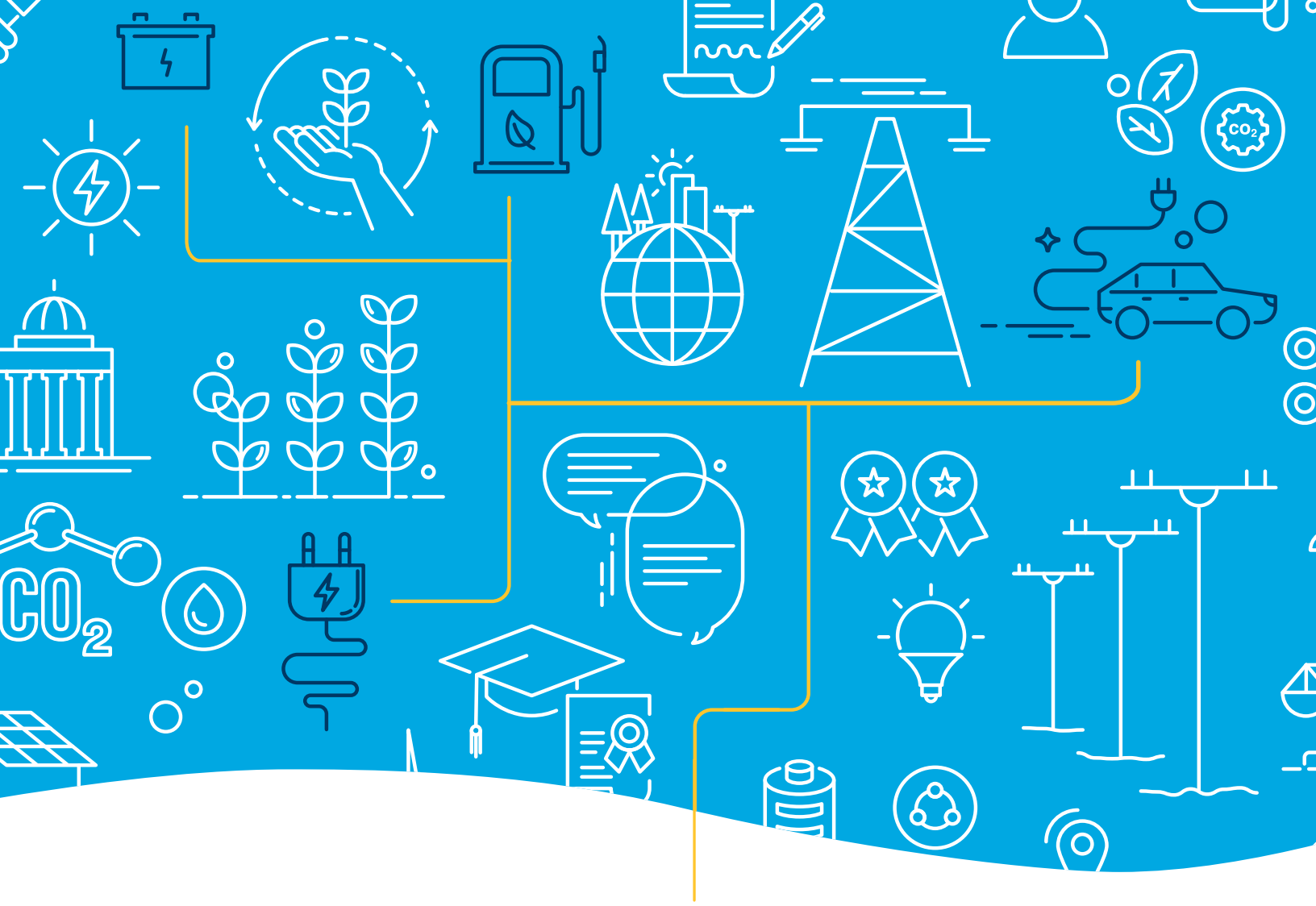

A Road Map to Decarbonization in the Midcontinent

TRANSPORTATION ELECTRIFICATION

MIDCONTINENT TRANSPORTATION ELECTRIFICATION COLLABORATIVE

GREAT PLAINS INSTITUTE

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Road Map Participants

The following participating entities took part in the development of this road map.

Nothing in this road map binds any signatories to any specific position. Nothing in the road map authorizes any signatory to speak on behalf of other signatories, though signatories are welcome to use the existence of co-signatories as evidence of the appropriateness of the recommendations in this road map.

Participants

Alliant Energy

Ameren

Center for Energy and Environment

ChargePoint

Clean Wisconsin

Dairyland Power Cooperative

Dane County Office of Energy and Climate Change

Ecology Center

Ford Motor Company

Fresh Energy

General Motors

Great River Energy

Greenlots

Madison Gas and Electric

Michigan Energy Innovation Business Council

MidAmerican Energy

Minnesota Power

Natural Resources Defense Council

Sierra Club

Tesla, Inc.

Union of Concerned Scientists

WEC Energy Group

Wolverine Power Cooperative

WPPI Energy

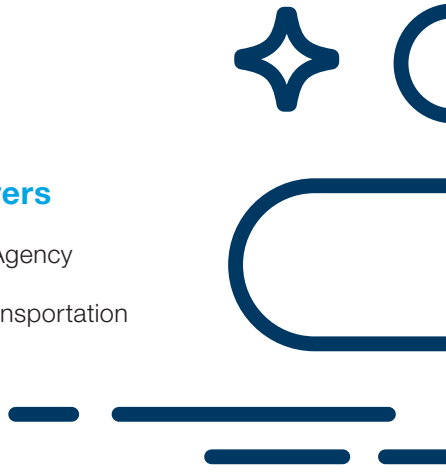
Xcel Energy

ZEF Energy

State Agency Observers

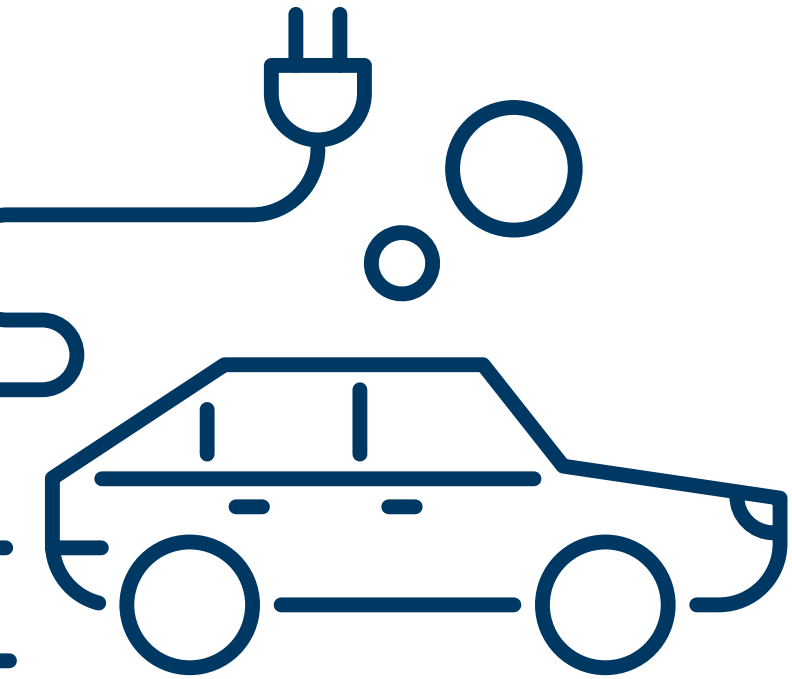
Minnesota Pollution Control Agency

Minnesota Department of Transportation



A Road Map to Decarbonization in the Midcontinent

TRANSPORTATION ELECTRIFICATION



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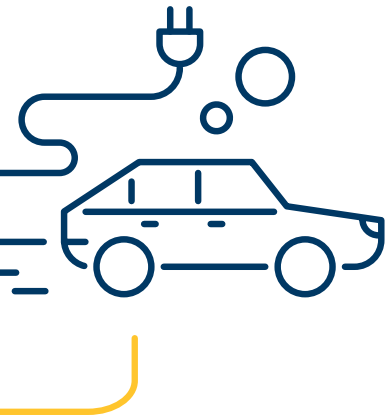
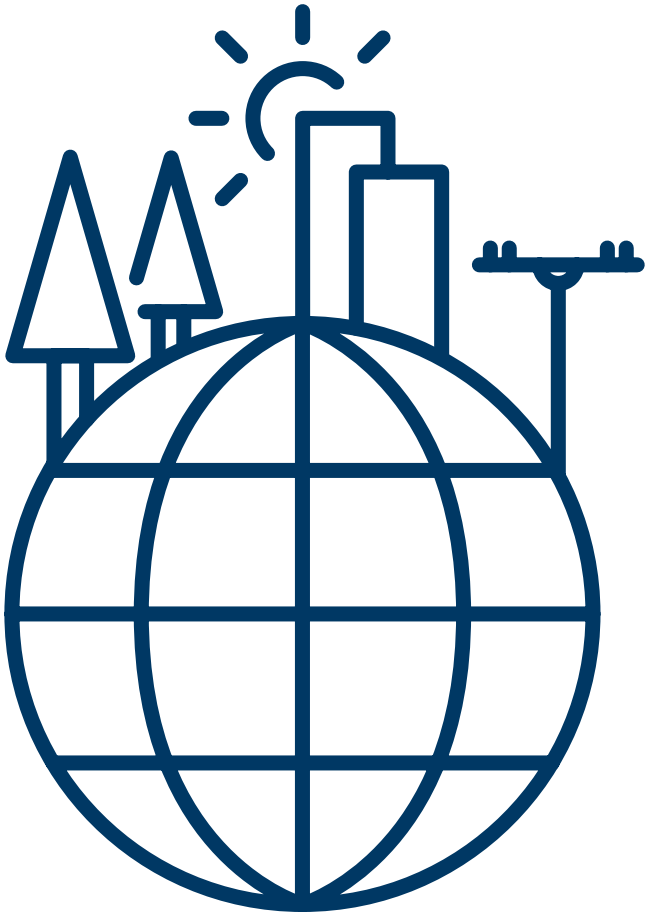
January 2019



Contents



ACKNOWLEDGMENTS

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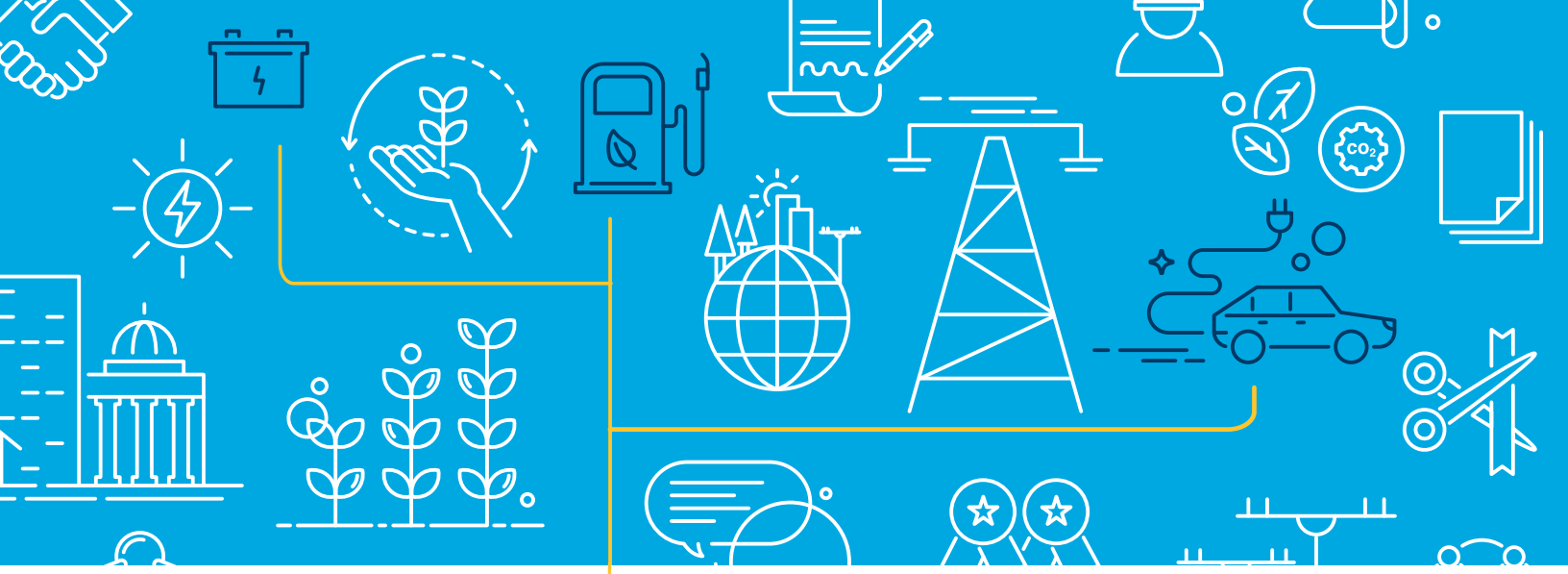
This road map benefitted from the advice and assistance of the following technical experts: Phil Jones, Dan Bowermaster, John Halliwell and Mark Kuwoski.

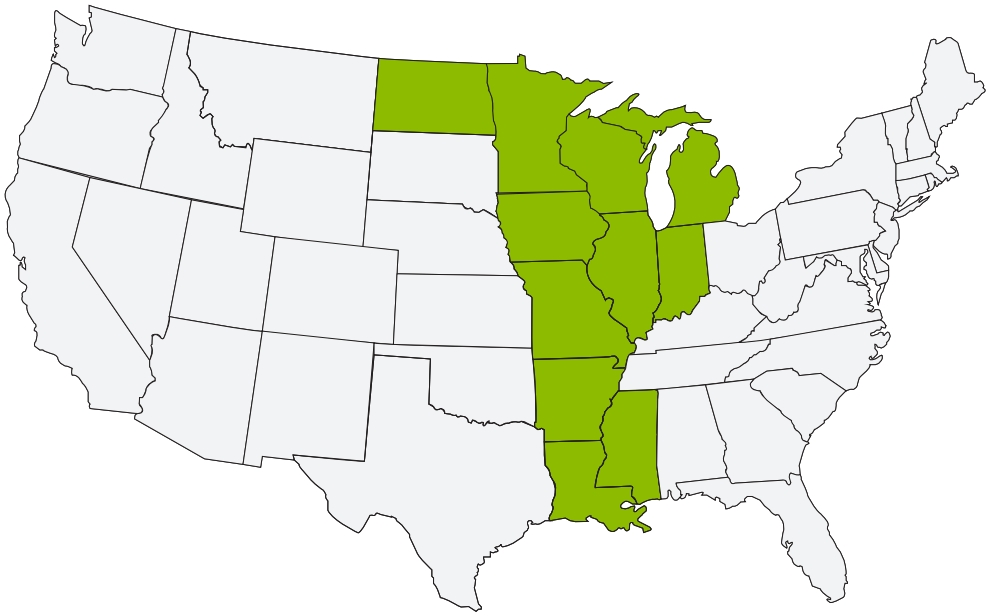


Introduction

ELECTRIC VEHICLES (EVs) ARE AN ESSENTIAL part of the effort to decarbonize the transportation sector by midcentury. When combined with a decarbonized electricity sector, EVs can contribute to rapid decarbonization of transportation while bringing many other economic and public health benefits.[1] To meet the decarbonization challenge while seizing the many opportunities EVs offer, governments, utilities, and competitive private sector actors need to work together to address the many barriers that stand in the way of rapid EV adoption across all vehicle classes. This road map points the way for leaders in the Midcontinent region.

1 In its *A Road Map to Decarbonization in the Midcontinent: Electricity Sector* (the "electricity road map"), the Midcontinent Power Sector Collaborative explored several different decarbonization goals for the electricity sector in the range of 80 to 95 percent by 2050. www.roadmap.betterenergy.org.

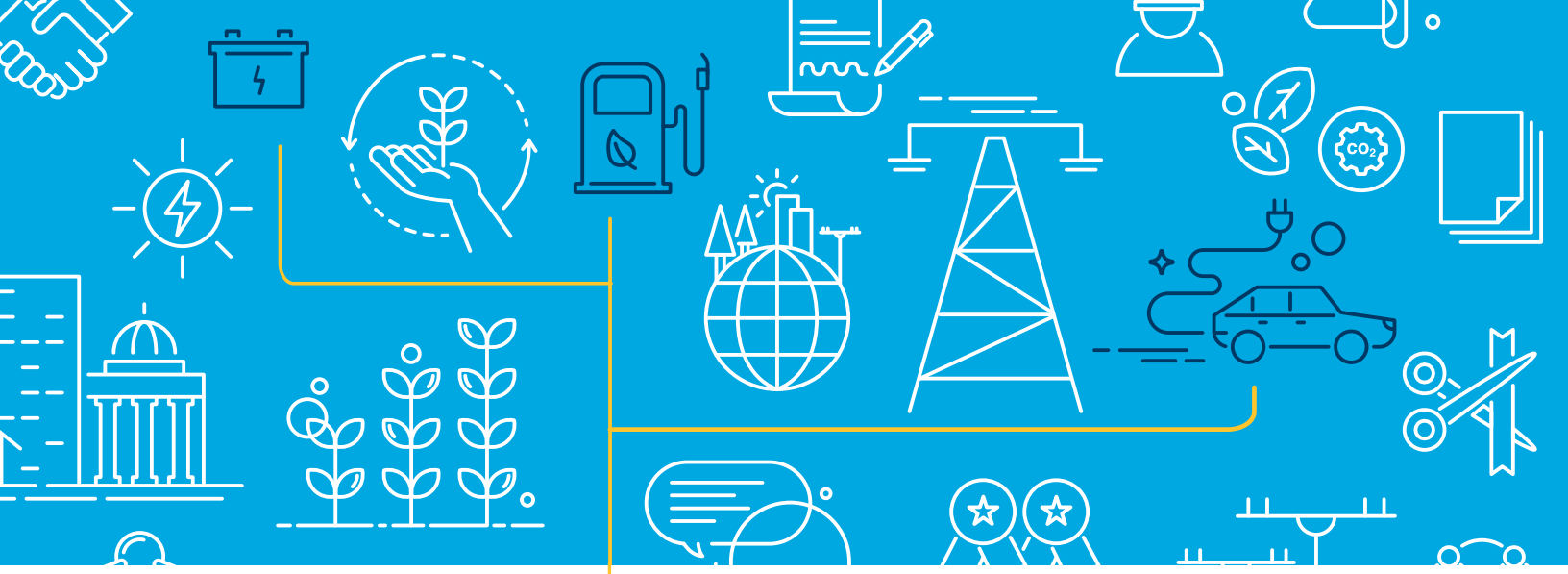
THE MIDCONTINENT REGION



The Midcontinent Transportation Electrification Collaborative (MTEC) is a diverse coalition working to speed the adoption of EVs in the Midcontinent region. MTEC members understand that vehicle electrification, in combination with clean electricity generation, is essential to decarbonizing the transportation sector, bringing along with it many additional human health and economic benefits. MTEC consists of automakers, electric utilities and cooperatives, EV charging companies, environmental groups and state officials from the region, facilitated by the Great Plains Institute. The analysis conducted by MTEC for this road map indicates that EVs bring great potential benefits to the region. Pairing transportation electrification with electric sector carbon reductions can be a cost-effective way to achieve economy-wide emissions reductions, as EVs can both reduce emissions in the transportation sector and provide direct benefits to the electricity system, including the potential to manage load so as to optimize generation resources, especially variable renewable resources like wind and solar. However, there are several barriers to widespread electrification, ranging from vehicle technology and battery costs to charging availability to consumer preferences and awareness. Overcoming these barriers will require additional public and private initiatives. MTEC therefore makes a number of recommendations for near-term investments and policies to accelerate EV adoption.

This road map begins with a brief discussion of the context for transportation electrification, including a review of carbon emissions trends, electricity as a vehicle fuel, the greater efficiency of EVs, the importance of vehicle miles traveled, factors influencing consumer decisions, and the current regulatory environment for EVs. Next, the road map outlines the results of the analyses commissioned by MTEC to better understand the implications of various EV pathways in the region. Lastly, the road map sets out the findings and recommendations of MTEC participants to state and local leaders, policy makers and private sector actors.

> “EVs bring great potential benefits to the region.



Understanding the Context for Electric Vehicles in the Midcontinent Region

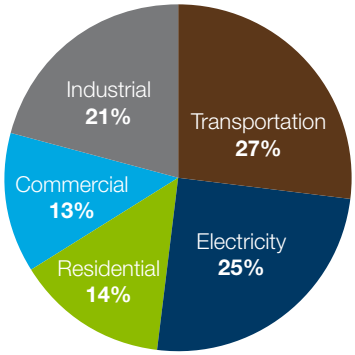
Transportation Emissions are Growing

IN THE UNITED STATES, transportation emissions have grown in the last decade, while emissions for the electricity sector have been declining. In 2017, transportation emissions exceeded those of electric power generation for the very first time, at 27 percent of total U.S. carbon emissions, as shown in figure 1.[2] Carbon emissions in the transportation sector depend on the interplay of three primary factors: the carbon content of the fuel used to power vehicles, the efficiency of vehicles, and how far the vehicles are driven, usually measured in vehicle miles traveled. EVs are fueled by electricity, a fuel that is already less carbon-intensive than gasoline or diesel, and a fuel that is expected to become even less carbon-intensive as the electricity sector decarbonizes.[3]

2 U.S. Energy Information Administration (EIA), 2018.

3 See David Reichmuth, *"New Data Show Electric Vehicle Continue to Get Cleaner,"* Union of Concerned Scientists (blog), March 8, 2018, https://blog.ucsusa.org/dave-reichmuth/new-data-show-electric-vehicles-continue-to-get-cleaner.

FIGURE 1: Transportation is the Highest-Emitting Sector of the Economy
(Percent Total Carbon Emissions 2017)



EVs are more efficient than internal combustion engines. Vehicle miles traveled will remain an important factor for carbon emissions until and unless the electricity used to charge EVs is zero-carbon.

Electricity as a Fuel: Cleaner and Less Expensive than Gasoline or Diesel

EVs are often called "zero emission vehicles," or ZEVs, because they do not have emission tailpipes and do not emit the pollutants that come out of internal combustion engines burning gasoline or diesel.[4] However, ZEVs are fueled by electricity, and generation of that electricity produces carbon emissions. Because fossil fuels (natural gas and coal) are still the predominant fuels used to produce electricity in the Midcontinent, it is important to understand the carbon "content" of the electricity that is and will be used to charge EVs. As discussed below, electricity is already generally cleaner than petroleum-based transportation fuels in the Midcontinent, and electricity is expected to get even cleaner, especially with new initiatives to decarbonize electricity.[5] In addition to being cleaner than gasoline and diesel, electricity is also a less expensive fuel, as shown in figure 2. According to the U.S. Department of Energy, on average it costs about half as much to drive an EV as it does to drive a comparable gasoline-powered vehicle.[6]

Gasoline versus Electricity in the Midcontinent

As shown in figure 5, electricity is already much cleaner than gasoline in the Midcontinent, even after taking into account lifecycle emissions.[7] This is true even though the region continues to generate a significant share of its electricity from coal and natural gas.

Recent Carbon Emissions Trends for Electricity Generation in the Midcontinent

While electricity is already less carbon intensive than gasoline, there is still room for improvement. As shown in figure 3, the Midcontinent still relies heavily on coal, which was used to generate 47 percent of electricity in 2017. Natural gas made up 23 percent of the generation. Wind and hydro energy made up 9 percent of the generation in the region, while nuclear energy made up 16 percent of the generation. Recent trends in the Midcontinent suggest a continuing shift away from coal and toward lower-carbon resources like natural gas and renewables.

Expected Future of Electricity Generation in the Midcontinent Region

Electricity is expected to be an even lower-carbon fuel in the near future. The recent modeling analysis conducted by the Midcontinent Power Sector Collaborative for its *Road Map to Decarbonization in the Midcontinent: Electricity Sector*, indicates that carbon emissions from the electricity sector in the Midcontinent region are expected to decrease as utilities rely less on coal and more on natural gas, wind, and solar. Figure 4 shows the possible range of emissions outcomes in the region through 2050 across a wide range of future modeled scenarios, shown in the grey shaded area. All of the modeled scenarios lead to some reduction in carbon emissions by 2050, and the two scenarios represented by the green and blue lines in Figure 4 represent the future scenarios resulting from continued lower natural gas prices and lower renewable costs. Thus, if the electricity road map

4 Plug-in hybrid-electric vehicles (PHEVs) have both internal combustion engines and battery electric motors. PHEVs operate on battery electric power for a certain range before the internal combustion engine begins to operate.

5 The Midcontinent Power Sector Collaborative (MPSC), facilitated by the Great Plains Institute, released its *A Road Map to Decarbonization in the Midcontinent: Electricity Sector*, in July 2018 (the "electricity road map"). The MPSC concludes "it is likely that the electricity sector will substantially decarbonize by mid-century." In its road map, the MPSC details several pathways to decarbonization in the electricity sector. See roadmap.betterenergy.org.

6 U.S. Department of Energy, "The EGallon: How Much Cheaper is it to Drive on Electricity?", June 10, 2013, at https://www.energy.gov/articles/egallon-how-much-cheaper-it-drive-electricity.

7 Emissions factors were computed using Argonne National Laboratory's GREET model, which simulates the energy use and emissions output of various vehicle and fuel combinations. See https://greet.es.anl.gov.

FIGURE 2: Electricity Costs Less than Gasoline (Cost per Mile)

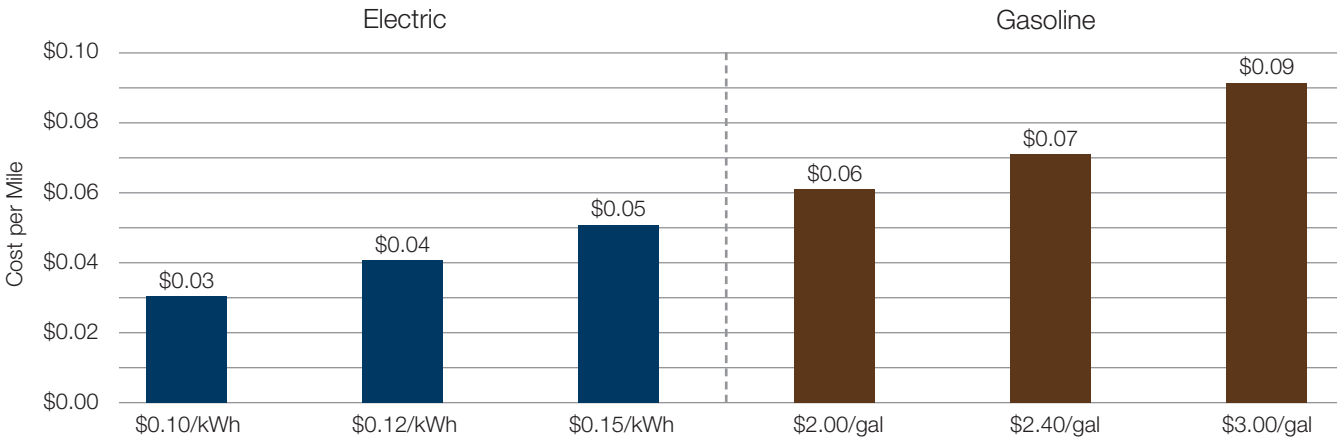
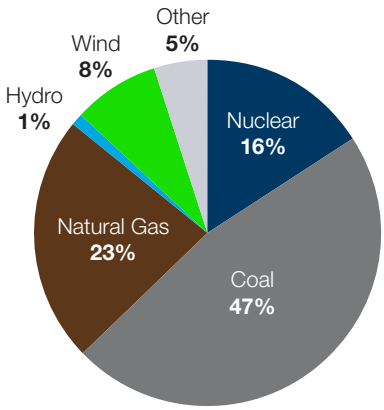


FIGURE 3: The Midcontinent Electricity Sector is Still Carbon-Intensive (Percent of Fuel Mix)



is correct, the emissions profile of the electricity sector in the region is expected to improve with existing policies and trends.[8] Even greater reductions would accrue with new interventions, including utility commitments, aimed at reducing carbon emissions.

The MPSC concluded that substantial decarbonization of the electricity sector is likely by midcentury due to a number of factors, including market trends, customer and investor wishes, and environmental and clean energy policy. Figure 5 shows the much-reduced carbon content of electricity in the region using the two decarbonization scenarios from the MPSC's modeling analysis.[9]

Electric Vehicles are More Energy Efficient

Because EVs are more energy efficient than their internal combustion engine counterparts, widespread EV adoption will improve the energy efficiency of the transportation sector. According to the U.S. Department of Energy, EVs convert about 59 to 62 percent of the electrical energy from the grid to power at the wheels, while conventional gasoline vehicles only convert 17 to 21 percent of the energy stored in gasoline to power at the wheels.[10] The emission benefits of electrified transportation are maximized when the electricity used is generated from zero-carbon sources such as wind or solar power.

The Importance of Vehicle Miles Traveled

Travel demand is a key variable when considering decarbonization in the transportation sector. While EVs in the Midcontinent region use a less carbon-intensive fuel and are more efficient than conventional internal combustion engines, they travel a similar number of vehicle miles. Vehicle miles traveled have historically increased when the cost of travel has decreased for consumers and when the economy is strong. The primary cost of travel for conventional vehicles has been a function of gasoline and diesel costs. Ride-sharing services and the addition of autonomous vehicles are two factors that can either increase or decrease vehicle miles

8 As noted in the electricity road map, the two principal trends leading to emissions reductions are low natural gas prices and decreasing renewables costs.

9 See electricity road map, supra note 1 at pp. 17-25.

10 https://www.fueleconomy.gov/feg/evtech.shtml. These efficiency numbers do not include the loss of energy in the production of the electricity or extraction and refining of the fossil fuel.

FIGURE 4: The Midcontinent Electricity Sector Expected to be Less Carbon Intensive Across Wide Range of Business as Usual Scenarios

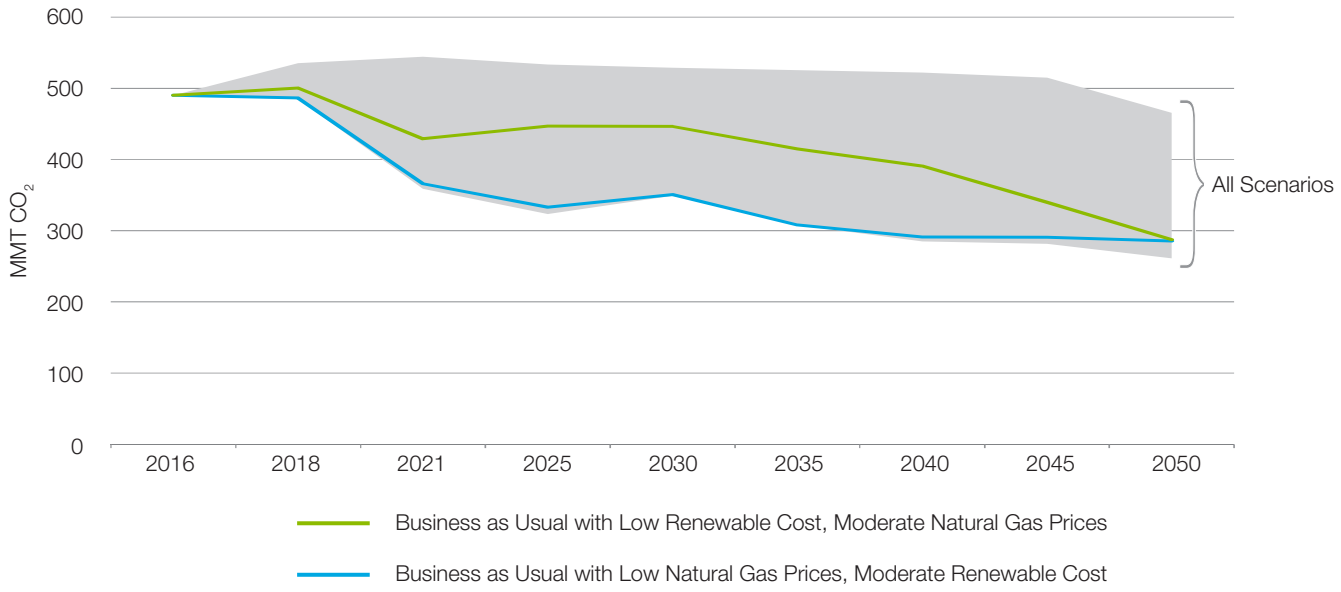
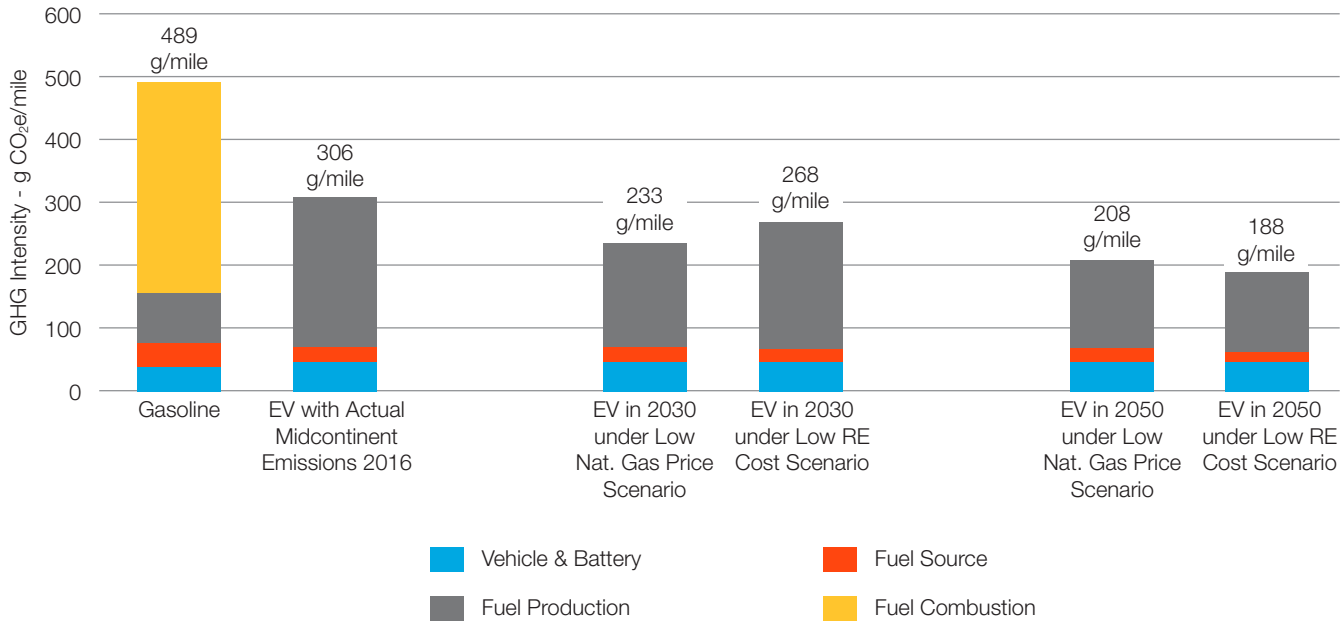


FIGURE 5: Electricity is Already Cleaner Per Mile and Expected to Get Cleaner Over Time in Business as Usual Scenarios (Grams CO_2 per mile)



traveled depending on circumstances. Some increases in mobility will be socially desirable—such as in the case of increasing the mobility of currently underserved populations—but avoiding overall increases in vehicle miles traveled will boost the benefits of electrification.

Consumer Choice: The Key Variable

If electrification is going to play a big role in the decarbonization of the transportation sector, consumers—both individuals and fleet owners—need to switch to purchasing EVs in spite of a number of barriers to EV adoption. According to the 2017 National Renewable Energy Laboratory (NREL) study, the top barriers to EV adoption are 1) range anxiety, 2) perceived ability to charge, and 3) vehicle purchase price and willingness to pay more for an EV.[11] For individuals and fleet owners alike, it will be important to make purchasing and driving EVs as easy as a conventional vehicles. Addressing these barriers can accelerate EV adoption and result in benefits when shaping the EV charging curve.

Range Anxiety

Individual consumers are wary of adopting EVs due to fear of running out of "fuel" without access to charging infrastructure. The NREL study indicated that the median range required by survey respondents to consider purchasing an EV was 300 miles. Automakers recognize the range anxiety issue and are investing widely in developing EVs that meet the desires of their customers and can alleviate range anxiety. While battery technology improvements and cost declines will drive EV vehicle costs towards parity with gas vehicles, vehicle range of those produced today is between under 100 to 335 miles, with costs generally increasing along with range. Range anxiety is also a function of charging availability. Historically, when pushing the gas tank to the limit in a gas vehicle, knowing one's proximity to a filling station provides some level of comfort. This is not different with an electric vehicle. As charging availability increases, range anxiety will become less of a concern. Fleet owners also require light-, medium- and heavy-duty vehicles that have sufficient range, in addition to other attributes, to meet the requirements of the fleet application.

Perceived Ability to Charge

There is strong evidence that awareness of EV charging infrastructure can make consumers more likely to choose EVs.[12] As a result, a coordinated approach to charging infrastructure investment and installation will provide individuals and fleet owners with the greatest benefit. Utilities, state and local government planners, EV network operators, and public utility commissions need to work together to develop plans for highway charging corridors, public charging installations at locations where vehicles are parked for significant periods of time (including workplaces), and residential charging installations (including multi-unit dwellings). Initiatives that advance charging infrastructure for fleet owners will improve the value proposition for fleet adoption of EVs.

11 Singer, Mark, "The Barriers to Acceptance of Plug-in Electric Vehicles: 2017 Update." National Renewable Energy Laboratory (NREL), November 2017. https://www.nrel.gov/docs/fy18osti/70371.pdf

12 Ibid.

Vehicle Purchase Price and Willingness to Pay More for an EV

Survey respondents to NREL's 2017 study provided an expected price range for their next vehicle purchase that was less than the cost to purchase an EV. Due to the cost of battery technology, prices for EVs are currently higher than a comparable gasoline or diesel vehicle. Many analysts expect up-front costs of EVs to decrease and reach initial price parity as early as 2025 or 2030,[13] but the shift in consumer demand for larger vehicles and longer range could push this parity timeline further into the future with increasing battery sizes. Until then, rebates, tax incentives, and tax exemptions are mechanisms that can be utilized by governments and utilities to reduce initial purchase price and increase demand for EVs. For fleets, which generally are more concerned with total cost of ownership, higher up-front costs are less of a challenge from a budgeting and financing perspective because fleet owners are much more aware of the cost benefits of lower total cost of ownership.

According to NREL, when told that EVs would reduce lifetime fuel costs by one-third, approximately half (47 percent) of survey respondents stated they would be willing to pay the full (higher) purchase price for an EV, and an additional 20 percent of respondents stated they would not pay the full purchase price but would consider the hypothetical EV.[14] 20 percent of respondents would not buy an EV regardless of incremental costs. Educating consumers on the reduced total cost of ownership of EVs, including lower fuel costs and significantly less maintenance compared to conventional engines, is a helpful tool to support increased EV adoption for at least half of the population. States should also reconsider increased registration fees targeting EVs as a strategy for replacing road maintenance fees. These fees reduce the financial benefits of EV adoption and, as EV adoption increases, are not a long-term solution to the funding problem.

Current Regulatory Environment for Electric Vehicles

This road map describes actions state and local leaders and private actors can take to accelerate EV adoption in the Midcontinent. Increasing EV adoption requires a broad and comprehensive suite of market-facing policies to build market demand, facilitate EV charging, and create a positive experience for EV drivers. A subset of these policies is discussed briefly below, but it is important to remember that accelerating transportation electrification will require concerted action on all fronts.

Tax Credits and Other Purchase Incentives[15]

At the federal level, the purchase of a light-duty EV can earn purchasers a tax rebate up to $7,500, which can go a considerable distance toward lowering the up-front cost of EV models. Unfortunately, the current federal tax credit is slated to phase out in 2019 for some manufacturers, including Tesla and General Motors if the tax credit is not reformed. Some states have adopted supplementary state-level purchase incentives, but Louisiana is the only Midcontinent state to have one in place. Examples

13 When comparing internal combustion and electric vehicles for purposes of "parity," the key variables include the up-front costs of the vehicle, the total cost of ownership of the vehicle as well as the functionality of the two vehicles, including for example the range of the electric vehicle. Costs related to charging infrastructure may also be a factor, but these costs are not always paid by the purchaser of the vehicle and therefore may not be perceived as upfront costs by the purchaser. For a review of manufacturing cost projections from numerous studies, see "Accelerating US Leadership in Electric Vehicles", by the Union of Concerned Scientists, August 2017.

14 Singer, Mark, "The Barriers to Acceptance of Plug-in Electric Vehicles", 14-16.

15 In addition to purchase incentives, states and utilities are implementing incentives for the installation of charging infrastructure and equipment. For an interactive map that details many of the incentives nationwide, see https://www.chargepoint.com/products/station-incentives/.

of state-level incentives for individual consumers are presented in Figure 6.[16]

The State of Georgia's vehicle purchase incentive demonstrates the effectiveness of state purchase incentives. Georgia enacted a $5,000 per vehicle tax credit for battery electric vehicle purchases in the state and very quickly became the state with the second-highest number of EVs on the road. When the Georgia legislature ended the tax incentive in 2015, however, EV sales in the state plummeted.[17]

Programs for medium- and heavy-duty vehicles and fleets are also emerging. In the Midcontinent region, the City of Chicago offers purchase incentives of up to $150,000 for hybrid-electric and all-electric trucks.[18] Chicago also offers up to $10,000 toward the purchase of electric taxis. Two states outside the region—California and New York—have introduced truck purchase incentive programs to accelerate adoption of electric trucks.

Clean Air Regulatory Treatment

None of the states in the Midcontinent region have adopted state low emissions vehicle (LEV) regulations, with or without a zero emissions vehicle (ZEV) sales mandate, though states in other parts of the country have done so as shown in the map in figure 7. The ZEV program is a supply-side mandate that requires major automakers to sell, or to purchase credits from other automakers that sell, EVs in states or regions that have adopted the program. Automakers are required to hit specific sales targets and must either purchase credits or pay fines if consumers do not buy enough EVs in the region. Leading EV automakers such as General Motors, Tesla, and Nissan already offer their EVs for sale nationwide, though sales outside of California lag significantly due in large part to the relative lack of incentives, infrastructure, and related programs detailed in this report.[19] As the analysis presented below demonstrates, EV penetration can be expected to improve air quality across the region, making federal Clean Air Act compliance easier for state regulatory agencies.

FIGURE 6: States are Offering Incentives for New EV Purchases

STATE	PURCHASE INCENTIVE
All	$7,500 federal income tax credit (subject to phase-out based on manufacturer-by-manufacturer sales basis)
California	$2,500 rebate (with income eligibility requirements)
Connecticut	$3,000 rebate for new vehicles with base price under $60,000
Colorado	$5,000 tax credit for purchase and $2,500 tax credit for lease
Delaware	$1,000 rebate for new vehicles with base price over $60,000; $3,500 rebate for new vehicles with a base price under $60,000
Louisiana	$1,500 income tax credit
Maryland	$3,000 excise tax credit for new vehicles with price under $60,000; Plus $700 rebate on wall connectors and installation
Massachusetts	$1,500 rebate for new battery and fuel-cell EVs with a purchase price below $50,000
New Jersey	Battery and fuel-cell EVs are sales tax exempt
New York	$500 rebate for new vehicles with base price over $60,000; $2,000 rebate for new vehicles with a base price under $60,000
Oregon	Up to $2,500 rebate for new vehicles with base price under $50,000 based on battery capacity
Pennsylvania	Up to $2,000 rebate for new vehicles depending on battery size
Texas	$2,500 rebate for new vehicles at the dealership
Washington, DC	Excise tax exempt

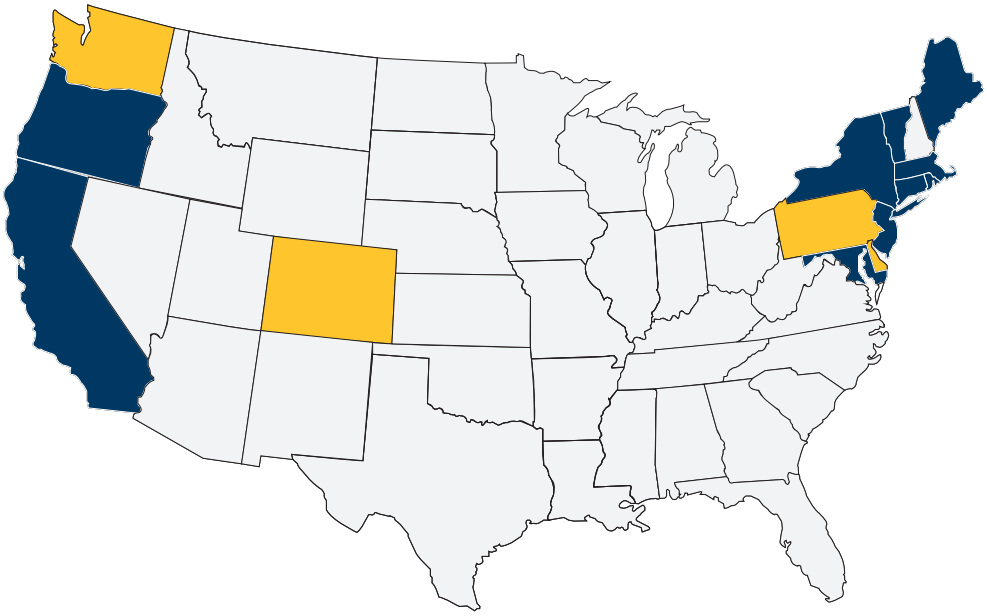
16 For California, see https://cleanvehiclerebate.org/eng; for Connecticut, see https://www.ct.gov/deep/cwp/view.asp?a=2684&q=561422&deepNav_GID=2183; for Colorado, see http://www.leg.state.co.us/CLICS/CLICS2016A/csl.nsf/fsbillcont3/D29A1044569D6D5987257F2400642E3F?Open&file=1332_rer.pdf; for Delaware, see https://dnrec.alpha.delaware.gov/climate-coastal-energy/clean-transportation/vehicle-rebates/; for Louisiana, see http://www.legis.la.gov/legis/ViewDocument.aspx?d=1052430; for Maryland, see https://marylandev.org/incentives/; for Massachusetts see https://mor-ev.org; for New Jersey see https://www.state.nj.us/treasury/taxation/zevnotice.shtml; for New York see https://www.nyserda.ny.gov/All-Programs/Programs/Drive-Clean-Rebate/How-it-Works; and for Washington, DC, see https://dmv.dc.gov/sites/default/files/dc/sites/dmv/publication/attachments/Amended%20Excise%20tax%20exemption%20categories%205%2013%20final.pdf.

17 https://politics.myajc.com/news/state--regional-govt--politics/georgia-lawmakers-try-bring-back-electric-vehicle-tax-break/MJIY2sPBwYK4NX-AtHsEqRJ/

18 Information on Chicago's truck and taxi programs is available at http://www.drivecleanchicago.com; information on New York's truck program is available at https://truck-vip.ny.gov; and information on California's truck program is available at https://www.californiahvip.org.

19 2018 market share in California is 7.08% compared with just 1.4% in the other states that have adopted the ZEV regulation. EV penetration in the Midcontinent states as defined by MTEC is 0.58%, ranging from 0.17% in Mississippi to 0.86% in Minnesota. See Advanced Vehicle Sales Dashboard, data compiled by the Alliance of Automobile Manufacturers using information provided by IHS Markit, available at https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

FIGURE 7: States that have Adopted Vehicle Emissions Standards



STATES WITH LOW EMISSION VEHICLE (LEV) STANDARDS ONLY
Colorado
Delaware
Pennsylvania
Washington
Washington, DC

STATES WITH LEV AND ZERO EMISSIONS VEHICLE STANDARDS
California
Connecticut
Maine
Maryland
Massachusetts
New Jersey
New York
Oregon
Rhode Island
Vermont

State and local incentives for electric and hybrid-electric buses have sought to meet federal Clean Air Act requirements to reduce air pollution while improving local air quality for urban populations most vulnerable to air pollution from diesel buses. California has adopted a clean air program to transition to all-electric buses by 2040 to improve air quality.[20]

What is managed charging?

Many studies have demonstrated that EVs can have enhanced benefits for the electric grid if consumer charging patterns can be influenced. There is particular interest in moving charging to off-peak times when the cost of generating electricity is lower, and in charging when renewable electricity generation exceeds demand. There are two primary approaches to influence consumer charging behavior: economic price signals provided through rate design (including time of use rates that offer lower-cost charging off-peak and higher-cost charging on-peak), and controlled charging through vehicle telematics or "smart" EV supply equipment (EVSE). Many utilities, EVSE operators and automakers around the country are experimenting with different approaches to see what will work and how customers respond to the programs. Whatever strategy is chosen, it is important that the benefits to the grid must be balanced with consumer experience and choice. Managed charging should not inadvertently discourage EV adoption or undermine drivers' EV charging experience.

Utility Plans

A number of the region's utilities, including participants in MTEC, have proposed or are implementing programs that will help to encourage the adoption of EVs on their systems. These programs have focused mainly on supporting the installation of charging infrastructure, customer education and outreach, and the development of rate design and load management strategies for EVs that help to create grid benefits, keeping charging costs low for consumers, and contributing to environmental benefits. Recent filings have also proposed infrastructure for fleet vehicles such as electric transit and school buses.[21] MTEC released a white paper detailing consensus principles for the design of utility EV programs.[22]

20 For more information on California's fleet bus rule, visit https://www.arb.ca.gov/msprog/bus/bus.htm.

21 Three MTEC participant companies are undertaking efforts to assist in the transition to electric buses, including Xcel Energy, DTE Energy and Madison Gas and Electric. For information on Madison Gas & Electric's program, see https://www.mgeenergy.com/news/20171215-electric-buses-advance.htm

22 Electric Utility Roles in the Electric Vehicle Market: Consensus Principles for Utility EV Program Design. Midcontinent Transportation Electrification Collaborative, April 2018, available at https://www.betterenergy.org/wp-content/uploads/2018/04/MTEC_White_Paper_April_2018-1-1.pdf. See summary of the paper on page 24 of this document.

Madison Gas and Electric Partners to Advance Electric Vehicles Across Communities

MADISON GAS AND ELECTRIC (MGE) partners across its community to electrify transportation, working with residential, commercial and fleet customers, both public and private, to grow the use of electric vehicles (EVs) in pursuit of shared energy goals. The electrification of transportation is one of MGE's key strategies for achieving deep decarbonization.

Charge@Home Program

MGE's Charge@Home program makes home charging easier and faster. MGE handles the installation and maintenance of a Level 2 smart charger at residential customer homes. Customers enroll for about $20 per month plus the cost of their electricity. There is no upfront installation cost. Participants agree to allow MGE to view their charging patterns and to manage home charging sessions remotely, if needed, to manage the grid.

Public & Multifamily Charging

MGE began installing public charging stations in 2009 to encourage EV adoption and to understand the need for public charging. Today, MGE's growing network includes 31 public charging stations, all of which are powered by wind energy.

Since 80 percent of charging occurs at home, MGE partners with developers and property managers to install charging stations at multifamily properties. MGE also works with business customers to implement workplace charging programs.

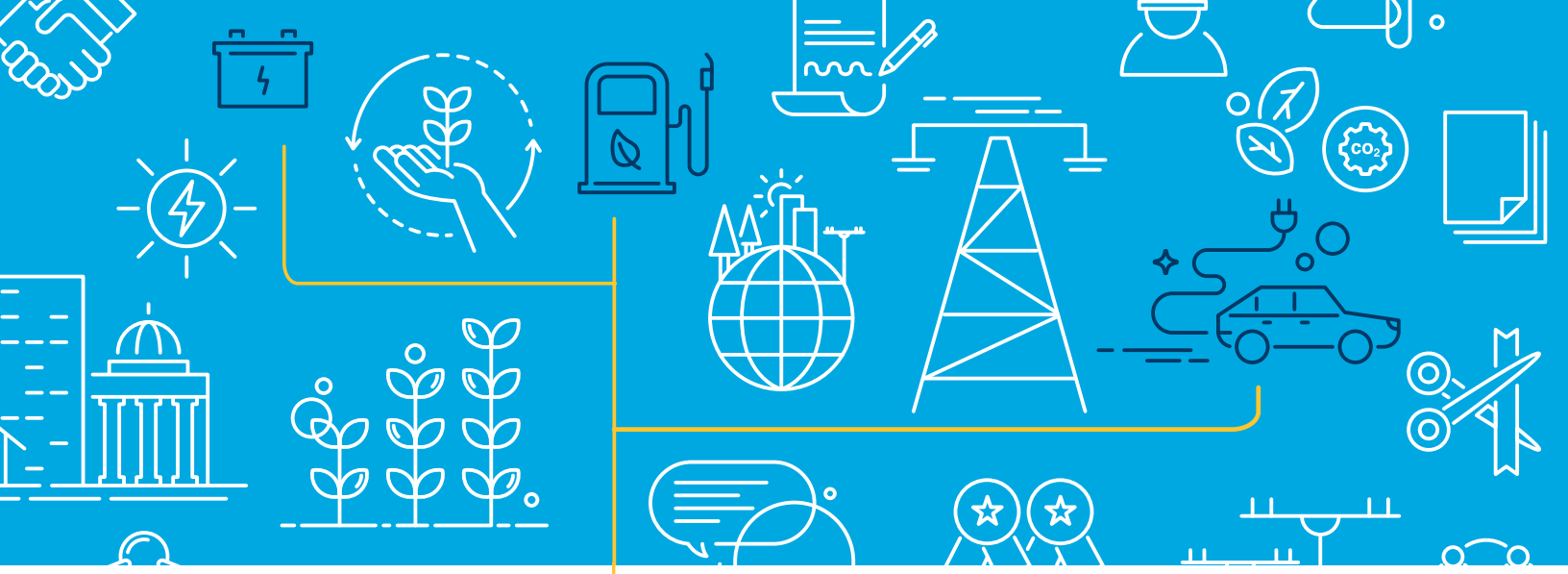
Customer Outreach & Education Programs

Especially important to EV growth is customer outreach and education. MGE partners with dealerships by providing resources and education to sales staff. MGE recently launched a new EV website — LovEV — and an online feature called EV Rider. EV Rider provides easy to understand information on electric vehicles and charging. It takes an informal, conversational approach, featuring local videos, short articles and interviews with industry experts. The LovEV web site helps customers who are considering an EV get up-to-date and accurate information about available models, driving range, costs, emissions and charging opportunities.

Partnering with Cities & Communities

As a community energy company, MGE also works with its municipal partners. For example, MGE helped the City of Madison secure $1.3 million in federal funding to advance the city's goal of electrifying 50 percent of the city's bus fleet by 2035. As part of the partnership with the city's Metro Transit, MGE also is providing 100 percent of the required local matching funds for charging infrastructure for the first three all-electric buses and continued in-kind support and expertise to address technological issues and to facilitate the cost-effective use of energy. Metro Transit expects its first all-electric buses in 2020.

> "Electrification of transportation is one of MGE's key strategies for achieving deep decarbonization.



Analysis of Pathways to Transportation Electrification

TO WHAT EXTENT CAN WE RELY ON ELECTRIFICATION to reduce carbon emissions in the electricity sector? What are the benefits of electrification? Are there potential pitfalls to be avoided? MTEC used sophisticated FACETS computer modeling to help answer these questions.[23] The modeling analysis projected outcomes in the Midcontinent region in both the electricity and transportation sectors across a wide range of scenarios and sets of assumptions.

23 For more information on the FACETS model and the modelers who use it, including Sustainable Energy Economics, see http://facets-model.com/. The full modeling analysis completed for this road map is available at roadmap.betterenergy.org, including a link to the assumptions and access to the various scenarios modeled.

Below are the findings from the modeling analysis:

- EVs can go a long way toward decarbonizing transportation. When looking at total combined carbon emissions in the Midcontinent across the transportation and electricity sectors, more transportation electrification leads to reduced emissions in all scenarios analyzed, even though electrification may require the generation of more electricity to meet demand.[24] Figure 8 shows the reductions across the low-, moderate- and stretch-electrification scenarios analyzed for MTEC.
- Transportation electrification yields major benefits in the form of opportunities to better utilize resources on the electricity system.
- Transportation electrification can make electricity an even cleaner fuel relative to gasoline in the Midcontinent, because new vehicle charging loads can be targeted to times when lower-cost, zero-carbon renewable energy is available on the system and might otherwise go unused. This is true even as the electricity sector may need to grow to provide fuel for EVs.
- Transportation electrification leads to significant reductions in non-carbon air pollution from transportation, including ground-level ozone-causing nitrogen oxides. This is true even after factoring in the potential increased electricity production needed to serve an electrified transportation sector. Figure 9 shows the nitrogen oxides emission reductions in the transportation and electricity sectors combined under different scenarios. The yellow dashed line represents a future in which natural gas prices remain low and renewables costs are moderate, while the shaded area represents the range across low-, moderate-, and stretch-electrification levels. The green dashed line represents a future in which natural gas prices are moderate and renewables costs are low, while the yellow-shaded area represents the range across low-, moderate-, and stretch-electrification levels.
- The analysis also suggests that particulate emissions from diesel-fueled vehicles will greatly decrease as electrification in medium- and heavy-duty vehicle segments increases.[25] Figure 10 shows the drop in diesel particulate emissions across the different electrification scenarios analysis for this road map.
- Flexible EV load means better resource utilization in off-peak time periods. As shown in Figure 11, managing EV charging can smooth out what would otherwise be peaks on the system. Because system peaks are the times when the cost of producing electricity is the highest, avoiding peaks can save consumers money. In

24 This result is true in part because the region's electricity sector is projected to see decreased carbon emissions across a wide range of assumptions as a business-as-usual matter.

25 For a description of the modeling analysis conducted, please see roadmap.betterenergy.org.

FIGURE 8: More Electrification Means Bigger Emissions Reductions Across All Scenarios
(Millions of Metric Tons Reduced in Electricity and Transportation from 2005 Baseline)

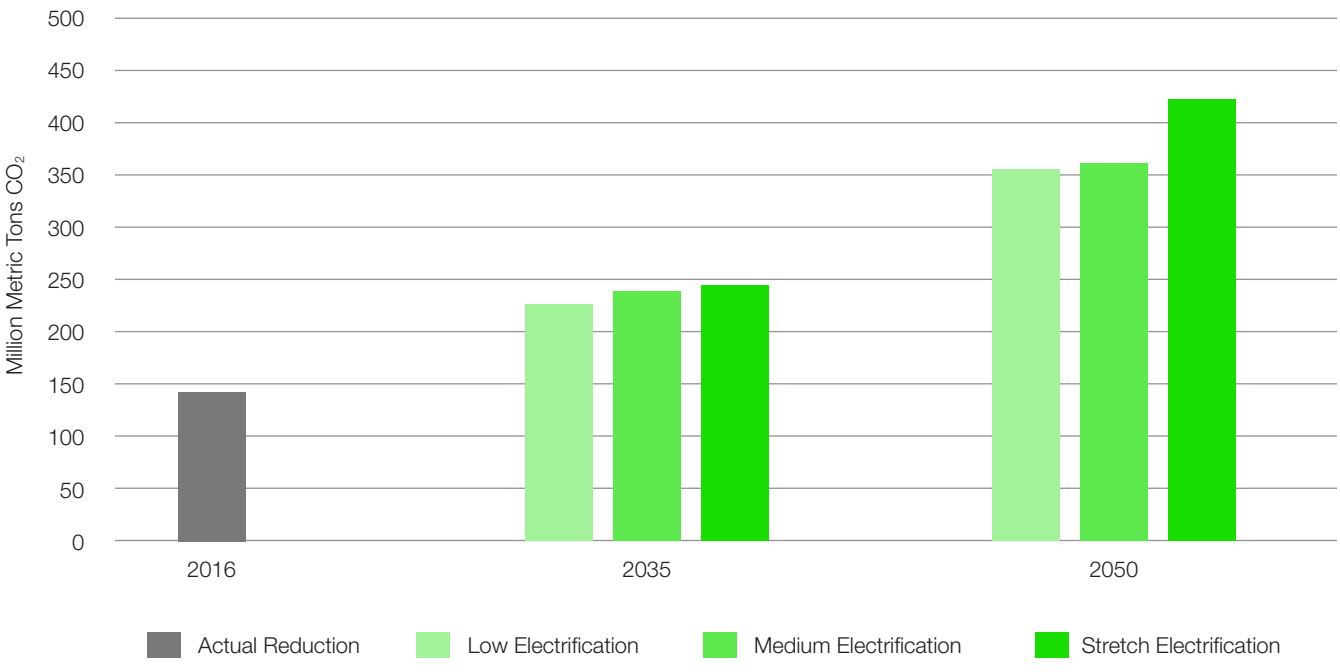


FIGURE 9: More Electrification Means Significantly Lower Ozone-Causing Nitrogen-Oxides Pollution
(Percent Reduced Across Low-, Medium-, and Stretch-Electrification Scenarios)

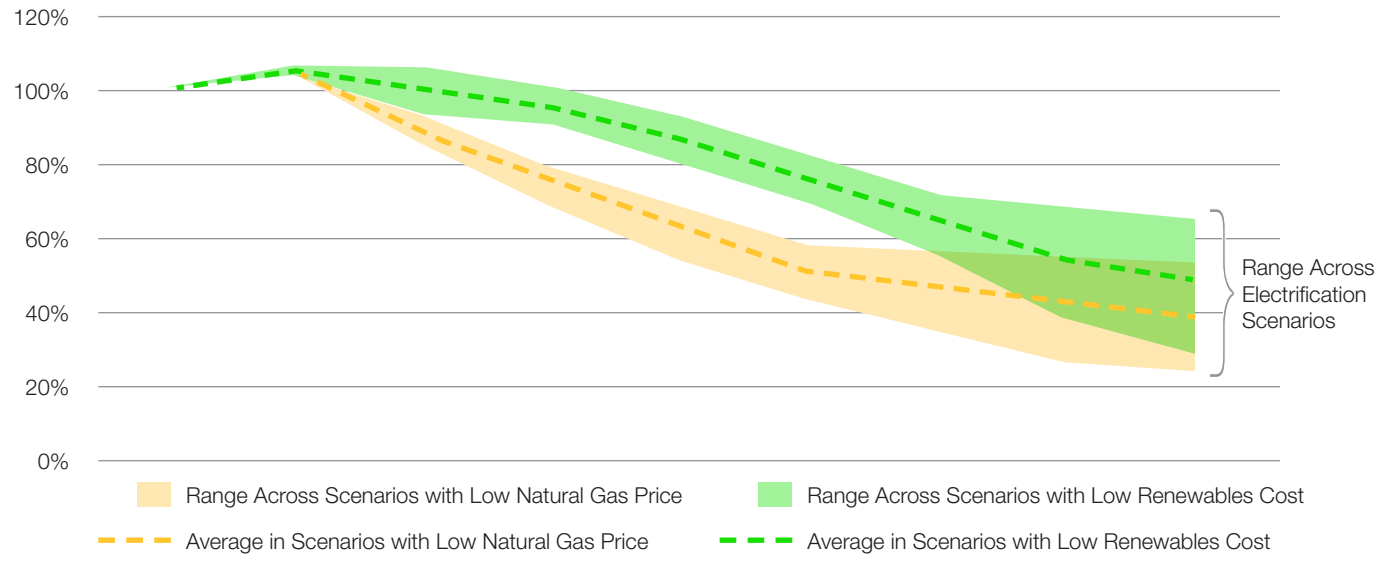
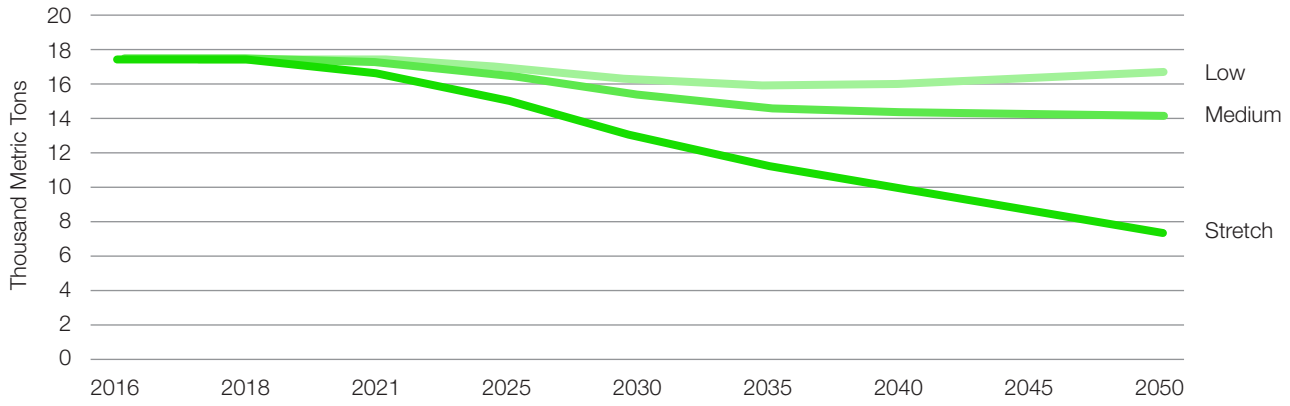


FIGURE 10: More Electrification Means Lower Particulate Emissions
(Reductions in Thousands of Metric Tons with Low Natural Gas Prices Across Low-, Medium-, and Stretch-Electrification Scenarios)



addition, because system operators plan the system to maintain sufficient power generation capacity to cover the system peak plus a reserve margin, managing peaks can help avoid investments in new capacity. In off-peak times, using power plants more means a lower cost per megawatt hour of electricity production and thus lower electricity rates.

- Flexible EV load can help avoid renewable energy curtailments and incorporate additional renewable generation. Figure 12 shows the effect flexible EV load can have on incremental renewable energy when charging is managed either through simple time of use rates or other more real-time control by the utility. In the early part of the time horizon, the system optimizes for underutilized wind and adds incremental wind; then, in the later part of the time horizon it drives additions of solar capacity with daytime charging.[26]

- Managing EV load can greatly reduce the cost of carbon reductions across the electricity and transportation sectors. The analysis shows that the economic benefits that managed charging brings to the electricity system are significant. Indeed, when the model was allowed to

26 In the MTEC analysis, "evening" charging means drivers plug in as soon as they arrive home at the end of the day; "late night" means drivers charge overnight; and "optimized" means the model chooses the time of day for charging based on lowest electricity prices.

FIGURE 11: Managed Charging Can Yield Big Benefits to the Electricity Sector By Smoothing Out Demand and Maximizing Renewable Generation

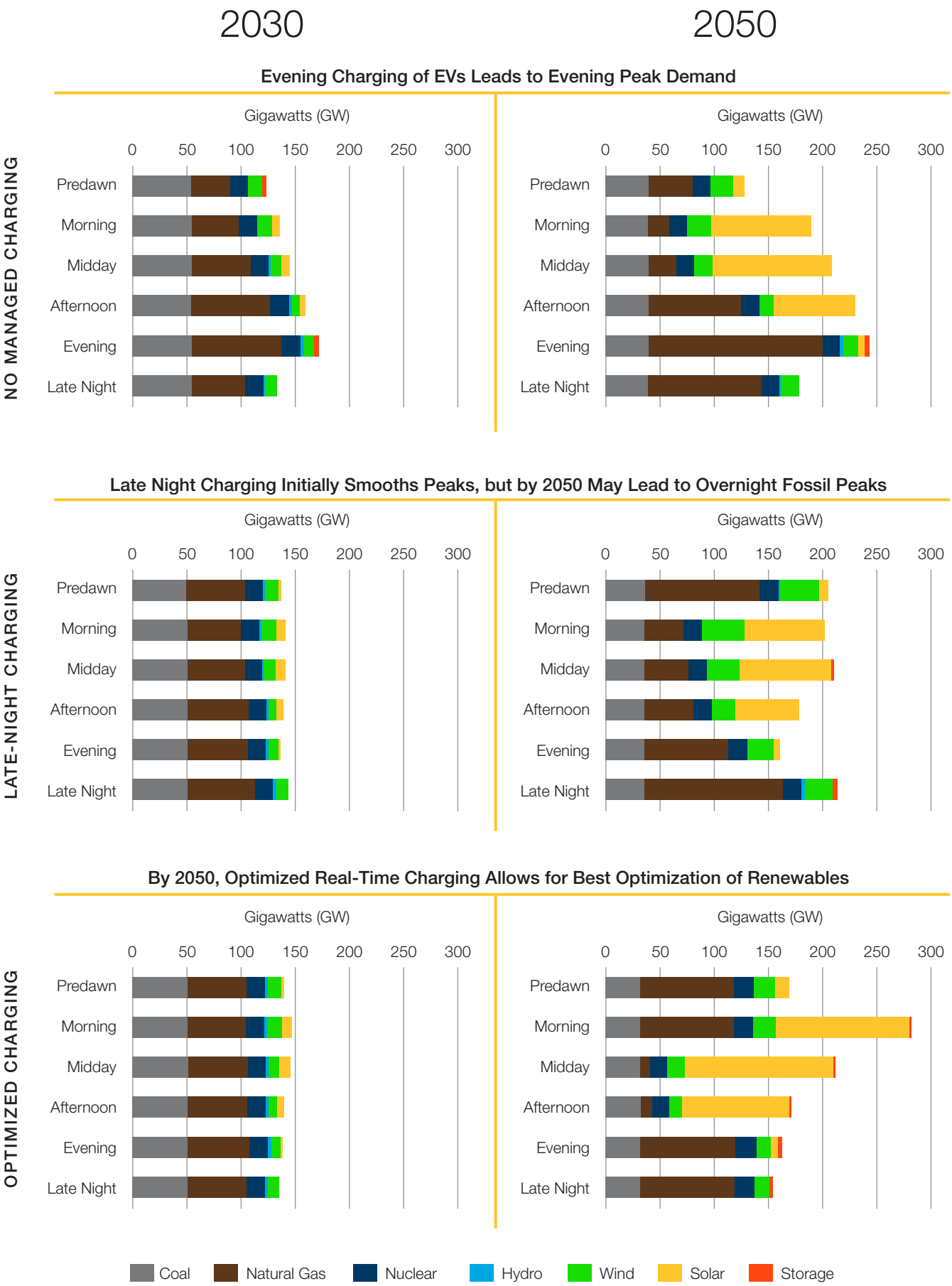
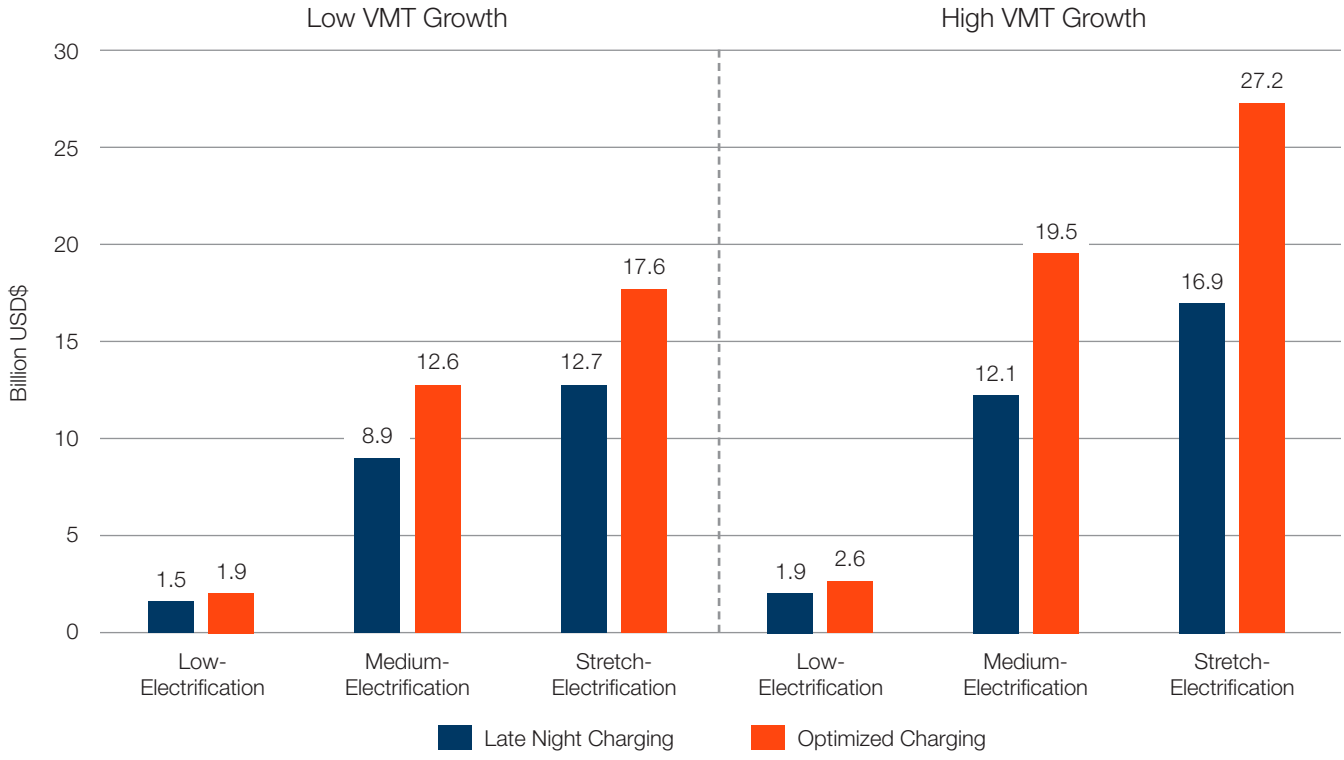


FIGURE 12: Managed EV Charging Allows for More Renewable Electricity
(TWh Across Managed Charging Scenarios)

FIGURE 13: Managed EV Charging Can Save Billions



optimize charging times—a proxy for real-time control of charging—the system saved up to $27 billion on a net present value basis over unmanaged charging. Late night charging—a result that might be effectuated through a night time of use rate—can save up to $17 billion. These savings levels are shown in Figure 13. In seeking to manage EV load, there must be careful consideration of the customer experience and choice to assure that the steps taken to shape the load curve from EV charging do not inadvertently deter EV adoption or disincentivize the deployment of EVSE at a wide range of appropriate locations.

- While transportation electrification is an essential part of any strategy to decarbonize the transportation and electricity sectors, it is quite possible that other strategies, including other low-carbon fuels will also be needed to decarbonize the transportation sector. The analysis conducted for MTEC found that electrification of light-, medium- and heavy-duty vehicles was able to achieve a combined 80 percent carbon reduction across the electricity and transportation sectors, but only when electrification reaches higher levels of penetration. Thus, the scale of benefits provided by EVs depends on how rapidly and broadly EVs penetrate the market. Accelerating and broadening EV penetration will improve the chances that electrification can play a larger role in sector decarbonization.

Great River Energy EV Initiatives

GREAT RIVER ENERGY and its member-owner cooperatives encourage end-use members to pursue electric uses that meet these three criteria: save consumers money, reduce greenhouse gas emissions and improve overall efficiency of the electric grid. After modifying its electric generating resources in ways that have led to a 27 percent reduction in carbon dioxide emissions since 2005, the cooperative believes that significant greenhouse gas reductions can be realized by electrification of the transportation sector. An introduction to the specific initiatives of Great River Energy within the transportation sector are below.

Electric School Bus Pilot

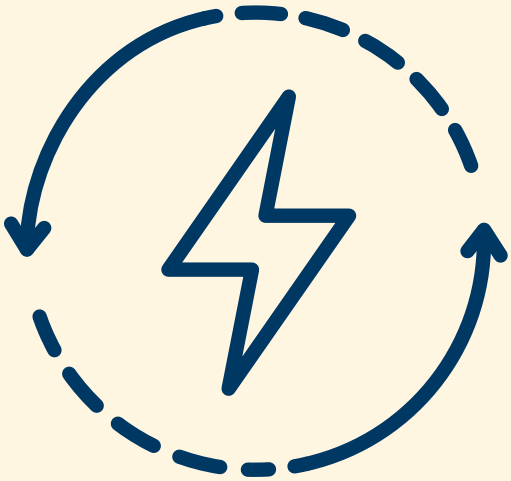
Beginning in the fall of 2017, some Minnesota students were transported to and from school on an all-electric school bus as part of a first-of-its-kind pilot project in the state. This opportunity was possible through a collaboration between Schmitty & Sons, Dakota Electric Association and Great River Energy to demonstrate a battery electric school bus in a cold-weather climate as well as on longer suburban and rural routes.

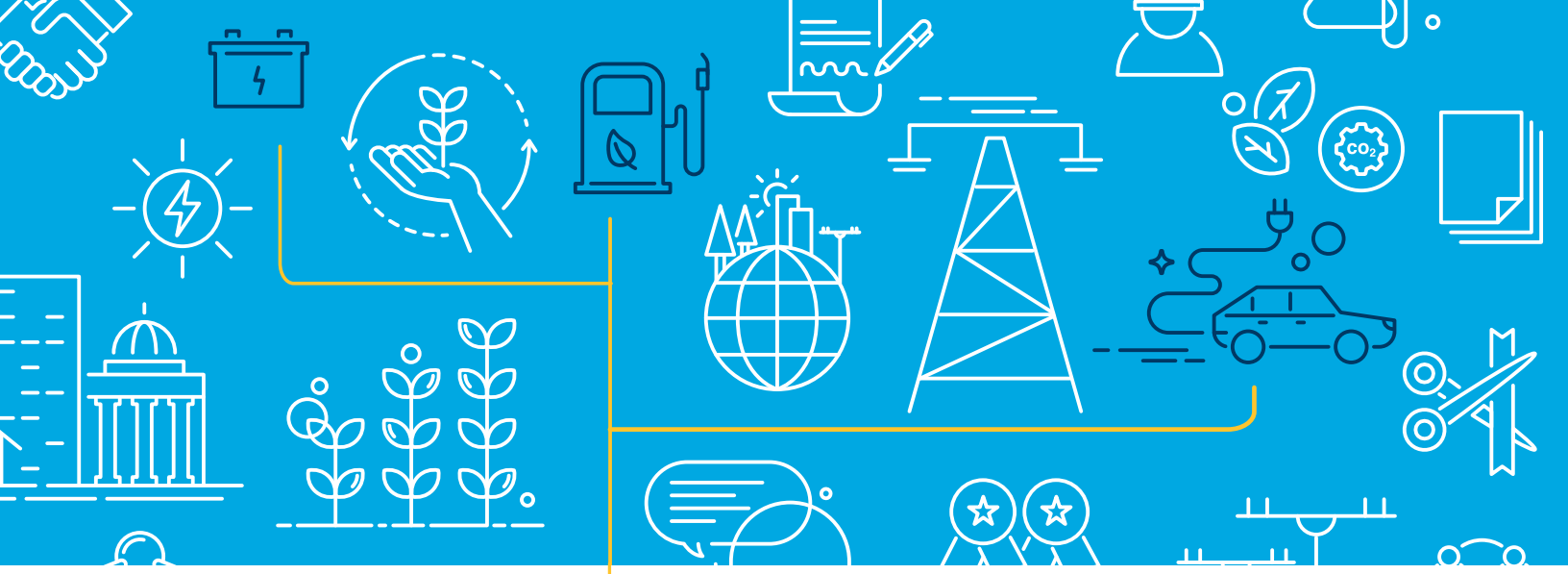
Electric Vehicle Charging Infrastructure

Great River Energy and its member cooperatives helped establish Minnesota's first electric vehicle (EV) charging corridor. Interstate 35 now has a series of fast-charging stations that can charge an EV in about 30 minutes. Charging infrastructure along Interstate 35 allows more EV drivers to travel between the Twin Cities and Duluth. Plans are currently underway to install additional charging stations farther north to allow travel by EV along the North Shore.

Revolt Electric Vehicle Program

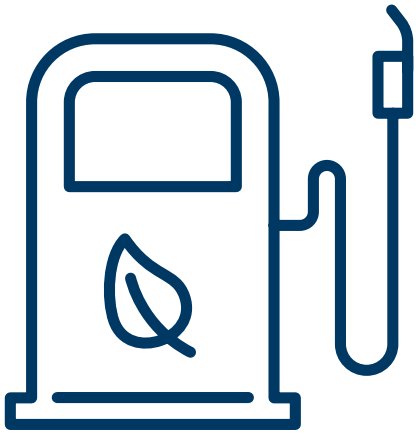
Great River Energy's member cooperatives offer free wind energy to fuel EVs owned by cooperative members. The Revolt program dedicates wind energy to completely cover the electricity used to fuel an EV for the life of the car. Households can have up to four EVs enrolled in this program. The program began in 2015 and has been extended each year, now through 2019 due to its popularity.





Key Findings

1. Transportation electrification is an essential part of a decarbonized transportation sector. However, there are several barriers to widespread electrification, ranging from vehicle technology and battery costs to charging availability to consumer preferences and awareness. Increasing EV adoption requires a broad and comprehensive suite of market-facing policies to build market demand, facilitate EV charging, and create a positive experience for EV drivers.
2. Even under optimistic "stretch" scenarios for EV adoption in the Midcontinent it is clear that other measures—such as low- and zero-carbon liquid fuels—may be necessary to reach higher levels of decarbonization in the sector.
3. Pairing transportation electrification with electric sector carbon reductions can be a cost-effective way to achieve emissions reductions.
4. EVs are generally less expensive to operate and maintain than traditional vehicles and the cost of the technology is decreasing rapidly.
5. Electricity used in an EV in the Midcontinent is already a cleaner fuel than gasoline, diesel and compressed natural gas (CNG). Working toward further decarbonizing the electricity system, including through increased renewables deployment, will make electricity an even cleaner transportation fuel.



6. EVs not only reduce carbon emissions, but emissions of other pollutants such as nitrogen oxides and particulate matter. Reductions in nitrogen oxides and particulate matter protect public health generally, and especially protect the health of sensitive populations like children and the elderly.[27]

7. EVs present great opportunities for the electricity system and all electricity consumers. When properly managed, EV charging will result in better utilization of existing resources, especially variable resources such as wind and solar, and better utilization of resources can lead to lower electric rates.

8. EV charging times matter. Rate designs that incentivize vehicle charging at times of high renewable energy generation are important measures to lower the cost of decarbonizing the electricity and transportation sectors.

9. Other low-carbon fuels and strategies will be needed. It is likely that EVs will not supply all of the needed carbon reductions in the transportation sector. Action must be taken to encourage greater efficiency in internal combustion engines and the development and production of other low- and zero-carbon fuels to cover any gap left in the sector and to address parts of the sector that may not be served by battery electric vehicles.

10. Consumers are the key. Decarbonization of the transportation sector through electrification depends on the consumer. State leaders and private sector actors need to work to create a consumer ecosystem that encourages consumers to buy EVs.

11. Travel demand matters. While greater EV penetration can produce strong economic and health benefits, the greatest environmental benefits are realized when travel demand rises less. Indeed, the analysis tended to show that benefits were greatest when EV penetration was the highest and vehicle miles traveled were the lowest.

27 https://www.epa.gov/criteria-air-pollutants/naaqs-table

Xcel Energy EV Initiatives

To achieve the economy-wide reductions believed needed to limit warming to 2˚C, it will be necessary to decarbonize other sectors besides electricity. Transportation — now the highest carbon emitter — is an initial focus for Xcel Energy beyond electricity. Xcel is introducing new electric vehicle (EV) pilot programs, infrastructure investments, technologies and rates to make residential EV charging easy, help large customers electrify their fleets, electrify public transit and support fast charging on highway corridors and in communities. Xcel is also exploring technologies and rate designs to match EV charging with times of the day when renewable generation is high and energy costs are low. Xcel's proposed EV portfolio, with a proposed budget of approximately $25 million for the next three years, includes new, innovative pilot programs and initiatives.

Home Charging Making Charging Easy and Affordable

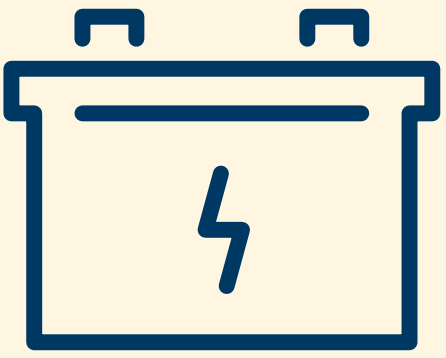
Xcel Energy is actively deploying charging equipment for a two-year Residential EV Service Pilot in which customers can choose to pay for Level 2 charging equipment installation either upfront or through monthly payments and select from two charger manufacturers. Trained electricians simplify the installation process and advisory services are offered throughout the pilot period. Other pilots and initiatives Xcel Energy has proposed or is developing related to home charging include: EV charging subscription service, residential smart charging, digital tools for consumers and public charging pilot for multifamily properties.

Fleet Charging: Increasing Awareness and Lowering the Costs of Infrastructure

To help inform fleet operators about EV conversions, Xcel Energy has been teaming up with providers of EV analytics. As part of these services, Xcel offers telematics and analytics solutions, consulting, evaluation and data assessment to enhance customers' fleet electrification strategies. Additional fleet pilots and initiatives Xcel Energy has proposed include: providing fleet charging infrastructure to help defray some of the upfront costs of incorporating EVs for both light-duty and battery electric bus fleets, and a vehicle-to-grid demonstration for school buses.

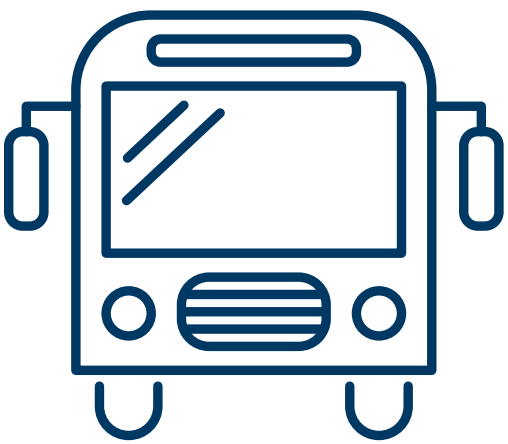
Public Charging: Encouraging the Development of Infrastructure for All Customers

Xcel Energy provides support to EV site hosts and charging station developers by installing and connecting service to make the process as seamless as possible. Xcel is currently building collaborative models to increase deployment of infrastructure for public charging networks. Additional public charging pilots and initiatives Xcel Energy has proposed or is developing include: "make ready" infrastructure for fast charging for corridors, community charging infrastructure by partnering with the cities of Saint Paul and Minneapolis along with HOURCAR, a local ridesharing service, to provide equitable mobility services, and workplace smart charging for customers interested in providing EV charging for their employees while also minimizing the impacts of this charging on the grid.



Recommendations for Action

GIVEN THE SUBSTANTIAL ECONOMIC AND PUBLIC health benefits that EVs bring, EV adoption should be encouraged through state policies, incentives and utility regulatory actions.



- **Purchase Incentives.** The most effective mechanism for increasing consumer demand for EVs is to reduce the initial purchase price to the level of cost parity with other comparable gasoline and diesel vehicles.
  - State leaders could consider supporting the extension of the federal tax credit for EV purchasers by removing or substantially increasing the manufacturer-specific cap. Currently the credit includes a cap of 200,000 vehicles for each automobile manufacturer. Already Tesla and General Motors are facing a phase-out of the credit for their purchasers in 2019.
  - State leaders in the Midcontinent should consider providing EV purchase incentives in the form of rebates or point-of-sale incentives to offset the higher up-front costs of EVs. Alternatives to simple rebates include making EV sales exempt from state tax and providing EV buyers a state tax credit. Utilities should also be allowed and encouraged to arrange for and/or provide purchase incentives for EVs for their customers.

- **Charging Infrastructure.** EV charging infrastructure is needed to assure consumers that they can get sufficient range from their EVs. State leaders and utility commissions should work with utilities and the competitive EV charging market to remove existing regulatory barriers to EV charging infrastructure. State utility commissions should consider allowing and encouraging utility investment in and ownership of charging infrastructure, as well as private sector ownership to encourage the greatest potential for development of charging infrastructure. State and local governments should also seek to invest in EV charging infrastructure, through use of Volkswagen settlement mitigation funds, direct funding, tax incentives or other financial incentives. Any program investing in EV charging infrastructure should include a meaningful investment in environmental justice and low-income communities.

- **Manage EV Charging and Include EVs in Resource Planning.** State utility commissions should consider working with utilities to establish electricity rate structures and technology-based smart charging programs that encourage charging at times most beneficial to the electricity system and consumers. Strategies intended to manage charging by consumers should take into account customer choice and the need to provide a consumer experience that promotes adoption of EVs. As EVs reach higher levels of penetration, utilities, auto manufacturers, and EV charging site hosts should be prepared to manage EV load in real time using available technologies, while being cautious to ensure drivers are able to charge when they have a need. Managed charging should be optional and a driver should always have the ability to opt out of any individual demand response event if the driver's immediate needs require. A well-managed EV fleet can play a role in utility resource planning going forward, making it possible to integrate more wind and solar generation into the system than would be possible without EVs and other flexible/managed loads.

- **Consumer Education.** State leaders should invest in consumer education programs to increase consumer awareness of EVs, incentives, utility programs, and the driving experience. State utility commissions in coordination with state air quality agencies should work with utilities to educate consumers about the lifetime benefits of EV ownership.

- **EVs Benefit All.** State and local leaders, utility commissions, utilities and the private sector should work to ensure that EVs benefit all. Investments aimed at increasing EV penetration can result in better utilization of system resources and thereby lower costs for all consumers, not just EV owners. In addition, state and utility programs should be designed to provide equitable access to vehicles and charging infrastructure for low-income customers and communities.

- **Building Codes.** States should update their building codes to ensure that new public and residential buildings are "EV Ready", meaning the installation of conduit, wiring, and sufficient electrical capacity to support the future installation of EV chargers. EV building codes can substantially improve the cost-effectiveness of future charger installations by reducing or eliminating the need for costly retrofits.

- **Travel Demand.** Because the public health and economic benefits of EV adoption are greatest when vehicle miles traveled are the lowest, states should continue to implement policies and measures to lessen the growth of vehicle travel demand and improve system-wide efficiency, such as mass transit, ride pooling, high-occupancy vehicle lanes in high-congestion areas, and similar measures.

- **State and Municipal Vehicle Purchases.** When making purchases for fleets, state and municipal leaders should lead by example and seek to purchase EVs whenever possible.

WHITE PAPER
Electric Utility Roles in the EV Market

Electric Vehicles (EVs) are expected to become an ever-increasing part of the Midcontinent region's transportation mix. As the demand and utilization of EVs increases, so does the EV-specific demand for electricity, raising many important questions for electric utilities and state and local policymakers.

In April 2018, the Midcontinent Transportation Electrification Collaborative (MTEC) released a whitepaper, *Electric Utility Roles in the Electric Vehicle Market: Consensus Principles for Utility EV Program Design*. This report aims to provide initial guidance on greater utility involvement in the EV sector to accelerate EV adoption and associated charging services. The paper's guiding principles are that utility EV programs should strive to:

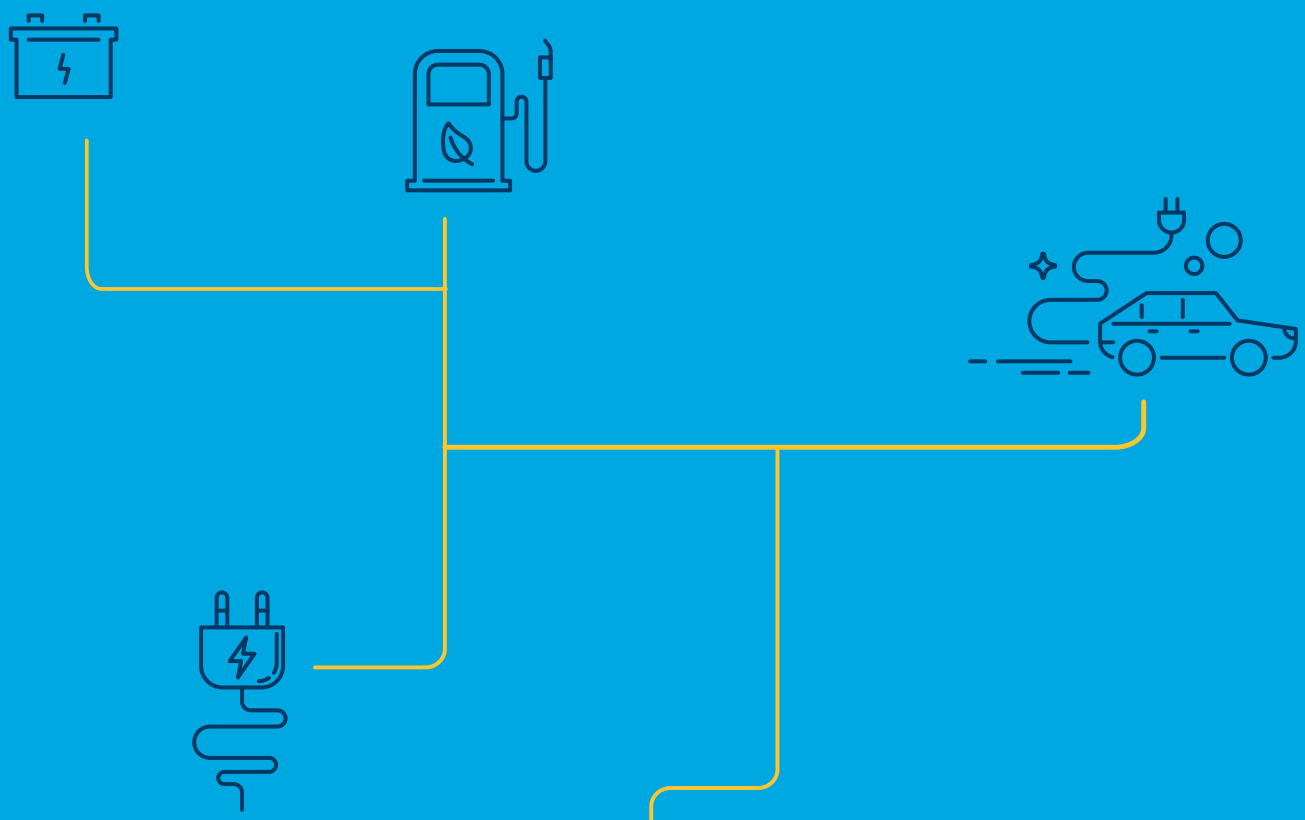
- Benefit customers
- Decarbonize the electric grid and transportation sector
- Benefit energy security, reliability, and the economy
- Help to overcome barriers to adoption of EVs
- Seek to offer cost-effective environmental and public health benefits from EVs
- Contribute to a competitive marketplace while maintaining a good consumer experience
- Contribute to the contribution of advanced mobility

MTEC takes on a holistic view of future challenges and the stakeholders who can create novel and innovative solutions. Building on this whitepaper, MTEC will continue to foster effective regional collaboration to expand EV charging infrastructure and increase EV adoption.

To read the full report, visit https://www.betterenergy.org/blog/new-white-paper-offers-road-map-for-electric-vehicles-to-help-transform-the-electric-grid/.

Next Step: The Building Sector

The Midcontinent Power Sector Collaborative (MPSC) will next explore the electrification of the building sector and the role it can play in decarbonization. This work is premised on the expectation that a decarbonized electricity sector must grow to serve increasingly efficient and electrified transportation and buildings sectors. The MPSC will release a buildings electrification road map for the Midcontinent later this year.



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