IESO Demand & Conservation Planning Technical Paper: Electric Vehicles

Scenario Analysis of Electricity Energy and Peak Demands from Electric Vehicle Adoption and Charging

July 2025

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Table of Contents

1. Executive Summary

As the operator and planner of Ontario's electricity system, one of the Independent Electricity System Operator's main roles in the electricity sector is to plan and prepare for future needs. A significant function of this work is demand forecasting, which projects demand into the future based on available information and data. Forward-looking analyses of this nature naturally come with uncertainties, owing to anticipated developments that have not yet happened, or may not necessarily occur at all.

With electricity demand in Ontario forecast to increase by 75 per cent by 2050, the IESO anticipates growth at great speed and scale, driven in large part by electrification, and specific commercial and industrial sector development. To ensure electricity procurements and energy policy are aligned with system needs, it's crucial that the IESO enhances its understanding of the underlying factors of this growth to minimize forecast uncertainties and optimize value to the system over the long-term planning horizon.

Looking ahead, the aggregated assessment of these inherent uncertainties with new load development will inform an Ontario demand growth margin, a new forecasting measure to provide a stable growth signal for the province to manage the uncertainty over the next few years, while also providing clarity for electricity planning purposes. In the meantime, the IESO has published a series of technical research papers that examine underlying trends in specific sectors or use cases that will drive demand growth in the long term.

This technical paper, on electric-vehicle (EV) adoption and charging scenarios, first looks at the factors that could result in uncertainties in forecasting demand from this segment: evolving government policies and targets; technological advances; consumer preferences; supply chain constraints; global economic and geopolitical conditions; and lack of historical data to project future, long-term EV uptake. The paper then examines impacts on electricity demands at the bulk system level by exploring different adoption scenarios of light-duty EVs as well as medium-/heavy-duty EVs before analyzing a variety of possible peak impacts caused by EV charging. The analysis indicates that even should EV adoption encounter "headwinds," transportation electrification will still drive significant provincial demand growth. The paper concludes that the passive managed charging approach of relying on electricity rates – for example, using time-of-use and ultra-low overnight rates to incent charging habits – is effective for managing provincial grid impacts in the near term; however, long-term active management – where EV charging is scheduled or adjusted in response to system conditions – is more effective in managing cost and reliability impacts of large-scale transportation electrification.

It should be noted that while the analysis is informed by the best data available to the IESO at this time, the EV space is evolving quickly and many assumptions are characterized by relatively high uncertainty, especially further into the forecast period. The IESO will continue to update its transportation demand forecast regularly, reflecting new research and market and policy developments. Additionally, the technical paper focuses on the provincial power system reflecting the IESO's mandate; however, some of the scenarios and issues identified may materialize earlier or later in specific areas of the distribution system reflecting clustered EV adoption and other local conditions.

2. Introduction

The electric vehicle (EV) market has been fast growing and there are increasingly more EVs on the road in Ontario every year. By the third quarter of 2024, there were nearly 200,000 EVs registered in Ontario, which represents nearly 2% of total vehicles of all fuel types. Their electricity charging demand is estimated as approximately 700 GWh per year, which represents about 0.5% of total electricity consumption in the province. The IESO forecasts that EV charging demand will continue to grow significantly in Ontario due to a variety of policy and market factors. Most notably the federal Electric Vehicle Availability Standard which establishes legally binding sales targets for zero-emission vehicles as a proportion of light duty vehicle sales, reaching 100% of new vehicles in 2035.[1]

In the 2025 Annual Planning Outlook (APO), the IESO projects that the number of EVs in Ontario will increase to 11.6 million by 2050. The associated electricity charging demands will be over 42 TWh a year. This is a sixty-fold increase over a quarter decade. By 2050, EV charging demands will represent about 16% of total electric consumption as estimated in the 2025 APO, making it the largest single electricity end use.

EV charging energy and peak demands are impacted by many factors. There are high uncertainties associated with forecasts of EV quantity and charging demands, impacting both energy and peak forecasts. The IESO forecasts EV demand with available information, such as government policies and targets, Ministry of Transportation registration data, market trends, studies, as well as assumptions informed by professional forecasting judgement and peer organization's outlooks. This paper explores the energy impacts of an alternative EV adoption forecast relative to the 2025 APO reference, partially inspired by recent EV sales trends and adjustments to global manufacturing plans and speculation about the long-term impact of various housing and personal mobility trends. The paper also investigates how different charging patterns would impact the grid, particularly peak demand, as the broader composition of Ontario's load changes over time.

This technical paper is intended to help explore the range of EV charging energy and peak demand that may materialize in Ontario and how EV charging will continue to be a source of uncertainty in the broader provincial long-term demand forecast. It also intended to support discussions around provincial government, regulatory, and utility initiatives to help shape EV charging patterns to minimize ratepayers impacts of transportation electrification.

It should be noted that while the analysis is informed by the best data available to the IESO at this time, the EV space is evolving quickly and many assumptions are characterized by relatively high uncertainty, especially further into the forecast period. The IESO will continue to update its transportation demand forecast regularly, reflecting new research and market and policy developments.

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[1] https://www.canada.ca/en/environment-climate-change/news/2023/12/canadas-electric-vehicle-availability-standard-regulated-targets-for-zero-emission-vehicles.html

Additionally, the technical paper focuses on the provincial power system reflecting the IESO's mandate; however, some of the scenarios and issues identified may materialize earlier or later in specific areas of the distribution system reflecting clustered EV adoption and other local conditions.

3. Electric Vehicle Adoption

EVs are among the most important components of the drive towards climate change mitigation, decarbonization and electrification[2]. Currently, EVs represent a small portion of Ontario vehicle stock and the associated charging electricity demand is small. But the number of EVs on the road is fast growing and projected to increase significantly over the next decades. The quantity of EVs is the key and the first step to estimate EV charging demands and their impacts on electricity system. As a new and rapidly evolving technology, historical trends provide a limited basis for projecting future EV uptake and electricity demand in long term. This section analyzes scenarios of EV adoption by categories of light duty EVs and medium/heavy duty EVs.

3.1 Adoption Scenarios of Light Duty Electric Vehicle

The majority of vehicles are categorized as light duty and almost all EVs on road today are light duty EVs (LDEV). This class of vehicles includes passenger cars, SUVs, and pick-up. In Ontario, light duty vehicles represent over 97% of the registered vehicles of all fuel types. Light duty vehicles are generally also the most suitable to be electrified due to technical characteristics of EV drivetrains and typical vehicle use cases, and there is an emerging North American industry consensus that decarbonization of the light-duty vehicle segment will be achieved with plug-in and battery electric vehicles. Projection of the quantity of LDEV and their charging electricity demands are critical in EV electrical demand forecasting.

Many factors affect EV adoption and their impacts vary over time. This section explores two scenarios of LDEV adoptions. The first is premised on the current federal government sales policy and status quo per-capita Light Duty vehicle registrations. This is the "reference" scenario used in the 2025 APO demand forecast. The second is an alternative case assuming fewer EVs are registered each year due to different potential factors, discussed further below. With the determined EV new sale adoption over years, quantity of EVs on the road and their associated charging electricity demands are estimated subsequently.

A stock and flow model is used to translate new sales into quantity of EVs on the road. This is similar to demand forecasts of other end uses that the IESO carries out for the APO demand forecasts. Existing vehicle stock including all fuel types comes from Statistics Canada. In a given year, a number of new vehicles will be added into the stock to satisfy the overall needs like the population growth and retirement of a certain number of vehicles as they reach the end of their lives. These two factors determine the quantity of new vehicle sales in a year and a portion of them will be EVs. Therefore, the share of EVs in the stock continues to grow and more EVs are expected to be on the road year over year. As a result, more electricity is drawn from the grid to charge EVs and meet the transportation needs.

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[2] See the Government of Canada's 2030 Emissions Reduction Plan (2022)

In December 2023, the Government of Canada published regulations that require manufacturers and importers to meet annual zero-emission vehicles sales targets. These requirements are targeted for commencement in the 2026 model year, with a requirement that at least 20% of new light duty vehicles offered for sale be zero emission vehicles, which will increase annually to at least 60% by 2030 and 100% by 2035. The first LDEV adoption scenario is in line with these current government targets and regulations. It is projected that the number of LDEVs in Ontario will be nearly 11.5 million in 2050.

The second scenario is intended to explore the impacts of slower LDEV adoption. Many factors can affect EV adoption, such as policy measures, technology advancement, consumer preferences, supply chain constraints, as well as global economic and political conditions. These factors are evolving and sometimes turn around dramatically over a short period of time. For example, in the past three years supply chain in auto industry quickly shifted from constraints to over-supply. Of note, an increasing number of Ontarians are expected to live in denser, transit-oriented communities which may drive changes in per capita light duty vehicle registrations as consumers choose transit, ride-hailing, and vehicle-sharing services to meet their personal mobility needs. For the purposes of this technical paper, an alternative scenario is developed with assumed slower adoption rates. In contrast with reference scenario, which aligns with the federal government targets and is considered in the 2025 APO, the slow adoption scenario assumes that 75 percentage of light duty vehicles sold in 2035 will be battery powered. Therefore, it will take eight more years to achieve the 100 percentage targets. The IESO will continue monitoring market developments and policy directions to inform future modelling.

Figure 1 | Scenarios of LDEV New Sales

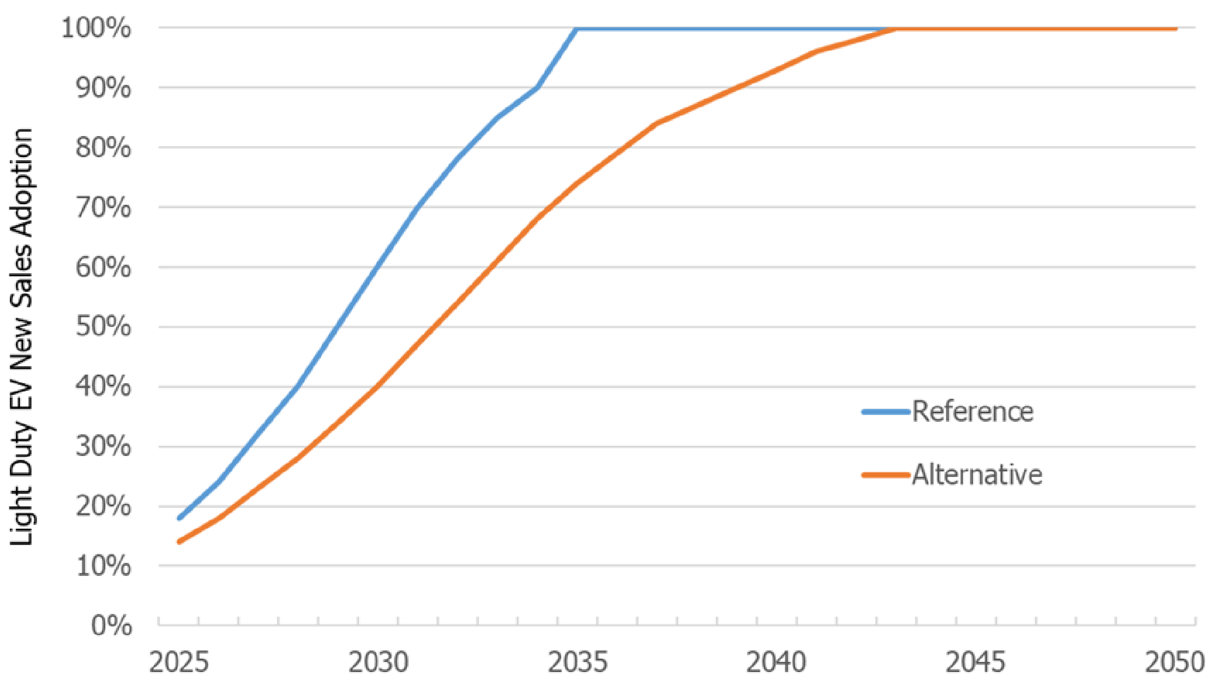
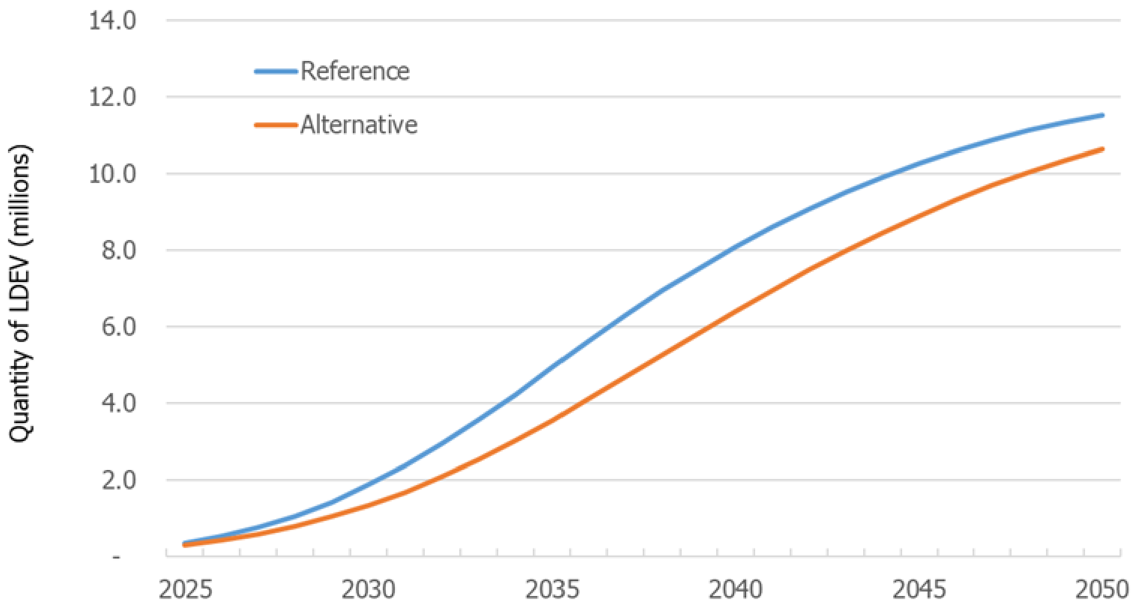


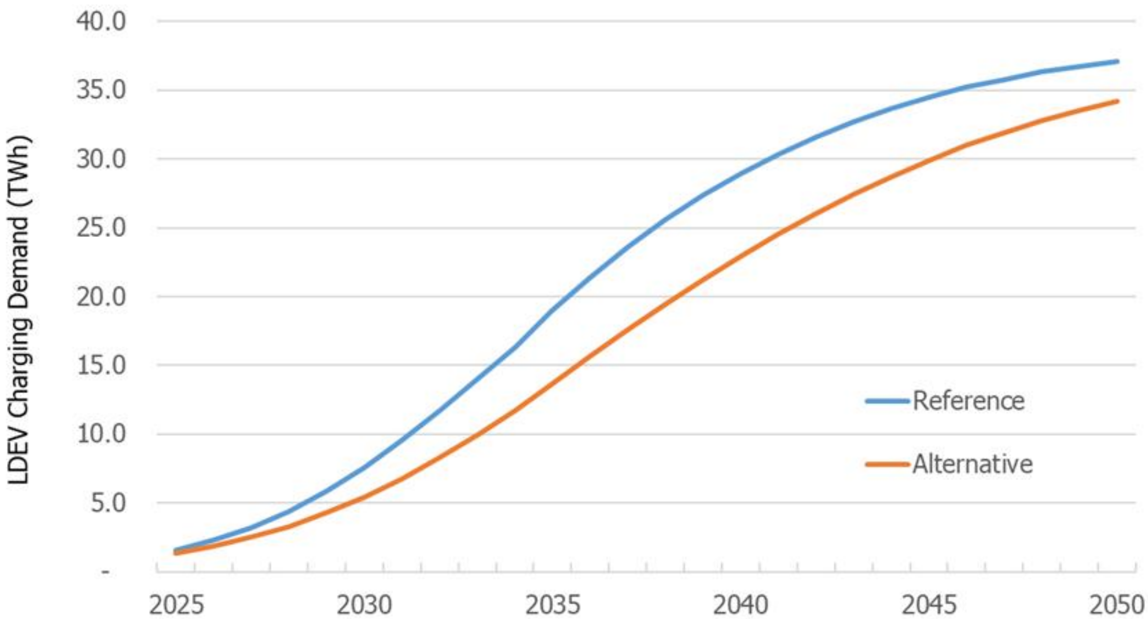
Figure 1 compares two scenarios of LDEV sales as a percentage of total vehicle sales. The reference case reflects current per capita vehicle ownership and aligns with the government EV sales targets, reaching 60% by 2030 and 100% by 2035. The slow adoption case reflects that some influencing factors may not materialize as expected.

Figure 2 | Scenarios of LDEV Stock



The variance of LDEV new sales translates to different quantity of EVs on the road. As presented in Figure 2, reference case projects that LDEV will reach 8.1 million in 2040 and 11.5 million by 2050. The slow adoption case lags, reaching 6.4 million in 2040 and 10.6 million by 2050.

Figure 3 | Scenarios of LDEV Annual Charging Demands

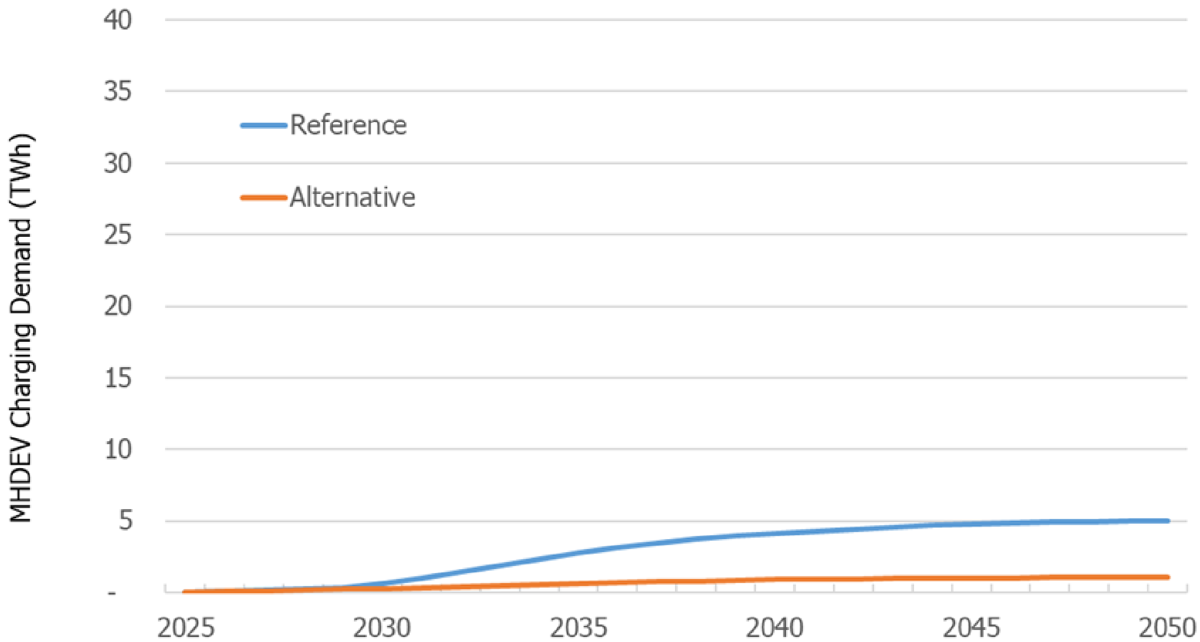


EV charging demand is determined by the quantity of EVs, average vehicle driving distance, and fuel efficiency. The latter two are kept the same across scenarios. Therefore, two EV charging demand cases forecasts were developed based on EV adoption and stock scenarios. They are illustrated in Figure 3. Annual charging demand will be over 37 TWh under reference scenario and over 34 TWh by 2050 under slow adoption scenario. Following trends of LDEV stock, LDEV charging demand in the two scenarios diverges over the years. The slower target adoption translates to about 5 TWh less electricity required in 2035.

3.2 Adoption Scenarios of Medium/Heavy Duty Electric Vehicle

Medium and heavy-duty vehicles represent nearly 3% of today's total vehicles in the province. Forecasting demand from medium and heavy-duty electric vehicles (MHDEV) present additional challenges compared to the light-duty segment. While light duty vehicles are used for either personal or business purposes, medium and heavy-duty vehicles are operated almost exclusively for business with a variety of unique usage patterns and requirements that may make electrification less attractive, particularly where longer range is necessary. While there is essentially industry consensus that electric vehicles will dominate the North American light duty market, there is much more uncertainty around future market shares of battery electric, hydrogen fuel cell, biodiesel, and other clean fuel vehicles in the medium and heavy-duty segment. Additionally, while the federal government has notionally set sales targets for medium and heavy duty zero-emission vehicles, these targets are not as clearly defined as for light-duty, being for a currently undefined subset of vehicle types "as feasible".

Figure 4 | Scenarios of MHDEV Annual Charging Demands

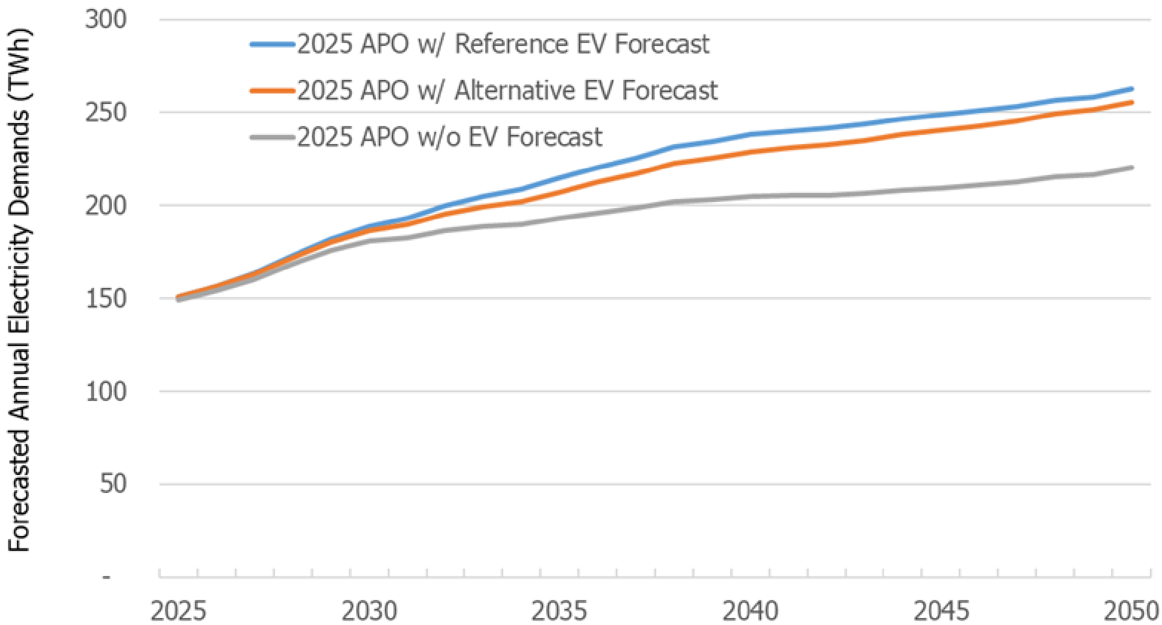


Two scenarios of MHDEV adoption are discussed in this section exploring how medium/heavy duty vehicles could electrify. Both scenarios assume the full electrification of school bus fleet and transit bus fleet. It is generally agreed that the battery powered electrification is the preferred approach for school buses and transit buses.[3] It is assumed that almost all transit and school buses in the province will be powered by batteries by year 2050. One scenario considers that these buses are the only medium/heavy duty vehicles that will be powered by batteries. Another scenario assumes that about 17% of non-bus medium/heavy vehicles will also be powered by batteries by 2050 and directly draw power from the grid.

Figure 4 compares two scenarios of battery powered MHDEV. Charging demand is forecasted to be 1 TWh by 2050 under the slow adoption scenario, in which all come from electrified school buses and transit buses. The reference scenario assumes that nearly one fifth of other medium and heavy-duty vehicles will be powered by batteries over years. As a result, an additional 4 TWh charging demands is projected by 2050. How medium and heavy-duty vehicles will be electrified carries a much higher uncertainty than LDEV, especially those other than transit and school buses. But their impacts on the overall electricity demands are quite small due to its low quantity.

[3] CUTRIC's 2024 Zero Emissions Database report indicates the battery electric busses represent 98% of all zero-emission busses that have or are presently being procured by Canadian transit agencies.

Figure 5 | Two Scenarios of EV Demand Forecasts



LDEV and MHDEV combined contribute to EV charging demand forecasts. Two scenarios of EV demand forecasts in addition to non-EV demands forecasted of the 2025 APO are illustrated in Figure 5. EV demands continue fast growing in both scenarios and become a critical component of the overall demand forecast.

4. Scenarios of EV Charging and System Impacts

EV is a special end use with unique characteristics. An EV can be charged and draw power from electricity grid and store on its onboard battery at various time, locations, and power levels. Most EVs are parked more than twenty hours a day, when they can be charged while not in motion. EVs are also mobile and therefore can be charged at a variety of locations like homes, workplaces, or commercial charging stations. In addition, state of batteries and power levels of chargers determine the duration of a charging session. EV owners' driving behaviours and preferences have impacts on how and when they charge EVs. These factors bring a much higher uncertainty and challenge to forecast hourly EV demands. At the same time, the flexibility of time, location, and power level provide great opportunities to manage EV charging.

Generally, EV charging can be managed passively or actively. Passively managed EV charging relies on dynamic electricity rates to incent EV drivers to charge during low-rate, off-peak hours. As a result, EV owners lower their electricity cost and utilities avoid adding more loads during peak periods. Dynamic pricing rate options, like Ontario's Time of Use (TOU) and Ultra Low Overnight (ULO) rate options, are usually set for months or years reflecting typical daily demand and supply patterns. Actively managed charging allows utilities to directly schedule, slow, or curtail, charging on a close to real time basis reflecting daily grid conditions, typically while respecting consumer-specified charging requirements (e.g. the need to achieve a minimum 80% state-of-charge by 7:00 am each weekday). This management may take place via communication with a smart vehicle charger or directly with a vehicle through it's onboard telematics. In the past several years, a number of Ontario local utilities and other parties have implemented active managed charging programs or pilots, some with funding from the IESO's Grid Innovation Fund. Examples include the Alectra's Charge @ Home, Hydro One's myEnergy Rewards, and Hydro Ottawa's EV Everywhere initiative.

4.1 EV Charging Profiles

Passive managed charging uses price signals to shift charging demands for the benefits of electricity system and rate payers. EV charging with TOU rate and ULO rate are analyzed in this paper.

TOU has been in effect in Ontario for over a decade. Under the current TOU structure, on-peak and mid-peak rates are about 2 and 1.5 times as the off-peak rates respectively. The timing of mid- and on-peak periods varies by summer and winter seasons; however, the off-peak period is consistently weekdays between 7:00 am – 7:00 pm and weekends and holidays. TOU is an effective tool to manage EV charging and the associated electricity demands. It has a fixed schedule and rate structure, which are easy for EV owners to understand and follow to lower their cost. Charging profiles of TOU scenario and unmanaged scenario were derived from a real-world dataset that was collected from Geotab's *Charge the North Study*[4].

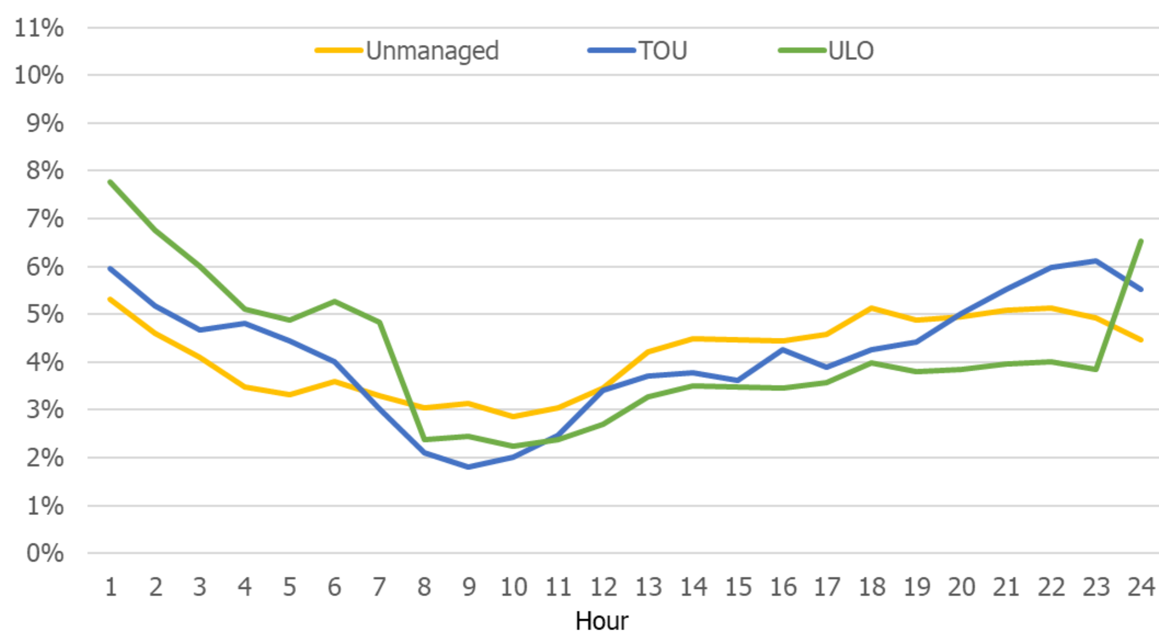
[4] https://www.geotab.com/blog/preparing-for-evs/

Since 2023, Ontario residential and small business customers have a new pricing option to choose from, the Ultra Low Overnight (ULO) rate plan which features a higher on-peak rate but a very low overnight off-peak rate. The price during the on-peak period, which is between 4 pm to 9 pm on weekdays, is about ten times higher than price during the ultra low overnight period, which is between 11 pm to 7 am every day. The ULO rate plan provides additional incentive for EV owners to shift charging to lower price overnight periods when possible.

The ULO is relatively new and IESO does not currently have access to EV charging submeter data. This technical paper adopts a modelling approach developed by a consultant retained by the IESO in 2023, informed by the results of an Alectra-led pricing pilot that informed development of the ULO rate option. It was assumed that the ULO charging profile will reduce EV charging demand by 60% during the on peak period, by 40% during the mid peak period, and by 20% during the weekend off peak period relative to entirely unmanaged charging. The resulting cumulative load reduction was then reallocated across the overnight period.

Figure 6 and Figure 7 show typical day charging profiles in summer and winter. The y-axis reflects the percentage of the daily charge demand occurring in each given hour. The areas under each curve are equal to 100% of the EV charging load for a typical day. Charging profiles of unmanaged, TOU, and ULO are compared.

Figure 6 | Typical Day Charging Profile - Summer



Three scenarios of charging profiles on a typical summer day are illustrated in Figure 6. Unmanaged charging curve is flatter than the other two, with the lowest percentages around 3% in the morning and the highest percentages around 5% in the evening. The TOU charging profile has a larger spread, from about 2% in the morning to about 6% in late evening and mid night. The ULO charging profile is the peakiest among the three, in which 8% of a day's charging demand occurs at a midnight hour. ULO is more effective than the other two to shift EV charging demands to night hours.

Figure 7 | Typical Day Charging Profile - Winter

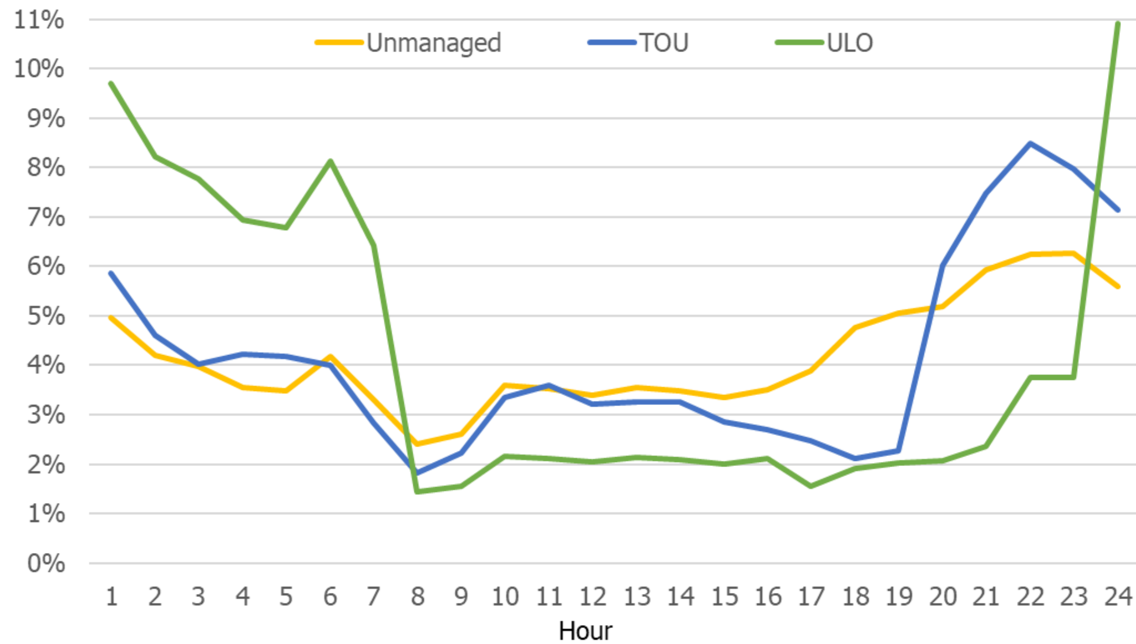


Figure 7 shows charging profiles on a typical winter day. All three scenarios are deeper U-shape than summer profiles. Under the current TOU rate plan, the off-peak TOU is from 7 pm to 7 am in winter. As a result, the TOU charging profile sees a steep ramp up from 2% at 7pm to over 8% at 10 pm. The ramp up is held up and starts a couple of hours later but goes faster under ULO, in which the off-peak period starts at 11pm. Both TOU and ULO are effective to keep EV charging demands lower during on-peak and mid-peak periods, which generally helps minimize electricity system costs. However, with long-term large scale EV adoption, the cumulative rapid ramp in charging demand during the transition to low-price periods may present voltage and frequency challenges for local distribution networks and the bulk power system. This risk is exacerbated with the increasing number of EVs and charging equipment equipped with automatic timers. For example, modelling results show that EV demand will increase from nearly 5.5 GW at 11pm to 15.9 GW at midnight on the winter peak day in 2040, an 10.4 GW increase over an hour.

Active charging management is more effective in aligning EV demand requirements with grid needs. Therefore, EV charging demands are satisfied while system peaks are kept low and costs to ratepayers are limited. EV charging can be managed by a number of approaches like grid to vehicle communication and utility direct control programs. There are a variety of goals to optimize EV charging according to different perspectives. At bulk system level, the goals can be to avoid transmission congestion, minimize peak capacity needs, or maximize renewable energy usage. At distribution level, avoiding overloading of a specific transformer or a substation could be the objective. Therefore, EV charging can be managed in many different ways to serve different needs. This technical paper focuses on minimizing new peaks caused by EV charging at bulk system level.

4.2 EV Charging and Its Impacts on the Overall Demands

EV is an integrated component in the complex electricity system. The interplay of EV demands with non-EV demands is critical in managing overall system peaks. Ideally, EV demands should not coincide with peaks of non-EV demands. EV demands should occur while demands of other end uses are low. However, practically, not all EV demands can be maneuvered and EV demands can not be managed perfectly. How well EV charging demands can be managed is impacted by many factors, for example, participation of EV owners, effectiveness of electricity price signals, and accuracy of demand forecast of non-EV end uses. EV charging management should consider both the flexibility and convenience of EV owners as well as the benefits of system and rate payers.

Four charging profiles and their impacts on system peaks are analyzed in this section. They are unmanaged, TOU, ULO, and a generalized managed charging profile used for the 2025 APO. The first three charging profiles are described in the previous section. The generalized managed charging profile is a hypothetical one developed by a third-party consultant informed by Natural Resources Canada's EV Grid Readiness study and modelling assumptions from other Canadian system planners. The representative actively managed charging profile assumes that 50% of EV charging demands will be shifted away from on peak periods and re-allocated to other lower-demand hours within a day. It is assumed that this profile includes both passive and active management strategies.

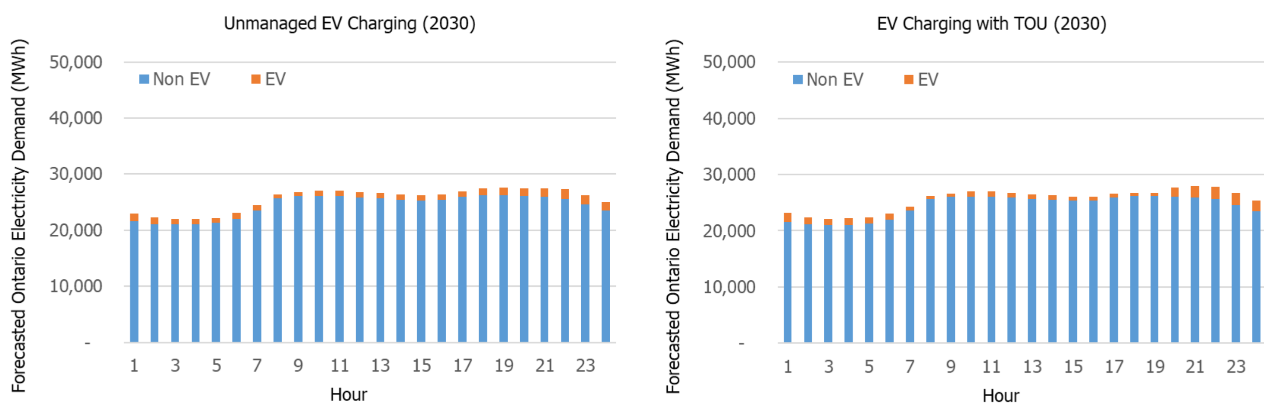
The choice of the generalized managed charging profile for the 2025 APO was based on a number of factors, including local utility deployment of EV managed charging programs, recent changes to regulation around how utilities can fund managed charging programs to minimize impacts on local distribution networks, the strong government direction to the Ontario Energy Board on facilitating EV integration, and IESO market research on consumer charging behaviour and using of timer functionality. The generalized managed charging profile approach also enables IESO demand forecasters to reflect expected long-term changes to managed charging initiatives in response to broader changes in load shape.

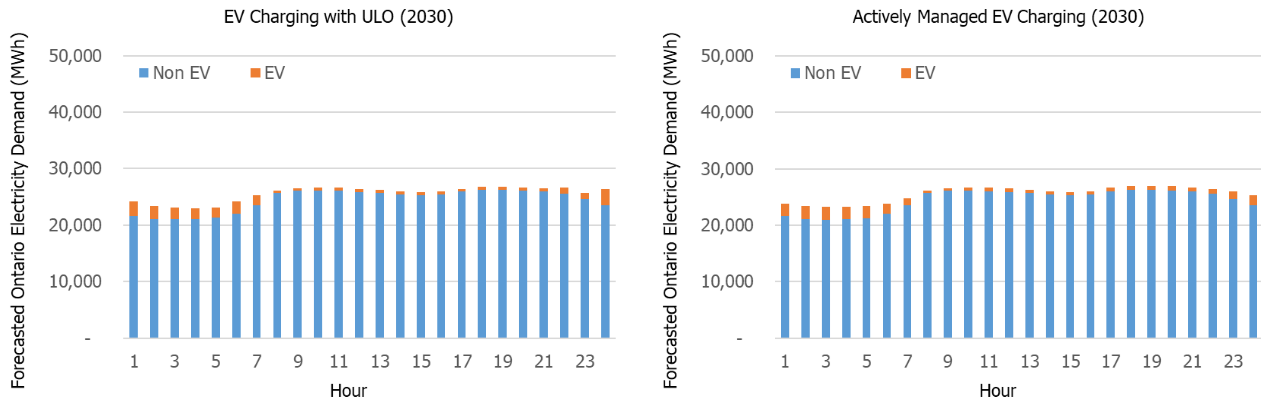
Hourly non-EV demand forecasts at bulk system level are available from the 2025 APO. They are treated as the base loads, which are the same across four EV charging scenarios. The EV's impacts vary from day to day, from month to month, and from year to year. Representative demand conditions on summer peak days and winter peaks days in 2030, 2040, and 2050 are analyzed and discussed below. Quantities of EVs in these years are projected to be 1.9 million, 8.2 million, and 11.6 million respectively.

Figure 8 | Scenarios of EV Charging on the Summer Peak Day - 2030

Figure 8 compares four charging profiles on the summer peak day in 2030. The EV demand is relatively small reflecting forecasted adoption levels. The difference between the on-peak and off-peak of non-EV demands are relatively large. Therefore, how EVs are charged impacts a little on the time and quantity of the peak. EV profiles have minimal impacts on the hourly shape of the overall electricity demand.

Figure 9 | Scenarios of EV Charging on the Winter Peak Day - 2030





The load shape of non-EV demands on the winter peak day in 2030 is flatter than summer, reflecting factors like summer daytime air conditioning load and winter overnight greenhouse lighting load. As illustrated in Figure 9, the demand difference between the on-peak hour and off-peak hour is smaller. Therefore, it leaves less room to shift EV demands from one time to another. In some cases, like charging with TOU, a secondary peak occurs. In other words, too much EV demands are shifted to off-peak hours and make them the new peak hours. As the EV demands are still relatively small in 2030, charging profiles play a non-significant role in the overall load shape.

Figure 10 | Scenarios of EV Charging on the Summer Peak Day - 2040

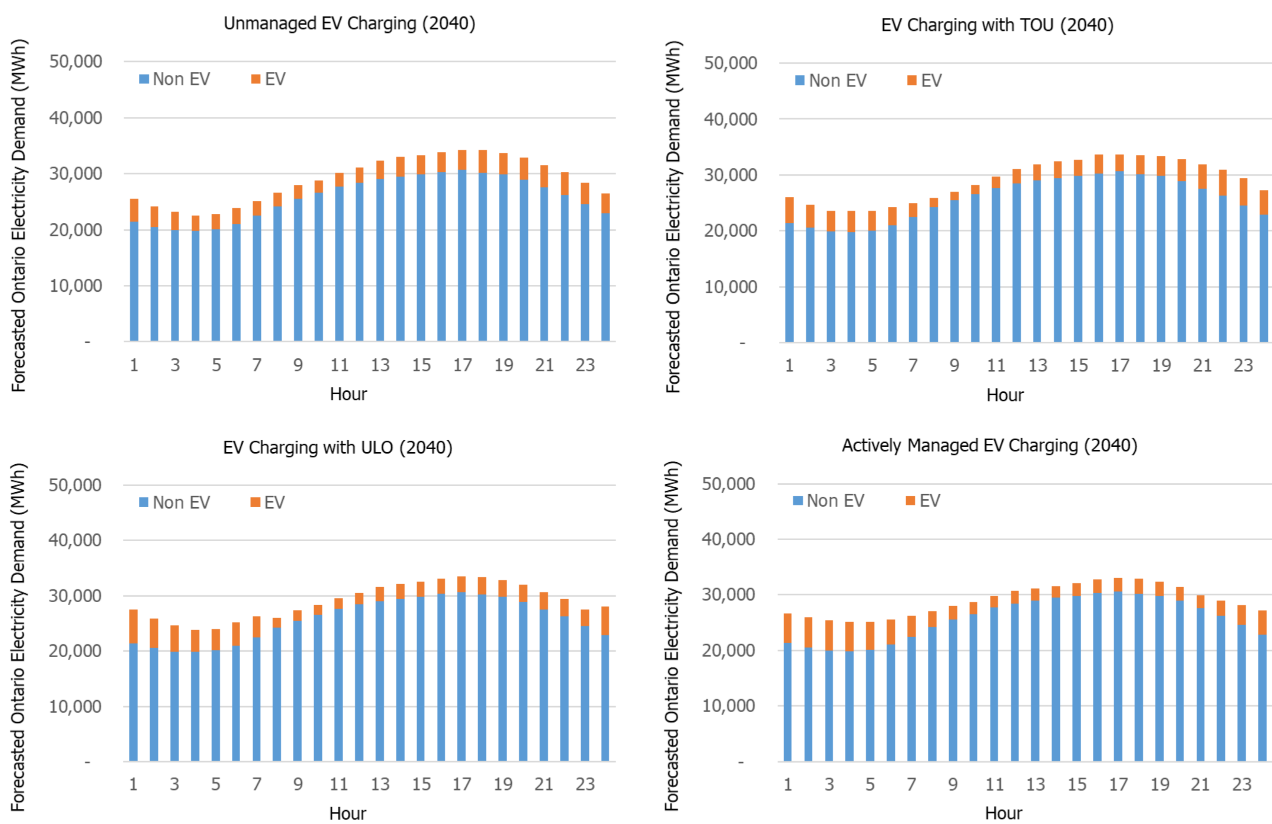
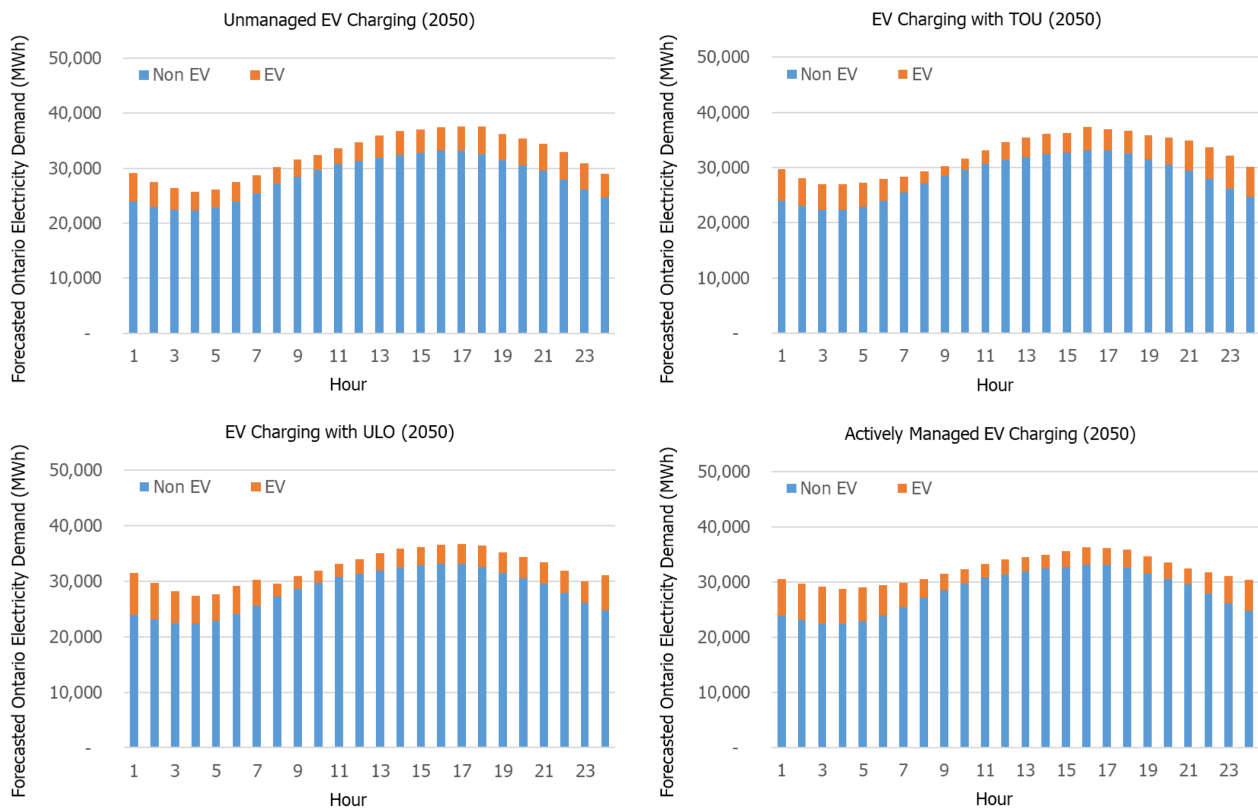


Figure 10 and Figure 11 show the impacts of four charging profiles on summer peak and winter peak in 2040. Both EV demand and non-EV demands increase from 2030, but EV demand increases much faster. TOU and ULO are effective in summer to shift EV demand from on peak to off peak, without materially change the overall hourly load shape. However, in winter, "over-shift" is caused by the TOU and ULO charging profiles, making the secondary peaks significantly higher than those with unmanaged EV charging.

Figure 11 | Scenarios of EV Charging on the Winter Peak Day - 2040

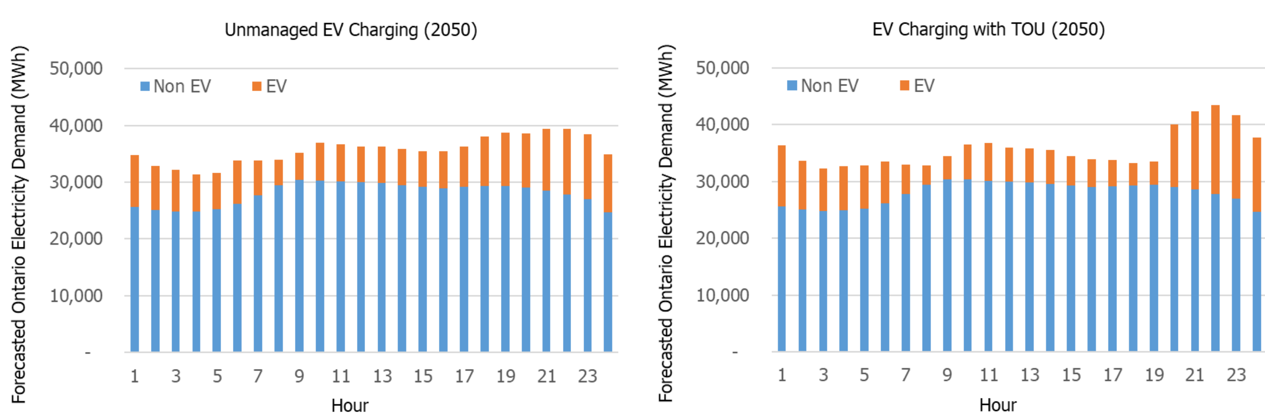
The scenarios consider the current TOU and ULO rate structure. They are effective in today's demand conditions and should be revisited from time to time to reflect the evolving demand conditions. It is critical to effectively manage EV profiles as EV demands represent a significant portion of future total demand.

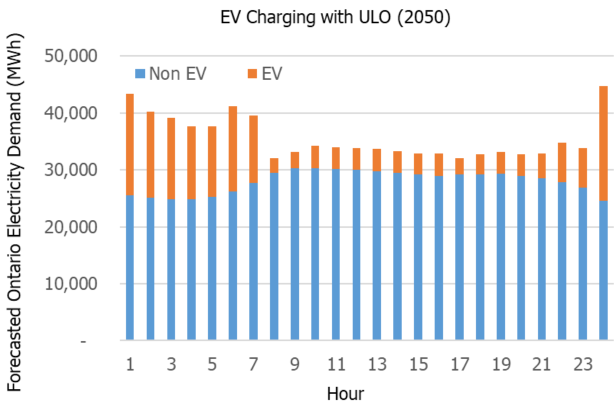
Figure 12 | Scenarios of EV Charging on the Summer Peak Day - 2050

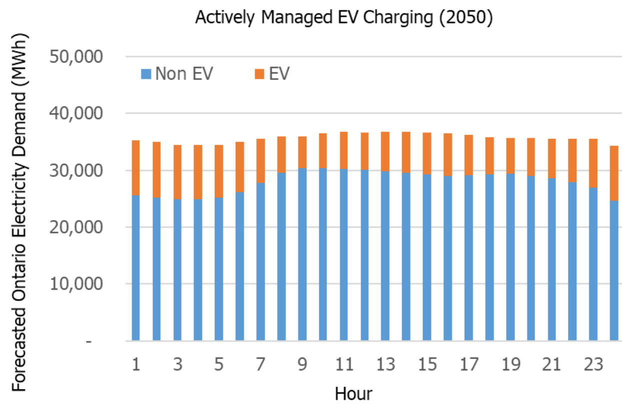


EV demands continue growing over time. The 2025 APO forecasts that EV demands will represent 16% of overall demands in 2050. As a result, EV profiles have a much larger impact on system peaks and load shapes. Figure 12 illustrates four scenarios of charging profiles and their impacts on hourly demands on the summer peak day in 2050. TOU's impact in moderate, which lower summer system peak by 308 MW than the unmanaged EV charging scenario. ULO shifts more EV demands to night hours and further lowers system peak by 675 MW. Actively managed charging profile is more effective to level out the overall load shape, making the difference between maximum and minimum demands smaller. The summer system peak is the lowest with generalized charging management, 375 MW lower than the ULO case.

Figure 13 | Scenarios of EV Charging on the Winter Peak Day - 2050







The load shapes of non-EV demand in winter are flatter than summer per the 2025 APO. As shown in Figure 13, the difference of maximum and minimum non-EV demands on the winter peak day in 2050 is about 5700 MW. The average hourly EV demand on that day is about 7700 MW. The overall system demands will fluctuate as EV charging profiles change. Due to the magnitude of EV demands, they must be managed carefully to avoid over-shifting, which will create new and higher peaks.

Under the current TOU and ULO structure, rate-based charging management does not alleviate the system peaks. Instead, the overall peaks become larger. For example, charging with ULO pushes back system peak by three hours to midnight, but also increase system by over 5300 MW. Besides, the electricity system will experience steep demand ramps during the transition between higher- and low-price periods.

5. Conclusion and Key Findings

This paper is a part of a series of demand research papers that aim to shed light on trends of evolving electricity demands. It focuses on EV's impacts on electricity demand forecast at bulk system level. EV is a special end use with unique characteristics. High uncertainty is associated with EV adoption and its charging demands. Representative scenarios of EV demand forecast both energy and peak are analyzed.

The demand forecast for the 2025 APO considers an EV adoption projection consistent with current federal government policy, which require that 100% of new light-duty vehicles offered for sale be zero emission vehicles by 2035 and a subset of medium- and heavy-duty vehicles by 2040. This paper compares the 2025 APO reference EV demand forecast to an alternative demand forecast premised on slower EV adoption. The analysis indicates that even with potential "headwinds," EV demand still represents a major source of load growth, reaching 24 TWh by 2040 in the alternative scenario, which is 9 TWh lower than the reference forecast.

How EVs are charged have a huge impact on system peaks and the overall load shape. Four charging profiles are analyzed in this paper. Passively managed charging with TOU and ULO rate structures are currently effective to shift EV demands to off-peak periods, minimizing impacts to the provincial electricity system and ratepayer costs. TOU and ULO are good tools to manage EV charging when EV demand is comparatively small to non-EV demand and when non-EV demand load is relatively "peaky" like present summer conditions. Long-term, rate structures will likely need to be revisited from time-to-time to reflect evolving demand conditions.

Looking towards the later part of the forecast period, two issues emerge which will require consideration by system planners, local utilities, regulators and policymakers and underline the value of active managed charging initiatives.

First, with large-scale EV adoption, the continued popularity of TOU and ULO rate options, and common use of automated charging timers, the electricity system could begin experiencing steep demand ramps during the transition between higher- and low-price periods, not unlike the "duck curve" phenomenon observed in systems with very high embedded solar penetration. Without additional coordination, this ramp pattern would pose impose additional system costs to maintain reliability.

Second, system demand conditions, both EV and non-EV, continue evolving. The overall system load shape excluding EV charging is forecasted to become flatter, particularly in the winter. This happens while EV demands are growing significantly. By 2050, average hourly EV charging demand is expected to be 2000 MW greater than the daily winter baseload to peak margin for non-EV load. This means that EV charging patterns will largely determine the timing of system peak.

As noted in the introduction to this technical paper, high uncertainty is associated with several elements of the EV demand forecast. This paper explores possible outcomes with various scenarios. The IESO will continue working to improve to the EV demand forecast, and other elements of the demand forecast informing the load shift analysis.

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