Labrador will experience very modest growth in EV uptake.

- By 2040, a total of **100,000 EVs** of the 307,000 LDVs are forecasted to be on the road
- EV adoption is expected to **fall significantly short of federal 2035 ZEV targets (100%),** reaching only 35% of new sales by 2035
- Despite the growth in overall EV uptake, the **market share shifts towards PHEVs by 2037** as public infrastructure deployment in this scenario is insufficient to meet needs of BEV drivers.





3. Light Duty Vehicles

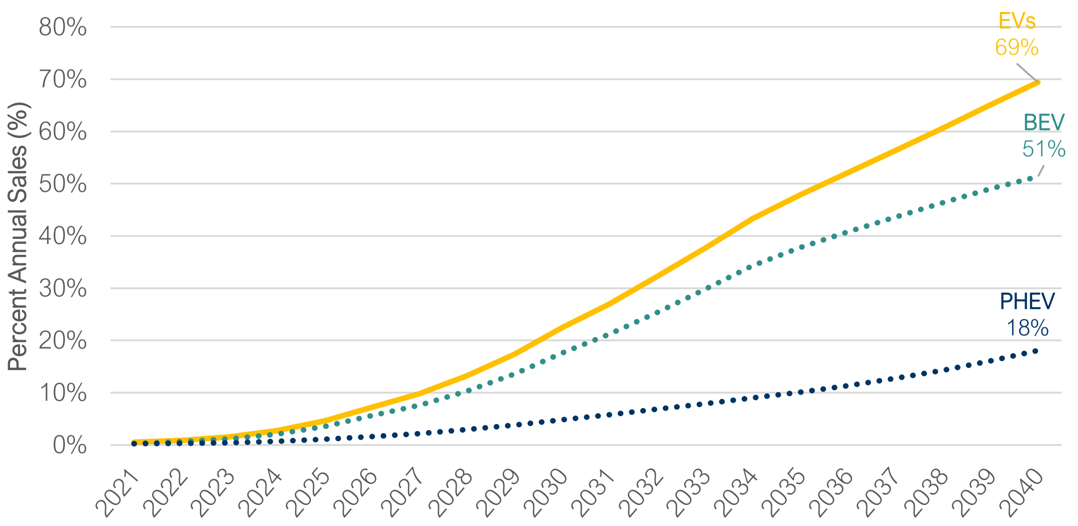
Medium Growth Scenario

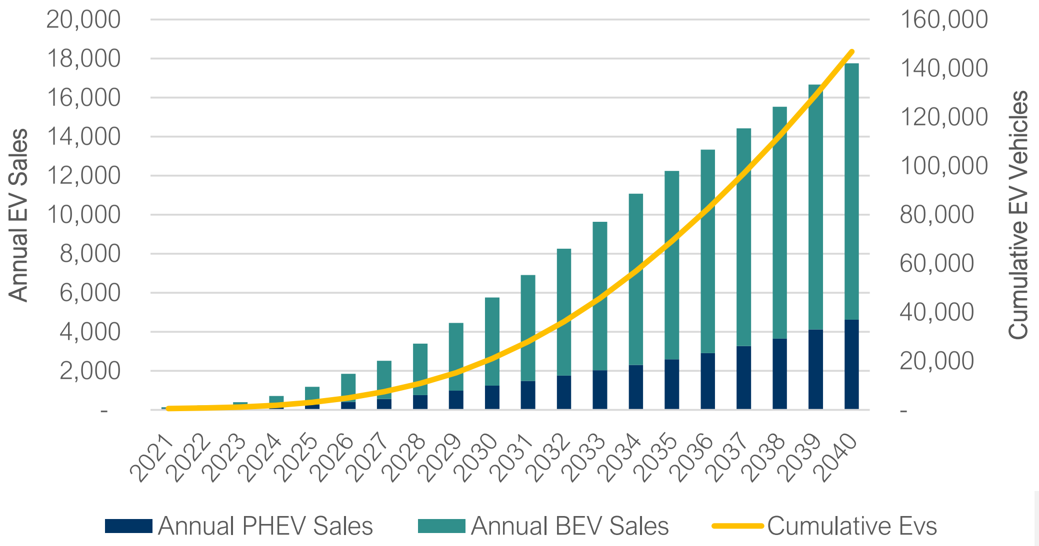
Policy/Program Interventions

Vehicle Incentives	Public DCFC (by 2040)	Public / Workplace Level 2 (by 2040)	Home Charging Access in MURBs (by 2040)
Current federal incentives (phased-out by 2026)	100 Sites (400 Ports)	340 Sites (1,000 ports)	20%

Expanding current EV support efforts will increase EV adoption and BEV market share in Newfoundland and Labrador (NL); however, NL will still likely fall short of Federal ZEV targets.

- By 2040, a total of **150,000 EVs** of the 307,000 LDVs are forecasted to be on the road within the province
- EV adoption is expected to **fall short of the federal 2035 ZEV target** (100%), reaching only 48% of new sales by 2035.
- The increased deployment of local infrastructure **maintains the historical growth of BEV market share**, with BEVs representing ~75 % of all EVs on the road by 2040.





3. Light Duty Vehicles

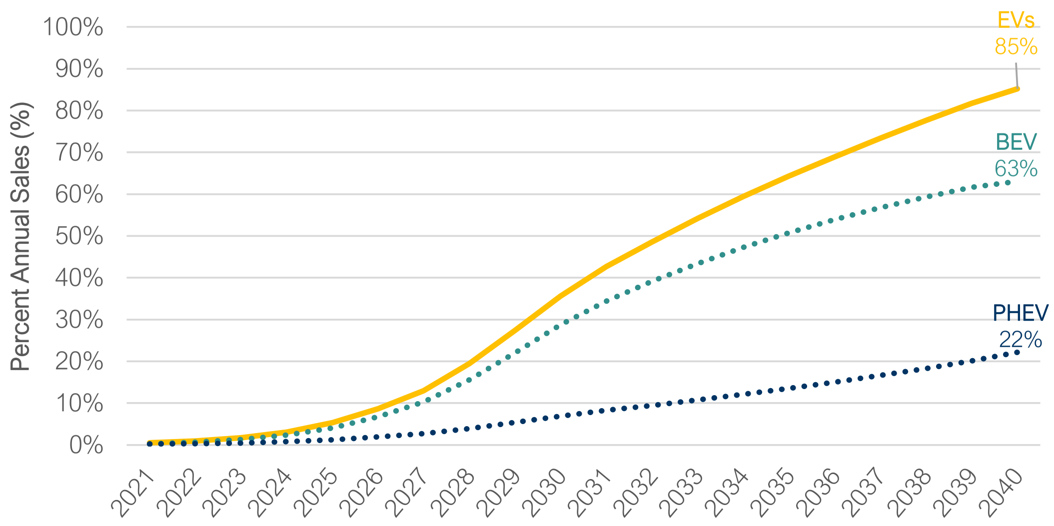
High Growth Scenario

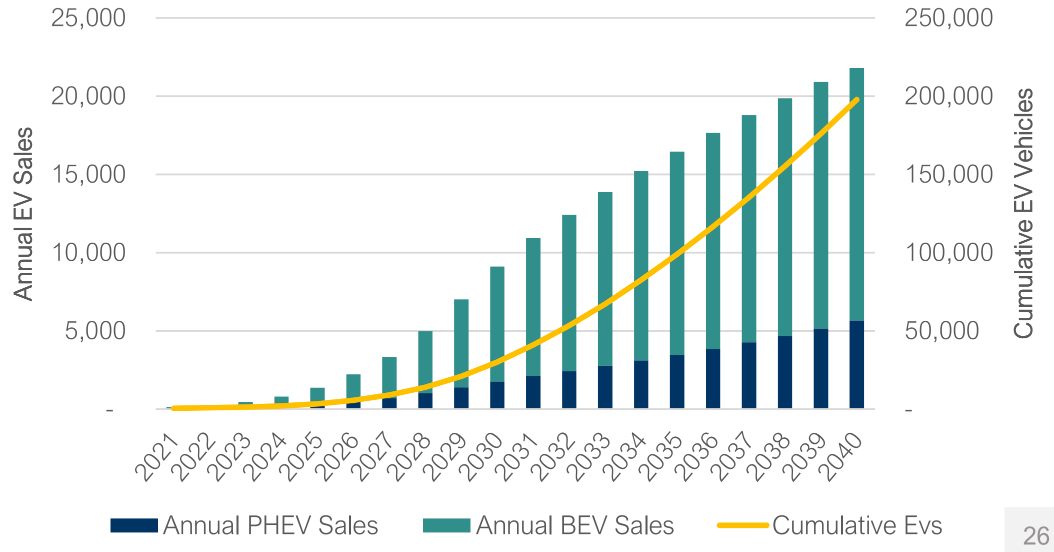
Policy/Program Interventions

Vehicle Incentives	Public DCFC (by 2040)	Public / Workplace Level 2 (by 2040)	Home Charging Access in MURBs (by 2040)
Current federal incentives (phased-out by 2035)	360 Sites (1,440 Ports)	400 Sites (1,600 ports)	45%

Aggressive expansion of public charging coupled with increased incentives, high EV local availability, and actions to increase home charging in MURBs would put Newfoundland and Labrador (NL) on trajectory to hit ZEV targets

- By 2040, a total of **198,000 EVs** of the 307,000 LDVs are forecasted to be on the road within the province
- EV adoption in NL would still not be expected to meet **the 2035 Federal ZEV Target of 100% of sales (65% annual sales)**
  - If the federal target is indeed locked-in, further interventions by government/industry actors may be required to address gaps





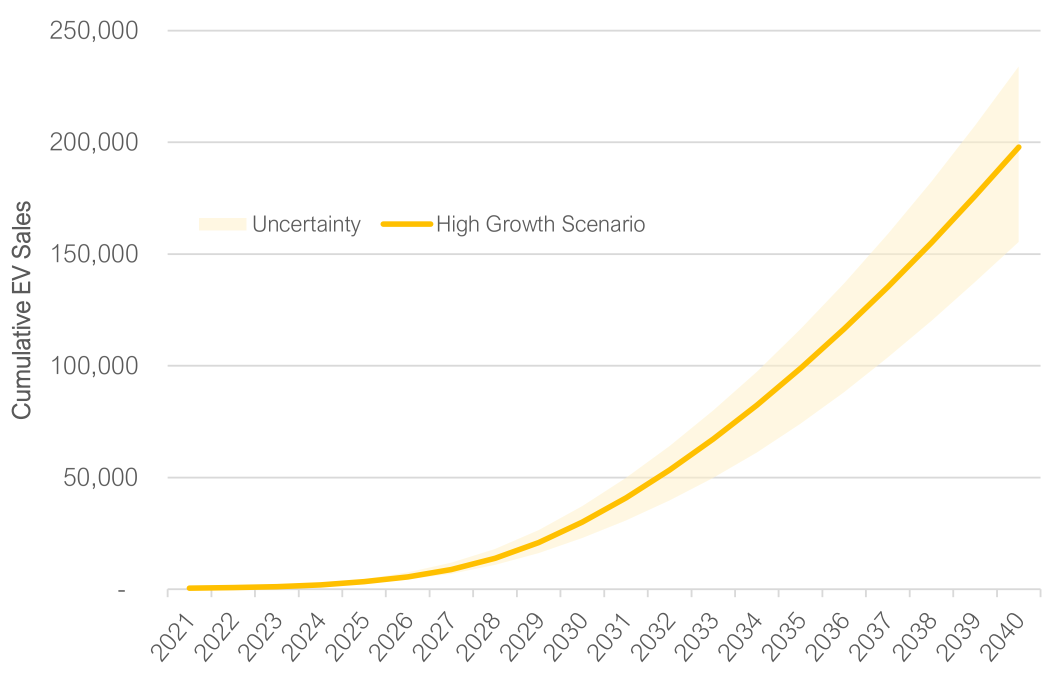
3. Light Duty Vehicles

Impacts of Uncertainty

Several key market and technology conditions will have an impact on the trajectory of EV adoption. For example, under the high growth scenario:

198,000 EVs on the road by 2040
(155k – 234k EVs)

- Uncertainty around key factors could impact adoption upwards or downwards by as much as 22%.
- Dunsky's base case battery cost forecast is most conservative in early years due to uncertainty around the timing of achieving economies of scale for battery production and tends towards a more optimistic battery cost forecast in the 2030's when the market is expected to be well-established.
- The increasing uncertainty around the absolute number of EVs on the road over time largely reflects the underlying uncertainty around total vehicle sales (ICE and EVs) in the province in the future.

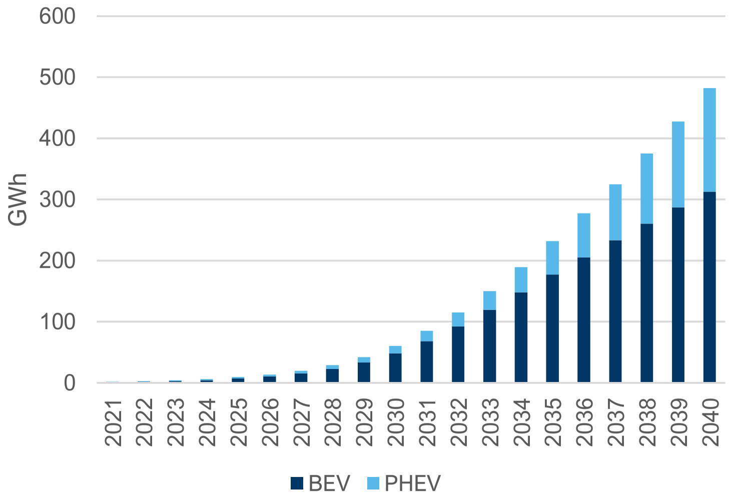


3. Light Duty Vehicles

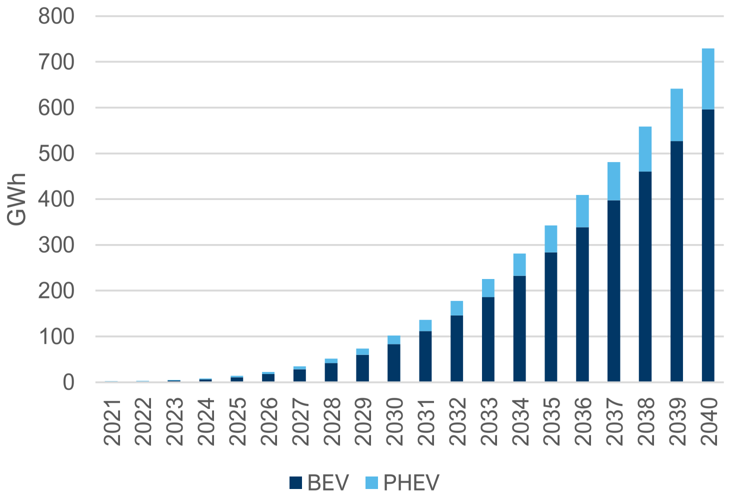
Load Impacts

Light duty EV adoption will have a significant impact on load growth in Newfoundland and Labrador, increasing load by 480 – 1,000 GWh by 2040

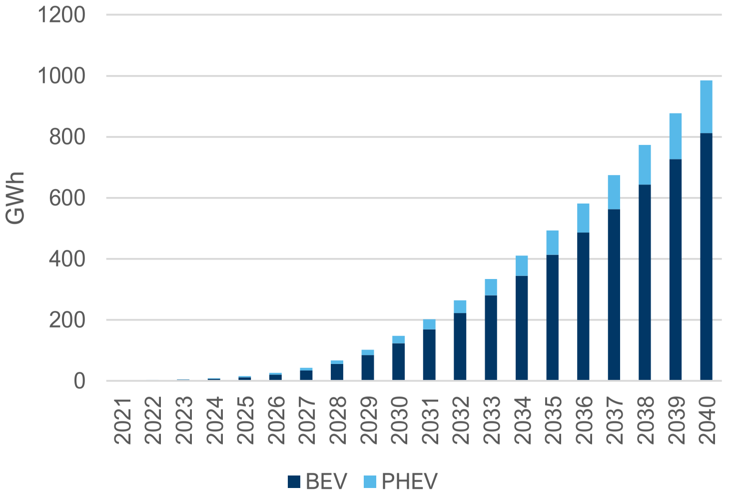
Scenario 1 - Electricity Load Impacts (GWh)



Scenario 2 - Electricity Load Impacts (GWh)



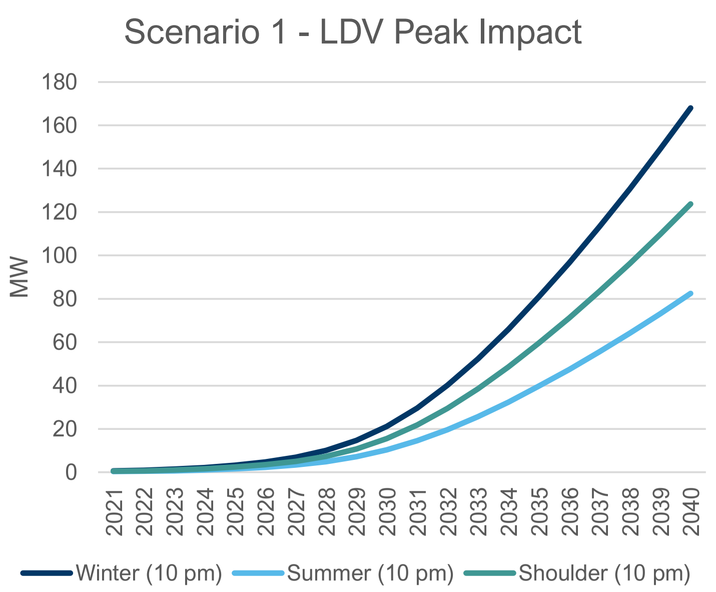
Scenario 3 - Electricity Load Impacts (GWh)

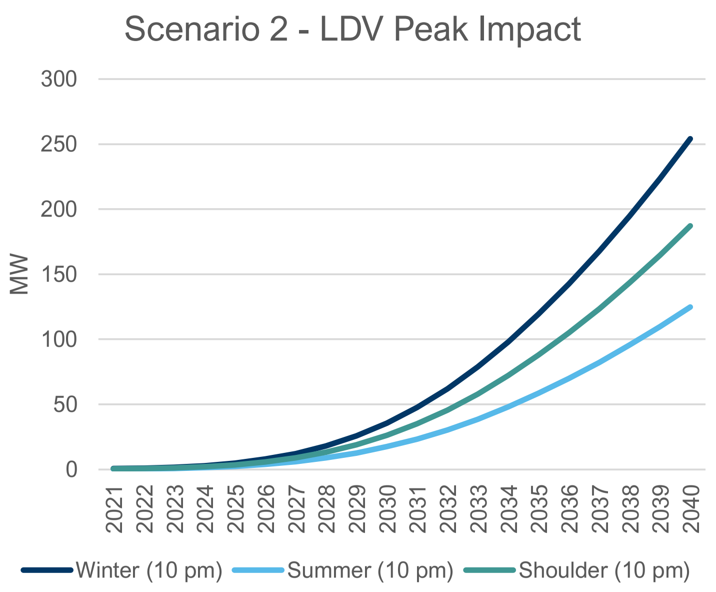


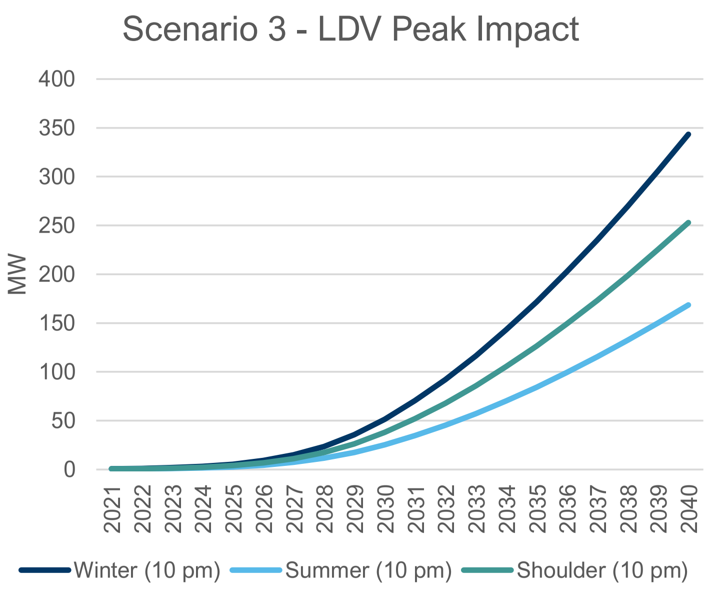
3. Light Duty Vehicles

Peak Day Impacts: Unmanaged

By 2040, light duty EVs will contribute 170 - 340 MW to peak demand in the winter at 10PM if unmanaged







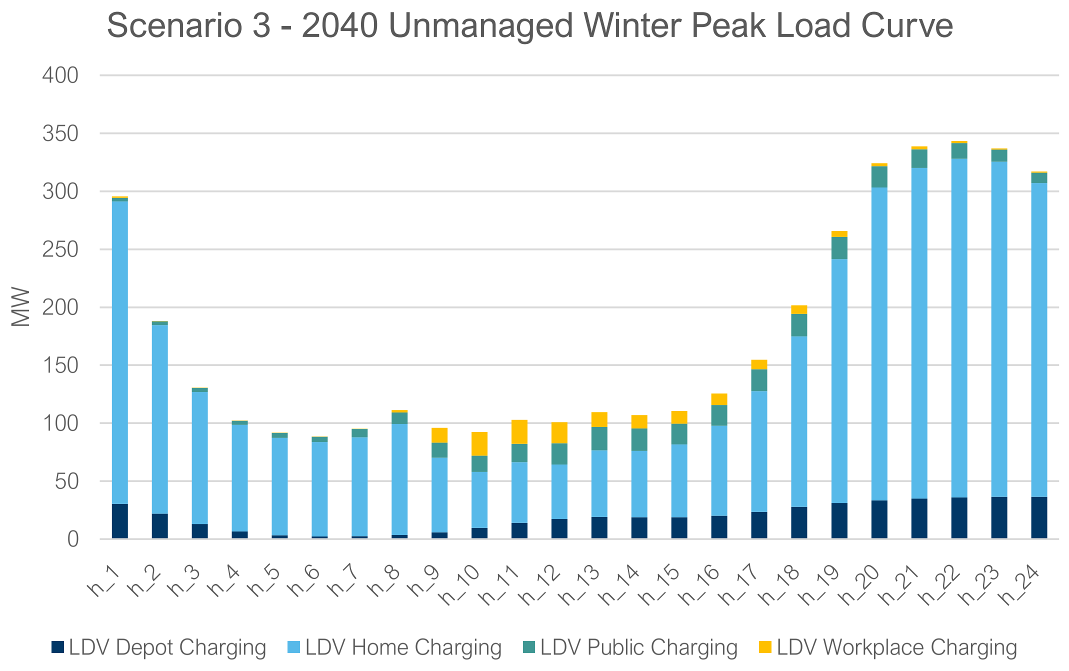
3. Light Duty Vehicles

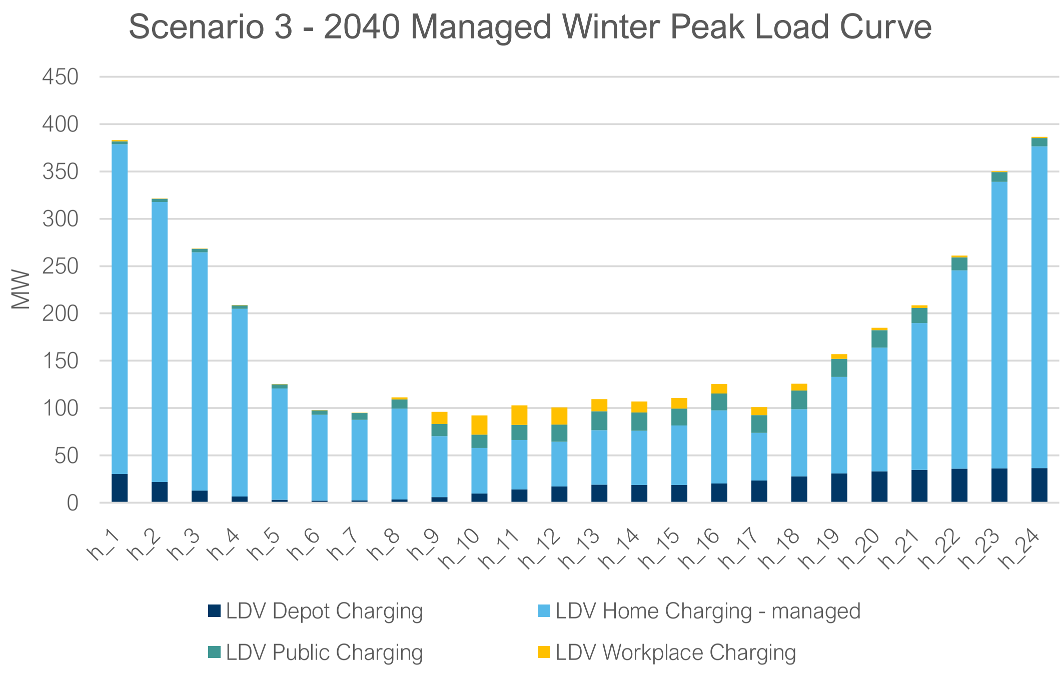
Managed Peak MW: High Growth Scenario (2040)

Home charging will impact winter peak loads the most significantly

If unmanaged EV Peak load hour will be 10pm (340 MW), if managed that will shift to 1am (385 MW), depending on the load management strategy

***See Appendix for slides on additional scenario's**





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4. Medium & Heavy Duty Vehicles

4.1 Provincial Scenarios
4.2 Regional Impacts
4.3 Provincial Results

MHDV Scenarios and Sensitivities

dunsky

Three scenarios reflecting likely trajectories for EV adoption in Newfoundland and Labrador under varying policy, technology and market conditions

	Scenario 1: Low Growth	Scenario 2: Moderate Growth	Scenario 3: High Growth
Vehicle Incentives	None	25% of incremental cost, up to $75k *(Ramped down and phased-out by 2026)*	50% of incremental cost, up to $150k *(Ramped down and phased-out by 2030)*

	Low Sensitivity Scenario (Most Conservative)	Base Case	High Sensitivity Scenario (Most Aggressive)
Battery Costs	Limited cost declines	Moderate cost declines	Aggressive cost declines
EV Model Availability	High availability of most models by 2030	High availability of most models by 2028	High availability of most models by 2024
Charging Power (for HDVs)	Up to 350 kW Charging (Varies by vehicle segment)	Up to 1 MW Charging (Varies by vehicle segment)	Up to 2 MW Charging (Varies by vehicle segment)
Electricity Cost Escalation	1% higher than historical	Historical levels *(≈ 3% per year)*	1% lower than historical
Fuel Price Escalation	Historical escalation	Historical escalation (≈ 2% per year) + $170/ton carbon tax by 2030	Historical escalation (≈ 2% per year) + $170/ton carbon tax by 2030

4. Medium & Heavy Duty Vehicles

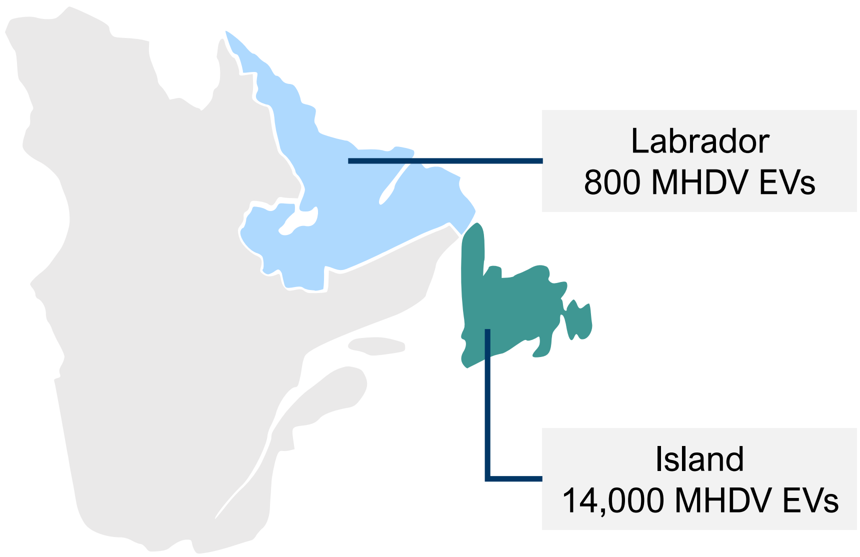
Regional Disaggregation

For commercial fleets, no differences in market penetration across regions was assumed, and results were disaggregated using number of registered vehicles in each area.

- Similar to the LDV market the vast majority of EVs are found in the Mainland (~95%) due to population/vehicle distributions

The following results in the report are at the provincial level and more detailed regional outputs can be found in the Excel-based results dashboard

2040 High Scenario - MHDVs

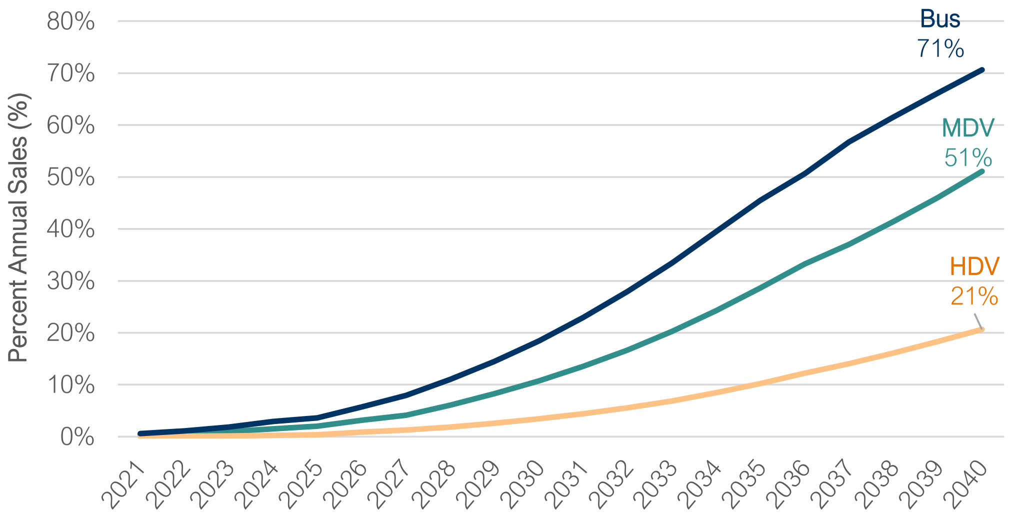


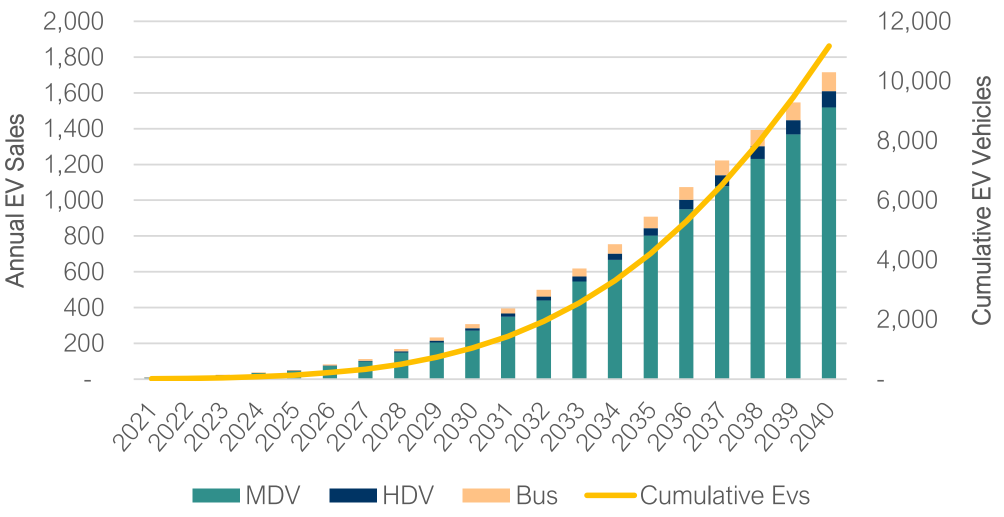
4. Medium & Heavy Duty Vehicles

Low Growth Scenario

Under the Low Scenario, Newfoundland and Labrador will experience varying growth in EV uptake for different vehicle segments.

- MDV trucks will lead the cumulative MHDV market **(51% annual sales and 10,000 cumulative sales by 2040)** – this market segment is largely comprised of urban/regional delivery vehicles that benefit from a strong business case for electrification thanks to consistent daily usage with high overall annual driving distances
- The bus segment is expected to be the most promising in annual sales, reaching **71% annual sales by 2040**
- The HDV truck segment is expected to observe the lowest EV demand **(21% annual sales by 2040)** due to a portion of the HDV truck market focused on either long-haul or other vocational applications (e.g., dump trucks) with greater technical challenges (i.e., range and payload requirements)

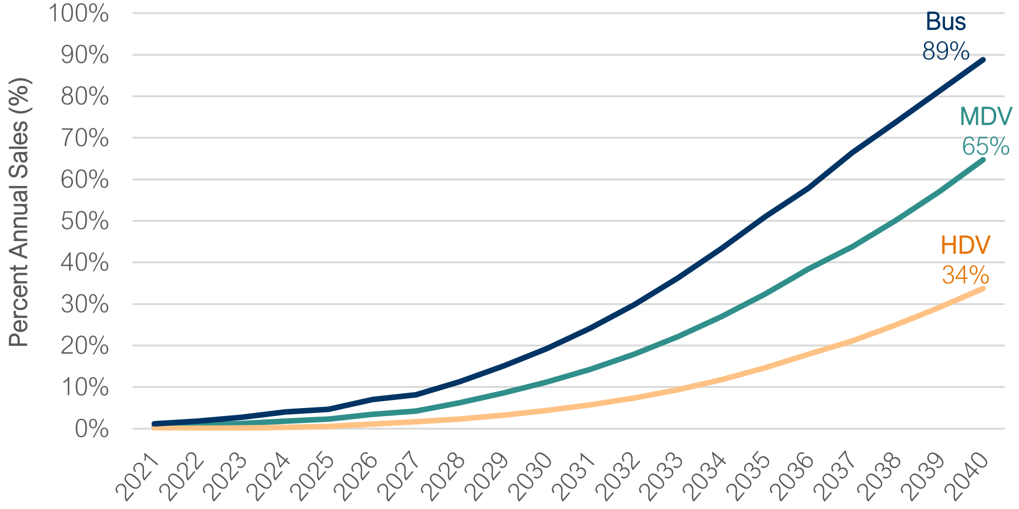


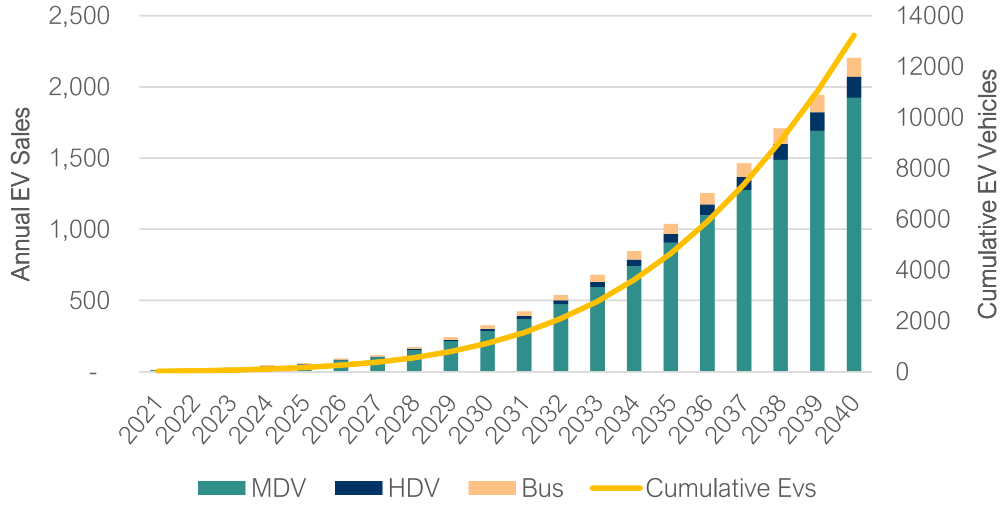


Medium Growth Scenario

Under the Medium Scenario, Newfoundland and Labrador will experience modest growth in EV uptake.

- Vehicle incentives for MHDV segments improve the economics across all vehicle segments
- Like the low scenario, there will be varying growth in EV uptake for different vehicle segments.
- HDVs see a significant increase in market share due to the availability of megawatt-scale fast charging capabilities assumed under this scenario.



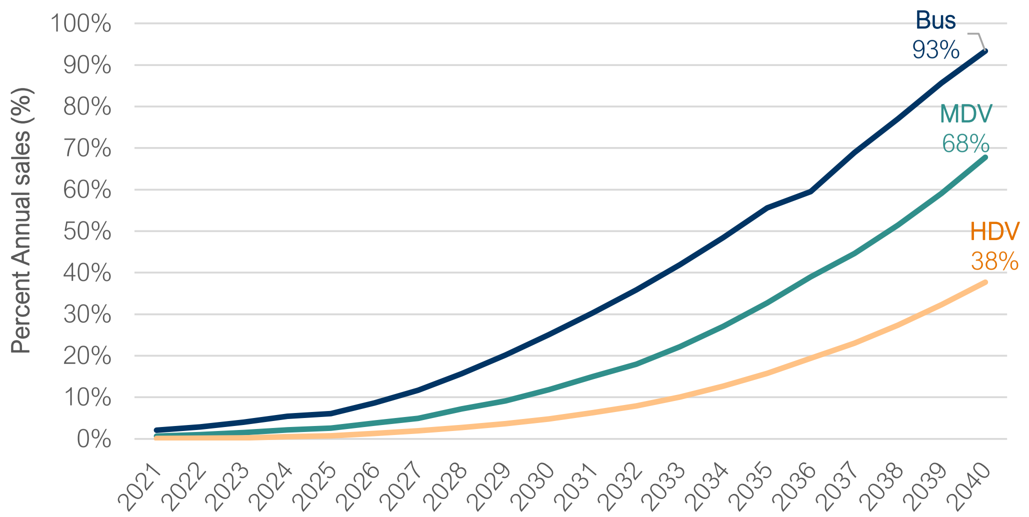


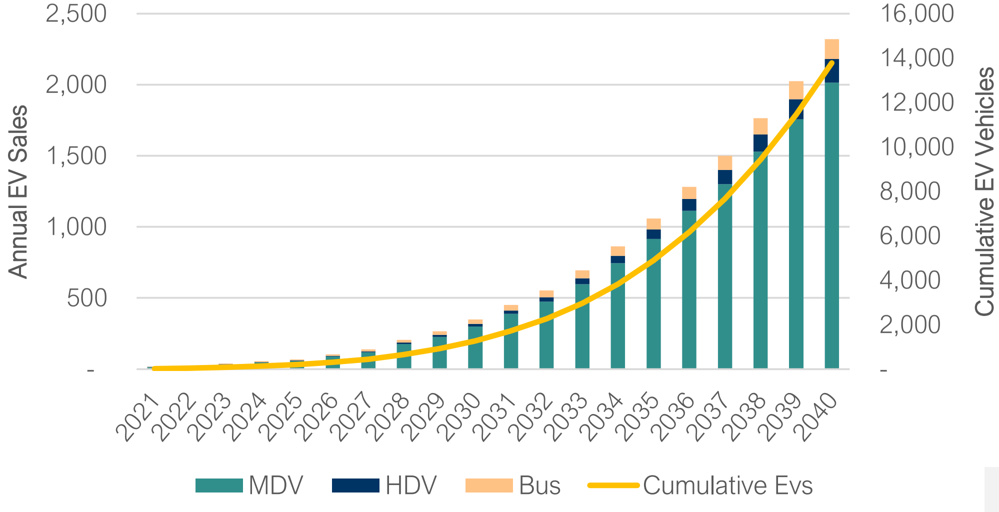
4. Medium & Heavy Duty Vehicles

High Growth Scenario

Under the High Scenario, Newfoundland and Labrador will experience high growth in EV uptake.

- Vehicle incentives for MHDV segments improve the economics across all vehicle segments
- Like the low and medium scenario, there will be varying growth in EV uptake for different vehicle segments.





4. Medium & Heavy Duty Vehicles

Load Impacts

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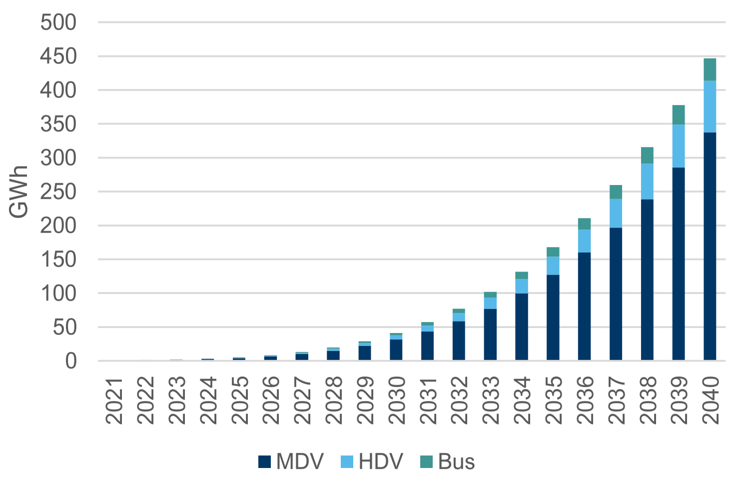
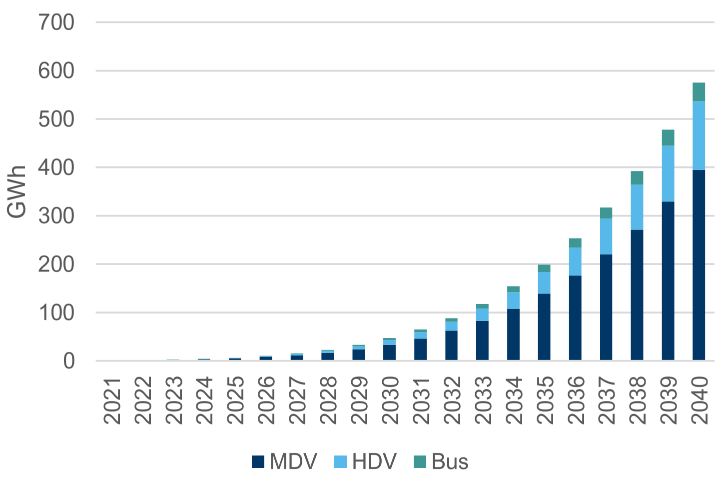
MHDV EV adoption will have a significant impact on load growth in Newfoundland and Labrador, increasing load by 450 – 615 GWh by 2040

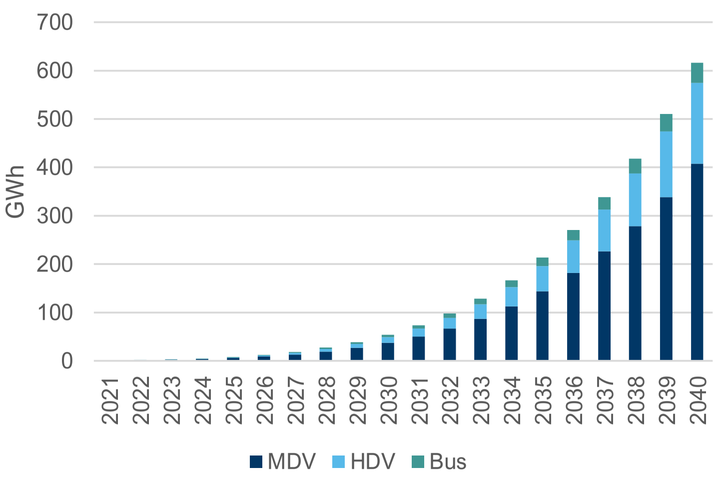
Scenario 1 - Electricity Load Impacts (GWh)



Scenario 2 - Electricity Load Impacts (GWh)



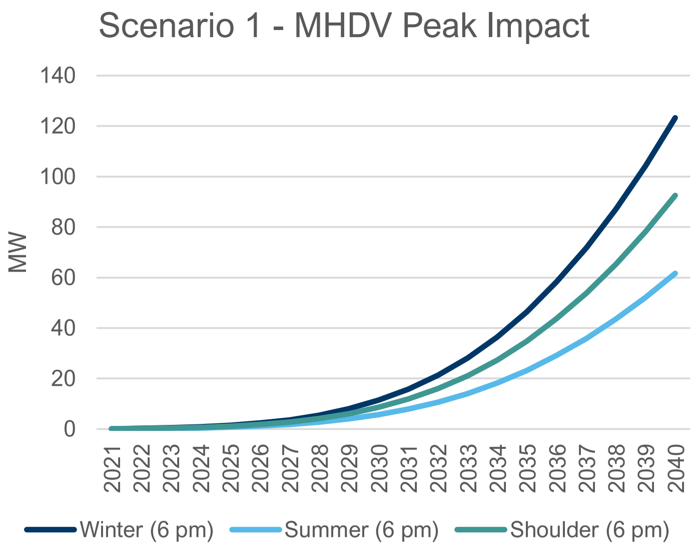
Scenario 3 - Electricity Load Impacts (GWh)

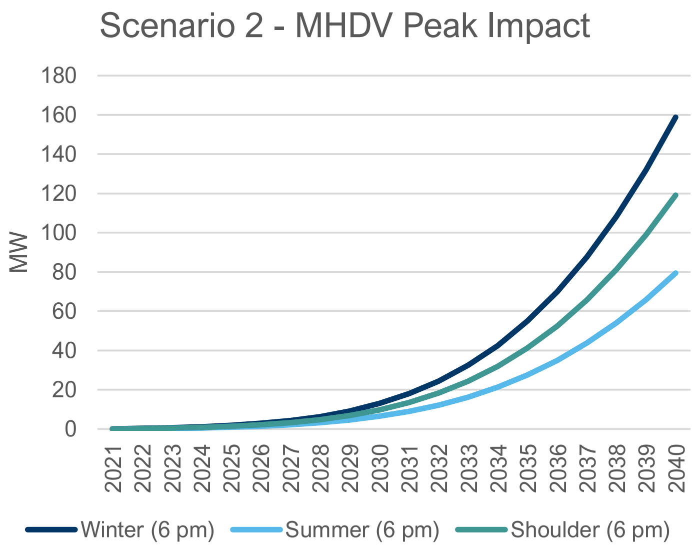


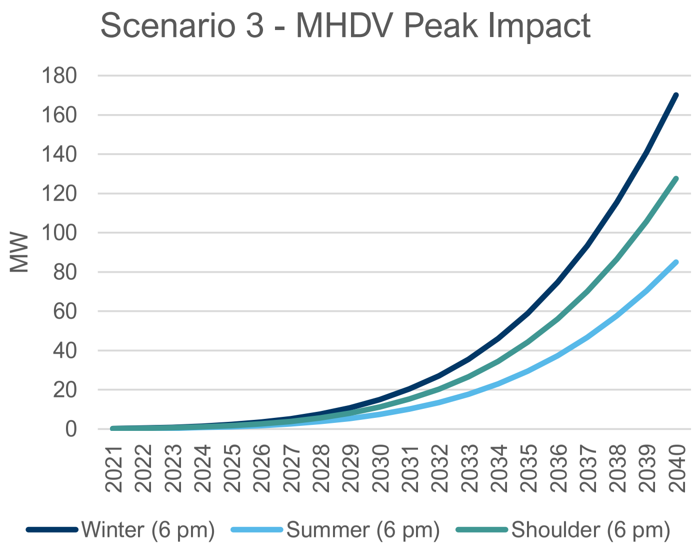
4. Medium & Heavy Duty Vehicles

Peak Day Impacts

By 2040, MHDV EVs will contribute 125 - 175 MW to peak demand in the winter at 6PM







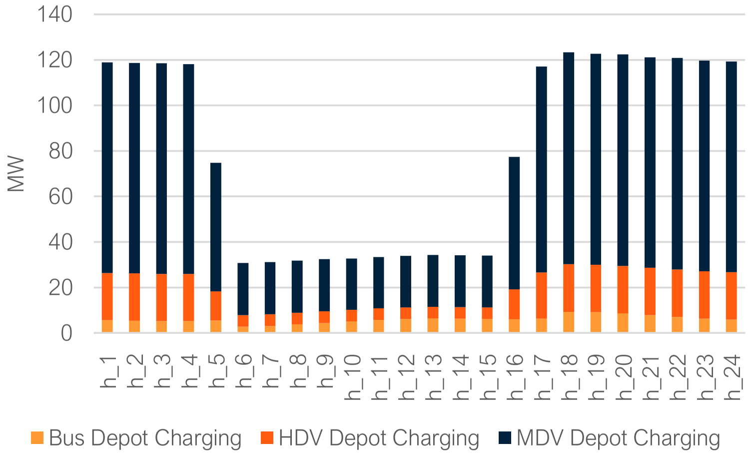
4. Medium & Heavy Duty Vehicles

Peak Day Hourly Load Profiles (2040)

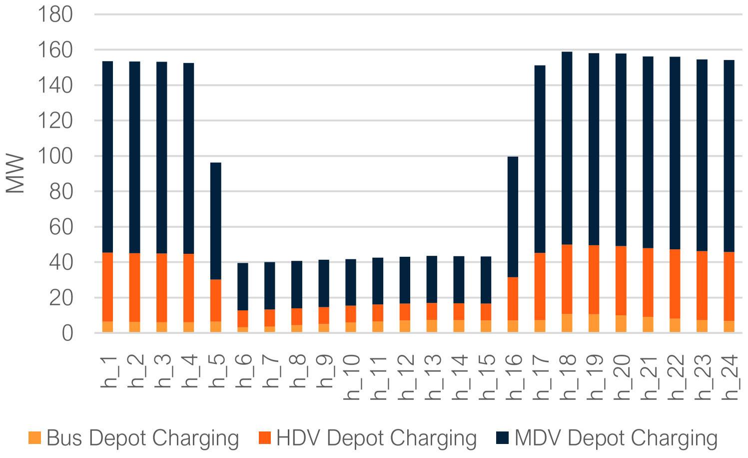
MHDV charging will impact winter peak MW's the most significantly

Peak hour will be 6pm for winter, summer, and shoulder. Load profiles for MHDV fleets are less flexible, with vehicles and infrastructure designed based on range requirements and the available charging window

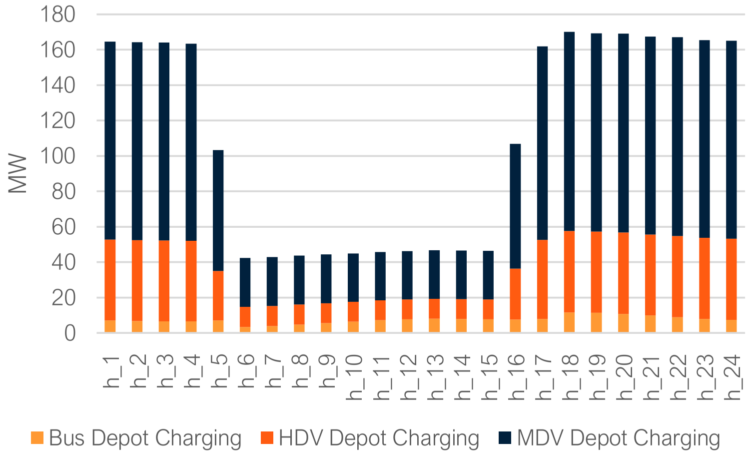
Scenario 1 - 2040 Winter Peak Load Curve



Scenario 2 - 2040 Winter Peak Load Curve



Scenario 3 - 2040 Winter Peak Load Curve



5. Conclusion

EV Adoption Potential

While these results present a wide range of possible outcomes, the overall scale of the EV transformation in Newfoundland and Labrador is significant under all scenarios, with between 100,000 and 200,000 light-duty EVs expected to be circulating in the province by 2040.

A further 10,000 to 14,000 medium- and heavy-duty (MHDV) EVs are likely to enter service by 2040, with a number of MHDV segments seeing strong potential for electrification (e.g. buses, medium-duty delivery trucks), while others have greater uncertainty based on technology progress (e.g. long-haul heavy-duty trucks).

While this growth in EV adoption in NL is significant, we anticipate that EV adoption in Newfoundland and Labrador will continue to lag behind the rest of Canada, achieving 65% of new LDV sales by 2035 in the High scenario.

5. Conclusion

Load Impact

EVs could generate up to **1,600 GWh in electricity sales in 2040**; however, if EV charging loads are left unmanaged they could **increase system peak loads** by as much as **525 MW** in the same year.

Personal light-duty EVs present the most promising opportunities for managed charging, with a variety of options for mitigating peak load impacts from EVs and providing benefits from EVs as flexible loads.

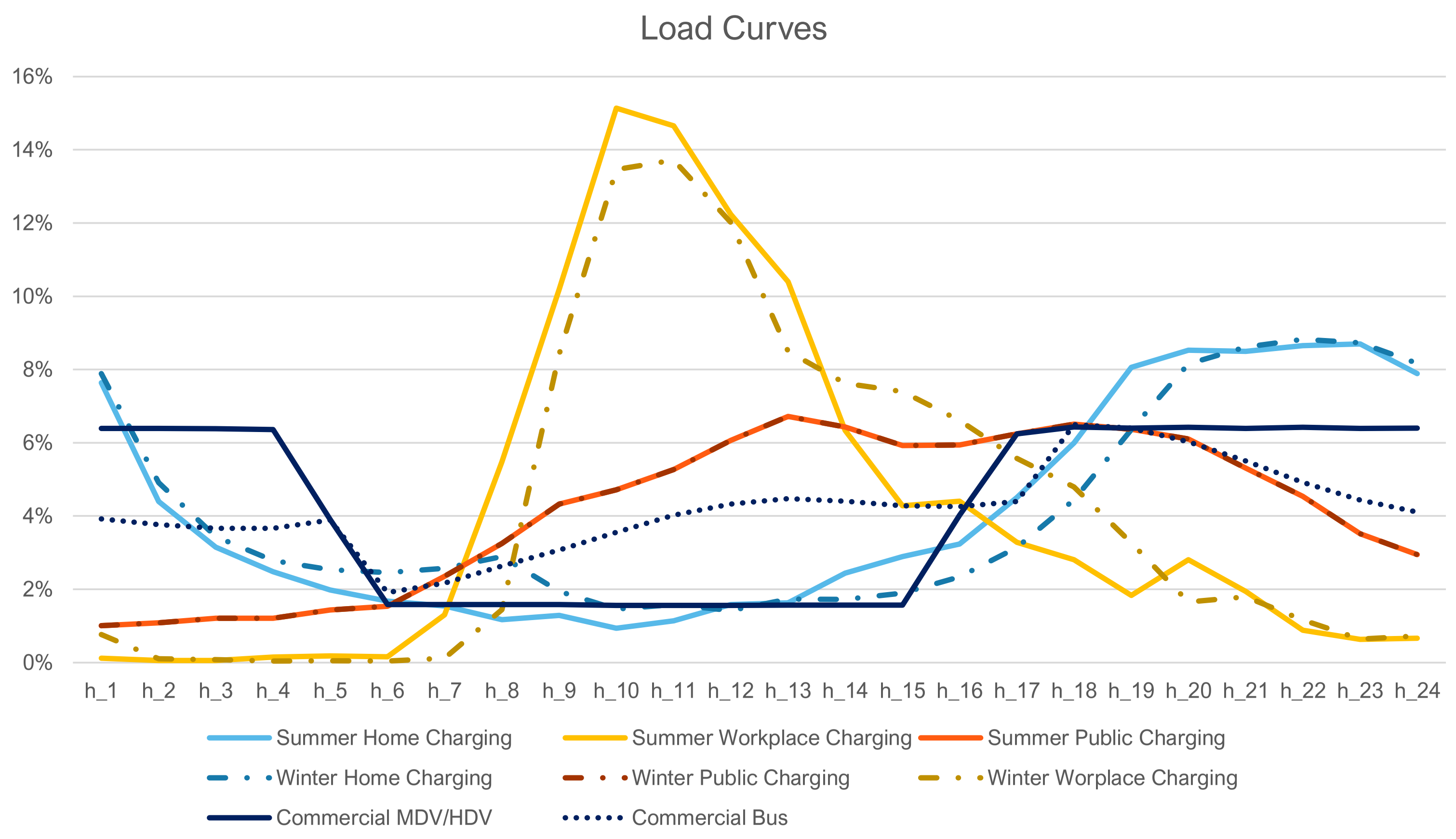
While medium- and heavy-duty EVs represent a much smaller number of vehicles, their size means that they contribute disproportionately to load growth. Many MHDV fleets will see a large number of vehicles charging in a single facility, motivating fleet operators to spread charging over as much time as possible and minimize peak loads within their own facilities.

Appendix

Appendix

Normalized Load Curves

The normalized load curves below outline the anticipated hourly load by charging type for both summer and winter conditions. These curves are used to project hourly load.



Appendix

Key Resources

Key Data Source	Use
Natural Resource Canada (NRCan), Comprehensive Energy Use Database (CEUD)	Province-wide vehicle sales and registrations, segment split (Car, Truck, SUV)
Community Accounts Unit Newfoundland and Labrador Hydro and Statistics Canada	Total Electric vehicle sales and BEV/PHEV split
Statistics Canada	Population, area of population centers, housing composition, driving distance, fuel prices
Newfoundland and Labrador Hydro	Electricity rates
Natural Resource Canada (NRCan) - Electric Charging and Alternative Fueling Stations Locator	Charging station deployment
Internal Dunsky Database	2020 vehicle cost, vehicle characteristics & projected EV model availability, battery costs

Appendix

Key Inputs

Vehicle	NRCan kwh/km	Vehicle Lifetime	Average Annual Driving Distance*
Car	0.21	11	19,000
SUV	0.26	11	19,000
Light-truck	0.29	11	19,000
MDV	0.80	16	30,000
HDV	1.24	20	120,000
Buses	1.20	16	22,000

*weighted averages for MDV and HDV segments reflect the sub segments that are more likely to electrify due to higher drive cycles.

Appendix

LDV: Key Inputs and Sensitivities

Gas Prices ($/Litre)

	2021	2025	2030	2035	2040
Low	$1.464	$1.612	$1.819	$2.052	$2.316
Mid	$1.464	$1.831	$2.210	$2.443	$2.707
High	$1.464	$1.831	$2.210	$2.443	$2.707

Average Electricity Prices ($/kWh)

	2021	2025	2030	2035	2040
Low	$0.160	$0.179	$0.200	$0.223	$0.250
Mid	$0.160	$0.181	$0.202	$0.226	$0.252
High	$0.160	$0.183	$0.204	$0.228	$0.255

Battery Costs ($/kWh)

	2021	2025	2030	2035	2040
Low	$296	$160	$80	$62	$48
Mid	$296	$217	$147	$99	$75
High	$296	$270	$209	$161	$121

*Average electricity prices were calculated based on historic delivered cost rates.

Annual New Vehicle Sales (Rounded to Nearest 10)

(Included both passenger and commercial LDVs, with commercial fleets assumed to make up 11% of sales)

		Low	Medium	High
Car	2021	11,440	11,440	11,440
	2025	10,990	11,440	11,910
	2030	10,450	11,440	12,520
	2035	9,940	11,440	13,150
	2040	9,450	11,440	13,830
SUV	2021	9,760	9,760	9,760
	2025	9,370	9,760	10,160
	2030	8,910	9,760	10,670
	2035	8,480	9,760	11,220
	2040	8,060	9,760	11,790
Truck	2021	4,340	4,380	4,430
	2025	4,210	4,380	4,560
	2030	4,000	4,380	4,790
	2035	3,810	4,380	5,040
	2040	3,620	4,380	5,300

Other inputs

	Value (2020)
Province Population	521,500
Population in centres with >1,000 people	384,500
Number of Population centres with >1,000 people	63
Estimated Land area of Population centres (sq. km)	400
Highway length (km)*	2,000

*The value represents an estimate of the length of highways within the state that need to be covered by charging infrastructure deployment based on data on length of key interstate highways, freeways, expressways and principal arterial roads.

Appendix

MHDV: Key Inputs and Sensitivities

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Diesel Prices ($/Litre)

	2021	2025	2030	2035	2040
Low	$1.457	$1.577	$1.742	$1.923	$2.123
Mid	$1.457	$1.834	$2.201	$2.382	$2.582
High	$1.457	$1.834	$2.201	$2.382	$2.582

Average Electricity Prices ($/kWh)

	2021	2025	2030	2035	2040
Low	$0.136	$0.152	$0.170	$0.190	$0.213
Mid	$0.136	$0.154	$0.172	$0.192	$0.214
High	$0.136	$0.156	$0.173	$0.194	$0.217

Battery Costs ($/kWh)

	2021	2025	2030	2035	2040
Low	$296	$160	$80	$62	$48
Mid	$296	$217	$147	$99	$75
High	$296	$270	$209	$161	$121

Annual New Vehicle Sales (Rounded to Nearest 10) - MHDV

	Segment	2021	2025	2030	2035	2040
MDV	Urban Delivery	1,590	1,590	1,620	1,660	1,690
	Utility Vehicle	7,280	7,280	7,290	7,300	7,310
HDV	Short-Haul	90	90	100	100	100
	Long-Haul	1,900	1,910	1,910	1,910	1,910
	Other	110	110	110	110	110
Bus	Transit	80	80	80	90	90
	School	260	260	260	260	260
	Coach	20	20	20	20	20

*Average electricity prices were calculated based on historic delivered cost rates.

Appendix

EVA Model: Methodology Overview

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EVA projects market adoption based on four key factors:

TECHNICAL

Assess the maximum theoretical potential for deployment
- Market size and composition by vehicle class (e.g. cars, SUVs, pickups)
- Model availability for each vehicle powertrain (e.g. ICE, PHEV, BEV)

ECONOMIC

Calculate unconstrained economic potential uptake
- Incremental purchase cost of PHEV/EV over ICE vehicles
- Total Cost of Ownership (TCO) (personal) or Internal Rate of Return (IRR) (commercial) based on operational and fuel costs

CONSTRAINTS

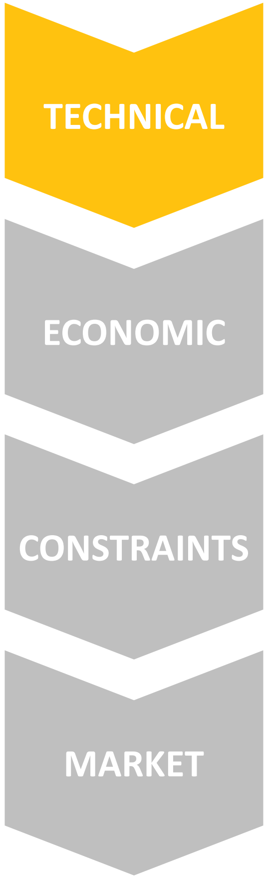
Account for jurisdiction-specific barriers and constraints
- Range anxiety or range requirements
- Public charging coverage, availability, and charging time
- Home charging access, others

MARKET

Incorporate market dynamics and non-quantifiable market constraints
- Use of technology diffusion theory to determine rate of adoption
- Market competition between vehicles types (PHEV vs. BEV)

Appendix

EVA Model: Technical



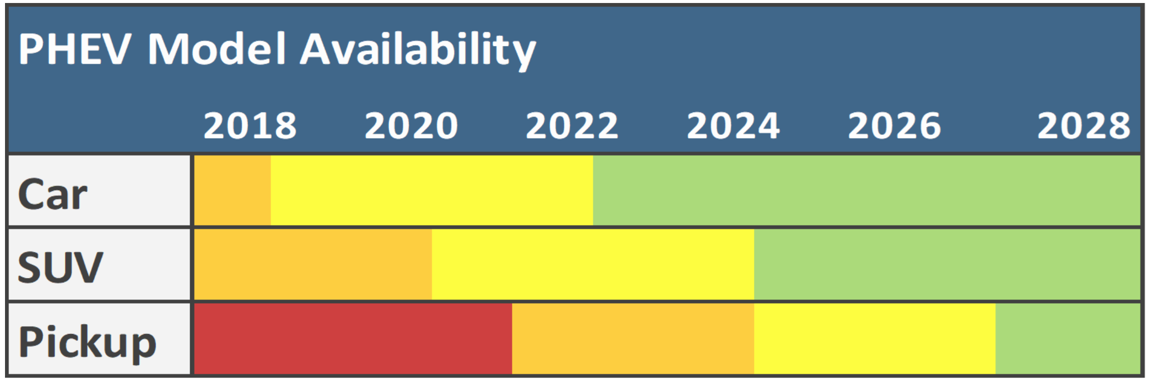
Assess the maximum theoretical potential for deployment

The model breaks down vehicles by segments (i.e. cars, SUVs, trucks, etc.) **and powertrain** (ICE, PHEV, BEV) with each class-powertrain being represented by an ***average*** vehicle option

Annual sales for each vehicle class represents 100% of attainable market

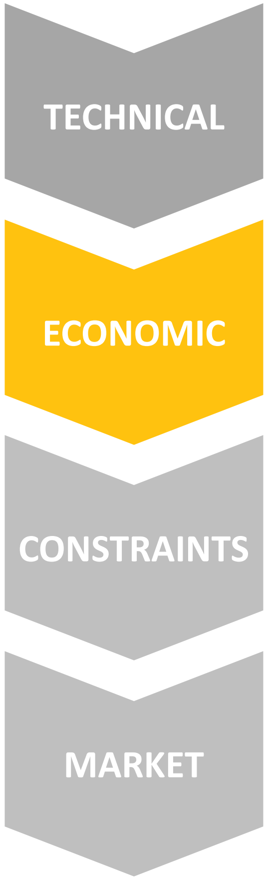
- Capture growth in forecasted vehicle sales and changing trends between vehicle segments

Model availability for each vehicle powertrain in each vehicle class is key



Appendix

EVA Model: Economic



Calculate unconstrained economic potential uptake

For each vehicle class and powertrain, vehicle cost is assessed bottom-up:

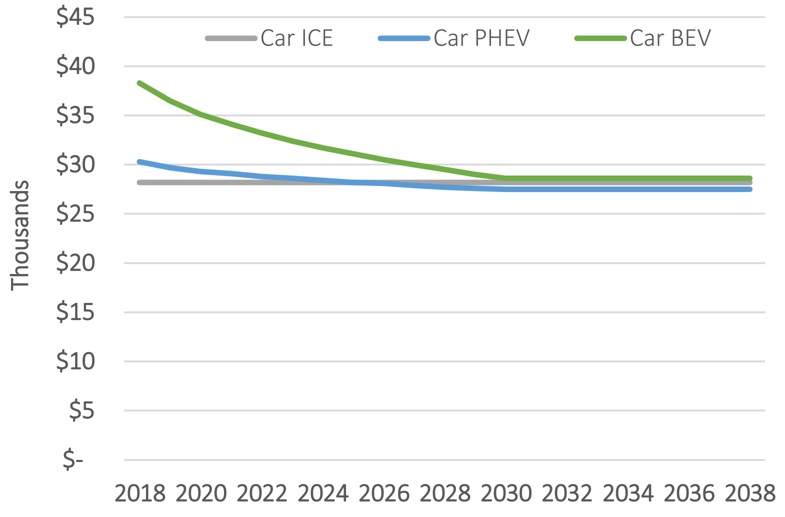
- Baseline vehicle cost
- ICE Powertrain cost
- Electric Powertrain Cost
- Battery Cost – based on BNEF and EIA forecasts[1]

For each vehicle class, Total Cost of Ownership (TCO) is based on

- Incremental Upfront cost of PHEV/BEV over ICE
- Lifetime operational cost savings incremental to ICE

Estimate unconstrained economic market potential based on identified willingness-to-pay from survey and research results

Sample EV cost decline scenario based on BNEF battery cost forecast



[1]Bloomberg New Energy Finance "EV Outlook 2018" and U.S. Energy Information Administration "Annual Energy Outlook 2018"

Appendix

EVA Model: Constraints

Account for jurisdiction-specific barriers and constraints

Market Constraining Factors include:

- **Range anxiety:** Capture the portion of the market that is constrained by the limited range of BEVs (does not apply to PHEVs)
- **Home Charging Availability:**
  - Given the importance of access to charging at home, EV adoption is constrained to the portion of the market where charging stations can readily be installed.
    - Building type (i.e. single-family vs. multi-family)
    - Percentage of each building type with access to charging (or driveways/dedicated parking)
  - Constraint can be reduced over time through targeted incentive programs and building code changes.

Appendix

EVA Model: Constraints

TECHNICAL
ECONOMIC
CONSTRAINTS
MARKET

… *(cont'd)* Account for jurisdiction-specific barriers and constraints

Public Charging constraints are captured in two ways:

- **Coverage** captures the geographical coverage of charging infrastructure by contrasting the number of stations deployed to the required number of stations regionally considering:
  - *Number of stations required along key **highway corridors** across the region to alleviate charging barriers for potential EV adopters based on highway lengths and typical station spacing.*
  - *Number of stations required in **population clusters** (defined as population centers with > 10,000 people) to achieve at least one charging station per cluster and ensure that drivers have access to a charger within a reasonable radial distance.*
- **Charging Availability** captures the availability and power of charging ports and corresponding charging time
  - *Captured as EVs per Port ratio (for L2 and DCFC)*
  - *"Ideal" ratio calculated based on*
    - Population density in key population centers across the region
    - EV Density in key population centers across the region
    - Annual average temperatures
    - Home charging access
  - *Dynamic relationship with EVs of the road*

Station

Port

Appendix

EVA Model: Market

TECHNICAL

ECONOMIC

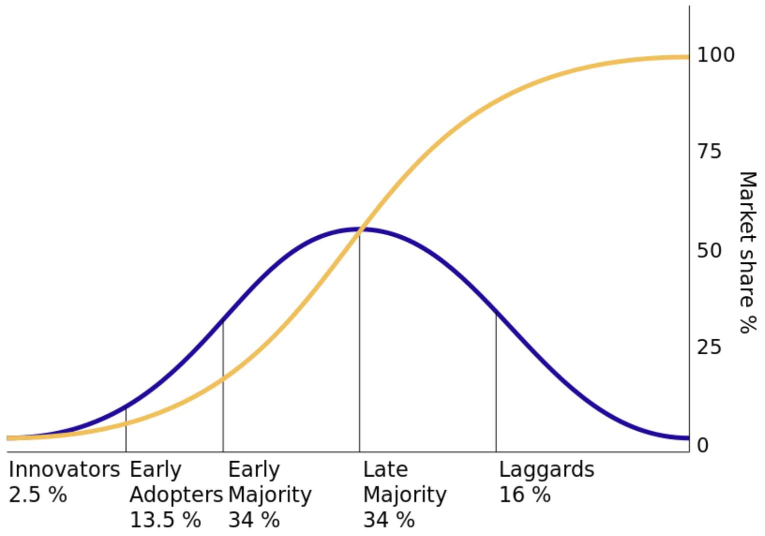
CONSTRAINTS

MARKET

Incorporate market dynamics and non-quantifiable market constraints

Estimate rate of market adoption using technology diffusion theory

- Captures the degree to which the market adopts new innovative technologies over time
- Accounts for the demographics and composition of market through segmenting potential adopters into five categories that vary by motivation for adoption (environmental, economic, etc.), willingness to take risks, technology understanding and other factors.
- Accounts for social interactions and public awareness (or lack of) and impact of programs on increasing awareness.



Appendix

EVA Model: Market

TECHNICAL

ECONOMIC

CONSTRAINTS

MARKET

… *(cont'd)* Incorporate market dynamics and non-quantifiable market constraints

PHEVs and BEVs are assumed to compete for the same market

- After comparing technical, economic, constrained and market potential of both technologies, a probabilistic function is used to assume a portion of the market will not be rational and will adopt the inferior of the two options, considering historical trends in the market.
- Certain policies/programs can have the effect of shifting the market from one technology to the other without necessarily impacting overall EV market share.

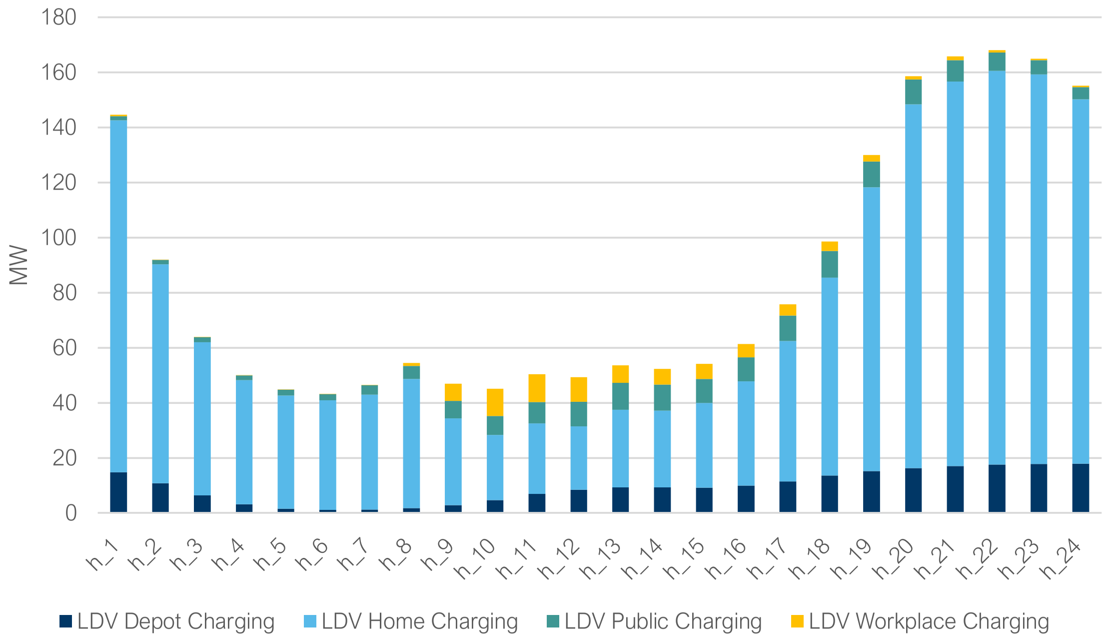
Appendix

Managed Peak MW: Low Growth Scenario (2040)

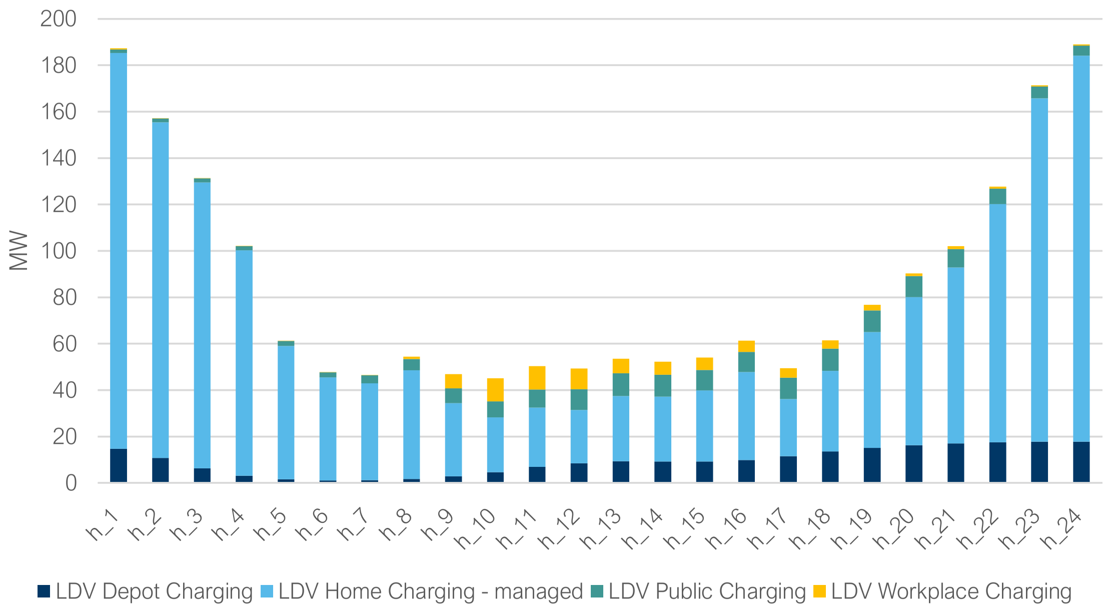
Home charging will impact winter peak MW's the most significantly

If unmanaged EV Peak load hour will be 10pm (170 MW), if managed that will shift to midnight (190 MW)

Scenario 1 - 2040 Unmanaged Winter Peak Load Curve



Scenario 1 - 2040 Managed Winter Peak Load Curve

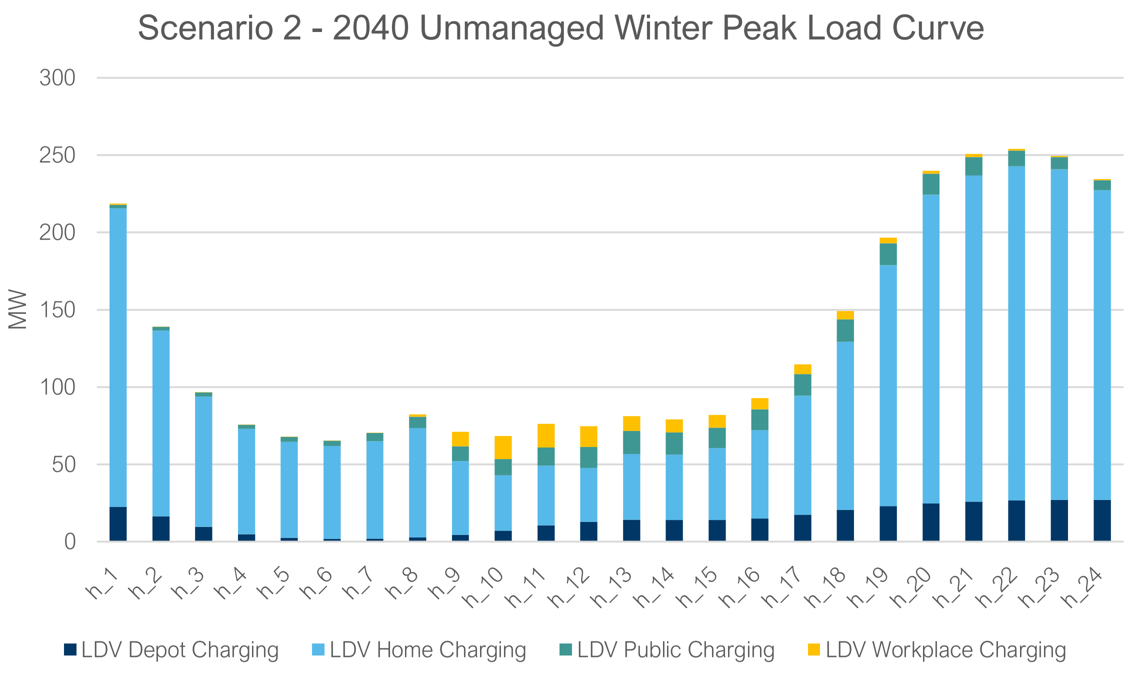


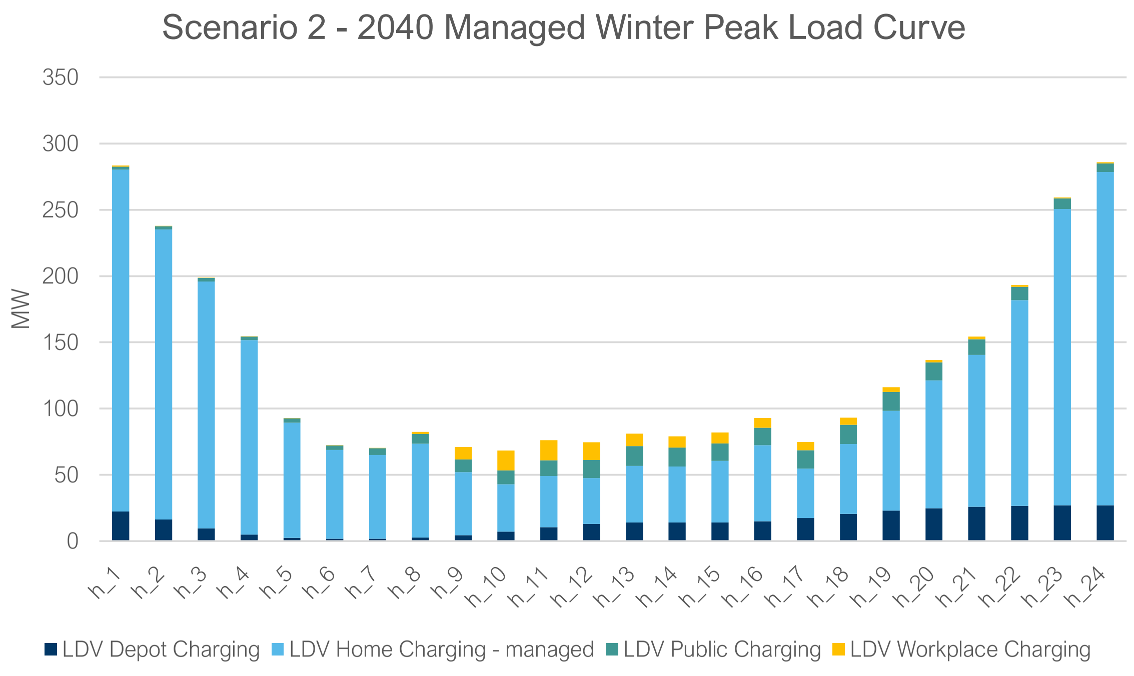
Appendix

Managed Peak MW: Medium Growth Scenario (2040)

Home charging will impact winter peak MW's the most significantly

If unmanaged EV Peak load hour will be 10pm (250 MW), if managed that will shift to 1am (280 MW)





Appendix

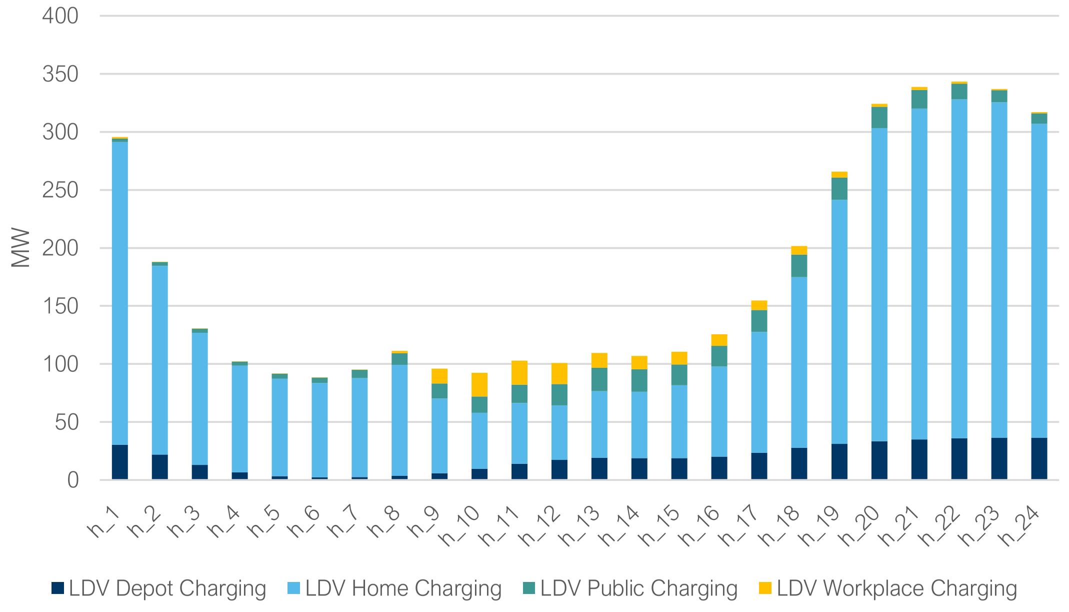
Managed Peak MW: High Growth Scenario (2040)

Home charging will impact winter peak loads the most significantly

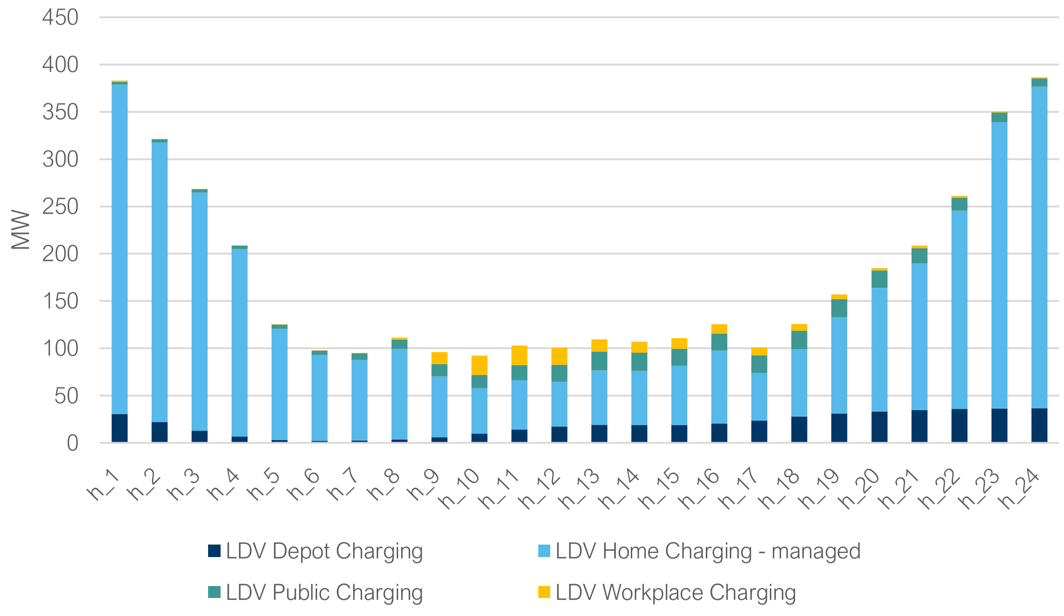
If unmanaged EV Peak load hour will be 10pm (340 MW), if managed that will shift to 1am (385 MW), depending on the load management strategy

***See Appendix for slides on additional scenario's**

Scenario 3 - 2040 Unmanaged Winter Peak Load Curve



Scenario 3 - 2040 Managed Winter Peak Load Curve



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Contact

Jeff Turner
Senior Research Lead
Jeff.Turner@dunsky.com
Tel: 416-947-8599 ext. 38

Emma Hill
Principal Analyst
Emma.Hill@dunsky.com
Tel: 514-504-9030 ext. 55

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