Charging Minnesota's Electric Vehicles

Strategies that Work for the Electric Grid and Consumers

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Executive Summary

Objective and approach

Electric vehicles (EV) play an important role in Minnesota's efforts to reduce greenhouse gas emissions. However, if not managed well, EV charging could strain the electricity grid and increase costs for Minnesota's electric utility customers. Conversely, if EVs charge primarily during hours when the grid has excess capacity, the costs imposed on the grid will be minimized and EVs will help reduce electricity costs for all customers through spreading the fixed costs of the grid over greater electricity sales. The extent to which EVs will impact electricity costs will largely depend on whether customers have an incentive to shift their charging away from peak demand hours.

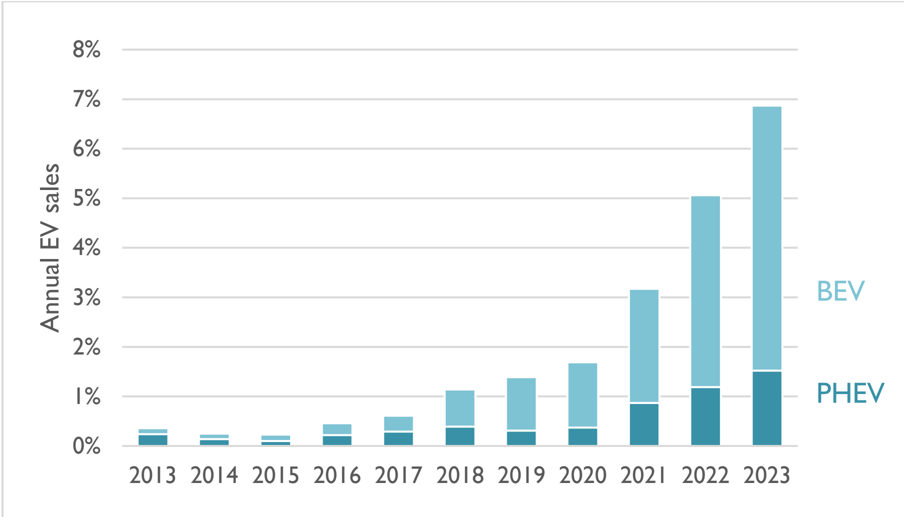
Synapse Energy Economics, Inc. (Synapse) developed this report to assess the potential energy and peak demand impacts from a possible range of EV adoption scenarios, examine how Minnesota's electric utilities are promoting greater adoption of EVs while mitigating the associated impacts on the electric system, and provide recommendations for program improvements based on industry best practices and lessons learned from other jurisdictions. This report provides decision-makers with recommended modifications to existing utility Energy Conservation and Optimization (ECO) programs to help enhance the effectiveness of EV programs in Minnesota.

Electric vehicles in Minnesota

EV adoption is growing rapidly in Minnesota, with nearly 7 percent of all light-duty vehicles purchased in 2023 being electric, as shown in Figure 1. Battery EVs accounted for 5.4 percent of light-duty sales, while plug-in hybrid EVs accounted for 1.5 percent of light-duty sales. As of 2023, there were approximately 50,000 light-duty EVs registered in Minnesota, representing about 1 percent of light-duty vehicles in the state. To meet Minnesota's EV targets of 20 percent of light-duty vehicles by 2030,[1] EV growth will need to continue to accelerate rapidly.

[1] Minnesota Department of Transportation, Minnesota Pollution Control Agency, and Great Plains Institute (2019) *Accelerating Electric Vehicle Adoption: A Vision* for Minnesota, pg. 4. Available at: https://www.lrl.mn.gov/docs/2019/other/190972.pdf.

Figure 1. Minnesota historical EV sales



Source: Alliance for Automotive Innovation, Electric Vehicle Sales Dashboard (December 2023). BEV is battery electric vehicle and PHEV is plug-in hybrid electric vehicle.

Potential impacts of electric vehicle managed charging

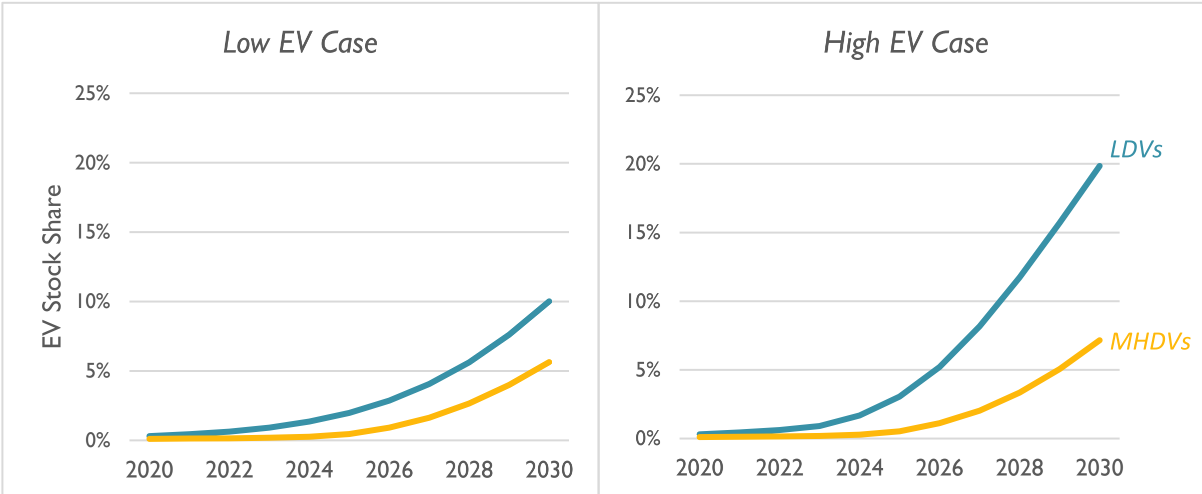
Minnesota has experienced significant growth in EVs over the last decade and is projected to continue to see increased electrification of the transportation sector. Synapse conducted an analysis to better understand how the increased load from EVs will impact the state's electric system based on two electrification scenarios. These two scenarios represent a possible range of electric light-duty vehicle and medium- and heavy-duty vehicle adoption trajectories in the state as described below.

- **High EV Case**: This case represents aggressive EV adoption with a target of 20 percent of light-duty vehicles by 2030, aligning with Minnesota's EV stock targets, and 7.2 percent of medium- and heavy-duty vehicles by 2030 in compliance with a California emissions law for these vehicle categories being adopted by many states.

- **Low EV Case**: This case represents a more gradual adoption trajectory. This approach uses the differential between the EV forecast from Bloomberg New Energy Finance and the High EV Case to estimate a lower-end adoption rate, assuming that the forecast represents a mid-point between the High EV Case and the Low EV Case. This results in EVs comprising 10 percent of light-duty vehicles and 5.6 percent of medium- and heavy-duty vehicles in Minnesota by 2030.

Synapse used an in-house model called EV-REDI to develop forecasts for EV stocks and sales in Minnesota for each year through 2030. Figure 2 presents our forecasts of EV stock shares (the percentage of all the vehicles on the road that are electric) by vehicle type through 2030 under the two scenarios.

Figure 2. EV stock share forecasts – Low EV Case and High EV Case



Source: Synapse stock share forecasts for light-duty vehicles (LDV) and medium- and heavy-duty vehicles (MHDV) developed with its EV-REDI model.

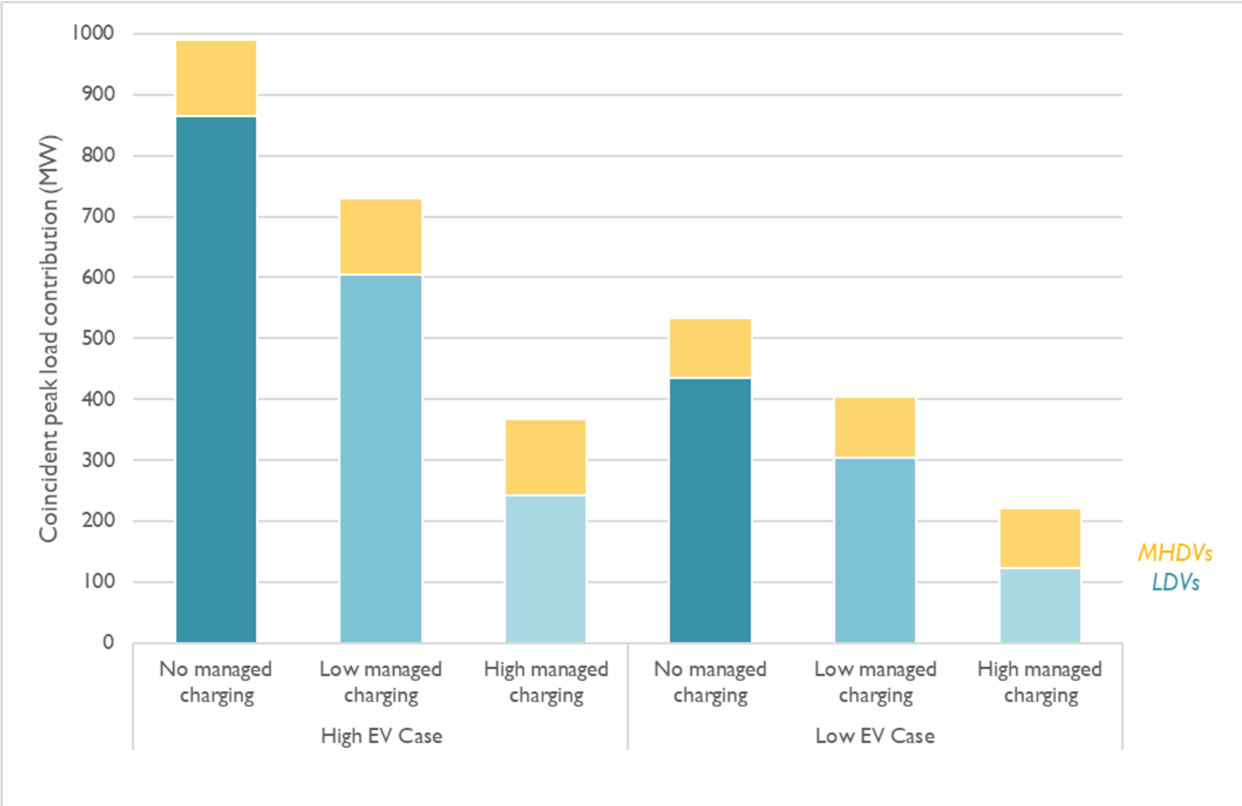
Using these EV adoption trajectories, we estimated the energy consumption and peak demand impacts associated with EV charging. Our analysis of electricity impacts from EVs for the two scenarios concludes that EV adoption could lead to considerable increases in electricity consumption and system peaks, potentially necessitating substantial utility investments. However, strategies such as managed charging could mitigate the peak demand impacts and reduce the need for extensive infrastructure upgrades. We estimate that EV managed charging could reduce the expected summer peak substantially. Further, despite potential increases in utility costs, higher revenues from electricity sales to EVs are likely to exceed the expected utility investments to support the EV adoption, thereby exerting downward pressure on utility rates. Table 1 below summarizes our results.

Table 1. Estimated energy consumption and peak demand impacts associated with EV charging

Impacts by 2030	Low EV Case	High EV Case
Electricity consumption		
Annual electricity consumption	2.9 TWh	5.2 TWh
% of current residential and commercial electricity load	4.4%	7.8%
Peak demand load increases		
Summer peak, no managed charging	452 MW 3% of current peak	827 MW 6% of current peak
Winter peak, no managed charging	116 MW 1% of current peak	218 MW 2% of current peak
Peak reduction with managed charging (light-duty vehicles)	24%	66%
Increases in annual utility investment in generation, transmission, and distribution due to EV loads		
Without managed charging	$55 million	$110 million
With managed charging	$15 million (30% reduction)	$31 million (72% reduction)
Rate impacts: increased utility revenues can lower electricity rates overall if they surpass utility system costs		
Annual utility revenues	$284 million	$565 million
Compare to annual utility costs without managed charging (incl. energy costs)	$120 million	$235 million

Figure 3 below shows detailed results of EV peak demand impacts for the summer. Our analysis does not include managed charging for medium- and heavy-duty vehicles due to limited data on how their charging can be managed without impacting commercial activities.

Figure 3. Managed charging impacts on summer coincident peak demand in 2030



Our findings highlight the importance of proactive planning and the critical role of managed charging in maximizing the benefits of EV adoption due to its potential to mitigate peak demand and rate impacts.

Minnesota's Energy Conservation and Optimization program and electric vehicles

Minnesota's Energy Conservation and Optimization (ECO) program is a utility-administered initiative designed to promote energy-efficient technologies and practices. The program introduces a more comprehensive approach to energy efficiency, emphasizing load management, efficient fuel-switching, and increased energy savings goals. The program's enabling legislation, the *Energy Conservation and Optimization Act* (ECO Act), currently mandates annual energy savings equivalent to 2.5 percent of annual retail energy sales of electricity and natural gas. The legislation aligns new energy savings targets with the increasing adoption of EVs in the state, recognizing EV managed charging as a significant opportunity for peak demand savings.

Utilities must submit Triennial Plans outlining their ECO program goals for the next three years. While the ECO Act allows utilities to exclude EV charging sales from their gross retail energy sales, utilities must demonstrate a connection between these sales and their specific EV programs, rates, or tariffs. This incentivizes utilities to develop EV charging initiatives.

For the 2024–2026 Triennial Plans only one of Minnesota's three investor-owned utilities, Otter Tail Power (Otter Tail) proposed an EV load management program, acknowledging the significant impact of EVs on reducing greenhouse gas emissions. The other two did not, although they offer EV programs outside the ECO framework.

EV program case studies

Synapse conducted case studies of the EV programs currently offered by Minnesota's investor-owned utilities. For each case study, we reviewed the program's overarching goals, program design, and performance to assess how each program compares to others in Minnesota and across the country. We then developed recommendations for improvements to each of these programs. Table 2 below summarizes the programs and our recommendations.

Table 2. Synapse Minnesota EV program case study summary

Program	Part of ECO program	Description	Recommendation
Otter Tail Power's Load Management for Electric Vehicles program	✓	Pairs $500 Level 2 EV charger rebate with requirement that customer enroll in an available time-of-use rate.	To reduce risk of free-ridership, reconsider the rebate amount or shift towards promoting time-of-use rate participation for customers who already possess Level 2 chargers or telematics.
Xcel Energy's Optimize Your Charge pilot	X	Provides $50 annual bill credit to customers that charge at least 25 percent during designated off-peak hour.	Increase minimum off-peak requirement from 25 percent to 80 percent to maximize benefits to the electric system.
Minnesota Power's fast charger program	X	Utility installs, owns, and operates a network of 16 public fast-charging stations.	Prioritize sites in disadvantaged communities to enhance equitable access to charging in underserved areas. Otherwise, focus on providing make-ready infrastructure to support private sector investment.

The recommendations contained in Table 2 are informed by similar utility programs in other jurisdictions. Table 3 below summarizes utility programs that Minnesota can look to for information on improvements to program design across residential rebates for Level 2 chargers, residential managed charging programs, and support for public fast-charging infrastructure.

Table 3. Examples of best practices in EV program design

EV Program Type	Utility	Jurisdiction	Description
Rebates for Level 2 Chargers	Baltimore Gas & Electric	MD	No longer provides rebates for residential chargers and instead encourages customers with eligible EVs with telematics or with eligible EV chargers to enroll in time-of-use rates.[a]
Residential Managed Charging	New York State Electric and Gas	NY	To be eligible to earn an annual $50 bill credit through the Optimize Your Charge program, customers must charge their EV during the prescribed 7.5-hour off peak period at least 80% of the time.[b]
Support for public fast-charging infrastructure	Joint Utilities of NY[c]	NY	Instead of owning and operating fast chargers, the utilities offer make-ready incentives for publicly available fast chargers with higher incentives to those located in disadvantaged communities.[d]

a) Baltimore Gas and Electric Company, EVsmart® Vehicle Charging Time of Use Rate webpage. Available at: https://www.bge.com/smart-energy/innovation-technology/electric-vehicles/ev-tou-rate.

b) New York State Electric and Gas. OptimizEV, pg. 3. https://www.nyseg.com/documents/40132/72042565/FINAL+NEVC002+NYSEG+Optimize+EV+Booklet+Program+Guide+09-2023.pdf/8ce75ef5-1129-d5a0-4dce-19dc627bd302?t=1696010775775.

c) The Joint Utilities of NY include: Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, Inc., Niagara Mohawk Power Corporation d/b/a National Grid, New York State Electric & Gas Corporation, Rochester Gas & Electric Corporation, Orange & Rockland Utilities, Inc.

d) Joint Utilities of New York, *New York Electric Vehicle Infrastructure Make Ready Program Amended Participant Guide* (2020). Available at: https://jointutilitiesofny.org/sites/default/files/JU%20EVs/January%202024%20update/JU%20Make-Ready%20Program%20Participant%20Guide.pdf.

Conclusions

Our analysis demonstrates the benefit that managed EV charging can have on mitigating adverse impacts to the distribution system. Our analysis also shows the importance of keeping the costs of supporting transportation electrification low to maximize net revenues from EV charging, which can reduce electricity rates for all customers. It is therefore important that utility EV programs focus on encouraging off-peak EV charging and be designed in a manner that maximizes benefits and minimizes costs. With these two important factors in mind, we provide the following guidance on utility EV program design:

- **Rebates for Level 2 chargers**: Instead of providing rebates for residential Level 2 EV chargers, utilities should provide incentives to encourage participation in an EV time-of-use rate or other off-peak charging program for customers that have an existing Level 2 charger and by leveraging on-board telematics. Should utilities continue to provide rebates for residential chargers, recipients of those rebates should continue to be required to enroll in a managed charging program or time-of-use rate.

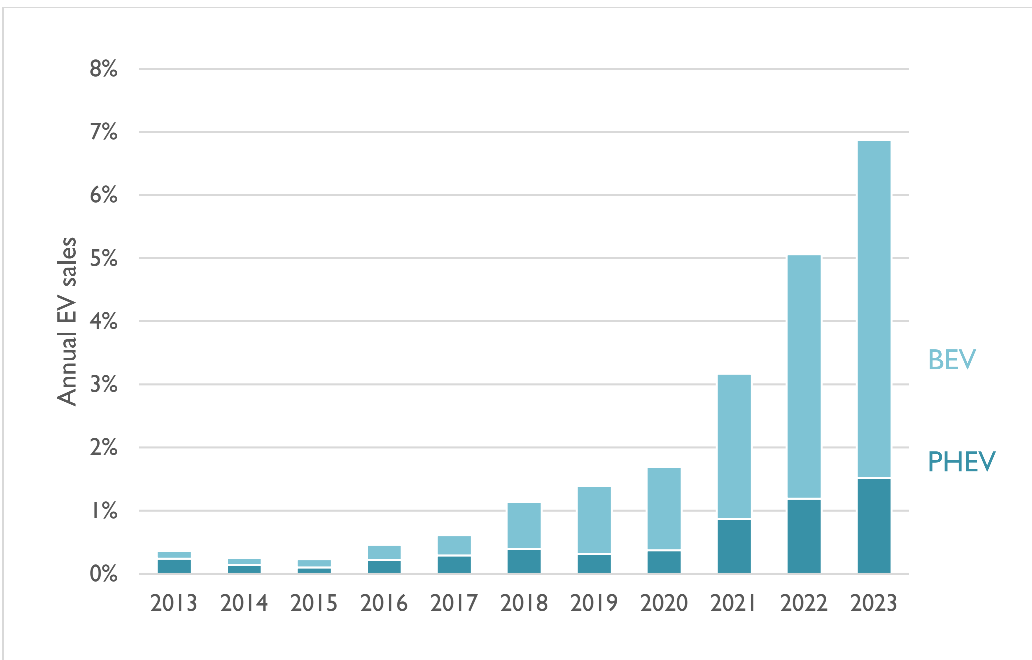
- **Charging requirements for off-peak charging incentives:** The minimum percentage of off-peak charging required for a customer to receive an incentive should be high enough to create meaningful benefits to the electric system. We recommend that managed charging programs such as Xcel Energy's Optimize Your Charge program should require participants to charge at least 80 percent of the time during the off-peak charging window to ensure that participation in the program reduces grid impacts that can benefit all customers.
- **Expansion of managed charging pilots:** We recommend that the Minnesota investor-owned utilities continue to examine opportunities to promote off-peak charging for additional customer segments including commercial and fleet customers.
- **Role of the utility in supporting charging infrastructure:** While it may be appropriate for utilities to own and operate a limited number of fast chargers to jumpstart the market, these efforts should be focused on disadvantaged and underserved communities where the private market may be slow to invest in charging infrastructure. Utility ownership of fast chargers increases costs to customers through rate-basing those investments and shifts risks of charging station revenue losses to customers. We recommend utilities instead focus on the necessary utility-side make-ready investments to support the deployment of private sector EV charging infrastructure to reduce costs and encourage private market competition.

Introduction

Electric vehicles (EV) play an important role in Minnesota's efforts to reduce greenhouse gas emissions. However, if not managed well, EV charging could strain the electricity grid and increase costs for Minnesota's electric utility customers. Conversely, if EVs charge primarily during hours when the grid has excess capacity, the costs imposed on the grid will be minimized and EVs will help reduce electricity costs for all customers through spreading the fixed costs of the grid over greater electricity sales. The extent to which EVs will impact electricity costs will largely depend on whether customers have an incentive to shift their charging away from peak demand hours.

EV adoption is growing rapidly in Minnesota, with nearly 7 percent of all light-duty vehicles (LDV) purchased in 2023 being electric, with battery electric vehicles (BEV) accounting for 5.4 percent, and with plug-in hybrid electric vehicles (PHEV) accounting for 1.5 percent of LDV sales (see Figure 4 below). As of 2023, there were approximately 50,000 electric LDVs registered in Minnesota, representing about 1 percent of LDVs in the state. To meet Minnesota's EV target of 20 percent of LDVs by 2030, EV growth will need to continue to rapidly accelerate.[2]

Figure 4. Minnesota historical EV sales



Source: Alliance for Automotive Innovation, Electric Vehicle Sales Dashboard (December 2023).

[2] Minnesota Department of Transportation, Minnesota Pollution Control Agency, Great Plains Institute. 2019. *Accelerating Electric Vehicle Adoption: A Vision for Minnesota.* Available at: https://www.pca.state.mn.us/sites/default/files/p-gen4-13.pdf.

In addition to the increase in EV adoption in Minnesota, the utility program landscape is changing to support transportation electrification and mitigate the impacts of EV charging on the grid. Xcel Energy (Xcel), Minnesota Power (MP), and Otter Tail Power (Otter Tail) all offer programs related to EV rate design, load management, and EV charging infrastructure. In addition, the 2021 *Energy Conservation and Optimization Act* (ECO Act), which has enhanced and expanded the scope of the state's energy conservation program, opened the door for EV load management programs to potentially be included in utility ECO plans.

Synapse developed this report to forecast the potential energy and peak demand impacts from EVs on the grid, examine how Minnesota's electric utilities are promoting greater adoption of EVs while mitigating the associated impacts on the electric system, and provide recommendations for program improvements based on industry best practices and lessons learned from other jurisdictions.

Potential impacts of electric vehicle managed charging

To estimate the range of potential EV charging impacts on peak demand, Synapse modeled two scenarios (a High EV Case and a Low EV Case) for the electrification of light-duty, medium-duty, and heavy-duty vehicles through 2030. We then estimated the additional electricity consumption and increases in peak demand expected from those scenarios in 2030. Further, we explored the potential peak demand reductions from EV managed charging strategies, which provide customers financial incentives to shift their charging away from peak demand hours through utility rebates, bill credits, or time-varying rates. Below we present these forecasts, as well as the expected electric utility investments required to support transportation electrification and the resulting customer rate impacts. Detailed descriptions of these analyses are available in Appendix A: Impacts of electric vehicle managed charging.

Electric vehicle forecasts

Synapse used its in-house model, EV-REDI (Electric Vehicle Regional Emissions and Demand Impacts), to develop forecasts for EV stocks and sales in Minnesota through 2030, focusing separately on LDVs and medium- and heavy-duty vehicles (MHDVs). The two scenarios that we modeled encompass a broad range of possible futures for EV deployment in the state. The two scenarios are as follows:

- **High EV Case**: Represents aggressive EV adoption with a target of 20 percent of LDVs by 2030, aligning with Minnesota's EV stock targets, and 7.2 percent of MHDVs by 2030 in compliance with the *Advanced Clean Trucks* (ACT) rule, which mandates a significant increase in zero-emissions truck sales by 2035.[3]

- **Low EV Case**: Represents a more gradual adoption trajectory. This approach uses the differential between the EV forecasts from Bloomberg New Energy Finance (BNEF) and the High EV Case to estimate a lower-end adoption rate, assuming that BNEF's EV forecast represents a mid-point between the High EV Case and the Low EV Case.[4] This results in EVs comprising 10 percent of LDVs and 5.6 percent of MHDVs in Minnesota by 2030. Table 4 presents the percentage of

[3] The ACT was developed by the state of California and approved by the U.S. EPA in 2020. The ACT requires truck manufactures to sell an increasing share of zero-emissions vehicles by 2035, ranging from 40 to 75 percent depending on the vehicle class. Since the passage of the ACT in California, 10 other states (Colorado, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont, and Washington) adopted the ACT. See Advanced Clean Tech News. 2024. "Embracing the Advanced Clean Trucks Rule, or Not?" January 10. Available at: https://www.act-news.com/news/embracing-the-advanced-clean-trucks-rule-or-not/#:~:text=Since%20its%20passage%20in%20California,Island%2C%20Vermont%2C%20and%20Washington.

[4] Bloomberg New Energy Finance (BNEF). 2022. *Long-Term Electric Vehicle Outlook*, as reported by BofA Global Research. https://rsch.baml.com/report?q=WCfBJmf-PxHbUk763NuZcw. BNEF's original report is available at: https://bnef.turtl.co/story/evo-2022/page/1.

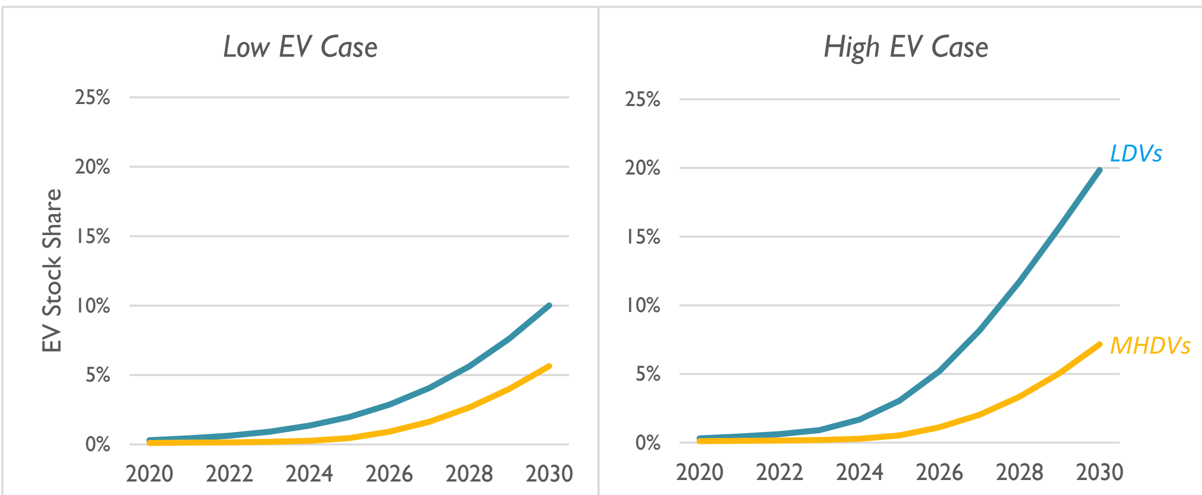
vehicles that are projected to be electrified by 2030 for the Low EV Case and the High EV Case, along with BNEF's forecast for LDVs.[5]

Table 4. EV stock targets for 2030 by case

	Low EV Case	BNEF	High EV Case
Light-duty vehicles	10.0%	15.0%	20.0%
Medium- and heavy-duty vehicles	5.6%	6.5%	7.2%

Our forecasts for each year, up to 2030, are direct outputs from EV-REDI based on the EV targets for 2030 shown in Table 4. Figure 5 presents our forecasts of EV stock shares (the percentage of all the vehicles on the road that are electric) under the two scenarios.

Figure 5. EV stock share forecasts – Low EV Case and High EV Case



In terms of vehicle sales, we estimate that the percentage of new LDV sales that will be EVs in 2030 will be 54 percent in the Low EV Case and 94 percent in the High EV Case. For MHDVs, we project that EV sales in 2030 will reach 31 percent in the Low EV Case and 40 percent in the High EV Case. Figure 6 presents EVs as a share of new vehicle sales for each case.

[5] Note that BNEF provides forecasts for several vehicle classes. The BNEF forecast presented in this table represents our translation of the original BNEF forecasts based on our assumptions regarding the shares of various vehicle classes in Minnesota.

Figure 6. EV sales share forecasts – Low EV Case and High EV Case

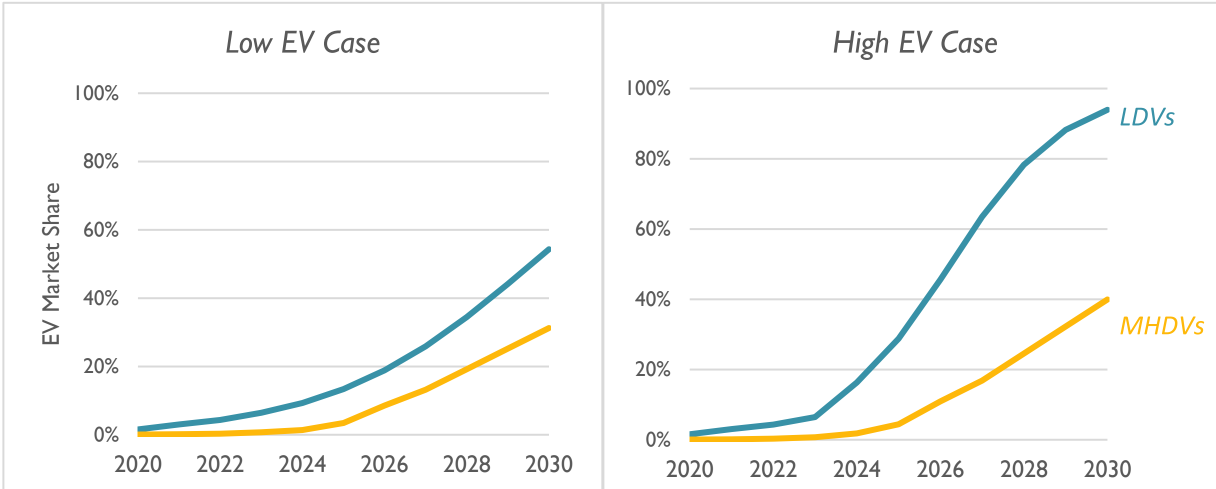
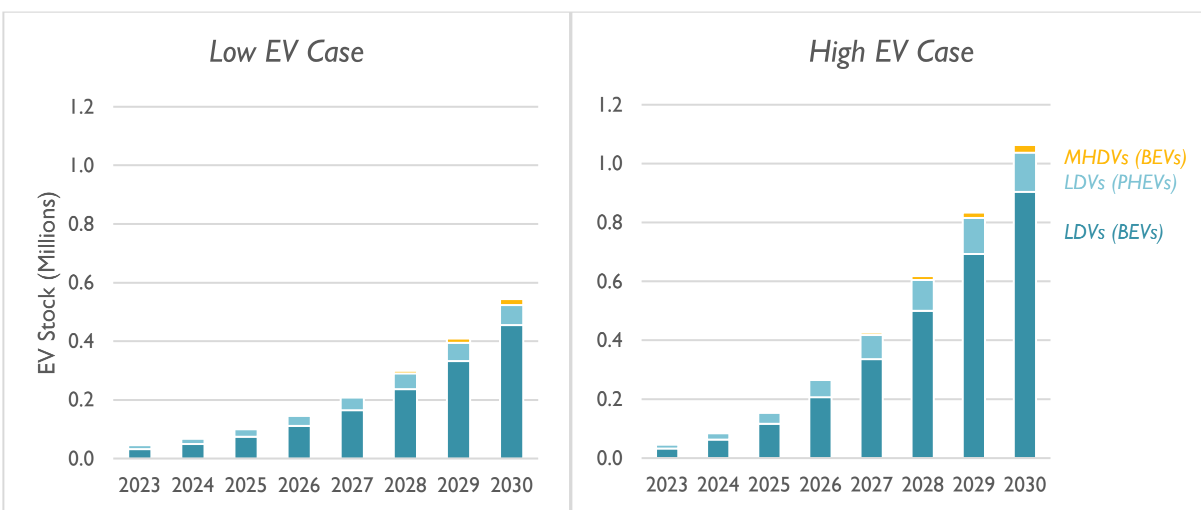


Figure 7 presents our forecasts of EV stocks in terms of millions of vehicles for the two cases. By 2030, the total number of electric LDVs in Minnesota is forecasted to reach 545,000 vehicles under the Low EV Case and 1,060,000 vehicles under the High EV Case. Notably, the number of LDVs in the High EV Case in 2030 is nearly twice that of the Low EV Case. MHDVs are projected to reach 20,500 under the Low EV Case and 26,000 vehicles under the High EV Case by 2030. As shown in this figure, the majority of EVs in Minnesota are forecasted to be LDVs, which are primarily fully electric (i.e., BEVs). Light-duty PHEVs are the second-largest EV type.

Figure 7. EV stock forecasts – Low EV Case and High EV Case

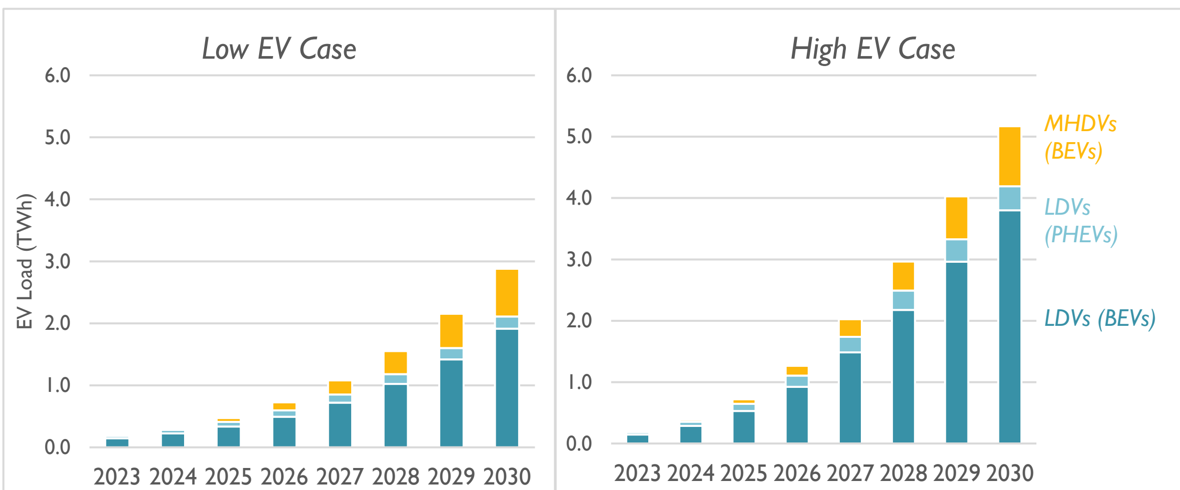


Electric vehicle electricity consumption

Based on our forecasts of EV adoption, EV efficiencies, and vehicle-miles travelled, we estimated annual electricity loads from EVs as shown in Figure 8. In the Low EV Case, the total electricity consumption from EVs is expected to grow from 0.21 terawatt-hours (TWh) in 2022 to 2.9 TWh by 2030. This is equivalent to 4.4 percent of the current total electricity load from the residential and commercial sectors in the state.[6] In the High EV Case, we project that the total EV load increases to 5.2 TWh, which is approximately 7.8 percent of the current residential and commercial electricity consumption.

In both cases, the majority of annual EV electricity consumption is attributable to LDVs, but MHDVs consume an outsized share of energy on a per-vehicle basis.[7] This is due to the larger size of those vehicles, lower efficiencies stemming from heavier vehicles, and larger per-vehicle miles traveled by MHDVs.

Figure 8. Annual EV electricity load forecasts by vehicle class – Low EV Case and High EV Case



Electric peak demand impacts

To assess the peak demand impacts from EV charging, we first allocated the annual EV electricity consumption to a representative summer peak month (July) and a representative winter peak month

[6] According to U.S. Energy Information Agency's (EIA) *U.S. Electricity Profile 2022*, the total electricity consumption for the residential and commercial sectors in the state was approximately 67 TWh in 2022. https://www.eia.gov/electricity/state/

[7] In the Low and High EV Cases for 2030 respectively, LDVs comprise between 96 and 97 percent of the EV stock volume and consume between 73 to 81 percent of the total EV energy load. In comparison, MHDVs consume between 26 and 19 percent of the 2030 EV load, despite only comprising between 2 and 4 percent of electric vehicles in 2030.

(January) in Minnesota and assumed an equal quantity of charging each day.[8] We then allocated the electricity consumption to each hour of the day using hourly EV load shapes under a standard charging scenario and a managed charging scenario.

For LDVs, we used standard hourly load shapes from the U.S. Department of Energy's EVI-Pro Lite tool[9] for St. Paul, Minnesota. For MHDVs, we used load shapes developed by Lawrence Berkeley National Laboratory.[10] These standard load shapes do not account for managed charging strategies.

To estimate the impacts of managed charging for LDVs in Minnesota through strategies such as financial incentives and time-varying rates to encourage off-peak charging, we developed (for both the Low EV Case and the High EV Case) a Low Managed Charging scenario aiming for a 30 percent EV peak demand reduction and a High Managed Charging scenario targeting a 72 percent EV peak demand reduction by 2030. These managed charging efforts reflect two ends of spectrum on EV managed charging, from "mass adoption" with lower peak reductions per participant (representing the High Managed Charging scenario) to more concentrated, enthusiastic user participation with higher peak reductions per participant (representing the Low Managed Charging scenario).[11]

The participation assumption for the High Managed Charging scenario is primarily based on the experience of opt-in time-varying rates implemented by utilities in the past.[12] The high-end estimate is not an upper limit, because we assume no managed charging for MHDVs due to limited data on how their charging can be managed without impacting commercial activities.[13] For comparison, a recent study by the National Renewable Energy Laboratory (NREL) estimated 30 percent to 83 percent peak demand reductions in 2032 from all types of EVs including MHDVs, which is in line with our estimates.[14]

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[8] The monthly load shapes are based on a data source from New England Independent System Operator (ISO), titled "2022 Final Transportation Electrification Forecast" (February 18, 2022), available at: https://www.iso-ne.com/static-assets/documents/2022/02/evf2022_forecast.pdf. We used this data source because we expect MDV/HDV load shapes are similar across the country as they are primarily influenced by business activities.

[9] We used the load shape based on the "Immediate – as fast as possible" charging mode in the EV-Pro Lite tool. The tool is available at https://afdc.energy.gov/evi-pro-lite/load-profile.

[10] Lawrence Berkeley National Lab. HEVI-LOAD MDV and HDV load profiles. Provided August 2022.

[11] At a significantly high level of participation, some fractions of the total participants may not respond to price signals all the time. As a result, we expect that the average reduction per customer for the High Managed Charing scenario is lower than the average reduction per customer for the Low Managed Charging scenario.

[12] Past studies have shown that opt-out time-of-use rates (one type of time-varying rate) tend to have very high participation rates (e.g., over 90 percent), but lower levels of load shifting per participant. See Environmental Defense Fund. 2015. *A Primer on Time-Variant Electricity Pricing*. Available at: https://www.edf.org/sites/default/files/a_primer_on_time-variant_pricing.pdf; Lawrence Berkeley National Laboratory (LBNL). 2023. *The use of price-based demand response as a resource in electricity system planning*. Available at: https://eta-publications.lbl.gov/sites/default/files/price-based_dr_as_a_resource_in_electricity_system_planning_-_final_11082023.pdf.

[13] Smart Electric Power Alliance. 2021. *The State of Managed Charging in 2021*. Available at: https://sepapower.org/resource/the-state-of-managed-charging-in-2021/.

[14] National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Kevala Inc., and U.S. Department of Energy. *Multi-State Transportation Electrification Impact Study: Preparing the Grid for Light-,*

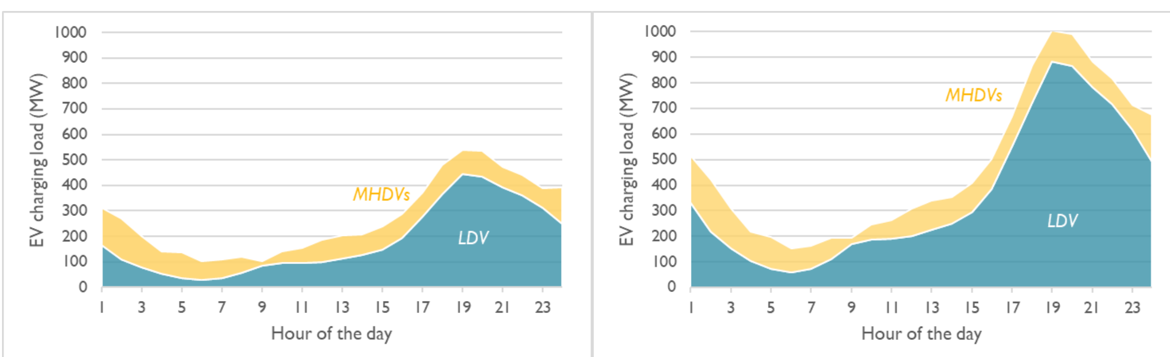
Table 5 presents these targets along with our assumptions for the average peak reductions per vehicle and customer participation rates.

Table 5. EV managed charging assumptions

	Low Managed Charging Scenario	High Managed Charging Scenario
Peak reduction per EV	100%	80%
Participation rate	30%	90%
Total peak reduction	30%	72%

Figure 9 shows our estimates of hourly LDV and MHDV load on a weekday in July 2030 in the Low EV Case and the High EV Case. Hourly EV load impacts during this time range from 98 MW at 6 AM to 456 MW at 6 PM in the Low EV Case and 142 MW at 6 AM to 838 MW at 6 PM in the High EV Case. Hourly EV load shapes for the winter are the same as the shapes for the summer, but the projected hourly winter loads are approximately 10 percent higher in the morning to 35 percent higher in the late afternoon than in the summer due to lower battery efficiencies during the winter season.

Figure 9. July 2030 weekday hourly demand, Low EV Case (left) and High EV Case (right)



To assess peak demand impacts, we first identified the hours of expected peak demand on the grid for the summer and winter seasons, prior to the addition of EV load. For summer, we assumed that the peak hour occurs at 7 PM in 2030, based on the current peak hours of 4 PM to 7 PM[15] and the expected

Medium-, and Heavy-Duty Electric Vehicles. Available at: https://research-hub.nrel.gov/en/publications/multi-state-transportation-electrification-impact-study-preparing.

[15] Midcontinent Independent System Operator (MISO). 2023. "Historical Daily Forecast and Actual Load by Local Resource Zone." Available at: https://www.misoenergy.org/markets-and-operations/real-time--market-data/market-reports/#nt=%2FMarketReportType%3ASummary&t=10&p=0&s=MarketReportPublished&sd=desc.

shift in peak hours to later in the day, due to greater solar PV penetration. For winter, we assume that peak demand occurs around 8 AM in January, based on a recent study by Synapse that assessed the current and future peak demand impacts from various building decarbonization scenarios for Minnesota.[16]

For the summer of 2030, we project that EVs will add between 452 MW (Low EV Case) and 827 MW (High EV Case) to today's summer peak demand without managed charging (representing 3 to 6 percent of today's summer peak demand).

For the winter, we project that EVs will add between 116 MW (Low EV Case) and 218 MW (High EV Case) to today's winter peak demand (representing 1 to 2 percent of today's winter peak demand).[17]

EV load contributes substantially less to winter coincident peak than it does to the summer peak. This is due to the daily load shapes of LDVs which account for most of the EV load and tend to be lower in the morning and higher in the evening (Figure 9).

We then estimated the impacts that managed charging would have on peak demand. Figure 10 and Figure 11 present the LDV and MHDV load contributions to the summer and winter peak demands, with and without managed charging, in 2030. As shown in Figure 10, for the summer of 2030, we project that EV managed charging just for LDVs could reduce the total EV peak demands by:

- 26 to 63 percent in the High EV Case. This would reduce summer EV peak demand from 990 MW to between 730 MW and 370 MW (equivalent to 5.1 percent to 2.6 percent of the current summer peak).
- 24 to 59 percent in the Low EV Case. This would reduce summer EV peak demand from 530 MW to between 400 MW and 220 MW (equivalent to 2.8 percent to 1.5 percent of the current summer peak).

As shown in Figure 11, for the winter of 2030, we project that EV managed charging just for LDVs could reduce the total EV peak demands by:

- 27 to 66 percent in the High EV Case. This would reduce winter EV peak demand from about 260 MW to between 190 MW and 90 MW (representing 1.6 percent to 0.8 percent of the current winter peak, respectively).

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[16] deLeon, S., K. Takahashi, E. Carlson, A. S. Hopkins, S. Kwok, J. Litynski, C. Mattioda, L. Metz. 2024. *Minnesota Building Decarbonization Analysis: Equitable and cost-effective pathways toward net-zero emissions for homes and businesses*. Synapse Energy Economics for Clean Heat Minnesota. Available at https://www.synapse-energy.com/minnesota-building-decarbonization-analysis.

[17] The current summer and winter peak demands in Minnesota are approximately 14,270 MW and 11,985 MW, respectively, based on Synapse Energy Economics (2024) *Minnesota Building Decarbonization Analysis*. Available at: https://www.synapse-energy.com/sites/default/files/MN%20Decarbonization%20Report_June%202024%2023-074.pdf.

- 26 to 63 percent in the Low EV Case. This would reduce winter EV peak demand from about 140 MW to between 100 MW and 50 MW (representing 0.9 percent to 0.4 percent of the current winter peak).

Figure 10. Summer coincident peak demand contribution from EVs in 2030, with managed charging

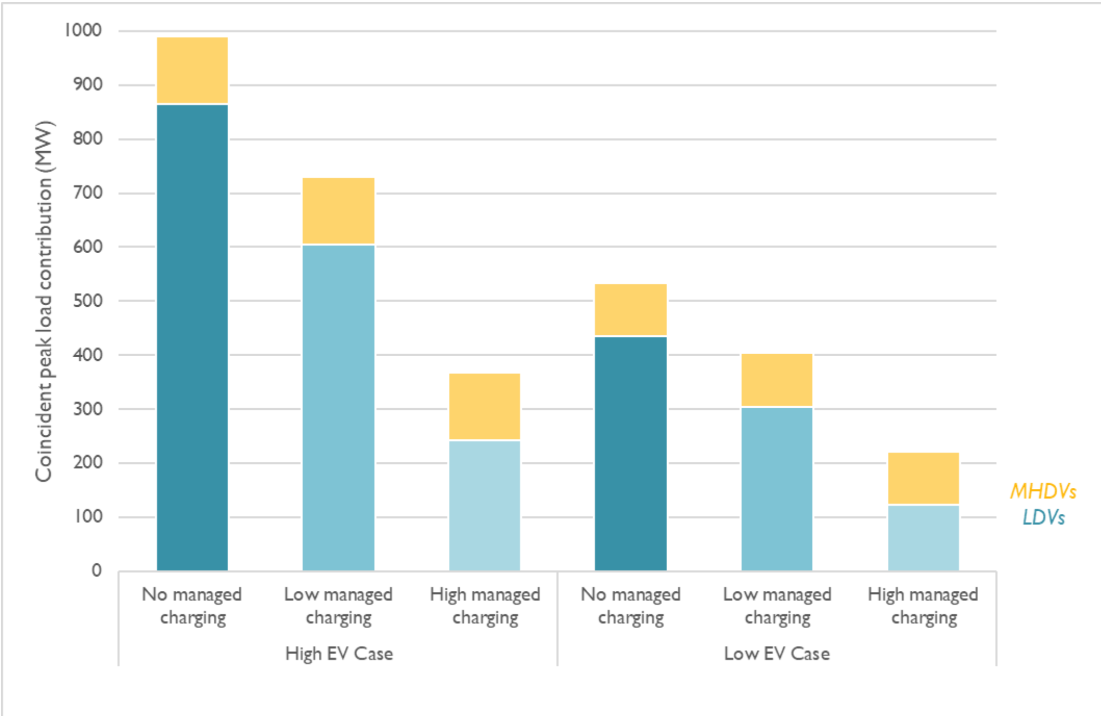
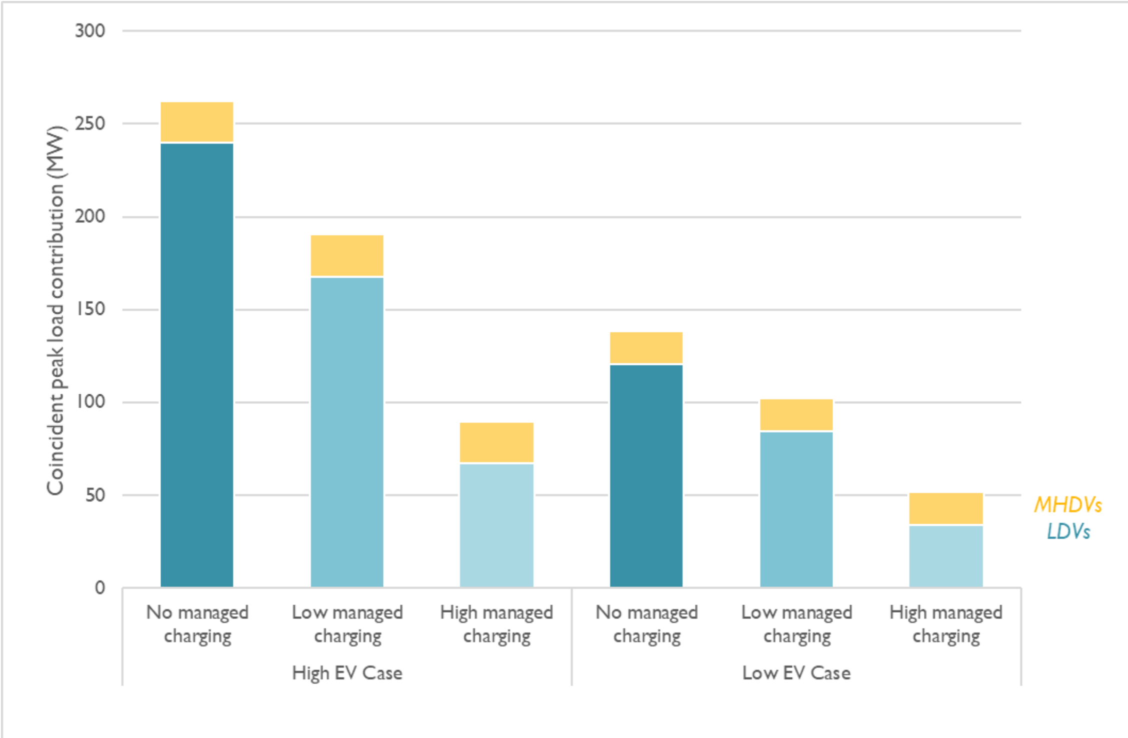


Figure 11. Winter coincident peak demand contribution from EVs in 2030, with managed charging



Utility investment impacts

Based on the expected peak demand impacts from future EV adoption for various scenarios, we conducted a high-level analysis of incremental annual utility costs related to EV charging for 2030, focusing specifically on the summer peak month when peak demands are expected to be highest. This analysis evaluated the incremental costs required for expanding electric generation capacity and transmission and distribution (T&D) systems to accommodate additional peak demand from EV charging.

The estimated cost of generation capacity is $104/kW-year, based on Xcel's recent filing regarding its ECO Triennial Plan for 2024–2026. The estimated cost for T&D expansion is based on Xcel's avoided T&D cost estimates, although we make an upward cost adjustment because Xcel's original T&D cost (about $11.4/kW-year for the current year) is one of the lowest avoided T&D cost estimates across many jurisdictions.[18] To account for this low avoided T&D cost, we made the simple adjustment of doubling Xcel's T&D avoided costs, which results in about $23/kW-year.

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[18] For example, see Mendota Group. 2014. *Benchmarking Transmission and Distribution Costs Avoided by Energy Efficiency Investments*. Available at: https://mendotagroup.com/wp-content/uploads/2018/01/PSCoBenchmarking-Avoided-TD-Costs.pdf; Synapse Energy Economics. 2018. *Value of Energy Efficiency in New York Assessment of the Range of Benefits of Energy Efficiency Programs*. Table 4. Available at: https://www.synapse-

These figures represent conservative estimates for a number of reasons: (a) our analysis does not assume any existing T&D capacity headroom and instead assumes all coincident peak demand from EVs incur utility system costs; and (b) some of the future T&D upgrades might also be driven by other factors such as building electrification and data center development, potentially supporting the incremental summer peak demands from EVs.[19] For more detailed description of our assumptions and methods, please see Appendix A: Impacts of electric vehicle managed charging.

The results of our analysis of utility investments are presented in Table 6. We estimate that in 2030 EVs could incur annualized utility costs of $55 million in the Low EV Case to $110 million in the High EV Case, without any EV managed charging. We expect that managed charging through EV programs or time-varying rates could reduce the incremental annual utility system costs to between $39 and $15 million in the Low EV Case and to between $77 million and $31 million in the High EV Case, depending on the level of managed charging assumed. These estimates do not include any program costs to administer and implement EV managed charging programs as this is outside of the scope of our analysis. However, it is important to note that implementing time-varying rates is associated with low ongoing program costs.

Table 6. Annual utility system investments to support EV adoption in 2030 ($ million)

	High EV Case			Low EV Case		
	No managed charging	Low LDV managed charging	High LDV managed charging	No managed charging	Low LDV managed charging	High LDV managed charging
Generation capacity	$90	$63	$25	$45	$32	$13
T&D	$20	$14	$6	$10	$7	$3
Total utility investment	$110	$77	$31	$55	$39	$15

Rate impacts

EV charging will generate new revenues for electric utilities due to the additional electricity sales. The overall impact of EVs on electric rates will depend on the extent to which these new revenues outweigh the costs of serving additional EV load. To develop an illustrative rate impact analysis, we compared the utility infrastructure cost estimates in 2030 shown in Table 6, plus the wholesale cost of electricity

energy.com/sites/default/files/Value_of_Energy_Efficiency_in_New_York_Final_Report_(April%202018).pdf; Synapse Energy Economics, et al. 2024. *Avoided Energy Supply Components in New England: 2024 Report*. Table 130. Available at: https://www.synapse-energy.com/sites/default/files/inline-images/AESC%202024%20May%202024.pdf.

[19] This is especially relevant for building electrification as the investments for building electrification are mainly for meeting winter peak demands and thus will create additional system headroom for the summer, which can be used to accommodate EV loads.

(assumed to be $30/MWh[20]), with the expected incremental utility revenues from EV charging.[21] We assumed a volumetric electricity rate of 13.5 cents/kWh based on 2022 statewide electricity rates.[22]

The results of our illustrative rate impact analysis indicate that the revenues from EVs will substantially outweigh the costs, even without managed charging. Figure 12 and Figure 13 present the results of our analysis of utility costs and revenues for residential customers for both scenarios. As shown in these figures, we estimated that the annual revenue exceeds the cost of serving EV load by about $330 million in the High EV Case and $164 million in the Low EV Case, without EV managed charging. In the EV managed charging scenarios ("Low managed charging" and "High managed charging") utility investments would be reduced by about 15 to 35 percent.

Because the expected revenues outweigh the utility costs, we expect that EVs will put downward pressure on rates and help reduce rates in the long term. As mentioned above, EV managed charging programs would add additional costs; however, time-varying rates, which are expected to have a greater impact on shifting EV charging to off-peak hours, tend to have low program costs. On the other hand, effective time-varying rates should reduce utility revenues, as they would encourage EV owners to charge EV batteries during lower priced, off-peak hours.

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[20] Based on current energy prices in 2023 at Minnesota hub in the MISO market. *See:* MISO historical annual real-time LMPs. Available at: https://www.misoenergy.org/markets-and-operations/real-time--market-data/market-reports/#t=10&p=0&s=MarketReportPublished&sd=desc.

[21] In this analysis, we assume that all impacts of LDVs are on residential customers, although in reality, some LDVs are used by commercial customers and will result in rate impacts for commercial classes.

[22] We derived this value based on an average statewide, all-in rate of 14.2 cents/kWh (including customer charge) for 2022 and a 5 percent contribution from the monthly customer charge (based on Xcel's current customer charge of $6 per month). The statewide average rate is based on EIA 861 database for 2022. Available at: https://www.eia.gov/electricity/data/eia861/. Xcel's current residential tariff is obtained from: Xcel Energy's residential electricity tariff, available at: https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/24-01-406-MN-Res-ElecRates-MN-Res-E-2002.pdf.

Figure 12. Total utility costs and total revenues of EV charging in 2030 – High EV Case

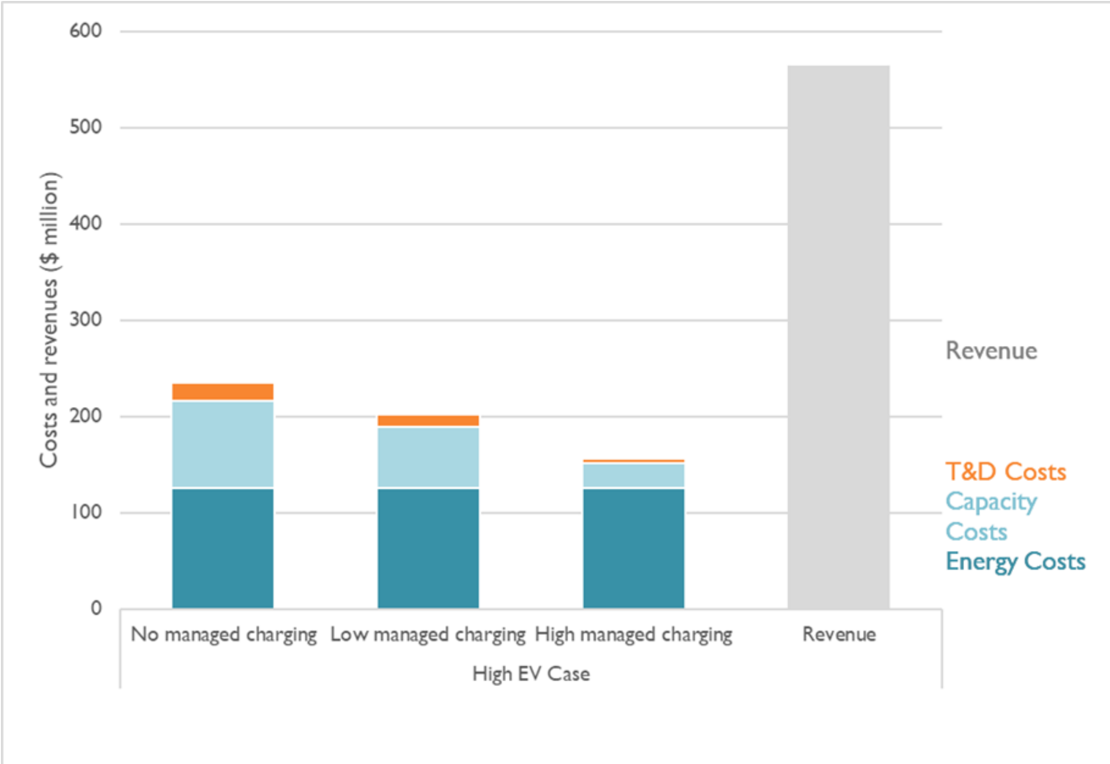
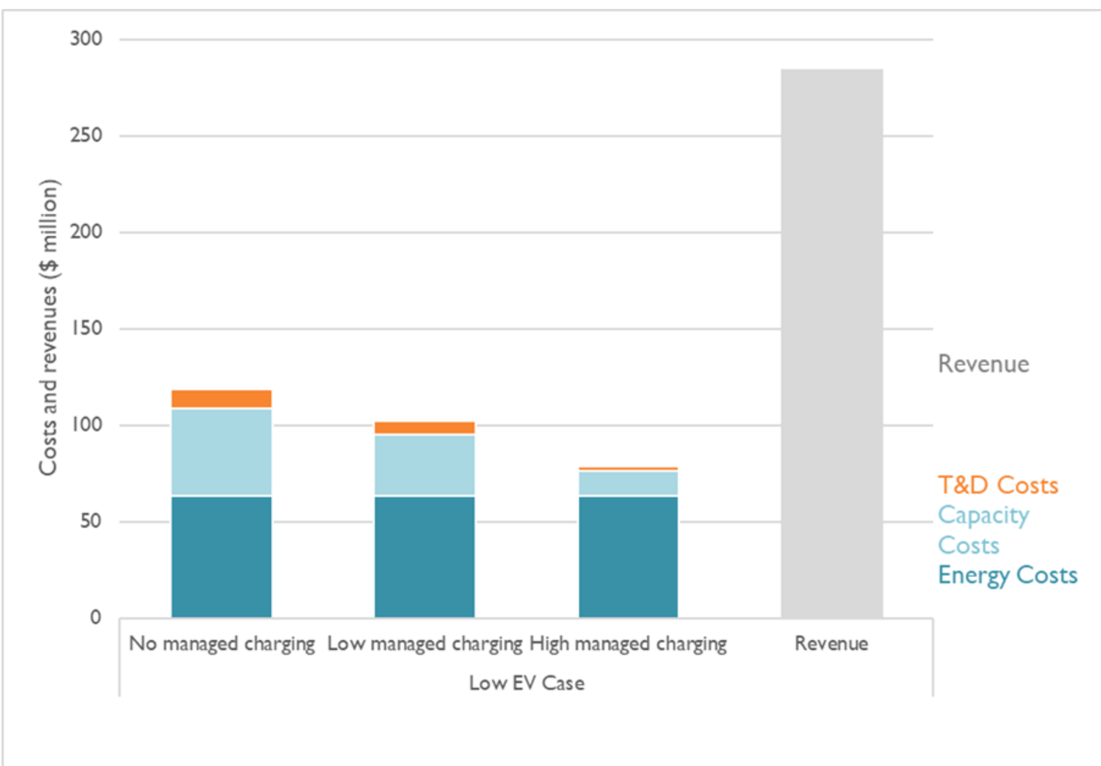


Figure 13. Total utility costs and total revenues of EV charging in 2030 – Low EV Case



Impact findings

Synapse's analysis provides a comprehensive overview of the potential future of transportation electrification in Minnesota. The key forecasts and results from our analysis are:

- **EV sales and stock**: By 2030, EVs could comprise 45 percent of LDV sales and 31 percent of MHDV sales in the Low EV Case, and 94 percent of LDV sales and 40 percent of MHDV sales in the High EV Case. Total EV stock for LDVs is projected to reach 10 percent in the Low EV Case and 20 percent in the High EV Case. Total EV stock for MHDV is projected to reach 5.6 percent in the Low EV Case and 7.2 percent in the High EV Case.

- **Electricity consumption**: EVs are expected to consume between 2.9 TWh (Low EV Case) and 5.2 TWh (High EV Case) of electricity annually by 2030, representing 4.4 percent to 7.8 percent of the state's current residential and commercial electricity load.

- **Peak demand impact**: Without managed charging, EVs could add 452 MW to 827 MW to the summer peak demand by 2030 (or 3 to 6 percent of today's summer peak demand), and 116 MW to 218 MW to the winter peak demand (or 1 to 2 percent of today's winter peak demand). Managed charging could reduce these peak demands by 24 percent to 66 percent, depending on the scenario.

- **Utility investment impacts:** Investments needed for incremental generation and transmission due to EV loads could reach $110 million per year by 2030 in the High EV Case and $55 million per year in the Low EV Case without managed charging. With managed charging, annual utility costs could be reduced to as low as $31 million in the High EV Case and $15 million in the Low EV Case, representing substantial reductions in utility investments by 30 to 72 percent.

- **Rate impacts:** Managed charging and the growth in EV electricity demand are expected to increase utility revenues significantly, potentially lowering electricity rates overall. Projected annual revenues from EV electricity sales could reach $565 million in the High EV Case and $284 million in the Low EV Case, surpassing the associated utility costs significantly.

The results suggest that substantial EV adoption could lead to considerable increases in electricity demand and peak demands, necessitating large utility investments. However, strategies such as managed charging could mitigate these impacts and reduce the need for extensive infrastructure upgrades. Further, despite potential increases in utility costs, higher revenues from electricity sales to EVs are likely to exert downward pressure on utility rates, benefiting all electricity consumers. The findings show the potential impacts and benefits of future EV deployments. They also highlight the importance of proactive planning and the critical role of managed charging in maximizing the benefits of EV adoption, highlighting its potential to mitigate peak demand impacts and rate impacts.

Minnesota's utility electric vehicle programs

The peak demand analysis above demonstrates the benefit that managed charging can have on mitigating adverse EV charging impacts to the distribution system. In addition, it is important to keep the costs of utility transportation electrification programs low to maximize net revenues from EV charging, which can reduce electricity rates for all customers. Thus, utility EV programs should focus on encouraging off-peak EV charging and be designed in a manner that maximizes benefits and minimizes costs.

In Minnesota, the utility program landscape is changing to support transportation electrification and mitigate the impacts of EV charging on the grid. Xcel, Minnesota Power, and Otter Tail all offer programs related to EV rate design, load management, and EV charging infrastructure. Synapse reviewed the current utility EV programs and developed three case studies that describe how the largest Minnesota utilities are supporting the transportation electrification while working to mitigate the impacts of EV charging on the grid.

Treatment of electric vehicles in the ECO program

The ECO program is a utility-administered program with regulatory oversight provided by the Minnesota Department of Commerce (the Department). Utility ECO portfolios promote energy-efficient technologies and practices by providing rebates, marketing, and technical assistance to utility customers.

On May 25, 2021, Governor Tim Walz signed the *Energy Conservation and Optimization Act* (ECO Act) into law.[23] The ECO Act primarily serves to modernize the precursor Conservation Improvement Program (CIP) to provide a more holistic approach to energy efficiency programming. Notable highlights of the ECO Act include the following:

- Providing participating electric and natural gas utilities the opportunity to optimize energy use and delivery through the inclusion of load management[24] and efficient fuel-switching programs[25]
- Raising the energy savings goals for the state's electric investor-owned utilities[26]
- More than doubling the low-income spending requirement for all investor-owned utilities[27]
- Providing greater planning flexibility for participating municipal and cooperative utilities[28]
- Including activities to improve energy efficiency for public schools[29]

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[23] Minn. Stat. § 216B.241.

[24] Minn. Stat. § 216B.241, subd. 13.

[25] Minn. Stat. § 216B.2403, subd. 8.

[26] Minn. Stat. § 216B.241, subd. 1c(b).

[27] Minn. Stat. § 216B.241, subd. 7(a).

[28] Minn. Stat. § 216B.2403, subd. 3.

[29] Minn. Stat. §§ 216B.2403, subd 3(j) and 216B.241, subd. 2(i).

Additionally, the Minnesota legislature determined that it is the energy policy of the state to "achieve annual energy savings equivalent to at least 2.5 percent of annual retail energy sales of electricity and natural gas through multiple measures," including but not limited to cost-effective ECO programs, rate design, programs designed to transform the market or change consumer behavior, and other efforts to promote energy efficiency and energy conservation.[30] In Synapse's view, these new energy savings targets, coupled with the growth of EV adoption in the state, make EV charging a clear target for achieving electricity savings goals prescribed by the ECO Act.

Investor-owned utilities in Minnesota are required to file triennial plans that outline their ECO program goals for the next three years. The ECO Act sets energy savings goals for electric and gas utilities that are calculated as a percentage of their total retail sales. Notably, the electricity savings goals are inherently related to EV load growth.

The ECO Act specifically allows utilities to subtract the electricity sales associated with EV charging from their gross annual retail energy sales.[31] Commerce issued a December 30, 2021, decision that provides approved technical guidance for determining EV charging sales that are eligible to be excluded from a utility's gross annual retail energy sales.[32] To be eligible for exclusion, a utility must demonstrate a connection between EV charging sales and that utility's program, rate, or tariff for EV charging. This means that just because a utility sells energy for EV charging, those sales are not all automatically subtracted from the utility's gross sales for the purposes of developing a utility's required ECO energy savings goal. This also creates a strong incentive for Minnesota utilities to establish EV charging programs, rates, and tariffs.

Minnesota also has a Technical Reference Manual (TRM) that contains standard methodologies and inputs for calculating the energy savings impacts of ECO programs in the state. The TRM discusses EVs in several contexts. For example, it notes that Minnesota Statute § 216B.1614 requires each public utility to have a tariff specifically designed for EV charging that offers time-of-day or off-peak rates to customers who own EVs. It also describes one of the key benefits of EV managed charging: that matching "EV charging with wind generation, which is typically greatest during overnight hours, could allow utilities to best utilize wind as a resource and potentially support increased wind generation." The

[30] Minn. Stat. § 216B.2401.

[31] Minnesota Statutes §216b.2402, subd. 10 provides the definition of "gross annual retail energy sales." Gross annual retail energy sales do not include the amount of electric sales prior to December 31, 2032, that are associated with a utility's program, rate, or tariff for EV charging based on a methodology and assumptions developed by the Department. After December 31, 2032, incremental sales to EVs must be included in calculating a utility's gross annual retail sales.

[32] "Deputy Commissioner's Decision: In the Matter of Technical Guidance to Determine Eligible EV Charging Sales to be Deducted from Utility Gross Annual Retail Energy Sales." Minnesota Department of Commerce. December 30, 2021. Docket No. CIP-21-837. Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={70AE0C7E-0000-CE17-8D33-2BB0C26177D4}&documentTitle=202112-181101-01.

TRM also includes detailed instructions and different options for calculating the amount of EV load that may be subtracted from utilities' gross sales and provides technical guidance for fuel-switching.[33]

Xcel, MP, and Otter Tail submitted their 2024–2026 ECO Triennial Plans in 2023, which were subsequently approved by the Department. Of these three plans, only Otter Tail's plan specifically mentioned a program designed to support the management of EV load. We discuss this program in greater detail below. Otter Tail also acknowledged in its comments on the investor-owned utilities' Triennial Plans that EVs and electric outdoor equipment options have a much greater impact on reducing greenhouse gas emissions than the replacement of residential natural gas appliances with electric ones.[34] In addition, Otter Tail proposed to subtract 2022 EV electricity sales from its weather-normalized retail sales.[35]

Xcel did not mention any EV programs in its Triennial Plan and did not propose that any 2022 EV charging sales be excluded from its gross retail energy sales.[36] Similarly, while MP did propose an amount of EV charging to be subtracted from its gross retail sales,[37] MP did not discuss any specific EV programs in its Triennial Plan.[38] Xcel and MP provide a suite of EV programs outside of the ECO program.[39]

Utility electric vehicle case studies

Synapse examined the EV programs currently offered by Xcel, MP, and Otter Tail and identified a mix of load management and EV infrastructure programs for the following three case studies:

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[33] State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs. Version 4.1. Final. January 31, 2024. Page 247.

[34] "Deputy Commissioner's Decision: In the Matter of Otter Tail Power Company's 2024-2026 Energy Conservation and Optimization Triennial Plan." Minnesota Department of Commerce. December 1, 2023. Docket No. CIP-23-094. Page 79.

[35] As noted in the Commission's approval of Otter Tail's Triennial Plan, Otter Tail initially mis-applied the 2022 EV sales, by subtracting them from the average annual weather-annualized sales from 2020 through 2022. The Deputy Commissioner corrected Otter Tail, noting that the 2022 EV sales could only be subtracted from the 2022 weather normalized sales, not from the three-year average. This resulted in a higher average retail energy sales number, and a correspondingly higher savings goal, which Otter Tail's energy savings plan was still able to meet. See Page 116 of the Deputy Commissioner's Decision to approve Otter Tail's 2024-2026 Triennial Plan.

[36] Xcel Energy, "2024-2026 ECO Triennial Plan: Minnesota Electric and Natural Gas Energy Conservation and Optimization Program." Docket CIP-23-92.

[37] "Deputy Commissioner's Decision: In the Matter Minnesota Power's 2024-2026 Energy Conservation and Optimization Triennial Plan." Minnesota Department of Commerce. December 1, 2023. Docket No. CIP-23-093.

[38] Minnesota Power, "Energy Conservation and Optimization Plan." Docket CIP-23-93.

[39] Minnesota Public Utilities Commission EV Webpage: https://mn.gov/puc/activities/economic-analysis/electric-vehicles/.

- Otter Tail's Load Management for Electric Vehicles program, which pairs a Level 2 EV charger rebate with the requirement that the customer enroll in one of the available time-of-use (TOU) rates.
- Xcel's Optimize Your Charge program, which encourages customers to charge during off-peak periods.
- MP's DC Fast Charger program, where MP installs, owns, and operates a network of public fast-charging stations.

For each case study, we summarize the program's overarching goals, program design, and performance, and assess how each program compares to others in Minnesota and across the country to inform recommendations for improvements.

Otter Tail

Program summary

The Otter Tail load management program for EVs pairs a $500 rebate for installing a Level 2 EV charger with a requirement for customers to enroll in one of Otter Tail's TOU rates. The goal of the program is to support EV charger deployment while at the same time enrolling customers immediately in managed charging to mitigate peak demand impacts. This program originated in Otter Tail's ECO Triennial Plan for 2024–2026, which was the first Triennial Plan to include EV-related load management programs. These programs encompass various demand response types, including EV load management, with a specific emphasis on winter season loads since Otter Tail is a winter-peaking utility.[40] About one-third of Otter Tail's customers currently participate in a load management program.

Otter Tail's ECO Triennial Plan budgets more than $300,000 per year from 2024 to 2026 for load management measures, which it expects to yield approximately 61 MW of winter peak demand reductions. Although EV peak reductions are not separately broken out, combined with other load management measures they demonstrate the highest benefit-cost ratio of any program in Otter Tail's triennial filing under the Minnesota Test, which is more than three times higher than the next-highest scoring program. Table 7 below shows Otter Tail's benefit-cost analysis results for its ECO programs.

[40] Otter Tail Power, "Energy Conservation and Optimization Plan." Docket CIP-23-94. Available at *https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={C0565C8D-0000-C010-A5F2-7B81B0CB3FB1}&documentTitle=20241-202894-01*.

Table 7. Otter Tail Power Minnesota ECO benefit-cost test results

	Minnesota Test	Utility Test	Ratepayer Impact Test	Societal Test	Participant Test
Load Management Program	24.62	24.62	8.02	13.75	2.13

Source: Otter Tail Power, "Energy Conservation and Optimization Plan." Docket CIP-23-94. Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={C0565C8D-0000-C010-A5F2-7B81B0CB3FB1}&documentTitle=20241-202894-01.

For customers to qualify for the load management program's $500 charger rebate, they must enroll in one of five eligible off-peak rates that Otter Tail already offers as part of its demand response program: Dual Fuel, Deferred Load, Fixed Time of Service (FTOS), Residential Demand Control (RDC), and EV Charging Rate.[41] What is unique about these rates is that many were designed for electrified loads other than EVs. Otter Tail has since expanded them to allow customers with EVs to enroll in them. The following section will briefly describe each of the off-peak tariffs that are included in the ECO Triennial plan's Load Management for EV charging program.

Electric Vehicle Charging Rate*:* The EV Charging Rate is a TOU rate in which energy is delivered only during off-peak hours (10 PM to 6 AM). All other hours of electric service are unauthorized and subject to penalty kilowatt-hour charges.[42] Currently, there are approximately 9 customers participating in this rate schedule, and the utility anticipates an additional 30 participants.[43] This is relatively few customers, but it must be noted that Otter Tail customers own fewer EVs than customers of the other investor-owned utilities in Minnesota, as shown in Table 8.[44]

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[41] *Id*. Pg. 116.

[42] *Id*. Pg. 112. https://www.otpco.com/pricing/minnesota/residential-rate-summary-mn/

[43] Otter Tail Triennial Plan 2024-2026. Pg. 114.

[44] Minnesota Public Utilities Commission, "Order Approving Pilot Program, Granting Deferred Accounting, and Setting Additional requirements." October 27, 2020. Docket No. M-20-181. Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId=%7b50A86B75-0000-C816-B1F8-2B2766A35C71%7d&documentTitle=202010-167708-01.

Table 8. Customers and EVs shares among Minnesota investor-owned utilities (2023)

Utility	Customers	% of Total Customers	Total EVs	% of Total EVs
Xcel Energy	1,365,978	86.5%	45,267	95%
Minnesota Power	151,172	9.6%	1,564	3%
Otter Tail Power	62,771	4.0%	577	1%
Total	**1,579,921**		**47,408**	

Sources: Total EVs: Atlas Public Policy, EValuateMN, *https://atlaspolicy.com/evaluatemn/*. Customer Count: EIA 861M Sales and Revenue *https://www.eia.gov/electricity/data/eia861m/*.

Dual Fuel Rate: The Dual Fuel Rate is a rate plan designed for customers with dual-fuel systems which use electricity as the primary fuel source with a non-electric backup. Otter Tail can interrupt electric service during peak conditions. Level 2 EV chargers can be included when an interruptible heating load is installed.[45] This rate offers a unique way to incentivize both building electrification and EV load management.

Deferred Load Rate: The Deferred Load Rate is designed for thermal-storage heating or cooling technologies that allow Otter Tail to control the system for up to 14 hours a day.[46] Level 2 EV chargers can be added to this rate if an eligible thermal storage heating system is also installed.

Residential Demand Control Rate: In the Residential Demand Control Rate, Otter Tail manages the customer's electric load to meet customer-chosen demand settings during peak energy demand periods to meet needed reduction, which can also include EV charging.[47]

Fixed Time of Delivery Rate: The Fixed Time of Delivery Rate is available for permanently connected thermal-storage and Level 2 EV charging systems and is designed to deliver electricity during low-demand hours from 10 PM to 6 AM. The rate provides a discount of 50 percent relative to Otter Tail's standard priced electricity.[48]

How the program compares to utility programs in Minnesota

Otter Tail was the only investor-owned utility in Minnesota to include EV charging load management programs in its 2024–2026 ECO Triennial Plan. In addition, the program's flexible selection of applicable

[45] Otter Tail Power Company, "Dual Fuel Rate." Available at https://www.otpco.com/ways-to-save/programs/dual-fuel/.

[46] Otter Tail Power Company, "Deferred Load Rate." Available at https://www.otpco.com/ways-to-save/programs/deferred-load/ https://www.otpco.com/ways-to-save/programs/deferred-load/.

[47] Otter Tail Power Company, "Residential Demand Control Rate." Available at https://www.otpco.com/ways-to-save/programs/residential-demand-control-rdc/.

[48] Otter Tail Power Company, "Fixed Time of Delivery Rate." Available at https://www.otpco.com/ways-to-save/programs/fixed-time-of-delivery/.

rates offers a path for customers with non-EV loads (such as thermal storage and heating and cooling technologies) to also enroll EVs on a discounted, time-varying rate.

Otter Tail's Load Management program, which pairs a TOU rate with a charger rebate, is a common approach by utilities across the state to help manage EV charging as soon as customers install chargers. For instance, MP provides a discounted residential EV service rate, mirroring Otter Tail's structure, that also offers a $500 rebate for the purchase of a qualified Level 2 charger. Dakota Electric also offers two voluntary options at reduced rates for charging plug-in EVs during specified off-peak hours, along with a rebate of up to $500 for charging circuit installations.[49] However, Otter Tail provides the most extensive array of rate options among the utilities that we reviewed.

Xcel Energy's "EV Accelerate at Home" program features a variation of the rebate-plus-rate structure exemplified by Otter Tail. Rather than provide a rebate for customer-owned chargers, Xcel's program offers to provide and maintain a separately metered Level 2 charger, which customers can rent for a monthly payment of $16.63.[50] This structure offers an alternative approach to a rebate to reduce the upfront cost of charger installation.

How the program compares to utility programs outside Minnesota

Otter Tail Power's Load Management program for EV Charging adheres to the best practice of requiring customers that receive an EV charger rebate to enroll in a time-varying rate to encourage off-peak charging. While Otter Tail's approach is sound, there are other EV charging programs and rate structures across the country with additional components to further support adoption or manage load during periods of system stress that merit consideration.

In order to help lower-income customers overcome EV charger cost barriers, Pacific Gas and Electric (PG&E) in California provides additional incentives for income-eligible households. While PG&E provides a standard $700 rebate on PG&E-approved EV charging equipment to all eligible residential customers,[51] income-eligible households can also receive $2,500 to support charger installation.[52] Notably, this program includes the provision of a free Level 2 charger valued at $500 and covers up to $2,000 for panel upgrades, distinguishing it from Otter Tail's program which does not assist in installation and panel upgrade costs for income-eligible customers.

Some programs use dynamic rates or other demand response events to encourage customers to avoid charging during actual system peaks. In Michigan, DTE Energy offers a similar program to Otter Tail's in

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[49] Dakota Electric (2023), "Electric Vehicle Packet". Available at https://www.dakotaelectric.com/member-services/programs-rebates/for-your-home/electric-vehicle-charging/.

[50] Xcel Energy, "EV Accelerate at Home." Available at https://ev.xcelenergy.com/ev-accelerate-at-home-mn.

[51] PG&E, "Residential Charging Solutions Rebate". Available at https://www.pge.com/en/clean-energy/electric-vehicles/getting-started-with-electric-vehicles/residential-charging-solutions-rebate.html.

[52] PG&E, "Empower EV Program." Available at https://www.pge.com/en/clean-energy/electric-vehicles/empower-ev-program.html.

that customers qualify to receive a $500 rebate upon installing a Level 2 charger and enrolling in a qualifying electric rate. One of DTE's rates is a Dynamic Peak Pricing rate, which includes a critical peak pricing component. This rate structure goes beyond typical TOU rates up to 14 weekends per year during "critical peak" events by increasing rates to as high as $1.03 per kWh.[53] The ability to call critical peak events gives DTE another way to manage EV load during rare periods of particularly high stress.

Dominion Energy in Virginia offers another approach to load management with its Dynamic Load Management program, which offers a fixed incentive for adjusting charging schedules and charging speed during high-demand periods. The program includes demand response events during peak system demand which can last up to four hours providing a bill credit of $40 per year for participants.[54]

Program assessment

While it is beneficial for Otter Tail to require customers that receive an EV charger rebate to enroll in an EV TOU rate, we caution that the $500 rebate is likely too high or not needed for non-low-income customers. An increasing number of auto makers are providing customers with a Level 2 charger or Level 2 charger incentives with the purchase of an EV. For example, Edmunds conducted a survey in 2023, detailing 19 common auto makers that provide either incentives toward the purchase of a residential charger (ranging from $100 to $500) or unlimited fast-charging for a certain number of years at a specified charging network.[55] There are also existing federal incentives to support the purchase and installation of EV chargers. For instance, the federal *Inflation Reduction Act of 2022* (IRA) extended and amended the 30C Alternative Fuel Vehicle Refueling Property Credit (30C income tax credit). A tax credit of up to $1,000 is available to customers who purchase and install qualified alternative fuel vehicle refueling property for their principal residence, including EV charging equipment, between December 31, 2022, and January 1, 2033.[56] These existing non-utility incentives could lead to high levels of free ridership in a utility program that provides incentives for EV chargers. Free ridership refers to situations whereby participants in a program would have adopted an EV or invested in charging infrastructure even without the existence of the program or incentive.[57]

For these reasons, some jurisdictions are moving away from utility incentives for Level 2 chargers. For example, in Maryland the utilities originally offered a $300 rebate to encourage customers to purchase a

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[53] DTE, "Dynamic Peak Pricing." Available at https://solutions.dteenergy.com/dte/en/Products/Dynamic-Peak-Pricing/p/DPP.

[54] Dominion Energy, "EV Charger Rewards." Available at https://www.dominionenergy.com/virginia/save-energy/ev-charger-rewards.

[55] Edmunds website: https://www.edmunds.com/car-news/evs-with-free-charging.html.

[56] Argonne National Laboratory Refueling Infrastructure Tax Credit webpage: https://www.anl.gov/esia/refueling-infrastructure-tax-credit.

[57] The impact of free ridership is a standard part of energy efficiency evaluations. Utility energy efficiency programs undergo independent third-party evaluations to determine a net-to-gross ratio that measures the portion of participation that would not have occurred but for the program. Evaluators apply this ratio to energy savings to determine what portion of those savings can be directly attributable to the utility program, often referred to as net savings.

Level 2 charger. Once those rebates were exhausted, the Maryland commission denied the utilities' request for additional budget, noting that "where the rebates were intended to cover the price gap between smart and non-smart chargers, the Commission finds that use of a smart charger is becoming less relevant as more EVs enter the market with the capability of leveraging on-board telematics."[58] Similarly, in Massachusetts, NSTAR Electric and National Grid each proposed to offer EVSE rebates to residential customers, with enhanced rebates to residential customers on their low-income discount rate or residing in an environmental justice community. The Massachusetts Department of Public Utilities ultimately limited those programs to low-income customers, stating that "the Companies' residential programs may disproportionately benefit higher-income customers…. Instead, the Department finds it appropriate to limit the availability of residential program EVSE rebates for one- to four-unit properties to low-income customers, who face the greatest financial barriers to EV adoption."[59]

We recommend that, Instead of providing rebates for Level 2 EV Chargers, future programs provide an incentive to encourage participation in load management programs for customers that have an existing Level 2 Charger and by leveraging on-board telematics.

Xcel Energy

Program summary

Xcel Energy has a non-ECO charging pilot program called Optimize Your Charge that launched in December 2022.[60] The goal of the program is to encourage customers to charge during off-peak periods without penalizing them with a higher rate if they do not. In 2023, Xcel enrolled 1,269 residential customers and 8 commercial customers in the program.[61] The program offers a fixed $50 annual bill credit per eligible charging station or vehicle when customers charge at least 25 percent during designated off-peak hours.

To be eligible for Optimize Your Charge, customers must have a Level 2 charger, BEV, or PHEV from Xcel's approved list and agree to charge their vehicles during hours of low demand. If customers do not

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[58] Maryland Public Service Commission Order No. 90036 in Case No. 9478, at 22-23. January 11, 2022.

[59] The Commonwealth of Massachusetts Department of Public Utilities ("MA DPU") December 30, 2022 Order in cases D.P.U. 21-90; D.P.U. 21-91; D.P.U. 21-92, pgs. 116-117.

[60] Xcel Energy. "Compliance Filing – Optimize Your Charge." Docket E002/M21-101. Filed March 14, 2022. Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={209A2980-0000-CC12-B9F9-E2B45B287463}&documentTitle=20224-184777-01.

[61] Xcel Energy. "Compliance Filing: Xcel Energy Demand Response Compliance." Docket Nos. E002/M-20-421, E002/RP-19-368, E002/M-21-101, E002/CI-17-401. Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={0079668D-0000-C33F-921B-7AD5269841F3}&documentTitle=20242-203019-02.

already have a Level 2 charger, they can rent one from Xcel through a separate program, then enroll.[62] Enrolled residential customers can choose between an 11:00 PM to 7:00 AM. charging schedule or a 10:00 PM to 6:00 AM charging schedule. Commercial customers can choose between a 9:00 PM to 5:00 AM schedule and a 1:00 AM to 9:00 AM schedule.

Customers that are already enrolled in one of Xcel's TOU rates are eligible to participate in the Optimize Your Charge pilot. To isolate the peak demand reductions of the Optimize Your Charge pilot from TOU rates, Xcel will use vehicle charging data to assess the charging profiles before and after participation in the pilot for customers who are already enrolled in a TOU rate.[63]

How the program compares to utility programs in Minnesota

Multiple utilities in Minnesota use TOU rates to manage EV load. However, the way Xcel's Optimize your Charge program pairs a fixed incentive with the capability to also enroll in TOU rates is unique. It is much more common for utilities in Minnesota to offer fixed incentives in the form of rebates to install charging equipment, while also requiring that customers enroll in a TOU rate to receive the rebate.

How the program compares to utility programs outside Minnesota

While utilities in other jurisdictions offer similar passive managed charging programs, they tend to require a higher percentage of off-peak charging for participants to be eligible to earn an incentive. For example, the New York State Electric and Gas OptimizEV managed charging program has a similar structure as Xcel's Optimize Your Charge program, yet only allows participants to earn incentives if at least 80 percent of their charging occurs within a 7.5-hour off peak period.[64] The same program offered by Rochester Gas and Electric also requires at least 80 percent charging during a 10-hour off-peak period.[65]

Program assessment

Xcel's Optimize Your Charge pilot aligns with best practices by not rebating a new Level 2 charger and instead providing an annual $50 rebate to reward off-peak charging. This programmatic design reduces program costs while encouraging charging at times that benefit the electric system. In addition, Xcel's

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[62] Xcel Energy, "Optimize Your Charge." Available at https://ev.xcelenergy.com/optimize-your-charge-mn.

[63] Xcel Energy. "Compliance Filing: Xcel Energy Demand Response Compliance." Docket Nos. E002/M-20-421, E002/RP-19-368, E002/M-21-101, E002/CI-17-401. Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={0079668D-0000-C33F-921B-7AD5269841F3}&documentTitle=20242-203019-02.

[64] New York State Electric and Gas. OptimizEV, pg. 3. https://www.nyseg.com/documents/40132/72042565/FINAL+NEVC002+NYSEG+Optimize+EV+Booklet+Program+Guide+09-2023.pdf/8ce75ef5-1129-d5a0-4dce-19dc627bd302?t=1696010775775.

[65] Rochester Gas and Electric. OptimizEV, pg. 3. https://www.rge.com/documents/40137/72049582/FINAL+REVC002+RG%26E+Optimize+EV+Booklet+Program+Guide+09-2023.pdf/58c63209-34d1-9859-a0dd-e092da1f730a?t=1696009789197.

program includes flexibility via compatibility with multiple rate plans. This is beneficial as customers all have different preferences and charging behaviors. However, we find that the requirement for participants to charge at least 25 percent during the off-peak window to be insufficient; it should be increased to 80 percent. Managed charging programs should incentivize participants to minimize on-peak charging and shift all or a majority of their EV charging load to off-peak periods, and particularly to avoid hours when the grid is most stressed.

While Xcel has a plan to avoid double-counting of the load reduction benefits due to a customer enrolling in both the Optimize Your Charge pilot and a TOU rate, we caution that the stacking of the $50 pilot rebate with the TOU rate could result in overcompensating for the resulting load reduction. We recommend that this issue be examined as part of an evaluation of the Optimize Your Charge pilot.

Minnesota Power

Program summary

MP has a non-ECO program, the DC Fast Charger program, that allows MP to install, own, and operate 16 direct-current fast-charging (DCFC) sites in northern Minnesota starting in 2023 to “encourage EV adoption by easing range anxiety and creating equitable access to charging for all EV drivers.”[66] MP plans to install one DCFC per site, ranging from 50 kW to 350 KW, each of which can charge two vehicles at a time. MP will also install one Level 2 charger per site as a backup option if the DCFC is in use or offline. MP will be responsible for the construction, operation, and maintenance of the fast charger at each site.[67]

So far, MP has prioritized locations in both rural and densely populated areas within MP’s service area where “there are large distance gaps between existing public chargers.” These include 14 chargers located in communities and two along highways. Specific sites for chargers within these communities will be chosen based on eight criteria: proximity to 3-phase power; 24-hour access; area lighting; proximity to highways or interstates; availability of public restrooms; and proximity to food, shopping, and local attractions. MP is now accepting site recommendations from customers.[68]

MP’s DC Fast Charger program grew out of the Minnesota Public Utilities Commission’s investigation into EV Charging and Infrastructure in 2019, which found that electrification of Minnesota’s transportation infrastructure is in the public interest because it can place downward pressure on rates, grow renewable energy through flexible charging measures, and reduce greenhouse gas emissions.[69]

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[66] Minnesota Power, “Electric Vehicle DC Fast Charger Program.” Available at https://www.mnpower.com/ProgramsRebates/EVdcfcProgram.

[67] *Ibid*.

[68] *Ibid*.

[69] Order of the Minnesota Public Utilities Commission, “In the Matter of a Commission Inquiry into Electric Vehicle Charging and Infrastructure.” February 2019, Docket No. E-999/CI-17-879.

In April of 2021, MP filed a petition to install and own the 16 DCFCs, as well as to track and recover expenses for the project via deferred accounting which was approved by the Commission in October of 2021.[70,71] MP claimed that it had already "aggressively developed" several programs, including rebates for home charging and EV charging rates, designed to "increase customer awareness of EVs and their related benefits, reduce the costs associate with owning an EV and encourage grid optimized charging." The missing piece in MP's EV support strategy was access to reliable public EV charging. By building out 16 sites, MP's intent was to stimulate EV adoption across the state and, in turn, drive additional demand for charging infrastructure.[72]

At the time of its petition, MP's customers owned approximately 260 EVs, and the utility estimated that by 2030 its customers would own about 4,200. This represented a six-year lag behind expected adoption trends at the national level. In addition, only seven public DCFC stations had been built throughout MP's 26,000 square mile service territory, two of which were only compatible with Tesla vehicles. MP analyzed usage at existing charging stations and EV adoption forecasts to determine a need for 16 DCFC stations, more than doubling the number of existing DCFC stations in its service territory. MP also proposed to include an automatic time-of-day rate structure at each charger that is consistent with how third-party provider stations would be billed.[73] The Commission approved MP's petition in 2021; however, vendor-related challenges have delayed project completion until the summer of 2024.[74]

How the program compares to utility programs in Minnesota

Otter Tail and Xcel are also actively deploying DCFC stations across their service territories. In 2020, Otter Tail petitioned and received approval to own and operate 11 DCFCs and 10 accompanying Level 2 chargers at a cost of $1.6 million, plus about $500,000 in operations and maintenance.[75] Otter Tail now has DCFC stations available in six communities: Dawson, Fergus Falls, Hallock, Mahnomen, Morris, and

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[70] Minnesota Power, "petition for Approval of Electric Vehicle Charging Infrastructure Investment." April 8, 2021. Docket No. E015/M-21-257 Available at https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={40B8B278-0000-CE17-A17C-68AC2AA0E27F}&documentTitle=20214-172682-01.

[71] Order of the Minnesota Public Utilities Commission. September 12, 2023. Docket No. E015/M-21-257 Available at: https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={60D5898A-0000-C51B-9316-7C26EBB8A938}&documentTitle=20239-198867-01.

[72] *Ibid*.

[73] *Ibid*.

[74] Minnesota Public Utilities Commission Decision, "In the Matter of Minnesota Power's (MP) Electric Vehicle Charging Infrastructure Investment." September 12, 2023. Docket No. M-21-257.

[75] Minnesota Public Utilities Commission Order, "Order Approving Pilot Program, Granting Deferred Accounting, and Setting Additional Requirements." October 27, 2020. Docket No. E017/M-20-181. Available at: https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={50A86B75-0000-C816-B1F8-2B2766A35C71}&documentTitle=202010-167708-01.

Perham; it aims to install five more DCFC stations in Minnesota by the end of 2024.[76] Similar to MP, Otter Tail received approval for deferred accounting for the DCFC program.[77]

Xcel also has received approval to build and own 21 DCFC stations throughout rural Minnesota.[78] In addition, Xcel has a Public Charging Infrastructure Pilot program in its EV portfolio.[79] Through this program, Xcel installs, owns, and maintains EV make-ready infrastructure – up to the customer's charging equipment, for developers of public charging stations along corridors and at community mobility hubs but does not own or maintain any charging equipment. As of January 31, 2024, Xcel reported 128 projects enrolled in the pilot with an additional 45 sites under construction, incurring $9.9 million in costs for the pilot.[80]

How the program compares to utility programs outside Minnesota

DCFC deployment is widely considered a cornerstone of proactive EV planning; however, the role of the utility versus the private market in supporting DCFC deployment differs based on the jurisdiction. There has been substantial debate over who should be allowed to own public charging stations—whether it should be "a market competition framework, a monopoly utility construct, or a hybrid where utilities are allowed to compete for public charging stations."[81] Some states such as Maryland, allow utilities to own a limited number of public charging stations,[82] while other states only allow for utility ownership of EV chargers when there is a clear market failure of the private market. For example, New Jersey adopted "Last Resort" criteria that the utilities must demonstrate before requesting to own and operate charging infrastructure. The criteria includes whether the proposed charging site is more than 25 miles from another charging station; whether the utility has had a minimum of 12 months of no expressions of interest from private owners of EVSE in overburdened communities; whether the utility has had a minimum of 18 months of no expressions of interest from private owners of EVSE in non-overburdened communities; and other factors including the density of the area.[83]

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[76] Otter Tail Power Company, "Drive Electric with an EV." Available at https://www.otpco.com/ways-to-save/topics/electric-vehicles/.

[77] Minnesota Public Utilities Commission Order, "Order Approving Pilot Program, Granting Deferred Accounting, and Setting Additional Requirements." October 27, 2020. Docket No. E017/M-20-181.

[78] Minnesota Public Utilities Commission Order in Docket No. E002/M-18- 643. December 5, 2022 at pg. 8.

[79] Minnesota Public Utilities Commission Order in Docket E002/M-18-643, December 5, 2022.

[80] Xcel Energy. Quarterly Report, Annual Report on EV Charging Tariffs, Programs and Pilots. Docket Nos. E002/M-18-643 and E002/M-20-711. March 1, 2024. Available at: https://www.edockets.state.mn.us/edockets/searchDocuments.do?method=showPoup&documentId={80A9278C-0000-C629-9BB5-FB177841E139}&documentTitle=202312-200934-04. At pg. 4.

[81] Gramlich et al. (2023), "Serving Customers Best: The Benefits of Competitive Electric Vehicle Charging Stations." Available at https://gridstrategiesllc.com/wp-content/uploads/2023/05/GS_EV-Paper.pdf.

[82] *Ibid.*

[83] New Jersey Board of Public Utilities Docket No. QO20050357, September 23, 2020, pg. 12.

Minnesota is another such state. Although utilities are allowed to own public charging stations, as shown by MP's DCFC program, Minn. Stat. 216B.02, Subd. 4 exempts entities that sell electricity for EV charging from regulation as a public utility, which allows non-utilities to develop and operate charging infrastructure. Laws like this are important for ensuring third-party competitiveness.[84]

An area where jurisdictions are more apt to allow for utility intervention in the private market is in disadvantaged and underserved communities where the private market often does not deliver the needed charging infrastructure. Priority for charging site selection should be given to disadvantaged communities in order to improve their air quality, particularly for MHDV electrification.[85] In California, for example, the California Public Utilities Commission allowed Southern California Edison to own up to 2,500 charging ports only if they were sited at multi-unit dwellings in disadvantaged communities.[86] New York State also has an EV make-ready program which provides incentives to install DCFC, through which approximately one-fourth of all funding must directly benefit disadvantaged communities.[87]

Program assessment

MP's DC Fast Charger program is similar to those offered in other jurisdictions that permit a limited number of utility-owned EV charging stations. While it may be appropriate for utilities to own and operate a limited number of DCFCs to jump-start the market, it is generally not the most cost-effective way to support electrification of the transportation sector. Allowing utilities to own DCFCs increases costs to electric customers due to the utility's ability to earn a return on those assets and the cost of debt, taxes, and other charges necessary for including those assets in the utility's rate base. In addition to these added costs, utilities are regulated monopolies and therefore have the advantage of guaranteed cost recovery from their customers, which creates an unfair advantage over potential competitors for EV equipment and installation vendors that can stifle private market growth.

An alternative approach to supporting DCFC buildout is for utilities to offer incentives to cover part of the necessary utility-side make-ready investments to support the deployment of private sector EV charging infrastructure. This is a function that only the utility can provide. Having utilities focus on services that the private market cannot provide enables utilities to reduce costs to electric customers while driving competition among EV service providers in the marketplace, which in time can drive down the costs of meeting Minnesota's climate goals.

Specific to charger deployment in disadvantaged and underserved communities, MP's 2023 EV plan prioritizes DCFC development in communities most affected by poverty and pollution and Tribal lands.

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[84] Gramlich et al. (2023), "Serving Customers Best: The Benefits of Competitive Electric Vehicle Charging Stations." Available at https://gridstrategiesllc.com/wp-content/uploads/2023/05/GS_EV-Paper.pdf.

[85] *Ibid*.

[86] California Public Utilities Commission, "DECISION AUTHORIZING SOUTHERN CALIFORNIA EDISON COMPANY'S CHARGE READY 2 INFRASTRUCTURE AND MARKET EDUCATION PROGRAMS," Application 18-06-015, September 2020. Available at https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M346/K230/346230115.PDF.

[87] Joint utilities of New York, "EV Make Ready Program." Available at https://jointutilitiesofny.org/ev/make-ready.

The Plan provides clear maps of those areas. MP's current DCFC site selection criteria, however, do not factor in proximity to disadvantaged communities, highlighting one area for improvement. Minnesota utility programs should make use of the most recent Minnesota EV infrastructure plan's information regarding disadvantaged communities to prioritize charger deployment in such areas.[88]

[88] Supra n. 57.

Conclusions and Recommendations

EV adoption has been growing rapidly in Minnesota over the past several years, with annual EV sales rising to nearly 7 percent of all LDVs in 2023. As of 2023, there were approximately 50,000 electric LDVs registered in Minnesota, representing about 1 percent of LDVs in the state.

EV adoption is expected to continue growing rapidly for the coming decade. In our Low EV Case, we assume that EVs will comprise 10 percent of LDVs and nearly 6 percent of MHDVs by 2030. In our High EV Case, we assume that 20 percent of LDVs and more than 7 percent of MHDVs will be electric by 2030.

The additional load from EV charging could increase summer peak demand by 3 to 6 percent, and winter peak demand by 1 to 2 percent. The expected investments to support these peak demand increases could range from $55 million to $110 million per year by 2030. However, strategies such as managed charging could mitigate the peak demand impacts and substantially reduce the need for extensive infrastructure upgrades. We estimate that EV managed charging could reduce the expected summer peak by 24 to 66 percent. Further, despite potential increases in utility costs, higher revenues from electricity sales to EVs are likely to exert downward pressure on utility rates, benefiting all electricity consumers.

These results demonstrate the benefit that managed EV charging can have on mitigating adverse impacts to the distribution system. Our analysis also shows the importance of keeping the costs of supporting transportation electrification low to maximize net revenues from EV charging, which can reduce electricity rates for all customers. For these reasons, utility EV programs should focus on encouraging off-peak EV charging and be designed in a manner that maximizes benefits and minimizes costs. With these two important factors in mind, we provide the following guidance on utility EV program design:

- **Rebates for Level 2 chargers**: Instead of providing rebates for residential Level 2 EV chargers, utilities should provide incentives to encourage participation in an EV TOU rate or other off-peak charging program for customers that have an existing Level 2 charger and by leveraging on-board telematics. Should utilities continue to provide rebates for residential chargers, recipients of those rebates should continue to be required to enroll in a managed charging program or TOU rate.
- **Charging requirements for off-peak charging incentives:** The minimum percentage of off-peak charging required for a customer to receive an incentive should be high enough to create meaningful benefits to the electric system. We recommend that managed charging programs like Xcel's Optimize Your Charge program should require participants to charge at least 80 percent of the time during the off-peak charging window to ensure that participation in the program reduces grid impacts that can benefit all customers.
- **Expansion of managed charging pilots:** We recommend that the Minnesota investor-owned utilities continue to examine opportunities to promote off-peak charging for additional customer segments including commercial and fleet customers.

- **Role of the utility in supporting DCFC:** While it may be appropriate for utilities to own and operate a limited number of DCFCs to jump-start the market, these efforts should be focused on disadvantaged and underserved communities where the private market may be slow to invest in charging infrastructure. Utility ownership of DCFCs increases costs to customers through rate basing those investments and shifts risks of charging station revenue losses to customers. We recommend utilities instead focus on the necessary utility-side make-ready investments to support the deployment of private sector EV charging infrastructure to reduce costs and encourage private market competition.

Appendix A: Impacts of electric vehicle managed charging

Synapse Energy Economics (Synapse) conducted an analysis of transportation electrification scenarios for Minnesota. Synapse's analysis focuses on the electrification of light-duty vehicles, medium-duty vehicles, and heavy-duty vehicles through 2030. We modeled a High EV Case and a Low EV Case for EV adoption and analyzed the impact of electricity consumption expected from those scenarios in 2030.

This section first provides a summary of the current penetration of EVs in Minnesota and then discusses details of our transportation electrification analysis and presents the results of our analysis. We present our estimates of EV sales and stock, annual electricity consumption, and peak demand impacts from EV adoption in the High EV Case and Low EV Case in 2030. We then present the expected incremental transmission and distribution investments to support the EVs and customer rate impacts under the two scenarios.

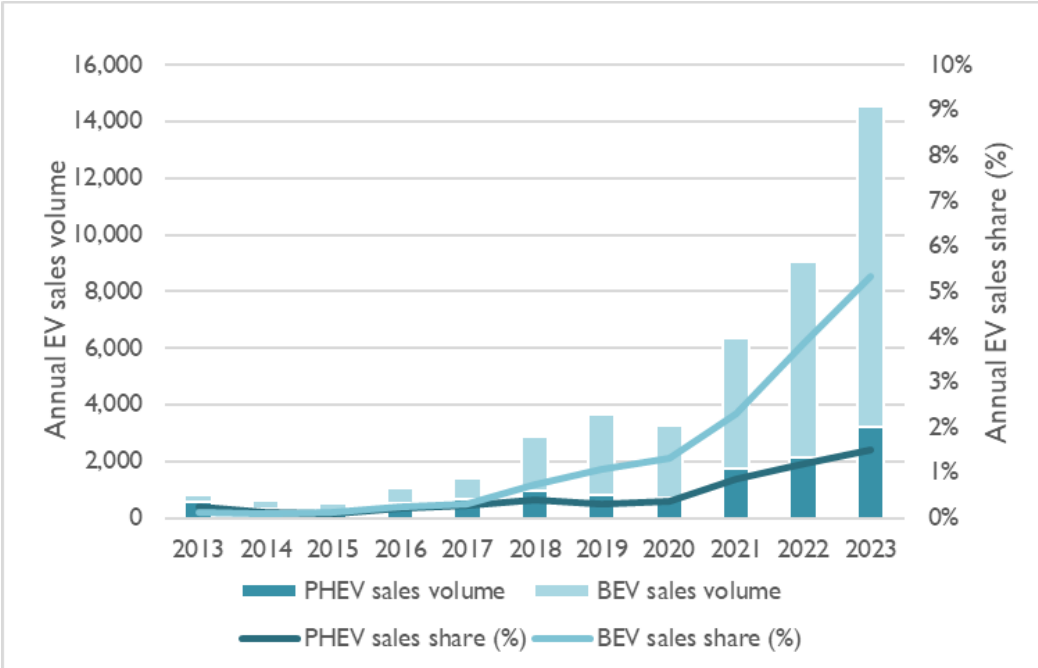
Electric vehicles share in Minnesota

Historically, elecrtric light-duty vehicle (LDV) sales have comprised a small percentage of total light-duty vehicle sales in Minnesota. Before 2018, fewer than 1 percent of light-duty vehicles (fewer than 1,000 EVs) sold were electric.[89] Since then, the share of EV sales has gradually increased over time (as shown in Figure 14 below). In 2023, nearly 15,000 EVs were sold, accounting for 6.8 percent of all LDV sales in the state. Before 2015, the majority of EVs sold were plug-in hybrid electric vehicles (PHEVs); however, since 2018, battery electric vehicles (BEVs) have accounted for three-quarters of annual light-duty EV sales.[90]

[89] Alliance for Automotive Innovation, Electric Vehicle Sales Dashboard, (December 2023) https://www.autosinnovate.org/EVDashboard.

[90] Alliance for Automotive Innovation, Electric Vehicle Sales Dashboard, (December 2023) https://www.autosinnovate.org/EVDashboard.

Figure 14. Minnesota historical EV sales



Source: Alliance for Automotive Innovation, Electric Vehicle Sales Dashboard (December 2023).

As of 2023, there were approximately 50,000 light-duty EVs registered in Minnesota; of these, around 35,000 are battery EVs (BEVs) and 15,000 are plug-in/hybrid EVs (PHEVs).[91] These represent approximately 0.7 percent of LDVs in the state.[92]

The number of EVs and charging stations began to increase significantly in 2018 and has been steadily growing ever since.[93] There are currently 1,949 total charging ports, three- quarters of which are Level 2 and the rest are direct-current fast chargers (DCFC).

EV and charging data for the state of Minnesota is updated regularly on the EValuateMN dashboard, published by the Atlas Public Policy, using vehicle registration data from the Minnesota Department of Transportation.

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[91] Atlas Public Policy, EValuateMN. Data last updated on January 13, 2024. Available at: https://atlaspolicy.com/evaluatemn/.

As of January 13, 2024, there were 50,633 EVs on the road, of which 35,287 are BEVs and 15, 346 are PHEVs.

[92] This EV stock share is based on EvaluateMN's estimates of 7.3 million LDVs in the state. Our EV scenario analysis, explained in the following section, estimates approximately 5 million LDVs in the state, which relies on different data sources.

[93] Atlas Public Policy, EValuateMN. Data last updated on January 13, 2024. Available at: https://atlaspolicy.com/evaluatemn/.

Electric vehicle scenario analysis

Scenarios and assumptions

Synapse developed forecasts of EV stocks and sales in Minnesota through 2030 and estimated annual electric load impacts from EVs using Synapse's in-house model EV-REDI (Electric Vehicle Regional Emissions and Demand Impacts). Our analysis forecasts EV stocks and sales for LDVs and medium- and heavy-duty vehicles (MHDVs) separately. Synapse developed and modeled two scenarios that represent a broad range of possible futures for EV deployment in the state. The two scenarios are as follows:

High EV Case: This scenario represents an aggressive EV deployment future. Under this scenario, Minnesota meets the state's EV stock target of 20 percent of LDVs in 2030 and adopts and complies with the *Advanced Clean Trucks* (ACT) rule for MHDVs.[94] The ACT rule requires truck manufacturers to increase their sales of zero-emissions trucks toward 2035 (with the final requirements ranging from 40 to 75 percent in 2035 depending on the vehicle class). The average stock target for MHDVs in Minnesota that we estimated using EV-REDI is 7.2 percent for 2030.

Low EV Case scenario: This scenario represents a more conservative EV deployment future. We derived LDV and MHDV stock shares for this scenario by using the differential between Bloomberg New Energy Finance's (BNEF) EV industry forecast and the High EV Case, and by applying that same differential to estimate a low-end adoption forecast. In other words, we assumed BNEF's EV forecast represents a mid-point between the High EV Case and the Low EV Case.[95] This results in EVs comprising 10 percent of LDVs and 5.6 percent of MHDVs in Minnesota by 2030.

Table 9 presents the modeled EV stock in 2030 for the Low EV Case and High EV Case scenarios along with BNEF's forecast. Note that BNEF provides forecasts for several vehicle classes. The BNEF forecast presented in this table represents our translation of the original BNEF forecasts based on our assumptions regarding the shares of various vehicle classes in Minnesota.

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[94] The ACT was developed by the state of California and approved by the U.S. EPA in 2020. The ACT requires truck manufactures to sell an increasing share of zero-emissions vehicles by 2035, ranging from 40 to 75 percent depending on the vehicle class. Since the passage of the ACT in California, ten other states (Colorado, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont, and Washington) adopted the ACT. See *Advanced Clean Tech News*. 2024. "Embracing the Advanced Clean Trucks Rule, or Not?" January 10. Available at: https://www.act-news.com/news/embracing-the-advanced-clean-trucks-rule-or-not/#:~:text=Since%20its%20passage%20in%20California,Island%2C%20Vermont%2C%20and%20Washington.

[95] Bloomberg New Energy Finance (BNEF). 2022. Long-Term Electric Vehicle Outlook, as reported by BofA Global Research. https://rsch.baml.com/report?q=WCfBJmf-PxHbUk763NuZcw. BNEF's original report is available at: https://bnef.turtl.co/story/evo-2022/page/1.

Table 9. EV stock targets for 2030 by case

	Low EV Case	BNEF	High EV Case
LDVs	10.0%	15.0%	20.0%
MHDVs	5.6%	6.5%	7.2%

Methods

Synapse used our in-house model EV-REDI to forecast EV sales and stocks for Minnesota. EV-REDI is a stock turnover and scenario analysis model that develops trajectories of future EV deployment along with key outputs such as annual electricity load and emissions reductions. EV-REDI produces these key outputs based on user-specified targets for EV stock, sales, or emissions as well as various state-specific data including total vehicles on the road, vehicle lifetime distributions, vehicle-miles traveled (VMT), fuel efficiencies, and emissions rates. EV-REDI also accounts for changing efficiencies of both EVs and conventional vehicles, changing trends in vehicle preferences, distinctions between driving patterns of PHEVs and BEVs. As with all forward-looking models, the projections are most accurate in the near term and uncertainty increases for years further into the future.

EV-REDI forecasts EV adoption and has the capability of providing outputs for the following categories of vehicles: light cars, light trucks, medium- duty vehicles, heavy-duty single trucks, heavy-duty combination trucks, and buses.

Results

Our forecasts for EV sales for LDVs under the two scenarios are direct outputs from EV-REDI based on our EV stock targets for 2030. As mentioned above, our forecasts for EV sales for the MHDV category are based on two levels of annual EV sales forecasts we developed based on California ACT Rule. The sales forecasts for the High EV Case meet the California ACT Rule in the long term. The sales forecasts for the Low EV Case were scaled down by approximately 22 percent to match the level of LDV sales expected for the Low EV Case relative to the High EV Case.

Our forecast of EV sales as a proportion of new LDV sales through 2030 is presented in Figure 15. We estimate that the electric LDV market share (in terms of new vehicle sales) in 2030 will increase to 54 percent in the Low EV Case and to 94 percent in the High EV Case. These market share projections are the level of EV sales required to meet the 2030 LDV stock target for each scenario. In other words, EV sales must follow this trajectory and reach 54 percent of new LDV sales by 2030 in order to meet the Low EV Case electric LDV stock target of 10 percent. Likewise for the High EV Case, EV sales must reach 94 percent of new LDV sales by 2030 in order to meet the High EV Case electric LDV stock target of 20 percent. To accomplish the High EV Case electric LDV targets, Minnesota must reach a 54 percent EV market share by mid-2027, which is three and half years ahead of the Low EV Case sales trajectory.

We project that the electric MHDV market share in 2030 reaches 31 percent of MHDV sales in the Low EV Case and 40 percent in the High EV Case.

Figure 15. EV sales share forecasts – Low EV Case and High EV Case

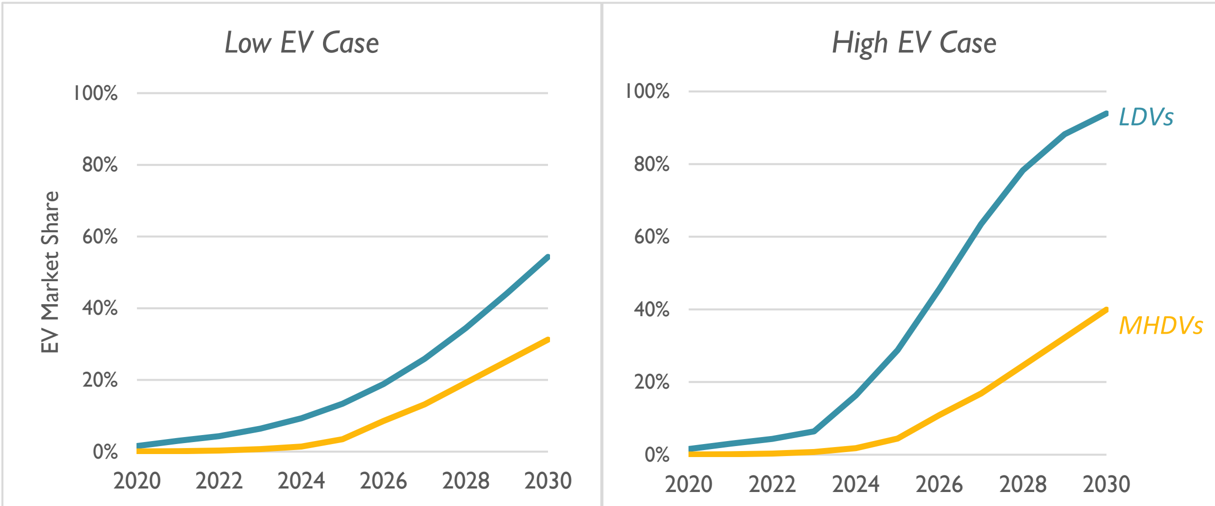


Figure 16 presents our forecasts of EV stock shares for LDVs and MHDVs under the two scenarios. EV stock share shows the percentage of all the vehicles on the road that are electric. The electric LDV stock share in 2030 is 10 percent in the Low EV Case and 20 percent in the High EV Case. The electric MHDV stock share in 2030 is 5.6 percent in the Low EV Case and 7.2 percent in the High EV Case.

Figure 16. EV stock share forecasts – Low EV Case and High EV Case

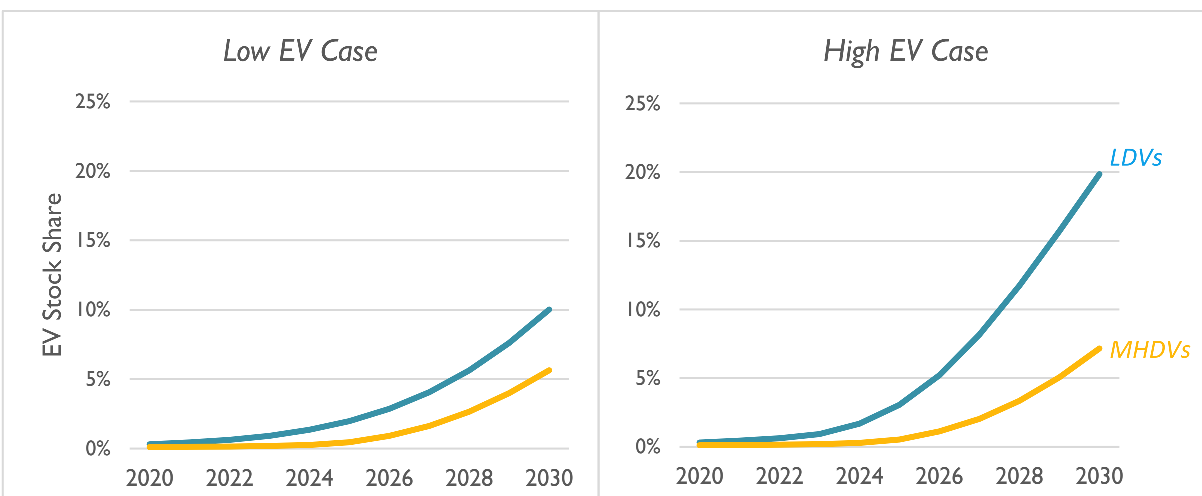
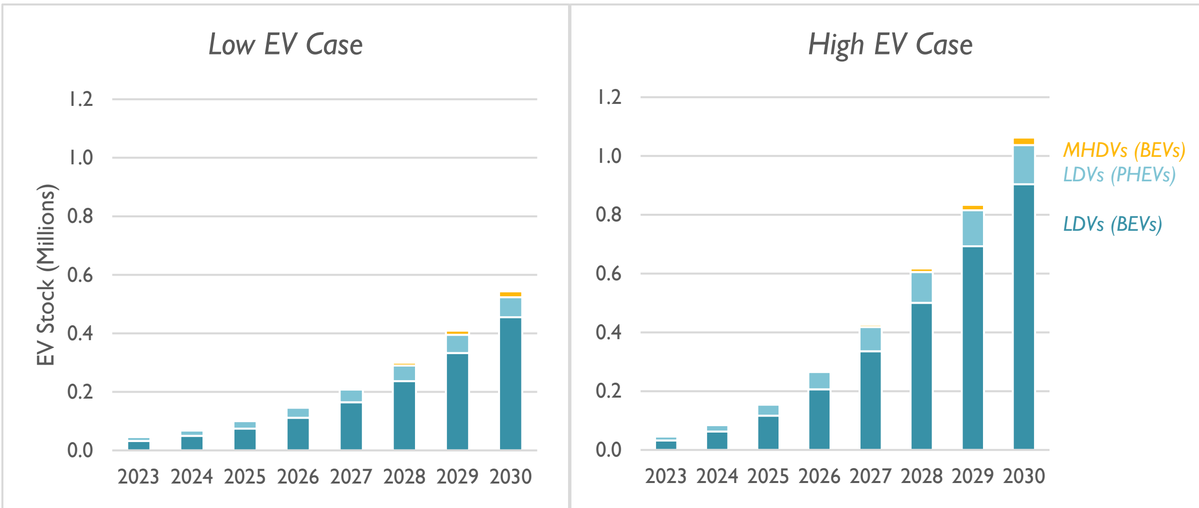


Figure 17 presents our forecasts of EV stocks in terms of millions of vehicles for the two scenarios. As shown in this figure, the majority of EVs forecast in Minnesota are LDVs, which are primarily fully electric vehicles (i.e., BEVs). Light-duty PHEVs are the second-largest EV type. While we project that the stock of MHDVs increases over time substantially as presented in Figure 17, the total number of MHDVs accounts for only 1 percent (High EV Case) to 4 percent (Low EV Case) of all EVs in 2030. By 2030, the total EV stock in Minnesota is forecasted to reach 545,000 vehicles under the Low EV Case and

1,060,000 vehicles under the High EV Case. Notably, the number of LDVs in the High EV Case in 2030 is nearly twice that of the Low EV Case. MHDVs are projected to reach 20,500 under the Low EV Case and 26,000 vehicles under the High EV Case by 2030.

Figure 17. EV stock forecasts – Low EV Case and High EV Case



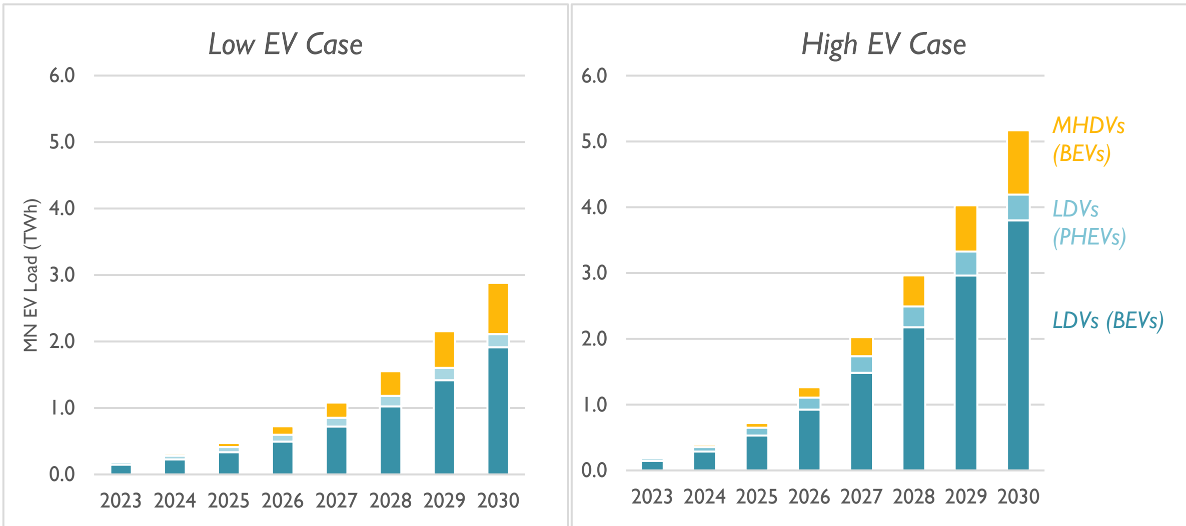
Based on the expected EV stocks through 2030 under the two scenarios and our forecasts of EV efficiencies and VMT, we project annual electricity loads from the EVs as shown in Figure 18. In the Low EV Case, the total electricity consumption expected from EVs grow from 0.21 TWh in 2022 to 2.9 TWh by 2030, which is approximately 4.4 percent of the current total electricity load from the residential and commercial sectors in the state.[96] In the High EV Case, we project that the total EV load increases to 5.2 TWh, which is approximately 7.8 percent of the current residential and commercial electricity consumption.

In both cases, the majority of annual EV charging load is attributable to LDVs, but MHDVs consume an outsized share of energy on a per-vehicle basis. This is due to the larger size of those vehicles, lower efficiencies stemming from heavier vehicles, and larger per-vehicle miles traveled by MHDVs.

In the Low and High EV Cases for 2030 respectively, LDVs comprise between 96 and 97 percent of the EV stock volume and consume between 73 to 81 percent of the total EV energy load. In comparison, MHDVs consume between 26 and 19 percent of the 2030 EV load, despite only comprising between 2 and 4 percent of EV in 2030.

[96] According to EIA's US Electricity Profile 2022, the total electricity consumption for the residential and commercial sectors in the state was approximately 67 TWh in 2022. https://www.eia.gov/electricity/state/.

Figure 18. Annual EV electricity load forecasts by vehicle class – Low EV Case and High EV Case



Electric peak demand impacts

Assumptions and methods

To calculate peak demand impacts from LDV and MHDV annual electricity consumption, we first allocated the annual EV load outputs from our EV-REDI modeling analysis to a representative summer peak month (July) and a representative winter peak month (January) in Minnesota, using monthly EV load shape data from ISO New England's transportation electrification forecast.[97] We used this data source because we expect MHDV load shapes are similar across the country as they are primarily influenced by business activities. We then allocated the monthly loads to each day in the summer and winter peak months assuming equal charging across each day in the peak months.[98]

For electric MHDVs, monthly EV loads are similar throughout the year except for school and transit buses. Since the load impacts from such vehicles are very small, we assumed that monthly EV loads and daily charging are the same for MHDVs across the year and thus, allocated annual loads to each day of the year equally.

[97] ISO New England. "2022 Final Transportation Electrification Forecast." Presentation at ISO New England, February 18, 2022. Available at: https://www.iso-ne.com/static-assets/documents/2022/02/evf2022_forecast.pdf.

[98] We assumed the daily average loads are the same between weekdays and weekends based on our review of EV charging data available from U.S. DOE's EVI-Pro Lite tool, available at: https://afdc.energy.gov/evi-x-toolbox#/evi-pro-ports.

We then allocated electric LDV and MHDV loads to hours of the day using hourly load shapes specific to each vehicle class and estimated peak demands for the summer and winter seasons. We used a baseline LDV load shape for EVs in St. Paul, Minnesota from the U.S. Department of Energy's EVI-Pro Lite tool, which does not assume any managed charging.[99] We used baseline MHDV load shapes that we obtained from Lawrence Berkeley National Laboratory.[100] To estimate peak demand impacts based on the hourly load results, we first identified the hours of expected peak demand on the grid for the summer and winter seasons, prior to the addition of EV load. The current summer peak ranges from 4:00 PM to 7:00 PM on a July weekday in the load zone of the Midcontinent Independent System Operator (MISO) area that includes Minnesota.[101] However, in 2030, we expect the summer peak hour to shift to later in the day from greater solar PV penetration, and thus select to examine summer peak demand impacts on a July weekday at 7:00 PM. For the winter season, we assume the peak hour occurs around 8:00 AM in January, based on a recent Synapse study assessing the current and future peak demand impacts from various building decarbonization scenarios for Minnesota.[102]

We also analyzed the impacts of EV managed charging for LDVs. EV managed charging is a load management strategy to remotely manage customers' EV battery charging by offering financial incentives for customers or to encourage customers to voluntary modify the timing of their EV charging through time-varying rates. Some of Minnesota utilities such as Xcel Energy, Otter Tail, and Dakota Electric currently offer such EV managed charging programs or tariffs (See *Minnesota's utility electric vehicle programs* section in the main report). Our managed charging analysis focuses on LDVs and does not include managed charging for MHDV because experience of managing charging for MHDV is currently very limited and it is not clear how much of those loads can be managed without disrupting commercial activities.[103]

Our analysis assumes two levels of EV managed charging: a Low Managed Charging scenario which assumes a 30 percent EV peak demand reduction in 2030; and a High Managed Charging scenario for LDVs, which assumes a 72 percent peak demand reduction in 2030. Table 10 presents these assumptions along with our assumptions for the components that combine to result in aggregate peak reductions: average peak reductions per vehicle and customer participation rates. We assume that EV batteries can generally shift all or most of the loads when appropriate incentives are provided. The High

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[99] We used the load shape based on the "Immediate – as fast as possible" charging mode in the EV-Pro Lite tool. The tool is available at https://afdc.energy.gov/evi-pro-lite/load-profile.

[100] Lawrence Berkeley National Lab. HEVI-LOAD MDV and HDV load profiles. Provided August 2022.

[101] MISO. 2023. "Historical Daily Forecast and Actual Load by Local Resource Zone." Available at: https://www.misoenergy.org/markets-and-operations/real-time--market-data/market-reports/#nt=%2FMarketReportType%3ASummary&t=10&p=0&s=MarketReportPublished&sd=desc.

[102] deLeon, S., K. Takahashi, E. Carlson, A. S. Hopkins, S. Kwok, J. Litynski, C. Mattioda, L. Metz. 2024. *Minnesota Building Decarbonization Analysis: Equitable and cost-effective pathways toward net-zero emissions for homes and businesses*. Synapse Energy Economics for Clean Heat Minnesota. Available at https://www.synapse-energy.com/minnesota-building-decarbonization-analysis.

[103] Smart Electric Power Alliance. 2021. *The State of Managed Charging in 2021*. Available at: https://sepapower.org/resource/the-state-of-managed-charging-in-2021/.

Managed Charging scenario has lower average peak reductions per vehicle because the participation level for this scenario is substantially higher than for the Low Managed Charging scenario. The High EV Case reflects more of a "mass adoption" case, while the Low EV Case reflects more enthusiastic participation by a smaller number of customers.[104] Our participation assumptions present two ends of the spectrum on EV managed charging, and the participation assumption for the High Managed Charging scenario is primarily based on the experience of opt-in time-varying rates implemented by utilities in the past.[105] The high-end estimate is not an upper limit, because we assume no managed charging for MHDVs. For comparison, a recent study on transportation electrification by NREL et al. estimated 30 percent to 83 percent peak demand impacts in 2032 from all types of EVs including MHDVs.[106]

Table 10. EV managed charging assumptions

	Low Managed Charging	**High Managed Charging**
Peak reduction per EV	100%	80%
Participation rate	30%	90%
Total peak reduction	30%	72%

Results

Figure 19 shows our estimates of hourly LDV and MHDV load on a weekday in July 2030 in the Low EV Case and the High EV Case. Hourly EV load impacts during this time range from 98 MW at 6 AM to 456 MW at 6 PM in the Low EV Case and 142 MW at 6 AM to 838 MW at 6 PM in the High EV Case. Hourly EV load shapes for the winter are the same as the shapes for the summer, but the projected hourly

[104] At a significantly high level of participation, some fractions of the total participants may not respond to price signals all the time. As a results, we expect that the average reduction per customer for the High Managed Charing scenario is lower than the average reduction per customer for the Low Managed Charging scenario.

[105] Past studies have shown that opt-out time-of-use rates tend to have very high participation rates (e.g., over 90 percent). See Environmental Defense Fund. 2015. *A Primer on Time-Variant Electricity Pricing*. Available at: https://www.edf.org/sites/default/files/a_primer_on_time-variant_pricing.pdf; Lawrence Berkeley National Laboratory (LBNL). 2023. *The use of price-based demand response as a resource in electricity system planning*. Available at: https://eta-publications.lbl.gov/sites/default/files/price-based_dr_as_a_resource_in_electricity_system_planning_-_final_11082023.pdf.

[106] National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Kevala Inc., and U.S. Department of Energy. *Multi-State Transportation Electrification Impact Study: Preparing the Grid for Light-, Medium-, and Heavy-Duty Electric Vehicles.* Available at: https://research-hub.nrel.gov/en/publications/multi-state-transportation-electrification-impact-study-preparing.

winter loads are approximately 10 percent (in the morning) to 35 percent (in the late afternoon) higher than in the summer due to higher battery energy loss effects during the winter season.

Figure 19. July 2030 weekday hourly demand, Low EV Case (left) and High EV Case (right)

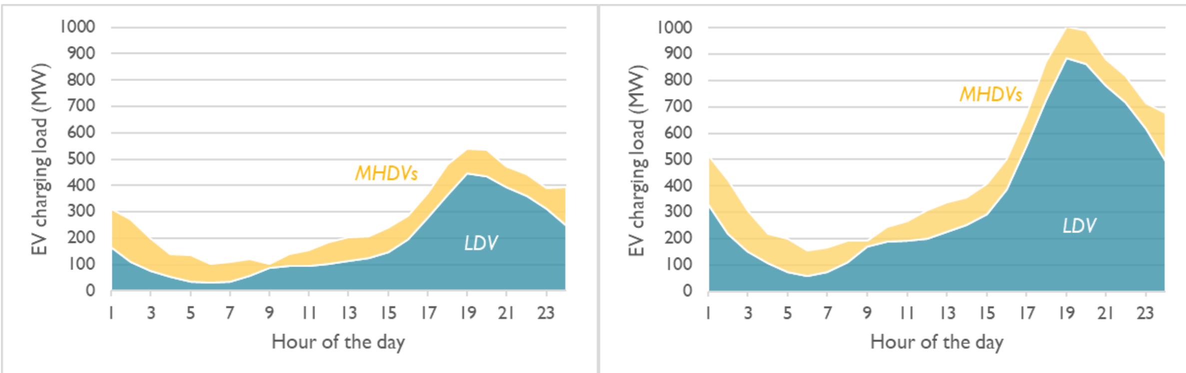


Figure 20 presents the summer and winter coincident peak demand contributions, without managed charging, of LDVs and MHDVs in 2030. For the summer of 2030, we project that EVs will add between 452 MW and 827 MW to today's summer peak demand without managed charging (representing 3 to 6 percent of today's summer peak demand). For the winter, we project that EVs will add between 116 MW and 218 MW to today's winter peak demand (representing 1 to 2 percent of today's winter peak demand).[107] As can be seen in this figure, EV load contributes substantially less to winter coincident peak than it does to the summer peak. This is due to the daily load shapes of LDVs which account for most of the EV load and tend to be lower in the morning and higher in the evening (Figure 19).

[107] The current summer and winter peak demands in Minnesota are approximately 14,270 MW and 11,985 MW, respectively, based on Synapse Energy Economics (2024) *Minnesota Building Decarbonization Analysis*. Available at: https://www.synapse-energy.com/sites/default/files/MN%20Decarbonization%20Report_June%202024%2023-074.pdf.

Figure 20. Coincident peak demand contribution from EVs in 2030, without managed charging

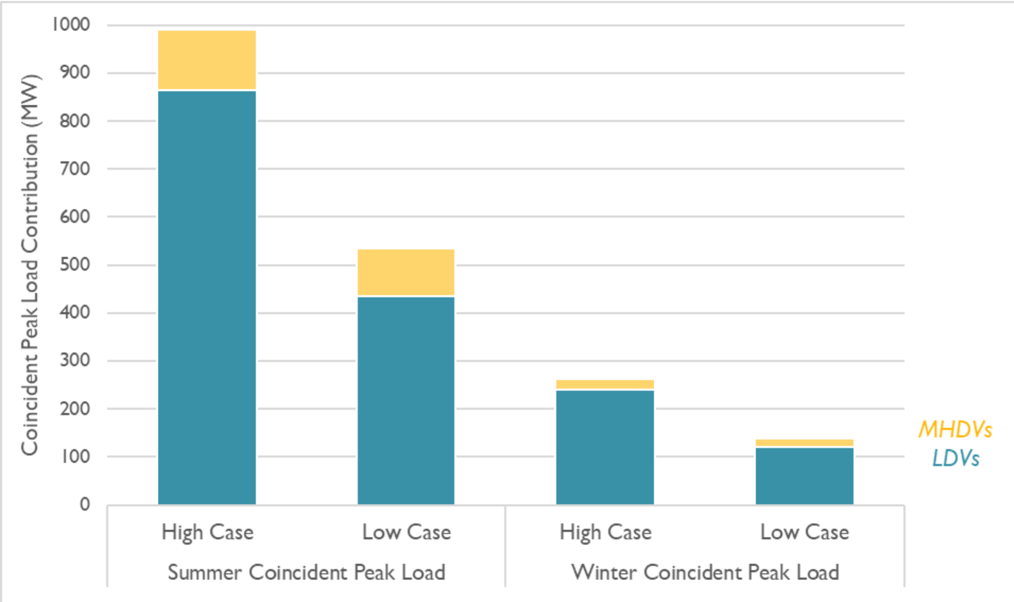


Figure 21 and Figure 22 present the LDV and MHDV load contributions to the summer and winter peak demands, with and without managed charging, in 2030. As shown in Figure 10, for the summer of 2030, we project that EV managed charging just for LDVs could reduce the total EV peak demands by:

- 26 to 63 percent from 990 MW to between 730 MW and 370 MW (representing 5.1 percent to 2.6 percent of the current summer peak, respectively) under the High EV Case; and
- 24 to 59 percent from about 530 MW to between 400 MW and 220 MW (representing 2.8 percent to 1.5 percent of the current summer peak) under the Low EV Case.
- As shown in Figure 11, for the winter of 2030, we project that EV managed charging just for LDVs could reduce the total EV peak demands by:
- 27 to 66 percent from about 260 MW to between 190 MW and 90 MW (representing 1.6 percent to 0.8 percent of the current winter peak, respectively) under the High EV Case; and
- 26 to 63 percent from about 140 MW to between 100 MW and 50 MW (representing 0.9 percent to 0.4 percent of the current winter peak) under the Low EV Case.

Figure 21. Summer coincident peak demand contribution from EVs in 2030, with managed charging

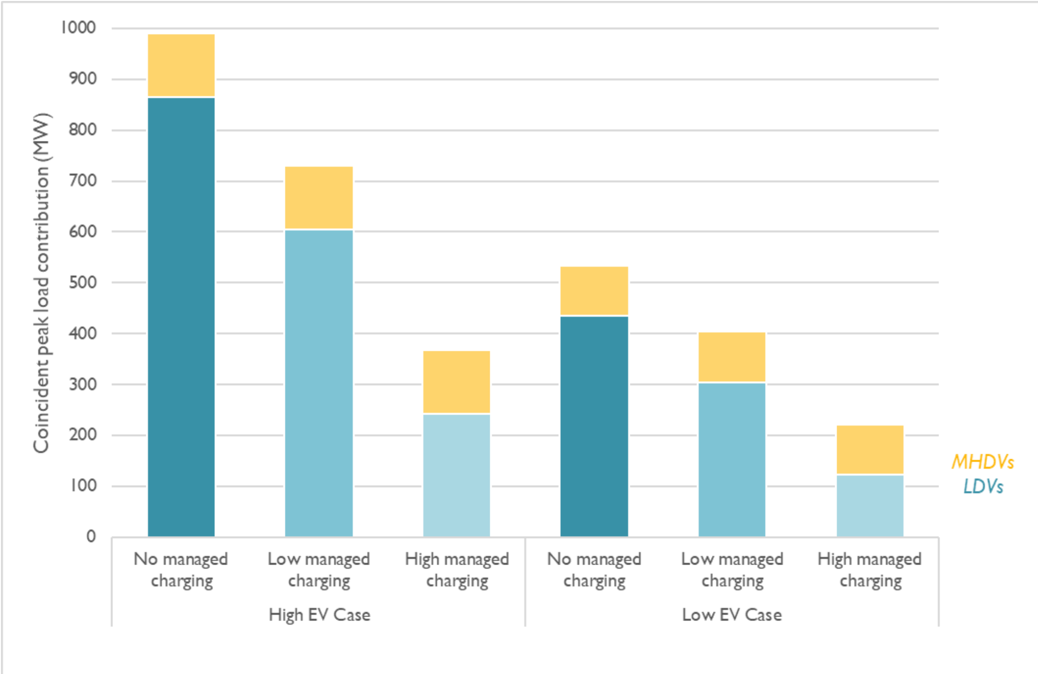
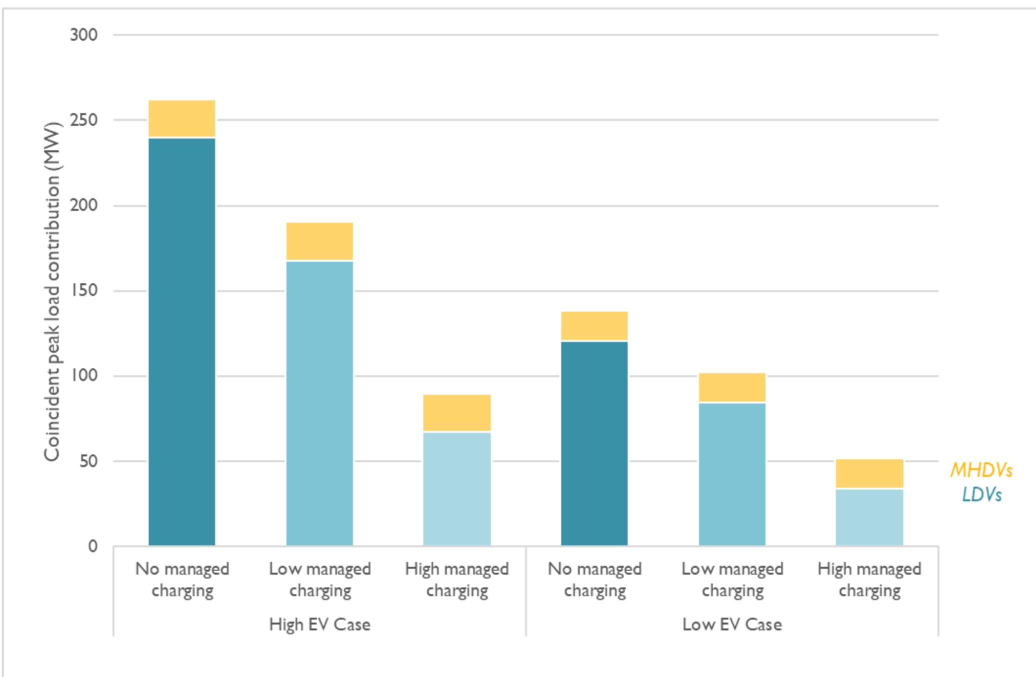


Figure 22. Winter coincident peak demand contribution from EVs in 2030, with managed charging



Utility investments impacts

Assumptions and methods

Based on the expected peak demand impacts from future EV adoption for various scenarios, we conducted a high-level analysis of incremental annual utility costs related to EV charging for 2030 and an illustrative analysis of potential rate impacts for residential customers.

For the utility investment analysis, we estimated the annualized costs of investment in incremental electric generation capacity and transmission and distribution (T&D) systems to accommodate additional peak demand from EV charging, using our estimated peak demand impacts from EVs in 2030 for the summer season. We do not use winter peak demands because winter peak demand impacts from EVs are much lower and today's electric system is generally sized to meet higher summer peaks.

Our cost estimate for generation capacity is $104/kW-year, which is based on Xcel Energy's recent filing regarding its ECO Triennial Plan for 2024–2026. Our cost estimate for T&D systems is based on Xcel's avoided T&D cost estimates, although we make an upward cost adjustment mainly because Xcel's original T&D cost (about $11.4/kW-year for the current year) is one of the lowest avoided T&D cost estimates across many jurisdictions.[108] To account for this low avoided T&D cost, we made the simple adjustment of doubling Xcel's T&D avoided costs, which results in about $23/kW-year.

There are a few assumptions that make our analysis conservative (in terms of our results). For example, we do not assume any existing T&D capacity headroom and instead assume all coincident peak demand from EVs incur utility system costs. In addition, some of the future T&D upgrades may also be driven by other factors such as building electrification and data center development, and EV loads may be able to use system headroom driven by these other factors. This is especially relevant for building electrification as the investments for building electrification are mainly for meeting winter peak demands and thus will create additional system headroom for the summer, which can be used to accommodate EV loads. It is also important to note that our analysis employs a few other simplified assumptions: (a) our utility cost estimates are based on the current cost estimates while our peak demand impacts due to EVs are for 2030 (some 2030 cost estimates, especially generation capacity, are likely to differ from the current estimate); and (b) we assume that T&D peak demands occur at the same time as the systemwide peak. While transmission-level peak hours are likely to be very close to the systemwide peak hours, the peak

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[108] For example, see Mendota Group. 2014. *Benchmarking Transmission and Distribution Costs Avoided by Energy Efficiency Investments*. Available at: https://mendotagroup.com/wp-content/uploads/2018/01/PSCoBenchmarking-Avoided-TD-Costs.pdf; Synapse Energy Economics. 2018. *Value of Energy Efficiency in New York Assessment of the Range of Benefits of Energy Efficiency Programs*. Table 4. Available at: https://www.synapse-energy.com/sites/default/files/Value_of_Energy_Efficiency_in_New_York_Final_Report_(April%202018).pdf; Synapse Energy Economics, et al. 2024. *Avoided Energy Supply Components in New England: 2024 Report*. Table 130. Available at: https://www.synapse-energy.com/sites/default/files/inline-images/AESC%202024%20May%202024.pdf.

hours at the distribution level are likely different from systemwide peak hours. Yet, this may be a reasonable assumption to get a rough sense of the overall statewide impacts.

Results

The results of our analysis of utility investments are presented in Table 11. We estimate that in 2030 EVs could incur annualized utility costs of $55 million in the Low EV Case to $110 million in the High EV Case, without any EV managed charging. We expect that managed charging through EV programs or time-varying rates could reduce the incremental annual utility system costs to between $39 and $15 million in the Low EV Case and to between $77 million and $31 million in the High EV Case, representing substantial reductions in utility investments (by 30 to 72 percent). These estimates do not include any program costs to administer and implement EV managed charging programs as this is outside of the scope of our analysis. However, it is important to note that implementing time-varying rates is associated with low ongoing program costs.

Table 11. Annual utility system investments to support EV adoption in 2030 ($ million)

	High EV Case			**Low EV Case**		
	No managed charging	Low LDV managed charging	High LDV managed charging	No managed charging	Low LDV managed charging	High LDV managed charging
Generation capacity	$90	$63	$25	$45	$32	$13
T&D	$20	$14	$6	$10	$7	$3
Total utility investment	$110	$77	$31	$55	$39	$15

Customer rate impacts

Assumptions and methods

EV charging will generate new revenues for electric utilities due to the additional electricity sales. The overall impact of EVs on electric rates will depend on the extent to which these new revenues outweigh the costs of serving additional EV load. To develop an illustrative rate impact analysis, we compared the utility infrastructure cost estimates in 2030 shown in Table 11, plus the wholesale cost of electricity, with the expected incremental utility revenues from EV charging. (In this analysis, we assume that all impacts of LDVs are for residential customers, while we know that some LDVs are used by commercial customers.) We assumed $30 per MWh for the cost of energy based on the current energy prices in

2023 at Minnesota hub in the MISO market.[109] To estimate the revenues expected from the sales of electricity for EVs, we assumed a volumetric electricity rate of 13.5 cents/kWh.[110]

Results

Figure 23 and Figure 24 present the results of our analysis of utility costs and revenues for residential customers for both scenarios. As shown in these figures, we estimated that the annual revenue is roughly $565 million in the High EV Case and $284 million in the Low EV Case. In contrast, the total utility costs including energy supply costs are much lower: about $235 million in the High EV Case and $120 million in the Low EV Case, without EV managed charging. Because the expected revenues outweigh the utility costs, we expect that EVs will put downward pressure on rates and help reduce rates in the long term. These figures also show that EV managed charging scenarios ("Low managed charging" and "High managed charging") will reduce the utility costs by about 15 to 35 percent, thus increasing downward rate pressure. As mentioned above, EV managed charging programs would add additional costs, but time-varying rates, which are expected to have a greater impact on shifting EV charging to off-peak hours, tend to have low program costs. On the other hand, effective time-varying rates should reduce utility revenues, as they would encourage EV owners to charge EV batteries during lower priced, off-peak hours.

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[109] MISO historical annual real-time LMPs. Available at: https://www.misoenergy.org/markets-and-operations/real-time--market-data/market-reports/#t=10&p=0&s=MarketReportPublished&sd=desc.

[110] We derived this value based on an average statewide, all-in rate of 14.2 cents/kWh (including customer charge) for 2022 and a 5 percent contribution from the monthly customer charge (based on Xcel's current customer charge of $6 per month). The statewide average rate is based on EIA 861 database for 2022. Available at: https://www.eia.gov/electricity/data/eia861/. Xcel's current residential tariff is obtained from: Xcel Energy's residential electricity tariff, available at: https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/24-01-406-MN-Res-ElecRates-MN-Res-E-2002.pdf.

Figure 23. Total utility costs and total revenues of EV charging in 2030 – High EV Case

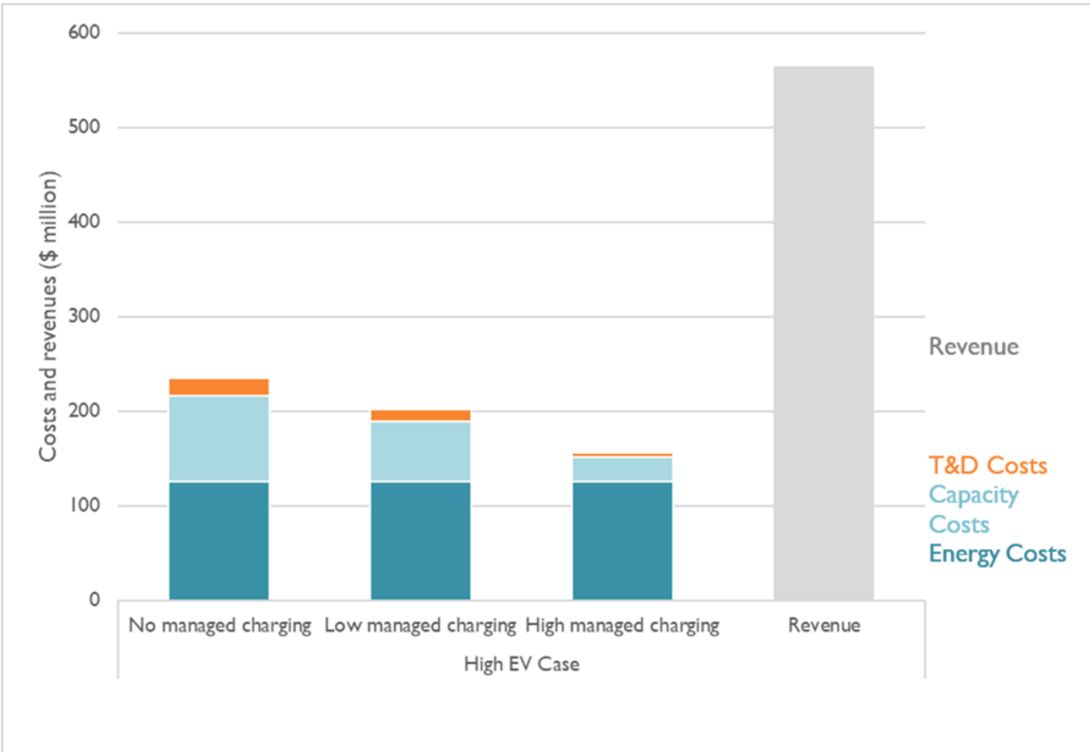

Figure 24. Total utility costs and total revenues of EV charging in 2030 – Low EV Case