CITY OF SIOUX FALLS

SIOUX FALLS ELECTRIC VEHICLE READINESS STUDY

SEPTEMBER 2024

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Introduction

The Sioux Falls Electric Vehicle (EV) Readiness Study was commissioned as a recommendation from *Sustainable Sioux Falls*, a sustainability framework released in 2023. EVs have a direct tie to sustainability as all-electric vehicles have zero tailpipe emissions, leading to improved air quality and reduced greenhouse gas (GHG) emissions. These sustainability ties are important as the transportation sector generates the largest share of GHG emissions of any U.S. economic sector (Figure 1).

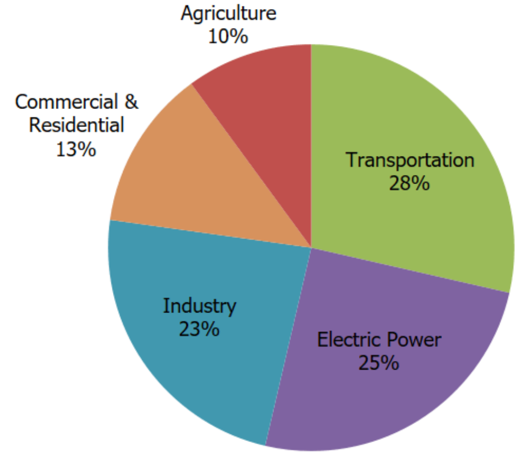

Figure 1: Total U.S. Greenhouse Gas Emissions by Economic Sector. Source: U.S. Environmental Protection Agency

The rise of electric vehicles (EVs) impacts 28% of U.S. greenhouse gas emissions. Targeting cleaner air through EVs requires collaboration and coordination between many different stakeholders due to the fundamental differences between EVs and gas-powered vehicles.

The purpose of the Sioux Falls EV Readiness Study is to assess and analyze forecasted EV trends, charging infrastructure needs, grid capacity, and safety implications to help Sioux Falls prepare for anticipated EV growth and remain investible.

This study report provides objective information on anticipated EV growth, where the growth is anticipated to occur, and considerations for stakeholders to meet the demands of the anticipated growth. To do this, the study looked at the range of anticipated EV growth in Sioux Falls and what can be done to be ready for all levels of growth. The City recognizes that this shift is heavily influenced by the private sector and is leading this study as a facilitator between stakeholder groups to prepare the community and service providers to serve residents and visitors who want this service. By planning for anticipated consumer and private sector demand, the City can stay competitive regionally and be a desirable community in which to live and work.

The report includes a wealth of information on EVs, and readers are encouraged to focus on the chapters that they are most interested in. The table below outlines the chapters included in the report and the information they contain.

EV Readiness Study Website

Table 1: Report Chapters Overview

Chapter	Description
Electric Vehicles 101	Provides information on what EVs are, their benefits and limitations, and addresses common EV concerns.
EV Ecosystem	Introduces what the EV ecosystem is and the stakeholder types that play a role.
Current EV Industry Trends	Provides data on how the EV industry is shaping nationally, regionally, and locally.
Why Get Ready	Gives context to understanding why EV readiness is important.
How to Get Ready	Analysis of Sioux Falls EV projections, charger amounts to serve those projections, and grid impacts.
Recommended Strategies	Recommends how EV readiness can be enhanced through specific strategies that are assigned to a stakeholder type.

An objective of this study was to simplify the sources of information relevant to EVs that affect the City of Sioux Falls and its stakeholders. A key element to this study report is the references cited throughout the document with links available for readers to learn more on certain topics.

Electric Vehicles 101

What is an EV?

Electric vehicles differ from traditional gas-powered vehicles, formally known as internal combustion engine (ICE) vehicles, in two fundamental ways: the fuel source that enables propulsion and how refueling the vehicle is conducted. EVs use one or more electric motors for propulsion from energy stored via rechargeable batteries located on the vehicle. “Refueling” occurs by delivering electricity to the onboard batteries using electricity from the power grid and energy recaptured during braking (known as regenerative braking).[1]

There are also differences in the key terms and acronyms as related to the different classifications of EVs (Table 2). The electric range is defined as the distance an EV can travel before needing to charge.

Table 2: EV Terminology

Term	Acronym	Definition	Average all-electric range (miles)
Electric Vehicle	EV	A vehicle that uses one or more electric motors for propulsion.	Varies by type of EV
Zero-Emissions Vehicle	ZEV	A vehicle that does not produce tailpipe emissions or other pollutants from the onboard source of power.	Varies by type of ZEV
Hybrid Electric Vehicle	HEV	A vehicle that is powered by an electric motor as well as an internal combustion engine. The battery is recharged through regenerative braking and the internal combustion engine.	0 (increases ICE efficiency)
Plug-in Hybrid Electric Vehicle	PHEV	A vehicle that is powered by an electric motor as well as an internal combustion engine. The battery is recharged by being plugged in.	20-40
Battery Electric Vehicle	BEV	A vehicle that relies on only electric motors for propulsion and draws its energy exclusively from the vehicle’s battery pack. A BEV is a type of Zero Emission Vehicle (ZEV) and can also be referred to as an all-electric vehicle.	250-350
Fuel Cell Electric Vehicle	FCEV	A vehicle that uses electricity to power an electric motor but uses hydrogen to produce electricity rather than drawing electricity from only a battery. A FCEV is a type of ZEV.	300-400

HEVs are the most established EV type, followed by PHEVs and then BEVs. Over time, BEVs are expected to become the dominant EV type as the technology continues to improve. For this reason, this study is mostly focused on readiness for BEVs. **For this report, the term EV will be used to reference vehicles that plug in to charge the battery, which are BEVs and PHEVs**.

[1] Regenerative Brakes: How Do They Work? - Kelley Blue Book (kbb.com)

It can be helpful to understand the components of different types of electric vehicles. Battery packs are made up of hundreds if not thousands of individual battery cells, which can look similar to the cylindrical batteries used in consumer products such as TV remotes (Figure and 4). BEVs have the fewest components as they are only powered by electric motors. PHEVs and HEVs are more complex as they have both electric motors and internal combustion engines. The main difference between PHEVs and HEVs is that PHEVs can be plugged in to charge the battery while HEV batteries are charged through regenerative braking and the internal combustion engine. Figure 2 shows the main components of a battery-electric vehicle. More information along with PHEV, HEV, and ICE diagrams is available on the Alternative Fuels Data Center website.[2]

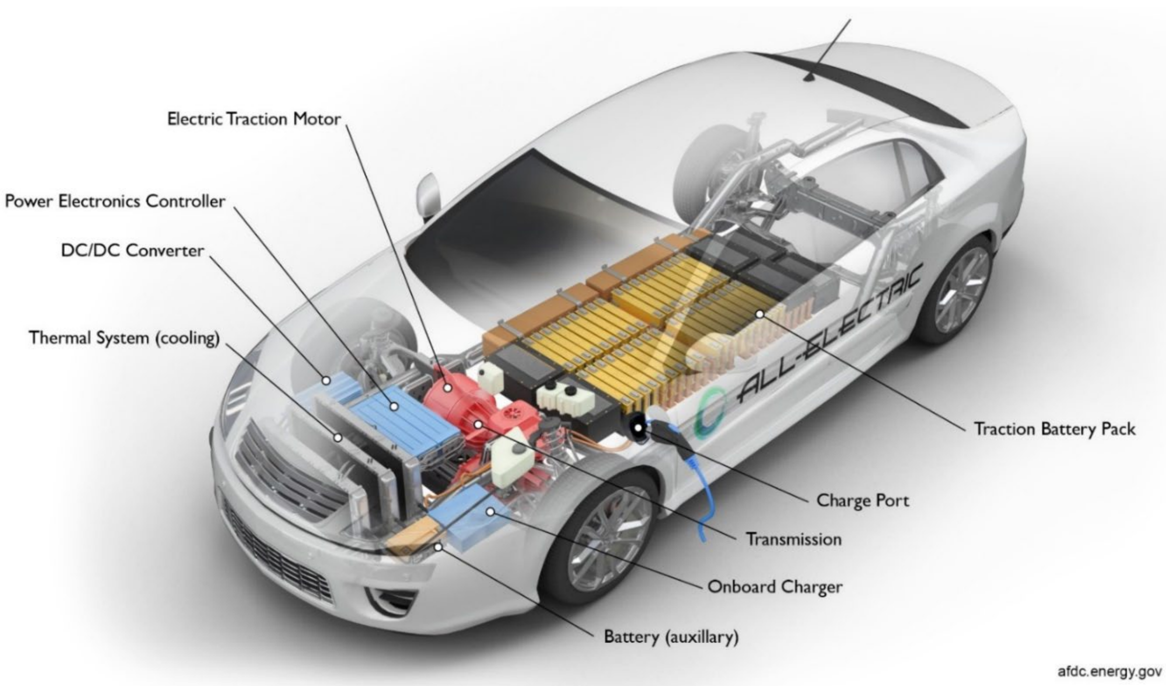

Figure 2: Key Components of a Battery Electric Vehicle (BEV). Source: [Alternative Fuels Data Center]

Figure 3: Example of battery cells that can make up EV batteries. Source: [Car and Driver]

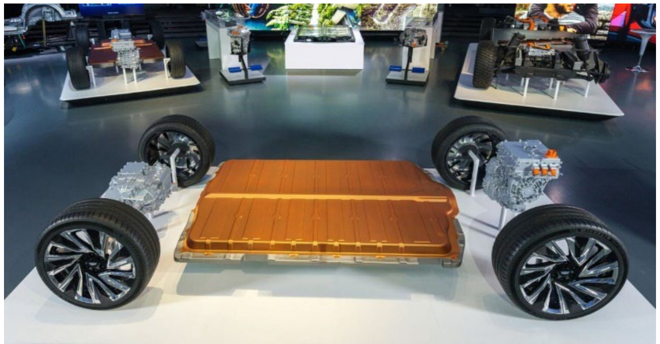

Figure 4: EV Battery Pack. Source: [Car and Driver]

[2] Alternative Fuels Data Center: How Do All-Electric Cars Work? (energy.gov)

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How Charging Works

Refueling EVs occurs through charging the vehicle's batteries. The concept of charging batteries is familiar for consumer electronics, but an unfamiliar idea to most drivers who have only experienced refueling ICE vehicles at gas stations. Electrical terminology for charging is outlined in Table 3.

Table 3: Charging Terminology

Term	Definition as it relates to EVs
Electric Vehicle Supply Equipment (EVSE)	All equipment used to deliver energy to an electric vehicle to recharge the vehicle's battery. Commonly referred to as a charger.
Connector	A device that plugs into the vehicle to enable charging. Connector types determine vehicle-charger compatibility.
Port	Provides power to charge one vehicle at a time. One port can house multiple connector types.
Charger	The unit that houses EVSE. Sometimes referred to as a charging station.
Station	A site with one or more EV charging ports at the same address.
Kilowatt (kW)	The rate energy is transferred to a vehicle. The more kW, the faster the vehicle will charge and the larger the power requirements to charge the vehicle.
Kilowatt-Hour (kWh)	The total amount of energy that can be transferred to a vehicle's batteries. The larger an EV battery pack, the higher the kWh rating and the more miles the vehicle can travel on one charge.

An example of EV charging terminology is shown in Figure 5. There are two chargers in the figure.

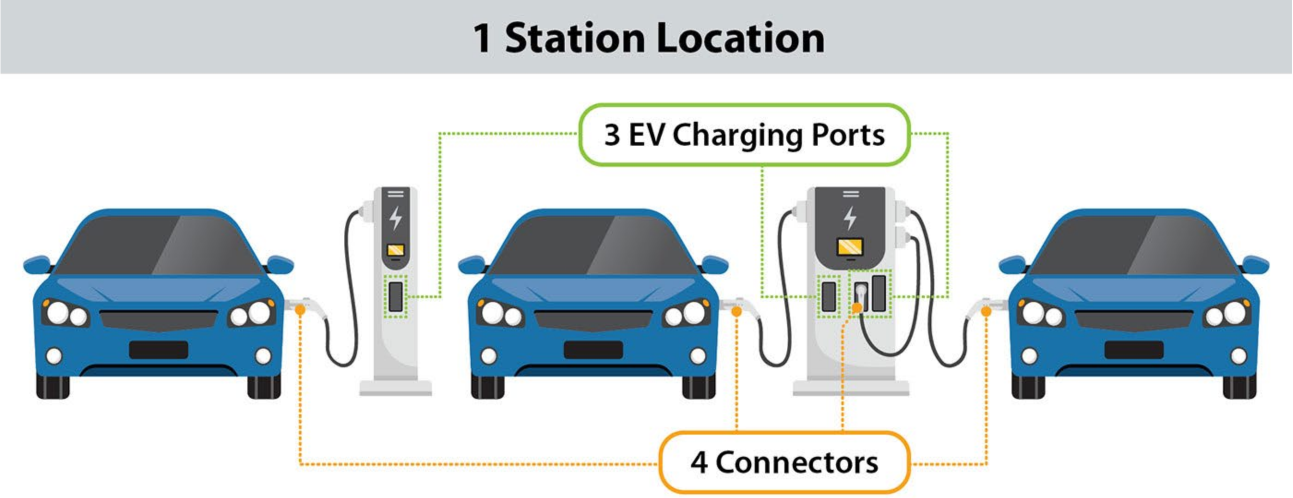

Figure 5: Station Location Terminology. Source: AFDC

Another unique feature of EV charging versus traditional ICE fueling is that there are different levels of charging that affect how long it takes for a vehicle to charge. The three main levels of charging are:

- **Level 1**
  - Used almost exclusively as a home charging option due to its extremely slow charging speeds.
- **Level 2**
  - Level 2 charging is used as a home charging solution for EV owners who want a faster charging option at home and as a public charging option at locations where vehicles are parked for long durations (such as at workplaces).
- **Direct Current Fast Charging (DCFC)**
  - Fastest charging option and is used for quick fill-ups at short destination locations (i.e., retail stores) and travel stops for long-distance travel.
  - Sometimes referred to as Level 3 (L3) charging.
  - There is a wide range of DCFC power levels and charging speeds.

Table 4 summarizes the characteristics of each charging type.

Table 4: Charging Types Overview

	Level 1	Level 2	Direct Current Fast Charging (DCFC)
Voltage	120V AC	208-240V AC	400-1000V DC
Typical Power Output	1.9 kW	7-19 kW	50-350 kW
Power equivalent to (example)	Hair dryer	Clothes dryer	Multiple homes
Estimated Electric Range Added per Hour of Charging	2-5 miles	10-20 miles	180-240 miles
Estimated BEV Charge Time from Empty	40 - 50 hours	4 - 10 hours	20 minutes -1 hour
Typical Locations	Home (single family)	Home (single and multi-family), Workplace, and Public (retail, recreation centers, convenience stores/travel stops)	Public (retail, recreation centers, convenience stores/travel stops)
Pros	Minimal to no electrical upgrades are needed, most EVs come with an L1 connector	Faster charging speed than Level 1 and lower infrastructure needs than DCFC	Fastest charging speed
Cons	Slow charging speed	Requires infrastructure upgrades to install. Charging speed limits public use to longer duration parking sites (i.e., workplace)	High cost of infrastructure upgrades required high cost of power
Average Installation Cost (electrical upgrades, equipment, labor, etc.)	Free for EVs that come with an L1 connector	$20,000 per port (commercial site) $1,000-$3,000 (single-family home)	$1,500-$2,000 per kW

Charger-Vehicle Compatibility

EVs can have different connector types, similar to the various connectors for charging consumer devices such as smartphones and laptops. Currently, there are three main charging standards, or connector types, used by automakers in North America. The J1772 (used for AC charging), CCS (used for DC charging), and Tesla's NACS (used for both AC and DC charging) have been the most widely used by vehicle manufacturers to date (Table 5).

Table 5: Connector Types in the U.S.

Connector Standard	Charging Levels Supported
J1772	Level 1, Level 2
Combined Charging Standards (CCS)	DCFC
North America Charging Standard (NACS)	Level 1, Level 2, DCFC

The divide among charging standards can create confusion for current and potential EV owners and require the use of EV charger adapters at stations with different connector types. The popularity of Tesla's EVs and, by extension, their proprietary NACS connector has created a divide between Tesla EVs and those from all other manufacturers. Almost all auto manufacturers have recently announced plans, however, to adopt Tesla's NACS connector after Tesla began allowing other automakers to use the design in 2022 (Figure 6).[3] By adopting the NACS standard, electric vehicles from other automakers can use Tesla's reliable and well-developed Supercharger network, which is the largest in North America, and vehicle and charger interoperability is simplified for consumers. This transition is expected to happen in 2024 and 2025.

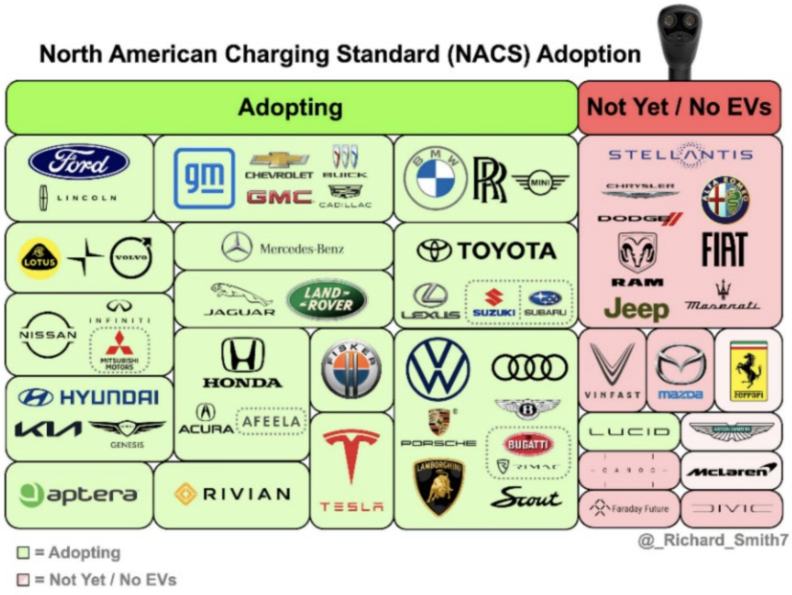

Figure 6: North American Charging Standard (NACS) Adoption as of 12/2023. Source: Automakers, compiled by [Richard Smith]

[3] The Great NACS Migration: Here's Who Switching to Tesla's Charging Port (motortrend.com)

Charging Categories

There are multiple applications of the charging levels introduced above. Chargers are generally grouped into one of three categories: single-family home charging, shared private charging, and public charging.

Single-Family Home Charging

Charging is conducted at detached single-family homes with either an L1 or L2 charger. This is the most common charging application.

Shared Private

Charging is conducted at locations where access is controlled but the chargers are shared within the access group. Examples include chargers at multi-unit dwelling locations, private workplaces where access is restricted to employees, and businesses where chargers are only available to customers such as hotels. Shared private chargers are predominately L2 chargers.

Public Charging

Public charging refers to charging that is available to any EV driver. These chargers can be publicly accessed but privately owned and operated similar to gas stations. Chargers can be located at a variety of locations, such as retail businesses, recreation and community centers, healthcare and education facilities, transportation facilities, and even on-street chargers located near where people live. Public chargers can be either L2 or DCFC chargers depending on the type of site.

Charging Pricing

EV charging pricing can be based on 1) the amount of energy delivered to the vehicle as a price per kilowatt-hour or 2) the time a vehicle was charging at a price per hour or minute. There can also be a flat rate session (or connection) fee that is charged no matter how long a vehicle is charged with the energy/time rates applied on top. Rates can differ based on charging speeds as well as time of day, similar to how utilities charge different rates during the peak time of the day under time-of-use plans. Charging providers can also assess idle fees, which charge drivers who leave their vehicle plugged into a charger after it has finished charging.

Charger Examples in Sioux Falls

These three charging stations highlight the different charger types, their applications, and the terminology associated with a station. To explore all the charging currently available in Sioux Falls, check out the website PlugShare.

Station Location: Quality Inn & Suites

Figure 7: L2 Charging Station in Sioux Falls. **Source:** PlugShare

Type: Level 2

Chargers: 4

Connectors: 12

Ports: 6 (each port has one J1772 connector and one NACS connector)

Access: Public

Cost: $.30/kWh

Target customers: Hotel guests

Station Location: Hy-Vee

Figure 8: DCFC Charging Station in Sioux Falls. Source: PlugShare

Type: DCFC

Chargers: 8

Connectors: 8

Ports: 8

Access: Shared Private (must be Tesla driver)

Cost: $.29/kWh

Target customers: Travelers looking for a fast charge during their trip (station located near I-29) and locals doing short duration shopping at Hy-Vee or other nearby businesses

Station Location: Railyard Flats

Figure 9: L2 Charging Station in Sioux Falls. Source: PlugShare

Type: Level 2

Chargers: 1

Connectors: 2

Ports: 2

Access: Public

Cost: $.03/min, $5/hr after four hours

Target customers: Drivers spending time downtown or living in nearby apartments

EV Benefits

EVs have numerous benefits, ranging from improved air quality to lower operating costs to energy independence.

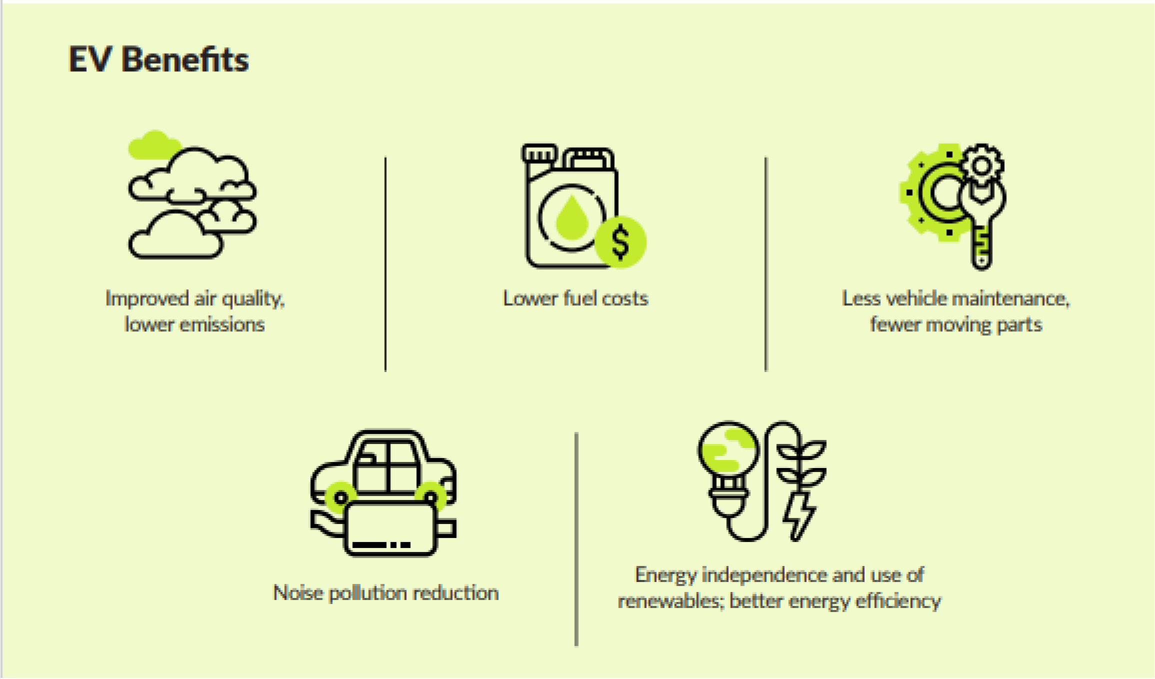

Figure 10: EV Benefits Overview

Improved Air Quality & Lower Emissions

Vehicle emissions can be divided into two general categories: air pollutants, which contribute to smog, haze, and health problems; and GHGs, such as carbon dioxide and methane.[4]

The elimination of tailpipe emissions prevents harmful pollutants from entering the atmosphere. A study by the American Lung Association found that the shift to 100 percent sales of zero-emission passenger vehicles by 2035 and medium- and heavy-duty trucks by 2040 would avoid up to 110,000 premature deaths and nearly 3 million asthma attacks by 2050.[5]

Vehicle Emission Categories (in order of most specific to most holistic)

Tailpipe: emissions produced directly from a vehicle.

Well-to-wheel/Fuel-cycle: emissions related to fuel production, processing, distribution, and use.

Cradle-to-grave/Lifecycle: Well-to-wheel emissions plus emissions associated with vehicle and battery manufacturing, recycling, and disposal.

Tailpipe emissions are one factor in a vehicle's life cycle emissions. Another factor is the emissions associated with fuel pathways, which include extracting, refining, producing, and transporting the fuel. By examining electricity sources, emissions from the fuel pathway for EVs can be explored. 84% of the electricity generated in South Dakota is renewable, leading to all-

[4] Alternative Fuels Data Center: Emissions from Electric Vehicles (energy.gov)
[5] Zeroing in on Healthy Air (lung.org)

electric vehicles producing more than 10 times less annual emissions than gasoline vehicles (Figure 10).[6] The figure also shows how emissions drop between the three types of EVs.

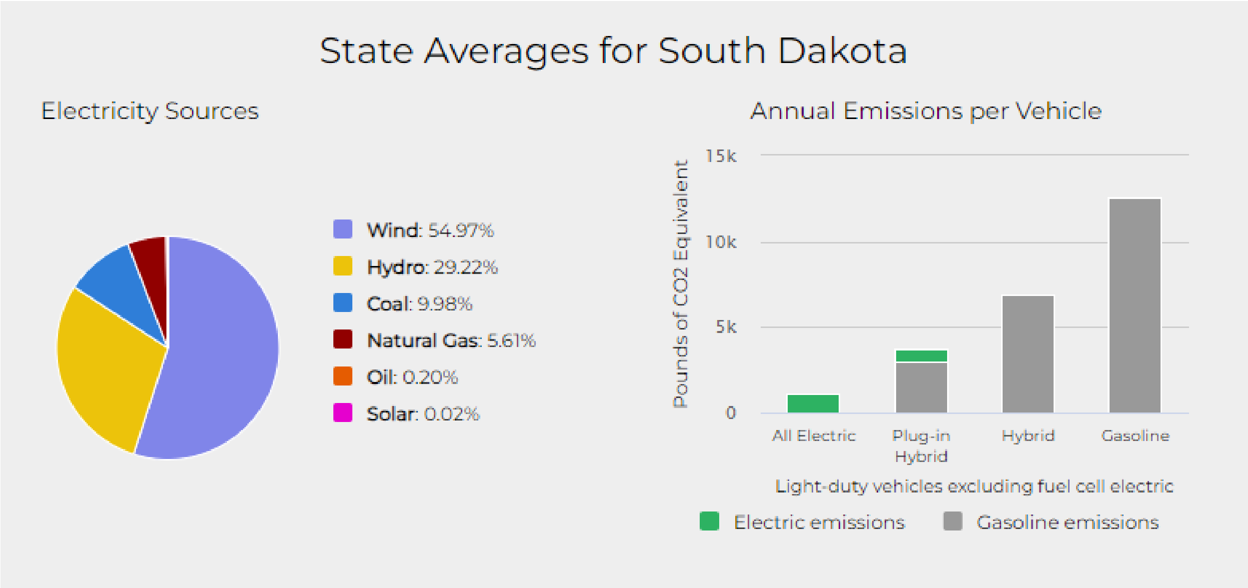

Figure 11: Annual Emissions by Vehicle Type. Source: AFDC

It is important to note that South Dakota is a net energy exporter, meaning that not all of the renewable energy generated in the state is consumed. According to the South Dakota Utilities Commission, only 40% of electricity consumed in 2022 in South Dakota is renewable.[7] While data for just Sioux Falls is not available, the share of renewables is likely higher as the four utilities in Sioux Falls report a higher percentage (Table 6). Xcel Energy, the largest utility provider in Sioux Falls, has a goal of providing 70% renewable energy in 2030 and 100% in 2050. As renewable energy increases, so does the environmental benefit of EVs.

Table 6: Sioux Falls Renewable Energy Percentages by Utility

Utility	Renewable Energy (%)
Sioux Falls Light & Power	66%
Sioux Valley Energy	41%
Southeastern Cooperative	46%
Xcel Energy	65%

[6] Alternative Fuels Data Center: Emissions from Electric Vehicles (energy.gov)
[7] 2022 Electricity Consumed in South Dakota (sd.gov)

Reduced Operation Costs

Drivers can save money on fuel and maintenance by owning an EV.

Fuel Costs

Electricity is cheaper than gasoline and diesel, and EVs are more efficient in using energy to move the vehicle. The amount saved on fuel depends on the number of miles driven and the price of gas and electricity. There are multiple online calculators available for drivers to estimate how much they could save based on their driving habits, including one from the Alternative Fuels Data Center, a U.S. Department of Energy website that contains a multitude of EV resources. For example, by comparing a Tesla Model Y with a Toyota RAV4 and using the default driving habit values along with an average price of gas of $3/gallon and electricity priced at $.12/kWh, the tool estimates an annual fuel savings of over $700 by driving the EV.

"I drive a Chevy Bolt about 1,000 miles a month and typically pay around $20 per month in electricity costs" – Sioux Falls resident & EV owner

Vehicle Maintenance

EVs do not need oil changes, cooling system flushes, transmission servicing, or replacements for air filters, drive belts, or spark plugs. Brakes also last longer than ICE vehicles due to regenerative braking. Consumer Reports estimates that an EV owner saves an average of $4,600 on maintenance and repair costs over the life of the vehicle compared to gas-powered vehicles.[8]

Energy Independence and Use of Renewables

EVs are powered by American-made electricity, reducing the need for imported oil and allowing for much more stable prices compared to gasoline, as gas prices are affected by a global market. The electricity can be produced from local and renewable sources, increasing resiliency and the sustainability benefits of EVs. As mentioned, 84% of the electricity generated in South Dakota was renewable in 2022, making it a leading state for renewable energy.

Increased Energy Efficiency

Most of the energy in gas-powered vehicles is lost to heat. Only 12-30% of the energy stored in gasoline is used to move the vehicle, while over 77% of the electrical energy delivered to EVs is used to move the vehicle.[9] EVs have shown to be over 4 times more efficient than gas vehicles on a mile per gasoline gallon equivalent.[10]

These efficiency increases lead to reduced energy use and lower fuel costs.

Miles per Gallon Equivalent (MPGe) is a measure developed by the U.S. Environmental Protection Agency that measures how many miles a vehicle travels using the amount of energy that is equivalent to a gallon of gasoline. This measure will be seen on stickers of EVs for sale at auto dealerships. MPGe ratings for available EVs are available at www.fueleconomy.gov

[8] Pay Less for Vehicle Maintenance With an EV - Consumer Reports

[9] All-Electric Vehicles (fueleconomy.gov)

[10] Alternative Fuels Data Center: Maps and Data - Efficiency Ratios for Light-Duty All-Electric Vehicles in the United States (energy.gov)

Common EV Concerns

EVs are a rapidly improving technology and the industry is still relatively in its infancy. There are common concerns among the public that discourage potential consumers from considering an EV. The facts about these common EV concerns are important for consumers to be aware of and some of these concerns can be addressed in part through additional context.

Lack of Charging Infrastructure

Nearly half (49%) of consumers who reject the idea of buying an EV say their primary reason is a lack of charging station availability according to J.D. Power.[11] Charging infrastructure is a critical piece of EV readiness and a main driver of this study.

However, sometimes there is a lack of awareness of existing charging infrastructure due to the comparatively lower visibility of chargers versus gas stations. According to PlugShare, a community-based tool that tracks charging locations, there are 25 station locations in Sioux Falls with a total of 74 L2 ports and 14 DCFC ports as of December 2023. The breakdown of this existing charging infrastructure is discussed later in this report.

Range anxiety: A common term used to describe the fear of not being able to reach a desired destination in an EV and having nowhere to charge along the way. Range anxiety is a key reason for consumers rejecting EVs.

Consumers who take long-distance trips have a common concern – termed "range anxiety" - about purchasing an EV due to EV range being less than a comparable gas-powered vehicle and the lack of charging available along their route. There is a large variety in the range of available EV models, from 100 miles to 500 miles, with most models falling between 250 and 350 miles.[12] Any reduction in range compared to similar gas-powered vehicles requires more refueling during long-distance travel. Historically this has been a challenge to find reliable charging along long-distance travel routes. This challenge is the target of dedicated federal funding through the National Electric Vehicle Infrastructure (NEVI) program.

The NEVI program provides a total of $5 billion to U.S. states to administer the buildout of a charging network that places chargers at least every 50 miles along interstate corridors and designated non-interstate alternative fuel corridors. Stations must also be within one travel mile of the interstate exit. South Dakota is set to receive $29 million in funding through Fiscal Year 2026. To receive this funding, the South Dakota Department of Transportation created a statewide plan that examined priority locations for chargers to meet the 50-mile distance requirement (Figure 11).[13]

[11] 2023 U.S. Electric Vehicle Consideration (EVC) Study | J.D. Power (jdpower.com)
[12] Edmunds Tested: Electric Car Range and Consumption | Edmunds
[13] South Dakota EV Fast Charging Plan - South Dakota Department of Transportation (sd.gov)

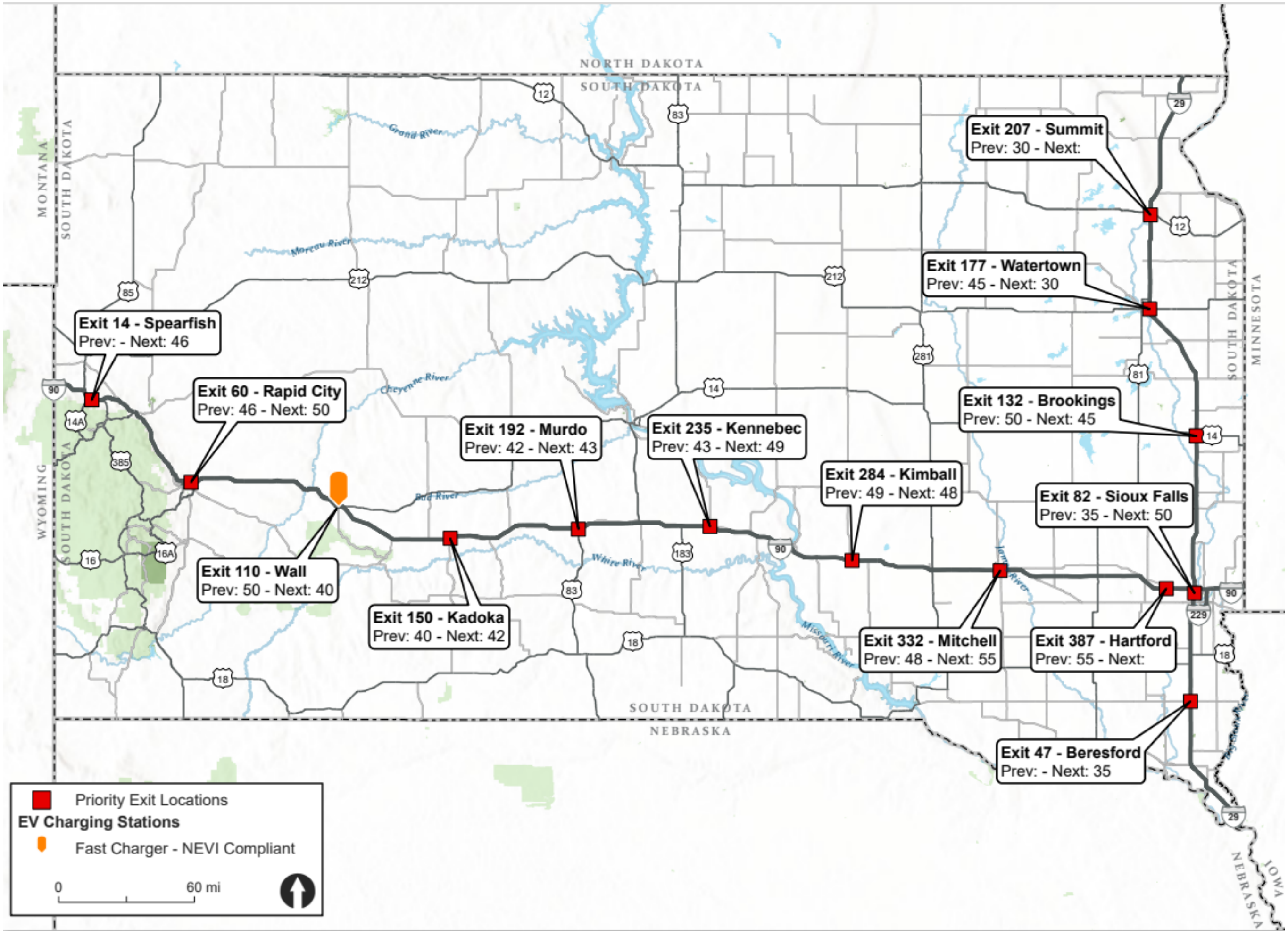

Figure 12: Priority Locations for EV Chargers to Meet NEVI Requirements. Source: SDDOT

Once these locations are built out throughout South Dakota and the rest of the country, long-distance travel in an EV will be much more convenient and will likely reduce range anxiety.

High Purchase Costs

EVs have historically cost more than comparable ICE vehicles and most models available to date have been in the luxury market. This trend is mainly due to the high cost of EV battery packs, the most significant expense when manufacturing an EV. However, battery prices have decreased significantly over the last 15 years (Figure 12).[14]

[14] Battery Prices Are Falling Again as Raw Material Costs Drop - Bloomberg

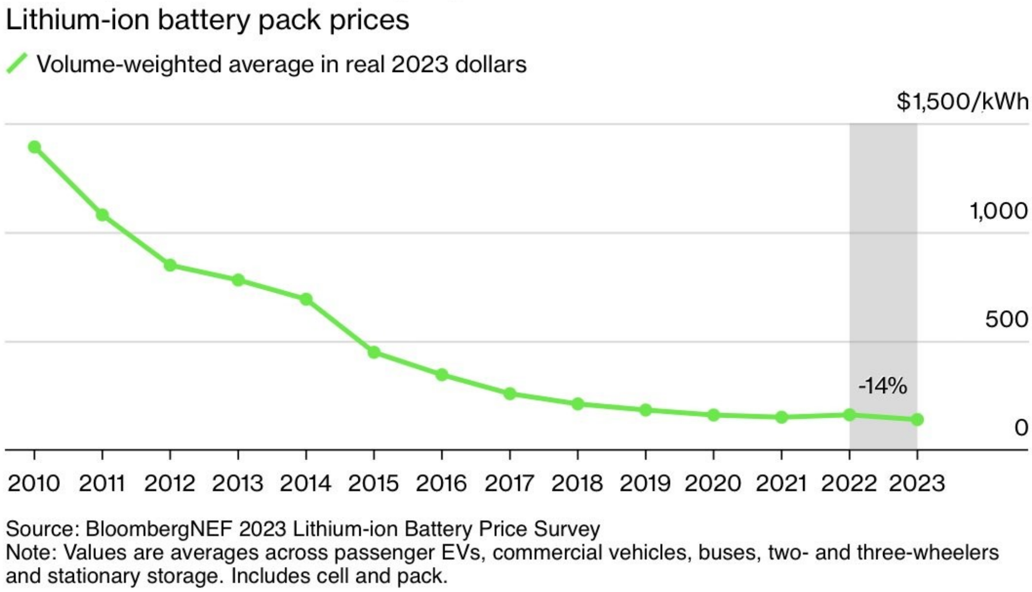

Figure 13: Battery pack prices over time. Source: [BloombergNEF]

This trend, along with automakers improving their EV manufacturing capabilities, has allowed EVs to be more competitive with ICE vehicles when it comes to purchase price. From October 2022 to October 2023, the average vehicle (all types) transaction price fell 1.4% while the average EV transaction price fell 20.2%.[15] As of the end of 2023, BEV prices are now within $2,000 of the overall industry average transaction price, shrinking from a gap of $19,000 in June 2022 (Figure 13).[16]

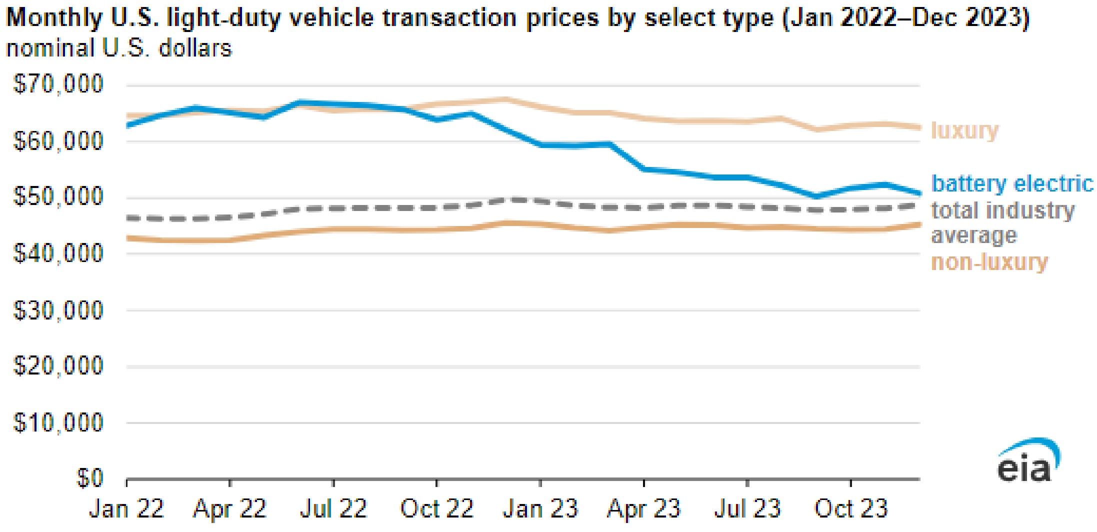

Figure 14: Vehicle Transaction Prices Over Time by Type. Source: [U.S. Energy Information Association]

[15] October 2023 Kelley Blue Book Average Transaction Price tables (coxautoinc.com)
[16] U.S. Energy Information Administration - EIA - Independent Statistics and Analysis

EVs are expected to reach price parity, the point at which an automaker can theoretically build and sell an EV with the same profit margin as a comparable combustion vehicle, in 2025 (Figures 14 and 15).[17,18]

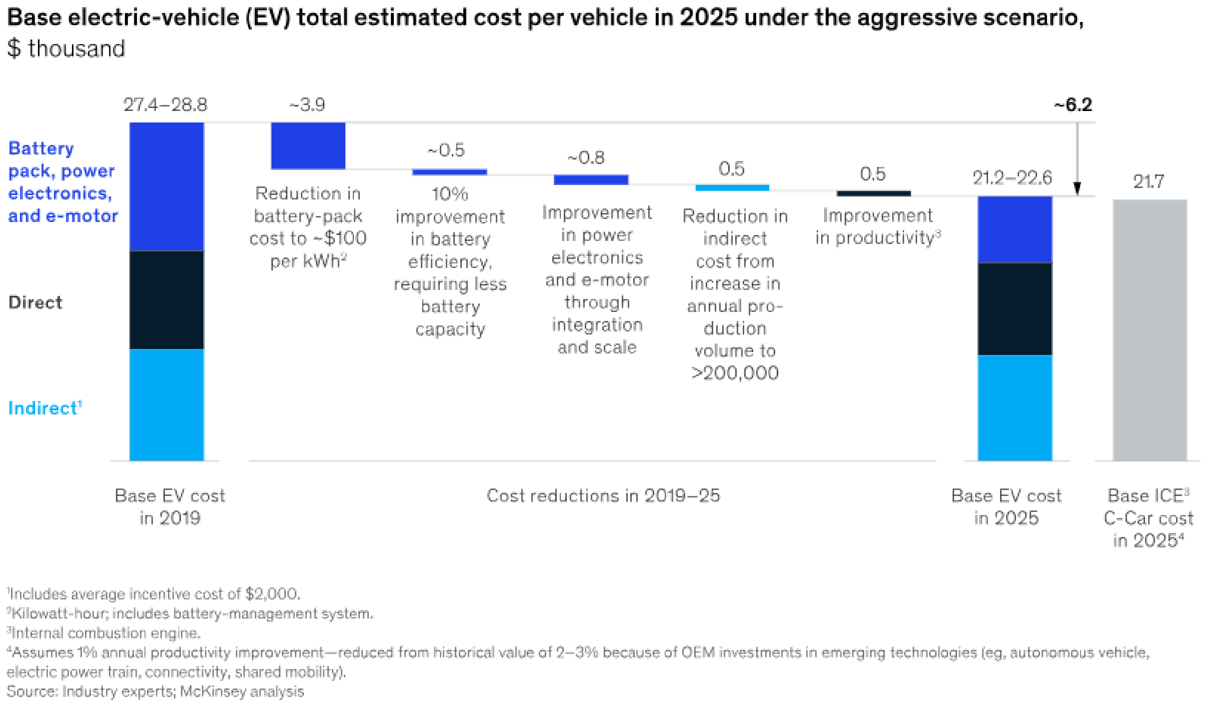

Figure 15: Projected price parity between EVs and ICE vehicles. Source: McKinsey & Company

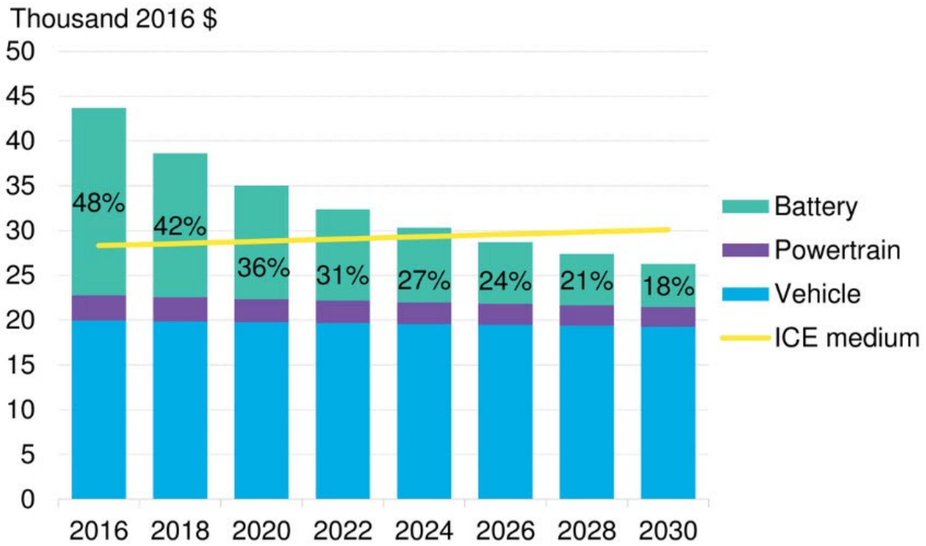

Figure 16: Projected decline in EV prices over time. Source: BloombergNEF

These declines in prices for manufacturers to build EVs will allow for the increase in more affordable models being available to consumers.

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17 The EV Price Gap Narrows | BloombergNEF (bnef.com)
18 Improving electric vehicle economics | McKinsey

Another factor impacting purchase price is incentives. The U.S. government offers the Clean Vehicle Tax Credit of up to $7,500 for qualifying vehicles.[19] The credit is currently slated to be available through 2032 and starting in 2024 consumers are able to receive the credit directly at the time of purchase instead of as a credit when filing a tax return.

These factors, along with the operating savings discussed earlier, will make EVs cost competitive in the coming years.

Environmental Concerns

The two main concerns about EVs and the environment are the impacts related to battery manufacturing and electricity powering EVs that was generated from fossil fuels.

A common concern is that the environmental impacts of building an EV battery negate the positive impacts of operating the vehicle. EV batteries are made of materials such as lithium, cobalt, manganese, graphite, steel, and nickel. These materials are mined from all over the world, which produces emissions in the mining, processing, and transporting processes. This leads to a typical EV creating more carbon pollution than a gasoline car during manufacturing. However, this increase in manufacturing emissions is outweighed by the amount of GHG emissions saved from driving over time with an EV (Figure 16).[20] The longer EVs are operated, the more environmental benefits they bring. There are companies such as Redwood Materials working on how to recycle the materials from EV batteries, with the goal of creating a closed-loop supply chain where materials can be recycled into new batteries. Another example is RePurpose Energy, which is taking retired EV batteries and converting them into energy storage solutions for renewable energy. While there is a long way to go in the sustainability of EV batteries, there are companies actively working on improving this issue.

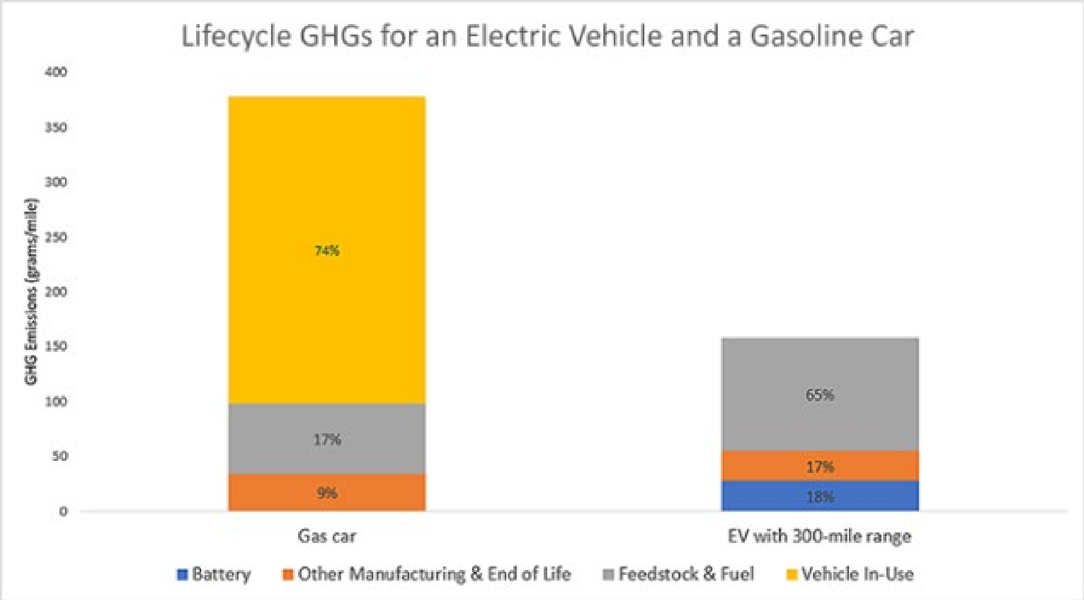
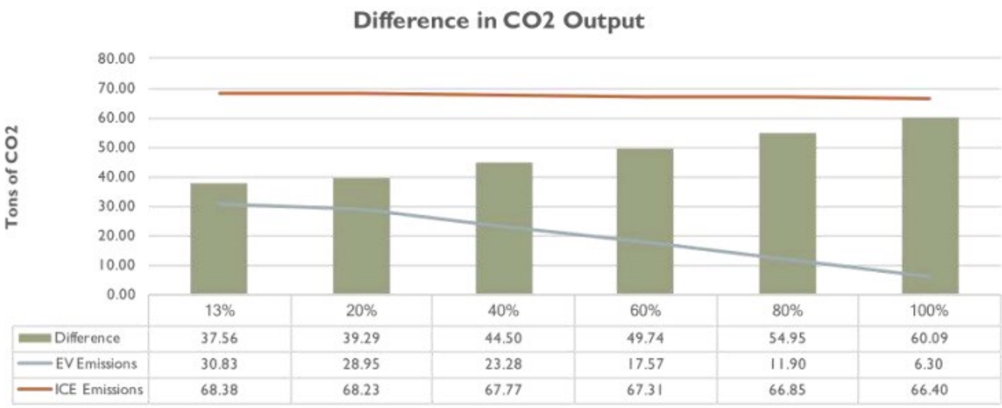


Figure 17: Comparing Lifecycle Greenhouse Gas Emissions Between an Electric Vehicle and a Gasoline Car. Source: Environmental Protection Agency

[19] Clean Vehicle Credits | Internal Revenue Service (irs.gov)
[20] Electric Vehicle Myths | US EPA

Another concern is that EVs do not provide environmental benefits if they are powered by fossil fuels. EVs powered by electricity generated from fossil fuels do generate more life-cycle emissions, but even in this scenario EVs are responsible for less emissions than ICE vehicles. A 2019 study found that an EV running off of just 13% renewable energy still produces 55% less GHG emissions than an ICE vehicle over the vehicle's lifetime (Figure 17).[21] However, this number jumps to a nearly 95% reduction in emissions if the grid is 100% renewable, showcasing the direct sustainability ties between renewable energy and the environmental benefits of EVs.



	13%	20%	40%	60%	80%	100%
Difference	37.56	39.29	44.50	49.74	54.95	60.09
EV Emissions	30.83	28.95	23.28	17.57	11.90	6.30
ICE Emissions	68.38	68.23	67.77	67.31	66.85	66.40

Figure 18: Difference in Carbon Dioxide Output by Renewable Energy Percentage. Source: Ryan Cornell

Lack of Power Grid Capacity

Increasing the number of EVs on the road will lead to increased electricity demand. How much this will impact the grid depends on many factors – which are discussed in greater detail in the assessment and analysis section of the report. The most crucial factor is predictable growth allowing utilities to plan generation, transmission, and distribution needs in advance of significant growth in charger demand.

Additional load has been added to the grid throughout time. This includes periods when technologies such as air conditioners, clothes dryers, and electric water heaters rapidly became common. One analysis by Consumer Reports found that electrifying 100% of the passenger vehicles on the road by 2050 will only require about 1% growth per year in electricity generation, which is below the 3.2% average annual growth rate for electricity generation over the past 70 years.[22] A 2019 study by the U.S. DRIVE partnership (a government-industry partnership focused on advanced automotive and related energy infrastructure technology research and development), conducted a study on the potential impact of EVs on the U.S. electric power system and concluded that based on historical growth rates, sufficient energy generation and generation capacity is expected to be available to support a growing EV fleet as it evolves over time, even with high EV market growth.[23,24] One nuance is that electrification could expand to larger vehicles such as semi-trucks and school buses.

[21] The Climate Change Mitigation Potential of Electric Vehicles as a Function of Renewable Energy (cgscholar.com)
[22] Blog: Can the Grid Handle EVs? Yes! (consumerreports.org)
[23] U.S. DRIVE | Department of Energy
[24] summary-report-evs-scale-and-us-electric-power-system-2019 (energy.gov)

These vehicles require more infrastructure than passenger vehicles to charge. This growth is another reason to plan for EV adoption across the entire transportation sector.

This grid impact will also be impacted by technology developments for when and how vehicles charge, including:

- **Off-peak charging** is a primary strategy for residential charging, where vehicles can charge when parked overnight. The grid is designed to handle peak loads, and oftentimes there is substantial capacity available during off-peak times. By charging overnight when the demand on the grid is low, the peak load experienced on the grid is lowered, thereby reducing the amount of infrastructure upgrades needed. This can be enabled by "smart charging," which uses internet connectivity to automatically start charging the vehicle at certain times.
- **Vehicle-to-grid (V2G) and Vehicle-to-home (V2H) charging** allows EVs to send power back to the grid or homes (known as bi-directional charging) in cases where demand is high or there is a power outage, increasing grid reliability and reducing impacts from grid outages due to other factors such as extreme weather.[25]
- **Battery-integrated charging technology** allows for high-powered DC fast chargers to draw energy from the grid at a slower rate and store the energy in batteries while then using this stored energy to charge vehicles, thus reducing the peak loads from the grid.

At the national level, the U.S. Department of Energy is managing several federal grant programs related to grid infrastructure. One project that has received federal funding is a joint transmission project between seven Midwest states, including South Dakota. The project will coordinate the planning, design and construction of five transmission projects, aiming to create scalable transmission solutions, new renewable generation, lower energy costs, enhanced community engagement, and workforce development.[26]

The utility providers in Sioux Falls have been active participants in this study and are aware of the potential for load growth. They are monitoring grid needs to adapt as anticipated EV growth occurs.

Safety Concerns

EVs must meet the Federal Motor Vehicle Safety Standards and undergo the same rigorous safety testing as conventional ICE vehicles sold in the United States. All-electric vehicles tend to have a lower center of gravity and more weight than conventional vehicles, making them more stable and less likely to roll over.[27] A safety consideration of EVs is that due to their quiet approach, they can be more hazardous for pedestrians and other non-motorists.

Fires involving EVs are significantly harder to extinguish than gas fires due to EV batteries being subjected to thermal runaway.[28] Sioux Falls Fire and Rescue has undergone training related to the handling of fires involving EVs. EV fire response procedures have been developed and each battalion is equipped to respond as needed. While EV fires have a more significant impact, they are less likely to occur according to data from the National Transportation Safety Board (Figure 18).[29]

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[25] What's Bidirectional Charging and Which EVs Offer It? | Cars.com
[26] Efficient and Collaborative Transmission Planning for the Central United States (energy.gov)
[27] Alternative Fuels Data Center: Maintenance and Safety of Electric Vehicles (energy.gov)
[28] EV Thermal Runaway : Importance for battery safety | Honeywell
[29] Gas vs. Electric Car Fires [2023 Findings] | AutoinsuranceEZ.com

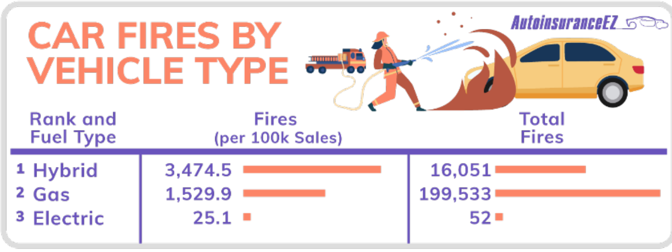

Figure 19: Fires by Vehicle Type. Source: National Transportation Safety Board, compiled by [AutoinsuranceEZ]

It is unclear whether the hybrid vehicles being number one is due to the electric motor or the internal combustion engine. As EVs continue to improve, decreasing the risk of battery fires is one of the anticipated improvements.

Cold Climate Performance

The range of EVs is reduced in cold weather due to having to produce heat for the vehicles interior and maintain an optimal battery temperature with energy that comes from the battery. The amount of range reduction varies by vehicle, but a test of four EV SUVs by Consumer Reports found an average reduction in range of 25% in cold weather versus mild weather.[30]

EVs do have better traction in the snow compared to similar ICE vehicles due to their heavy battery packs and equal weight distribution. The performance of EVs in cold weather and overall vehicle range are both EV technology trends automakers are working on improving.

EV Technology Trends

A significant amount of research and development is being done in the industry related to EV batteries. Batteries are the most important factor when it comes to the range an EV can drive under a single charge, how fast they will charge, how long the battery will last, and how much they cost to produce (Figure 19). Manufacturers know that improving these factors is important to increase sales, so it is expected that consumers will see improvements over time.

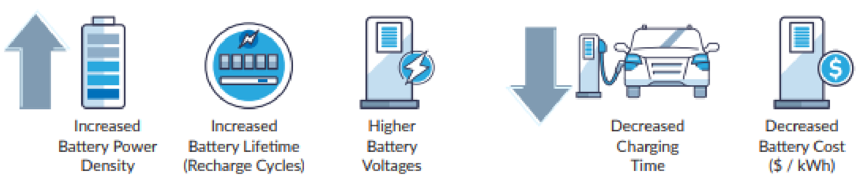

Figure 20: EV Technology Trends

A significant amount of these investments is expected to take place in North America. The Inflation Reduction Act (IRA) passed in 2022 aims to increase EV investments domestically and reduce the reliance on other countries for battery materials and manufacturing. As a result, over $100 billion of EV investment has been announced since the passage of the IRA, including over $72 billion in battery manufacturing.[31]

[30] How Temperature Affects Electric Vehicle Range - Consumer Reports
[31] Zero-Emission Vehicles Factbook (bbhub.io)

EV Ecosystem

As discussed, EVs are unique in that the infrastructure needed to support them involves a separate set of stakeholders than the traditional gas station model. Chargers can be placed anywhere there is electricity available and the capacity to support it. As part of this study, different stakeholders were engaged to determine what EV readiness means to them. Stakeholders were grouped into two main categories: providers and consumers. Providers remove barriers to EV ownership through the unique services they provide. Consumers are different types of existing/potential EV owners who are the recipients of the providers' services. This section introduces the different stakeholders, how they are interconnected, and the role they have in supporting a successful EV ecosystem.

Table 7: Stakeholder Overview

	Stakeholder	Description	Needs (consumers) or Role (providers)
Providers	City Departments	City of Sioux Falls departments, including Planning & Development Services, Fire & Rescue, Public Works, and Innovation & Technology.	Facilitate a safe and fair EV experience that supports both consumers and businesses.
	EV Industry	Businesses involved in the production and sale of EVs.	Produce high quality EVs at a range of price points and educate consumers on the EV user experience.
	Charging Providers (Charging Networks/ Businesses/Site Hosts/Developers /Auto Dealers)	Any business that could provide or facilitate charging infrastructure.	Provide ample charging opportunities to meet consumer demand while meeting business objectives.
	Utilities	Utility companies within Sioux Falls.	Develop and manage grid capacity for EV growth and provide power for charging stations.
Consumers	General Public/Potential EV Users	Residents of Sioux Falls and surrounding communities. Some are interested in EVs, some are not.	Education on EV ownership and charging infrastructure availability.
	Homeowners	Existing/potential EV owners who are homeowners looking for or are currently equipped with charging at their single-family residence.	Information on home charging installation process and rate structures.
	Residents Without Home Charging Access	Existing/potential EV owners who are not able to charge at their residences are commonly renters.	Access to reliable and convenient public chargers (both L2 and DC fast chargers) with quality amenities nearby.
	Tourists/Fast Charging Users	Existing/potential EV owners traveling to/through Sioux Falls that will need to charge quickly along their trip or Sioux Falls area residents looking for fast charging.	Access to reliable and convenient public DC fast chargers with quality amenities nearby.

These stakeholders are connected in many ways, creating an integrated EV ecosystem (Figure 20). Consumers need services from the providers to enable EV adoption, and the providers need the charging demand created from consumers adopting EVs. This interconnected nature creates the need for collaboration and coordination to foster an EV-ready community.

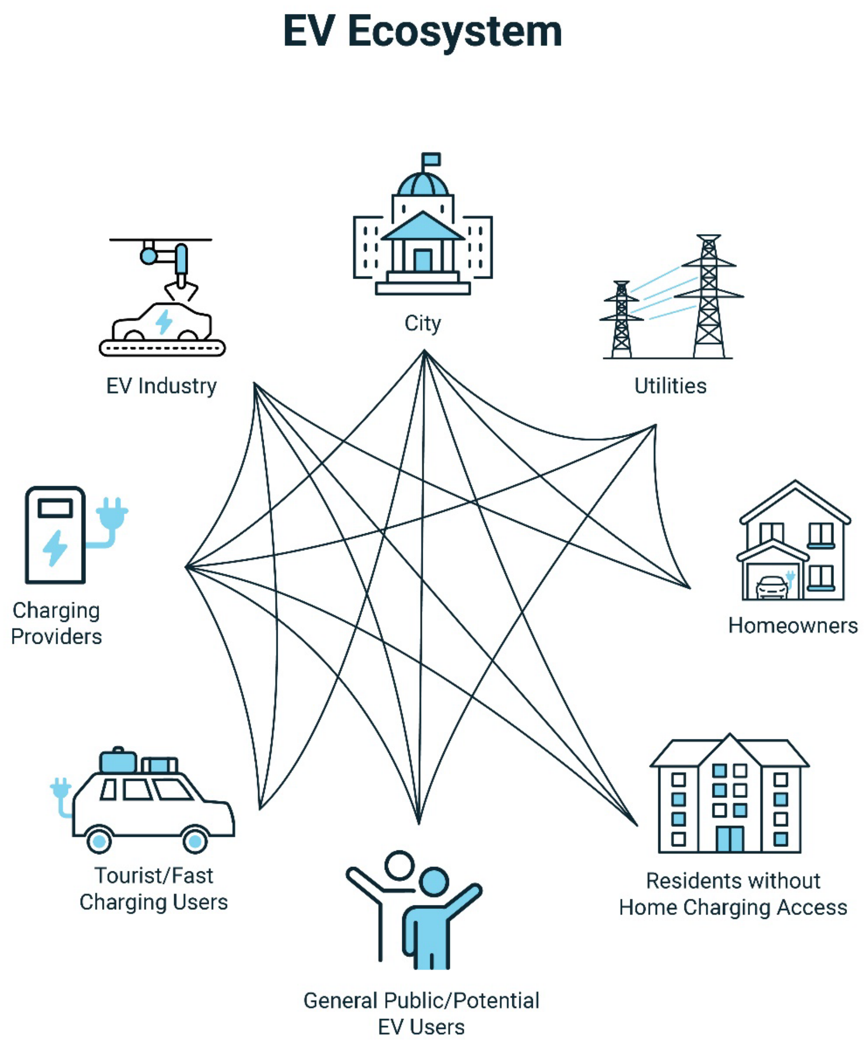

Figure 21: EV Ecosystem

Current EV Industry Trends

The EV industry is rapidly evolving and while the future is not entirely known, understanding current conditions and trends at a national, regional, and local level gives important context for forecasting what EV growth could look like in Sioux Falls. Common terminology used when discussing the EV market is found in Table 8.

Table 8: EV Market Terminology

Term	Definition as Presented in this Report
EV Sales Market Share	The percentage of new vehicle sales that are EVs.
Overall EV Market Share	The percentage of registered vehicles that are EVs.
Vehicle Registrations	The number of vehicles registered through a state. Provides an estimate of the total number of vehicles on the road in a given area.

National EV Context

U.S. Market Share Trends

The U.S. market share for HEVs, PHEVs, and BEVs continues to increase over time, with BEVs starting to grow significantly in the last few years (Figure 21).[32]

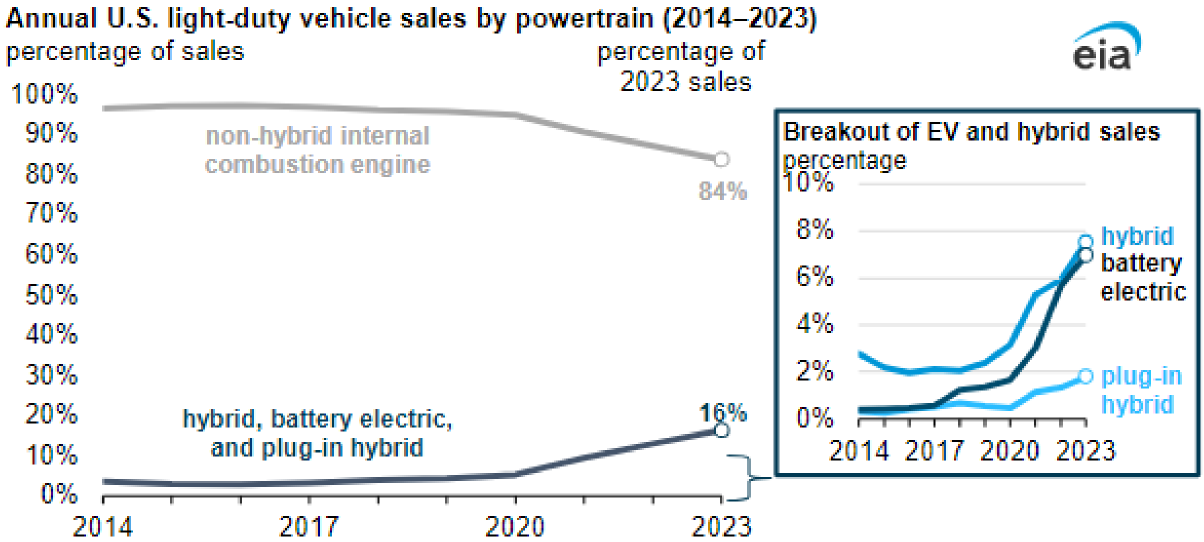

Figure 22: U.S. Electrified Vehicle Market Share Over Time. Source: U.S. Energy Information Administration.

It took 10 years for the US to sell its first million fully electric vehicles, two years to reach the second million, and just over a year to reach the third (Figure 22).[33]

[32] U.S. Energy Information Administration - EIA - Independent Statistics and Analysis
[33] US Electric Vehicle Sales Reach Breakthrough Pace - Bloomberg

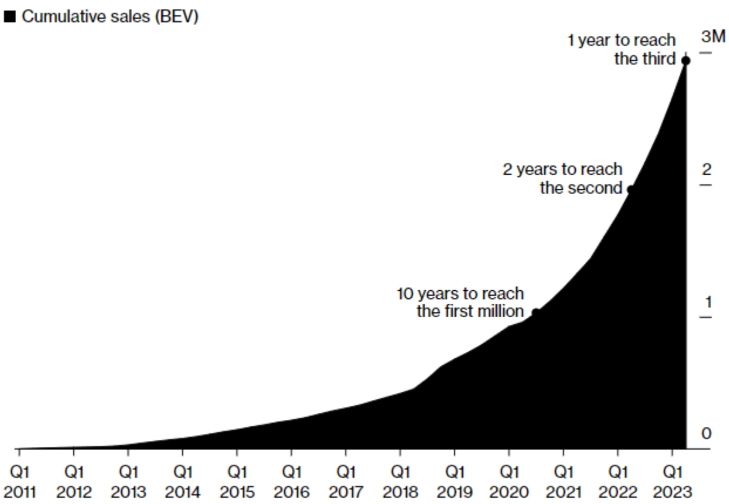

Figure 23: BEV Sales Over Time. Source: [BloombergNEF]

In 2023 it took less than a year to sell a million BEVs (Figure 23).[34] Most of the growth in EV sales in the past few years has come from BEVs.

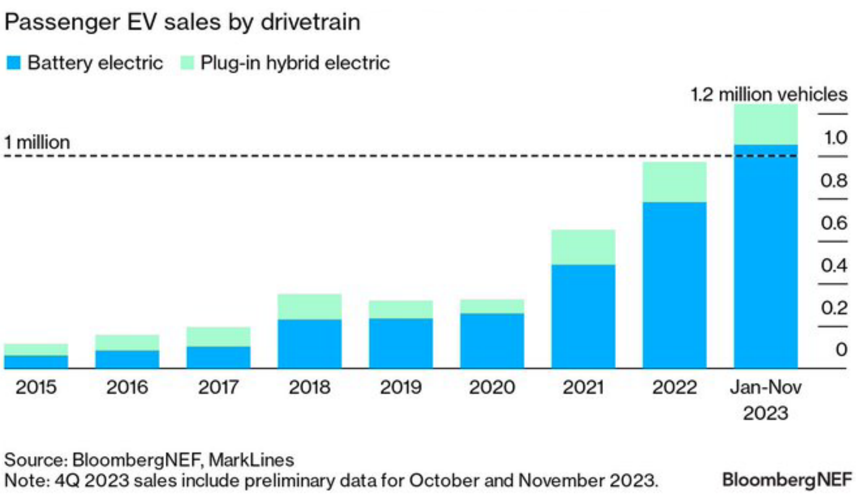

Figure 24: U.S. EV Sales Over Time. Source: [BloombergNEF]

While EV sales are growing across the country, it will take decades for the overall passenger vehicle fleet to transition due to the number of vehicles on the roads today and the number of years consumers own a vehicle before purchasing a new one. As of 2022, there were over 284 million light-duty vehicles registered in the U.S., with 2.4 million being BEVs and 1 million being PHEVs, which when combined account for just over 1% of all vehicles.[35] This relationship between sales market share and overall market share will be further shown in the Sioux Falls EV forecast presented in the assessment and analysis section later in this report.

34 BloombergNEF
35 Alternative Fuels Data Center: Vehicle Registration Counts by State (energy.gov)

EV Model Availability

A significant part of this growth has been the increase in the amount and variety of EV models available to consumers, specifically the increase in sport utility vehicles (SUVs) and pickup trucks. This is a critical segment in the U.S. auto market as seven out of the top 10 most popular vehicles in the U.S. are either SUVs or trucks.[36] The importance of SUV and truck EVs being available can be shown through the sales performance of the Tesla Model Y, which has become the second bestselling vehicle in the U.S. in 2023 despite being in just its third year of production.[36]

As of 2023, there are 45 BEV models and 37 PHEV models available in the U.S.[37] There are 18 additional models planned to be released in 2024.[38] Of these 18 models, 12 are SUVs and two are pickup trucks.

EV Plans for Major Automakers

The growth in EV models available is planned to continue, as most major automakers have officially announced plans for an increase in EV sales in the coming years (Table 9).[39]

Table 9: EV Plans by Automaker. Source: Automakers, Compiled by Protocol

Manufacturer	EV Sales Plans
BMW	50 percent of global sales to be electric by 2030.
Ford	40-50 percent of global sales to be electric by 2030.
General Motors	Sell only electric vehicles by 2035.
Honda	Entire vehicle lineup is to be zero-emissions in major markets by 2040.
Hyundai	Introduce 17 new EV models by 2030.
Mercedes-Benz	All new vehicle platforms will be EV-only by 2025.
Nissan	Over 40 percent of its U.S. sales to be fully electric by 2030.
Stellantis (Dodge, Jeep, Chrysler)	Half of all U.S. vehicle sales to be EVs by 2030.
Subaru	EVs to make up 40 percent of its global sales by 2030.
Toyota	Phase out gas-powered vehicles from its line-up by 2040.
Volkswagen	70 percent of all U.S. sales to be EVs by 2030.

[36] Tesla Model Y Jumps to 2nd in New Vehicle Registrations - Kelley Blue Book (kbb.com)
[37] electric-vehicle-sales-dashboard (autosinnovate.org)
[38] Electric Cars Coming in 2024 - Kelley Blue Book (kbb.com)
[39] EV transition: Every goal by carmakers and major markets - Protocol

Government Regulations

Government regulations can influence the types of vehicles automakers produce and sell. Two examples of this are the U.S. Environmental Protection Agency (EPA) GHG emission standards and adoption of California Air Resources Board (CARB) Advanced Clean Car (ACC) standards at the state level.

In 2024, the EPA finalized stricter GHG emission standards for model year 2027 and later passenger cars and trucks.[40] These standards apply to an automaker's overall vehicle line-up, rather than at the per vehicle level. As a result, automakers are not required to phase out gas vehicles entirely, but will need to introduce more EVs into their vehicle line-up to ensure average emissions will meet the new targets.

The CARB ACC standards were first introduced in California in 2012. These standards require an increasing number of vehicles sold to be zero-emission at the state level. 18 states have adopted at least part of the ACC standards, including nearby Minnesota. [41]

U.S. Projections and Growth Factors

A common projection for U.S. EV sales market share in 2030 is around 50%. When the threshold of 50% EV sales market share happens throughout the country depends on a variety of factors as identified in Table 10. These factors touch on all aspects of the EV ecosystem.

Table 10: Factors Affecting the Rate of EV Adoption

Factors Affecting the Rate of EV Adoption		
	Increase Adoption	*Decrease Adoption*
Innovation Characteristics	Price parity or lower price compared to ICEVs	Higher price than ICE vehicles
	Range comparable to ICE vehicles	Lower range than ICE vehicles
	High variety in EV models, vehicle types	Little variety in EV models, vehicle types
	Simplicity of vehicles, charging connectors	Complexity of vehicles, charging connectors
Adopter Characteristics	Ability to charge the vehicle at home	Inability to charge the vehicle at home
Contextual Factors	Well-developed public charging network	Limited public charging network
	Vehicle and utility incentives (consumer)	EV disincentives (e.g., higher registration fees)
	Vehicle production incentives (manufacturer)	Barriers to EV production (lithium availability)
	High cost of gas	Low cost of gas
	Low-cost, reliable electricity	Expensive, unreliable electricity
	Automaker commitments	Lack of confidence in EVs from the auto industry
	Government pressures (i.e. emission standards for automakers)	Lack of confidence in EVs from government agencies
	Availability of mechanics to service EVs	Inability of mechanics to service EVs
	Strong economy	Weak economy
	High number of EVs in the community, visibility	Low number of EVs in the community

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[40] Final Rule: Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles | US EPA

[41] Advanced Clean Cars Program | California Air Resources Board

Regional Context

EV adoption is not distributed evenly across the country. In the state with the most EVs, California, 3.5% of the vehicles registered in 2022 were EVs, while the state with the least amount of EVs, North Dakota, had only .15% EVs, which is over 23 times lower. [42] This trend is likely to continue due to discrepancies in policy and consumer preferences, so it is important to also examine regional, state, and local trends to see how EVs are growing in these areas. When looking at South Dakota and the six states that border it, the state ranked fifth out of the seven states in 2022 EV registrations as a percent of total registrations (Figure 24).

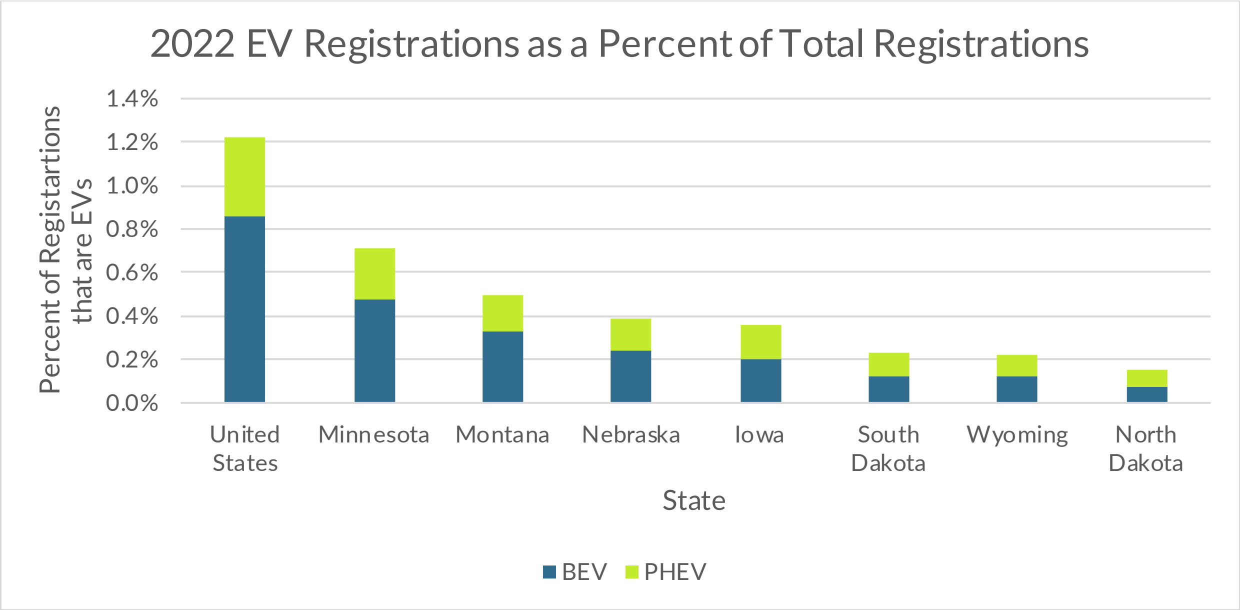

Figure 25: Comparing EV adoption among surrounding states. Source: AFDC

[42] Alternative Fuels Data Center: Vehicle Registration Counts by State (energy.gov)

One trend of note while analyzing registration data by states is the relationship between EV adoption and the split of BEVs and PHEVs. As the percentage of EVs increases, the split between BEVs and PHEVs shifts to be heavier towards BEVs (Figure 25).

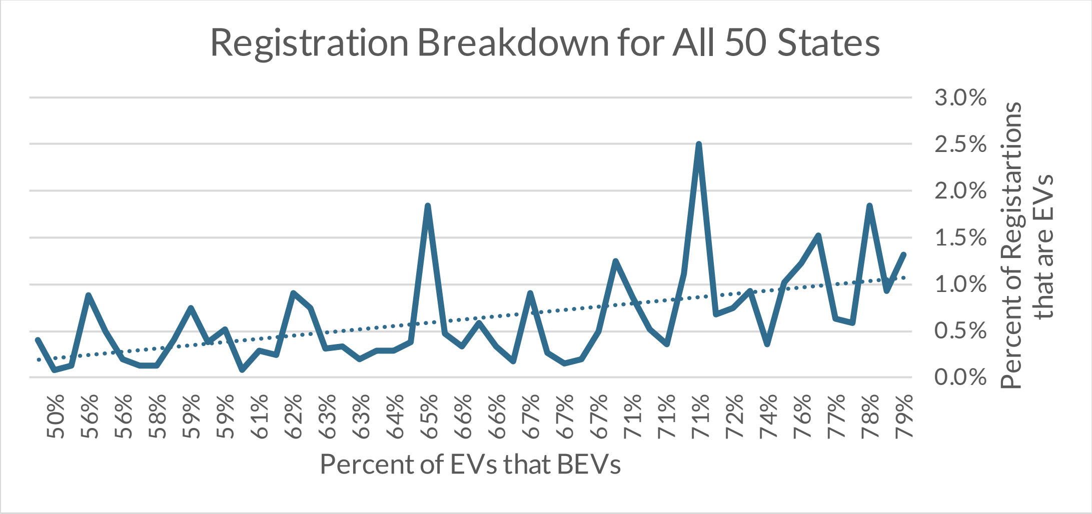

Figure 26: Comparing BEV and PHEV Split Based on Total EV Registrations. Source: AFDC

One potential reason for this trend is that at low EV adoption rates the charging infrastructure is likely to be limited, which leads to consumers preferring PHEVs due to their ability to also use gas for longer distance travel. As EV adoption increases, charging infrastructure increases, leading consumers to be more confident in purchasing BEVs. This introduces the 'chicken and egg' relationship between EVs and charging infrastructure. Consumers need to know there is adequate charging available for them to purchase an EV, and charging providers need to know there is enough demand for charging for them to invest in installing chargers. This relationship is another reason collaboration and coordination are needed among all stakeholder groups.

Local EV Context

EV Registrations and Sales

Vehicle registrations are tracked at the state level but can also be narrowed down to the city level by using registration addresses. As of the end of 2023, there were 948 EVs (BEVs + PHEVs) registered in Sioux Falls and that number has been growing since 2015 (Figure 26). The overall EV market share of .38% is above South Dakota's statewide value of .24% (2022 data).[43]

[43] Alternative Fuels Data Center: Vehicle Registration Counts by State (energy.gov)

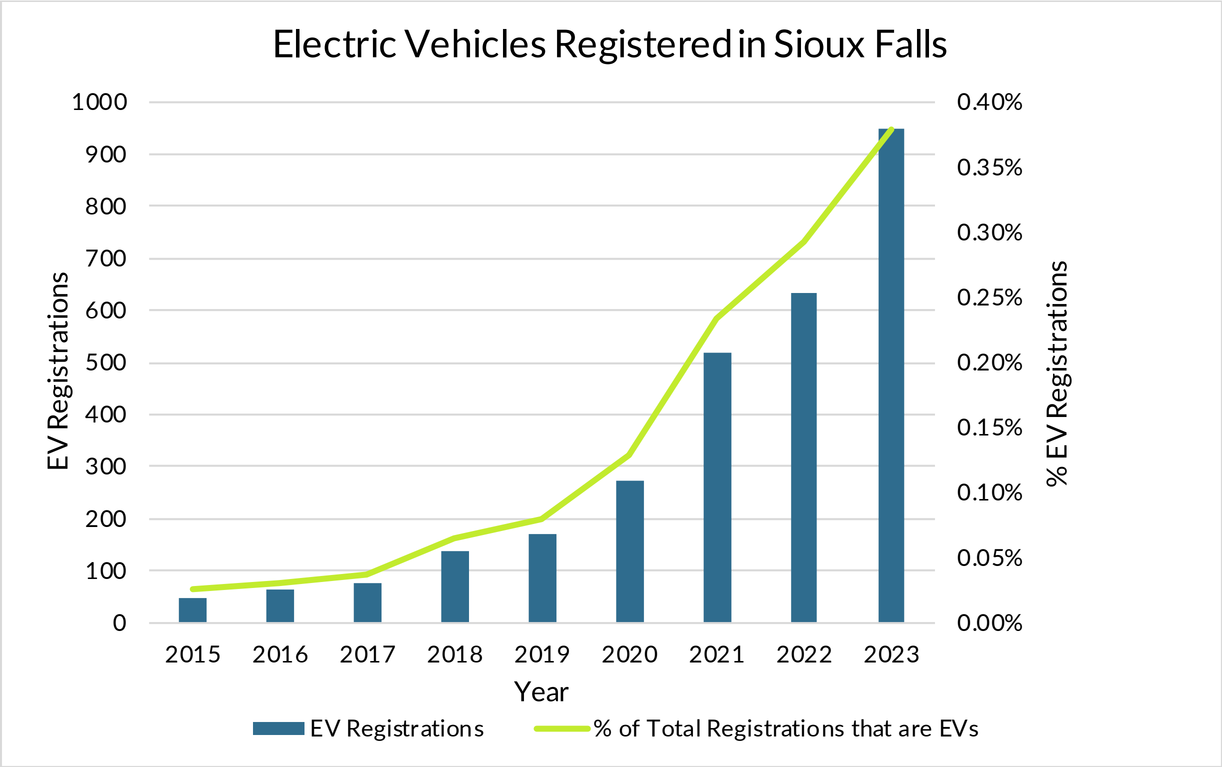

Figure 27: Sioux Falls EV Registrations. Source: South Dakota Department of Revenue

On the sales side, EV sales market share can be estimated using sales assumptions for the number of EVs and total vehicles sold. For the number of EVs, the increase in the number of EVs registered in Sioux Falls from 2021 to 2022 can be used. The total number of vehicles sold in Sioux Falls can be estimated using 2022 statewide sales data and breaking that down based on population proportions. 2022 data was used due to a lack of 2023 sales data at the time of analysis. By combining these numbers, it is estimated that 2% of vehicles sold in Sioux Falls in 2022 were EVs. This compares to 7% nationally and 1.6% in South Dakota.[44]

[44] Get Connected 2022 Q4 Electric Vehicle Report.pdf (autosinnovate.org)

Charger Availability

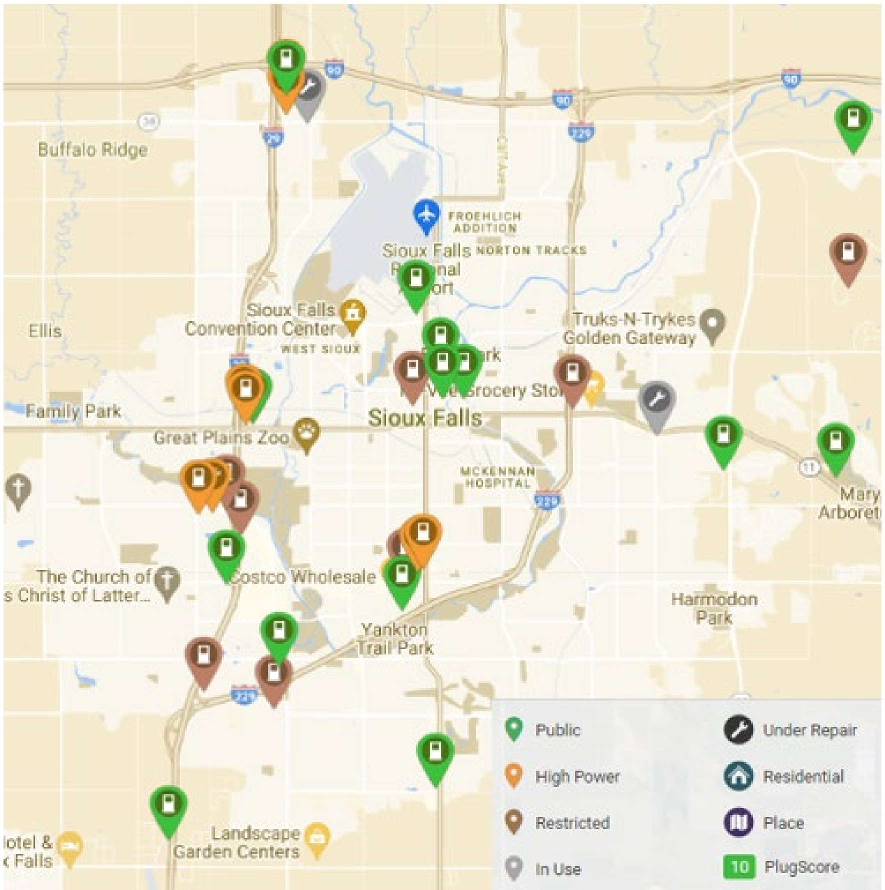

Figure 28: Existing Charging in Sioux Falls. Data as of 12/2023. Source: PlugShare

As of December 2023, there are 25 EV charging station locations in Sioux Falls with a total of 74 L2 ports and 14 DCFC ports (Figure 27). These locations are dominated by auto dealerships and hotels, as 76% of all stations are located at either of these location types (Figure 28).[45]

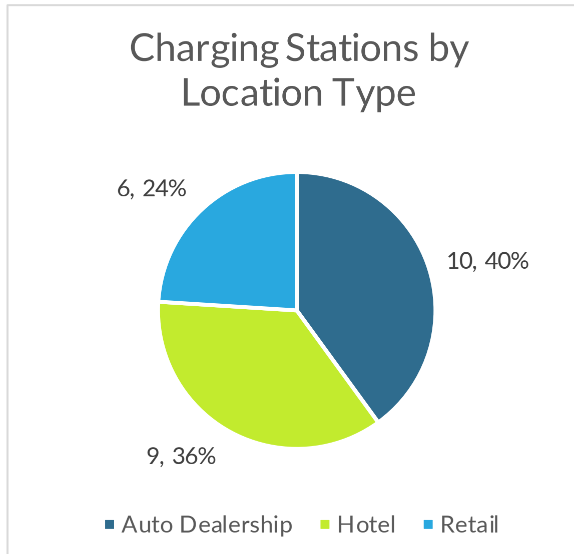

Figure 29: Charging Stations by Location Type. Source: PlugShare

When examining the breakdown of chargers, it is important to remember the two main categories of non-home chargers: shared private and public. At shared private locations, access is controlled to certain customer types. At public locations, charging is available to any EV driver. Table 11 provides details on the existing charging in Sioux Falls.

Chargers located at hotels are a notable example of why overall charging numbers must be broken down by category. Most hotels restrict charging to guests and while this is an excellent feature for hotels in Sioux Falls to offer for attracting visitors, these chargers do not serve Sioux Falls residents looking for public charging. In total, 44% of station locations (59% of L2 ports and 64% of DCFC ports) restrict access in some way.

Pricing also varies widely. Some locations are free, some charge by time, and some charge by the kWh, which ranges from $0.11 per kWh to $0.59 per kWh.

45 PlugShare - EV Charging Station Map

Table 11: Existing Charging in Sioux Falls. Data as of 12/2023. Source: PlugShare

Station Name	Type	Restricted?	Level 2 Ports	DCFC Ports	Cost
Billion Auto Kia Sioux Falls	Public	No		1	First hour, $20. Thereafter, $1/min
Billion Buick GMC Sioux Falls	Public	No		1	$30/hr
Billion Nissan	Shared Private	Yes, customers only	1		Free
Citi Bank	Shared Private	Yes, employees and customers only	20		Unknown
Cadillac of Sioux Falls	Public	No		2	$0.50/kWh + $5 session fee
GLo Best Western Dawley Farms Sioux Falls	Public	No	1		Free
Hampton Inn & Suites Southwest/Sioux Falls - Tesla Destination	Shared Private	Yes, hotel guests only	4		Free
Hampton Inn Sioux Falls - Tesla Destination	Shared Private	Yes, hotel guests only	4		Free
Historic Victorian Inn - Tesla Destination	Shared Private	Yes, hotel guests only	2		Free
Holiday Inn Sioux Falls-City Centre - Tesla Destination	Shared Private	Yes, hotel guests only	4		$25/night
Hy-Vee - Tesla Supercharger	Shared Private	Yes, Tesla vehicles only		8	$0.29/kWh
La Quinta Inn & Suites	Shared Private	Yes, hotel guests only	2		Free
Luxury Auto Mall	Public	No	2	1	$0.50/kWh + $5 session fee
PLSTATION PALOFT	Public	No	2		$3/hr
Quality Inn & Suites Airport North	Public	No	6		$0.30 per kWh
Railyard Flats	Public	No	2		$0.03/min. First 3 hrs free parking, $5.00/hr thereafter
Schulte Subaru	Public	No	1		$0.59/kWh
Super 8 Sioux Falls - Tesla Destination	Shared Private	Yes, hotel guests only	3		Free
TownePlace Suites Sioux Falls - Tesla Destination	Shared Private	Yes, hotel guests only	4		Free
Volvo Cars Sioux Falls	Shared Private	Yes, customers only		1	Free
Willow Run Golf Course	Public	No	2		Free
Xcel Energy Sioux Falls Service Center	Public	No	4		$0.11/kWh
Vern Eide Acura	Public	No	4		$0.49/kWh
Vern Eide Honda	Public	No	2		$0.49/kWh
Vern Eide Mitsubishi	Public	No	4		$0.49/kWh
Totals			**74**	**14**	

Why Get Ready?

More EVs are coming to Sioux Falls. Considering market forces alone, automakers have reached a threshold of popularity within the U.S. that enables them to transition to producing significant quantities of EV models over time.

The complex EV landscape is an unfamiliar territory to navigate. The importance of EV readiness includes:

- **Infrastructure preparedness**. Collaboration and coordination on the growth of charging infrastructure allows for the City and the power utilities to take steps to scale infrastructure to user demands. Having the appropriate level of EV charging will help keep Sioux Falls investible.
- **Public safety**. Understanding where vehicles reside and how and where they charge helps the City to be prepared for potential issues like vehicle and electrical fires and limit the potential for blackout events.
- **Reliable and convenient charging is available for everyone who wants it**. If charging is concentrated in only certain areas, barriers are in place for those without charging access.
- **Maximizing sustainability benefits**. Increasing readiness reduces barriers to EV adoption, thus maximizing the sustainability benefits that EVs bring while maintaining consumer choice.

The main goal of EV readiness is to achieve a healthy balance between the consumer and provider stakeholder groups where barriers to adoption are reduced for consumers who are interested in EVs while also keeping the supply and demand of charging infrastructure in sync.

How to Get Ready

Achieving EV readiness involves forecasting what potential EV growth could look like and what strategies support expected levels of growth. In Sioux Falls an EV forecast analysis and stakeholder engagement were completed to develop strategies to be ready for EV growth in the community.

Assessment and Analysis

As part of the analysis portion of this study, four questions were set out to be answered in a process that builds upon each step (Figure 29).

Figure 30: Analysis Process

EV Projections

The growth of EVs around the world has widely followed an S-curve of adoption, the common growth curve seen with the adoption of disruptive technologies (Figure 30). The S-curve approach, also known as the Diffusion of Innovations, takes its name from the characteristic "S" shape of the adoption trend line. Over time, the S-curve comes to fruition due to the different rates of growth as adoption increases (Figure 31).

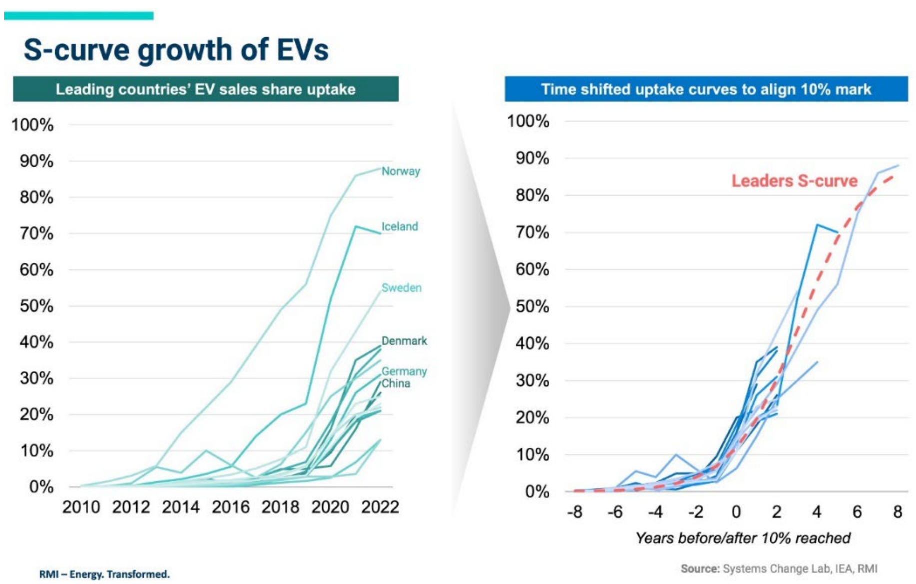

Figure 31: S-curve Growth of EVs. Source: Rocky Mountain Institute

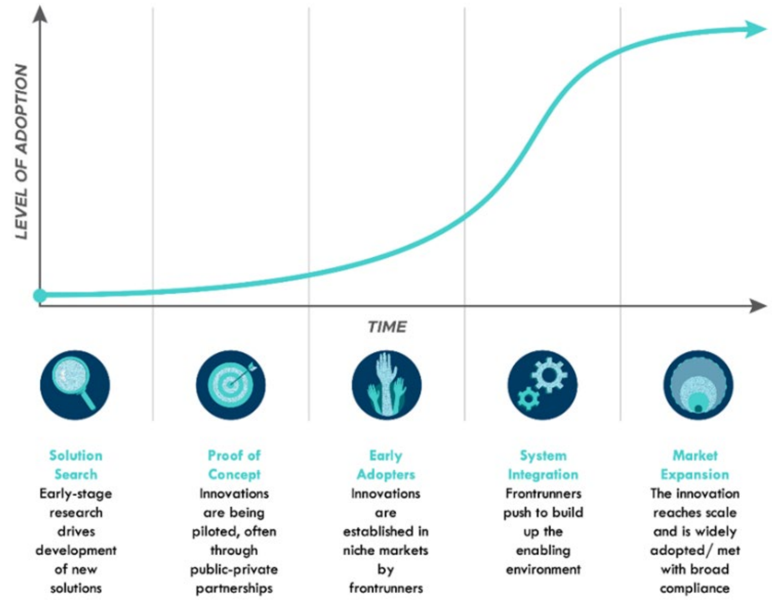

Figure 32: Stages of Adoption in S-Curve Model. Source: [Rocky Mountain Institute]

Sioux Falls is most likely in the Early Adopters phase, which is the common phase seen around the country, with some higher-adoption areas in the System Integration phase. The biggest unknowns when it comes to EV projections are when the System Integration phase of fast (exponential) growth will begin and how fast that growth will be.

An S-curve model was developed to forecast potential EV growth in Sioux Falls. Three growth scenarios, low, medium, and high, were created to account for the uncertainty in the market and capture a range of potential growth (Table 12). These scenarios were categorized by projected EV sales market share in 2030 and were applied to project how EV sales could grow over time (Figure 32). These sales were then accumulated (accounting for growth in overall vehicle sales due to expected population growth), to forecast the range of EVs that could be on the road in 10-years (2033) and how that range would relate to the overall percentage of vehicles that are EVs (Figure 33). The analysis found that there could be 7,500-20,000 EVs in Sioux Falls in 2033, accounting for 3-8% of all vehicles. These results emphasize the point introduced earlier that even if EV sales rise quickly, the rate at which the passenger vehicle fleet transitions to EVs is much slower due to the size of the vehicle fleet and the long duration of vehicle ownership. The analysis was brought out to 2050 as a long-term planning horizon and resulted in an estimated 35-45% of all vehicles being electric in 2050. This dispersion is shown in Table 12 and Figures 33 and 34.

Table 12: Adoption Scenarios and Results

Adoption Scenario	EV Sales Market Share in 2030	Number of EVs in 2033	EVs as a Percent of Vehicle Fleet in 2033
Low	10%	7,500	3%
Medium	20%	14,000	6%
High	30%	20,000	8%

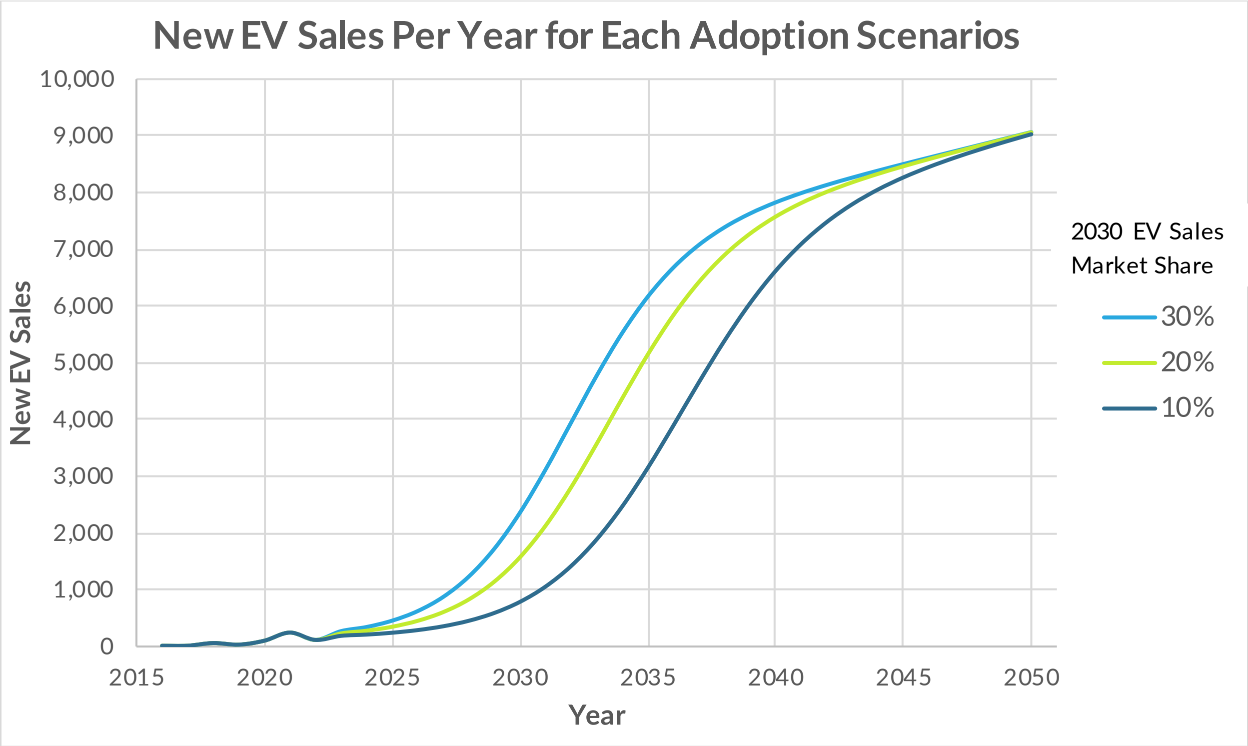

Figure 33: New EV Sales Per Year for Each Adoption Scenario

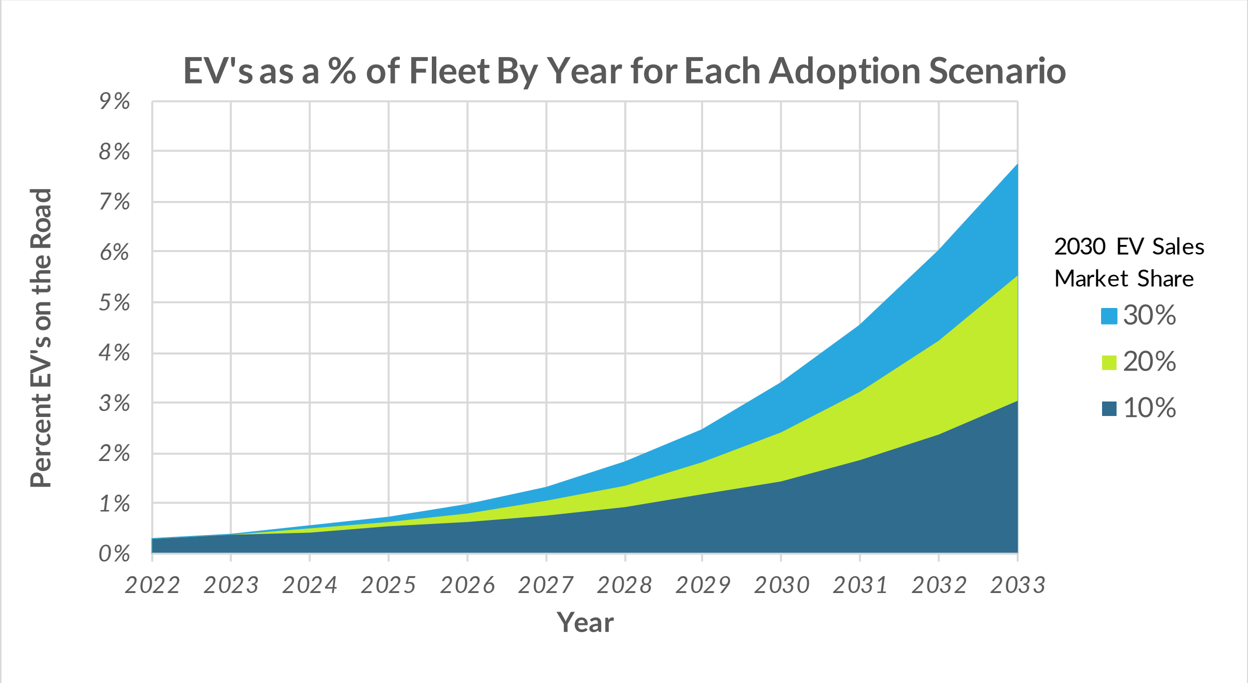

Figure 34: EV Total Market Share Over Time

EV Readiness Study Website

Charging Infrastructure Needed

The next step in the analysis is to determine how much electric vehicle charging infrastructure is needed to support the forecasted ranges of EVs. To do this the Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite, developed by the U.S. Department of Energy's National Renewable Energy Laboratory, was used.[46] The tool projects consumer demand for charging infrastructure for a given level of EVs and breaks down the results by the following charging categories:

- **Single Family Charging**
  - Private-access ports for residents of detached single-family homes as well as townhomes and twin homes. Includes a mix of Level 1 and Level 2 ports.
- **Shared Private Charging**
  - Private-access Level 2 ports for residents of apartments, condominiums, duplexes, and mobile homes as well as private-access ports at workplaces/hotels that are exclusive to employees of a company/hotel guests.
- **Public Level 2 Charging**
  - Ports available to the public at various locations (retail, recreation center, healthcare facility, education facility, community center, transportation facility, neighborhood, office).
- **Public DC Fast Charging**
  - DC fast charging ports available to the public at high-traffic locations (retail and recreation center locations).

The inputs and results are shown in Table 13.

Table 13: EVI-Pro Lite Results

Inputs				
Adoption Scenario	Existing (12/2023)	Low	Medium	High
% of EVs to the overall fleet (2033 except for existing)	.30%	3%	6%	8%
Electric Vehicles (2033 projections except for existing)	635	7,000	14,000	20,000
Results (Charging Ports)				
Single-Family	N/A	3,980	7,970	10,900
Shared Private Level 2	44	300	590	840
Public Level 2	30	420	830	1,150
Public DC Fast Charging	14	40	70	80
Total Charging Ports	**N/A**	**4,730**	**9,460**	**12,960**

The distribution of chargers by category remains consistent for each adoption scenario, with the most charging infrastructure needed at single-family residences (Figure 34).

[46] Alternative Fuels Data Center: Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite (energy.gov)

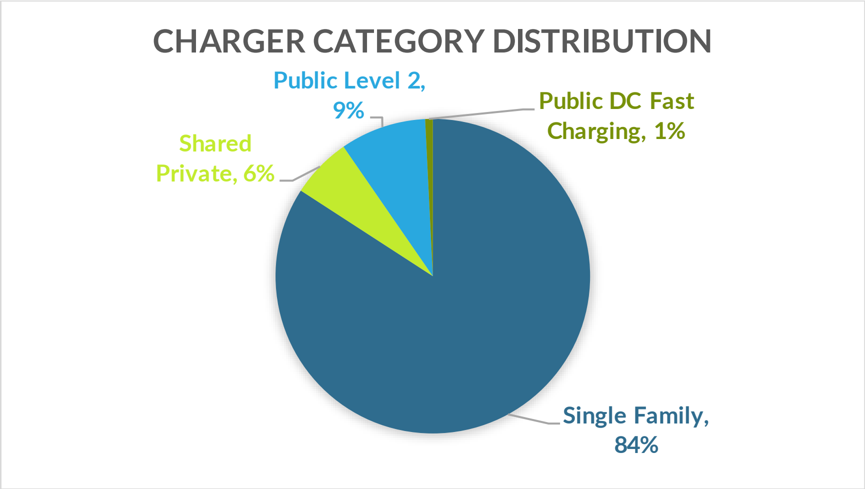

Figure 35: Charger Category Distribution

Each charging category plays a unique role in the EV ecosystem and the amount needed for each type is dependent on the other types. For example, if more home charging is available (single-family and shared private multi-family) then less public charging is needed. This is another example of why the EV ecosystem must be coordinated to make sure charging infrastructure is balanced for each category.

Charging Infrastructure Distribution

The distribution of public access chargers throughout Sioux Falls is important to provide convenient charging access for all EV drivers living and traveling through the area while also ensuring there is enough market demand to financially support the distribution. An analysis was completed to forecast how the charger amounts recommended by the EVI-Pro Lite Tool could be distributed based on travel patterns.

A travel modeling tool was utilized to simulate typical travel patterns for all trips occurring within the city limits, including parking activities. The EV study focused mostly on where vehicles park, the amount of parking, and the duration of parking activities. The parking durations were broken into two scenarios: two hours or less and two hours or more. This separation was created to differentiate between DC fast charging (DCFC) needs and Level 2 charging needs. The cut-off for these scenarios was two hours because it was assumed that EVs parked for less than two hours would require DCFC charging, while EVs parked for more than two hours would be satisfied with Level 2 charging.

The distribution of L2 and DCFC chargers for the medium adoption scenario is shown in the maps below (Figure 35 and 37). The maps also include locations of interest that the public identified during the public open house on July 12th, 2023. The largest concentration of parking trips to be served by chargers are located around the airport and nearby businesses, downtown, and the Empire/Western Malls area.

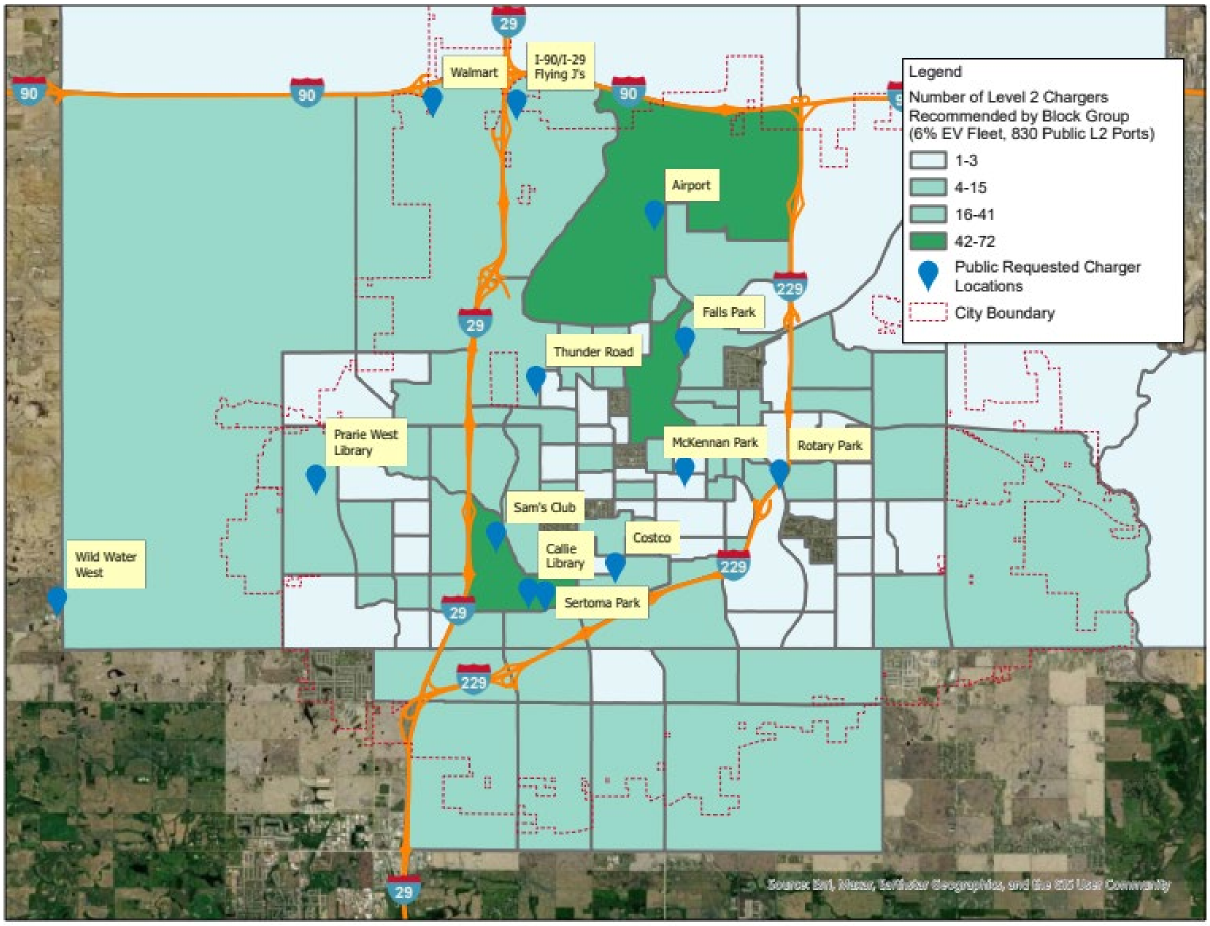

Figure 36: Level 2 Charger Distribution

EV Readiness Study Website

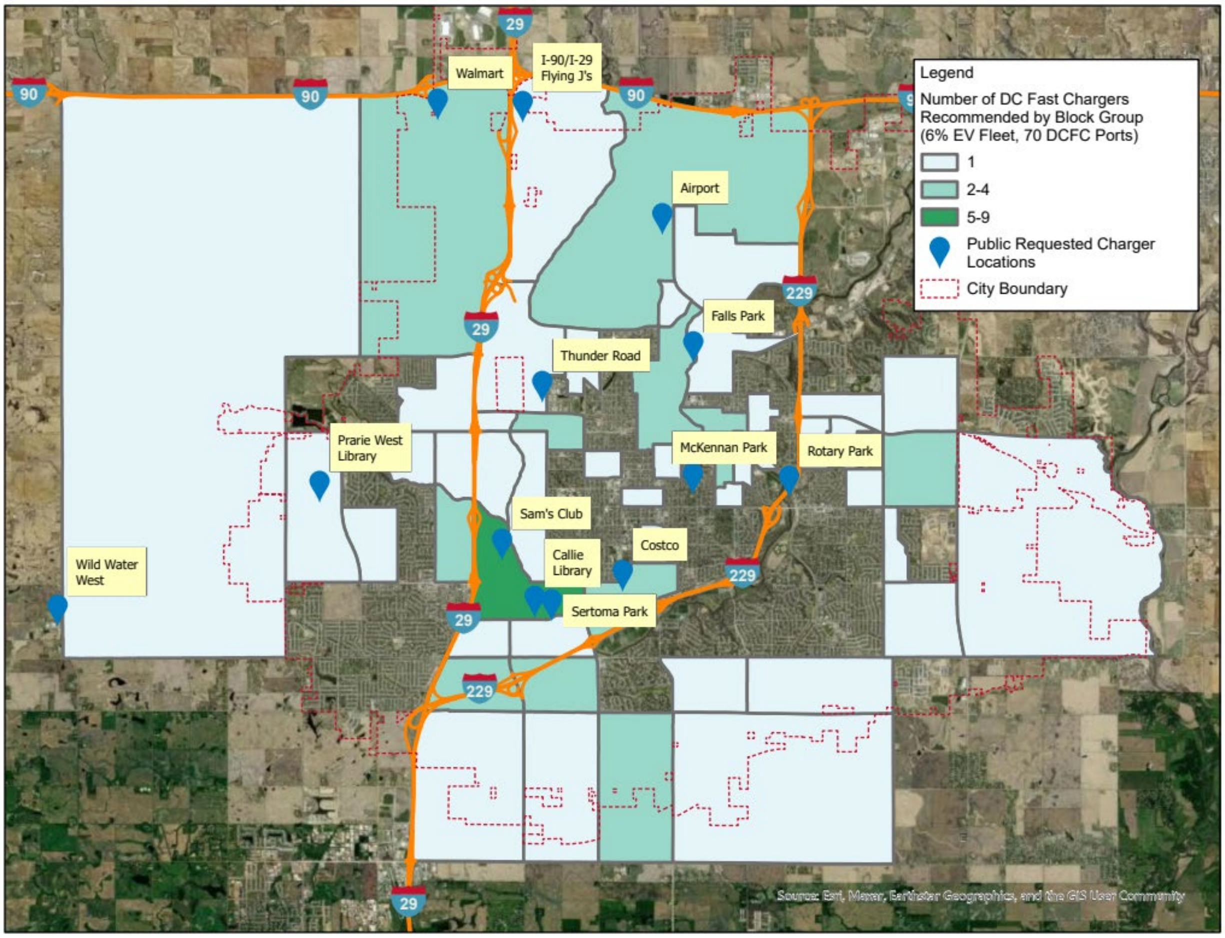

Figure 37: DCFC Distribution

The EV study team completed this location forecast for charger placement to achieve a couple of key objectives. One, a projection of where EV charging demand is the highest can help potential EV charging providers find a good opportunity to develop Level 2 or DCFC charger stations. High-use EV charging stations developed in Sioux Falls benefit the broader community economy and EV owners. Maintaining regularly updated maps of high EV charging potential creates a useful tool for charging providers.

Secondarily, the placement of EV charging is an important attribute in determining other aspects of infrastructure preparedness and public safety. Projecting where higher energy demand stations may be located can help charging providers and utilities to consider where larger EV charging stations may be both supportable by the grid and can be developed safely.

While documenting high EV charging potential is important, another aspect is the equitable distribution of charging infrastructure. This can be done by looking at where charging is located today and where the gaps are in the charging ecosystem.

Grid Impacts

A significant impact of the growth in EVs is the subsequent growth in power demand on the electrical grid. The electric utility grid is a complex system of infrastructure that combines power generation and power distribution, matched to customers' power demand. The grid includes elements such as power generation sources (e.g., natural gas, wind turbines, solar), electric transmission lines, substations, electric distribution lines, switches, transformers, and ultimately the electrical panels and charging ports required to charge EVs. Understanding the grid impacts related to EV adoption depends on multiple assessments of the various grid elements because a failure to provide reliable electrical service at one level of the grid may have cascading impacts. Additionally, the answer to individual sub-system-level assessments may or may not be all the relevant information needed to help utilities provide sufficient capacity and reliability of the power grid.

The electrical grid is managed by multiple utility providers in Sioux Falls (Figure 37). This blend of utilities can make deploying EV charging infrastructure challenging due to the mix of service territories, processes, and rates.

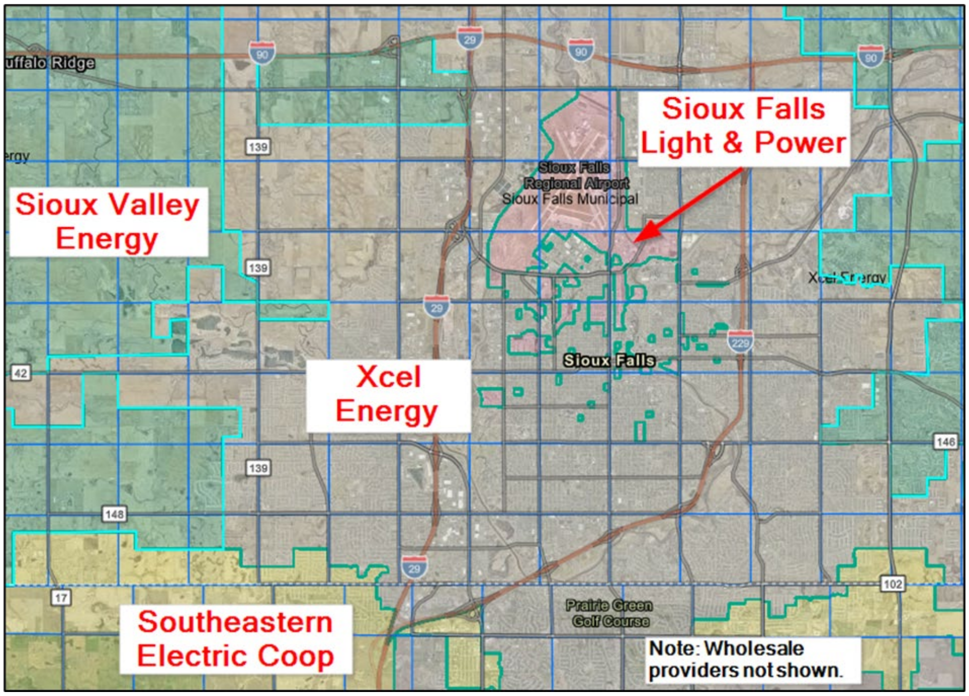

Figure 38: Utilities in Sioux Falls

A key metric when determining demand on the grid is peak electrical load. The grid needs to be able to manage peak loads to avoid grid failures. The EVI-Pro Lite tool used to estimate charging needs has a feature that estimates a load profile for certain levels of EVs. To support 10,000 EVs, the tool projects an average daily peak load of 10 MW from EV charging. Users can see load projections for different scenarios by going to the EVI-Pro Lite website and clicking the "Load Profile" tab. While the grid is a complicated system, utilities have been managing load growth for many years. The communication and coordination between utilities and charging providers/homeowners is a critical aspect of planning for grid upgrades that support EV charging.

Stakeholder Engagement

A key aspect of this study was the engagement of different stakeholders throughout the process. Listening sessions were held with a variety of stakeholders. A public open house was held to inform the public about the study and gather feedback, and an EV working group was formed as an advisory group that represented a wide variety of organizations.

Stakeholder Listening Sessions

Listening sessions were held on July 12th, 2023 and consisted of four small group sessions with 20 organizations represented (Table 14).

Table 14: Organizations Involved in Stakeholder Listening Sessions

Organizations	
Augustana University	Olsson Oil Company
Billion Automotive Group	Sioux Falls School District
City Light and Power	Sioux Valley Energy
City of Sioux Falls (Planning & Development, Mayor's Office, Fire and Rescue, Public Works)	SoDak 350 Advocacy group
Development Foundation of Sioux Falls	South Dakota Auto Dealers Association
Downtown Sioux Falls	South Dakota Home Builders Association
East River Electric	South Dakota Multi-housing Association
Experience Sioux Falls	Southeast Council of Governments
Graybar Electric	TranSource Truck and Trailer Centers
Heartland Energy	Xcel Energy
International Brotherhood of Electrical Workers	

EV Working Group

The EV working group was formed with representatives from the organizations involved in the listening sessions. The working group served as an external advisory group to give input and feedback throughout the study process. This feedback was used to help shape the strategies recommended in the next chapter.

General Public

The general public will control the rate of EV adoption and are a critical stakeholder in the EV ecosystem. An open house was held on July 12th, 2023, that allowed residents to learn about the study, ask questions, and solicit their feedback.

An online survey was also conducted that received 127 responses. This survey was shared on the City's EV Readiness Study webpage and shared through City social media platforms. 20% of responders own or lease an EV, showing that the survey was skewed towards EV owners as less than 1% of vehicles registered in Sioux Falls are EVs, but the survey still gave valuable insights from both EV owners and non-EV owners. Of the responders who own or lease an EV, the number one challenge they face when charging their vehicle is inconvenient charging locations. For non-EV owners, 40% of responders said they would "definitely" consider buying an EV, with only 9% answering "definitely not".

EV Readiness Study Website

Recommended Strategies

Strategies to increase EV readiness were developed to help all stakeholders prepare for the coming increase in EV users in the city. These strategies were informed through input from the EV Working Group. The following strategy recommendations have been grouped by the stakeholder taking action. The stakeholders that are assigned actions were each provider stakeholder (City, Charging Providers, EV Industry, and Utilities) along with the Homeowners stakeholder group (Figure 38). All stakeholder groups can be the beneficiary of a strategy being implemented. A comprehensive list of strategies is presented knowing that not all will be able to be implemented in the near term. Strategies are presented in three tiers of implementation in relation to the city's potential to address them. High potential means that the strategies will likely be pursued sooner but might still take a significant amount of time to implement depending on the level of effort required. Non-city stakeholders have listed strategies – but their potential for implementation is outside the city's control.

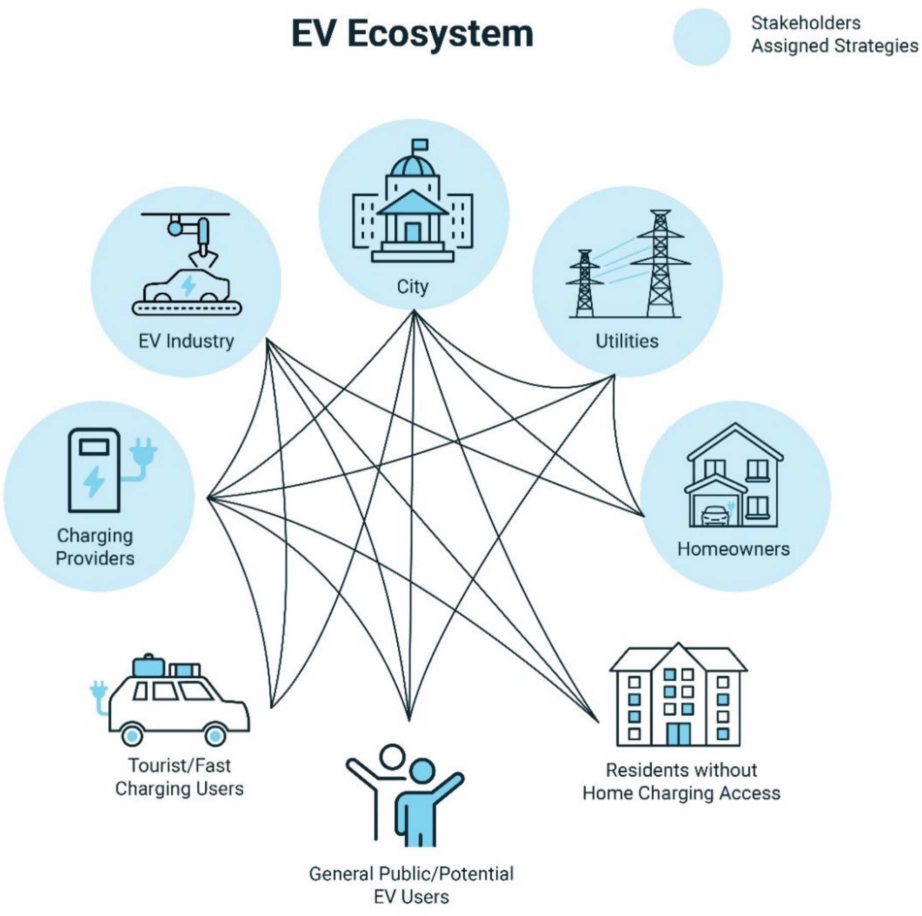

Figure 39: Stakeholders Assigned Strategies

EV Readiness Study Website

An overview of the strategies recommended for implementation is shown in Figure 39.

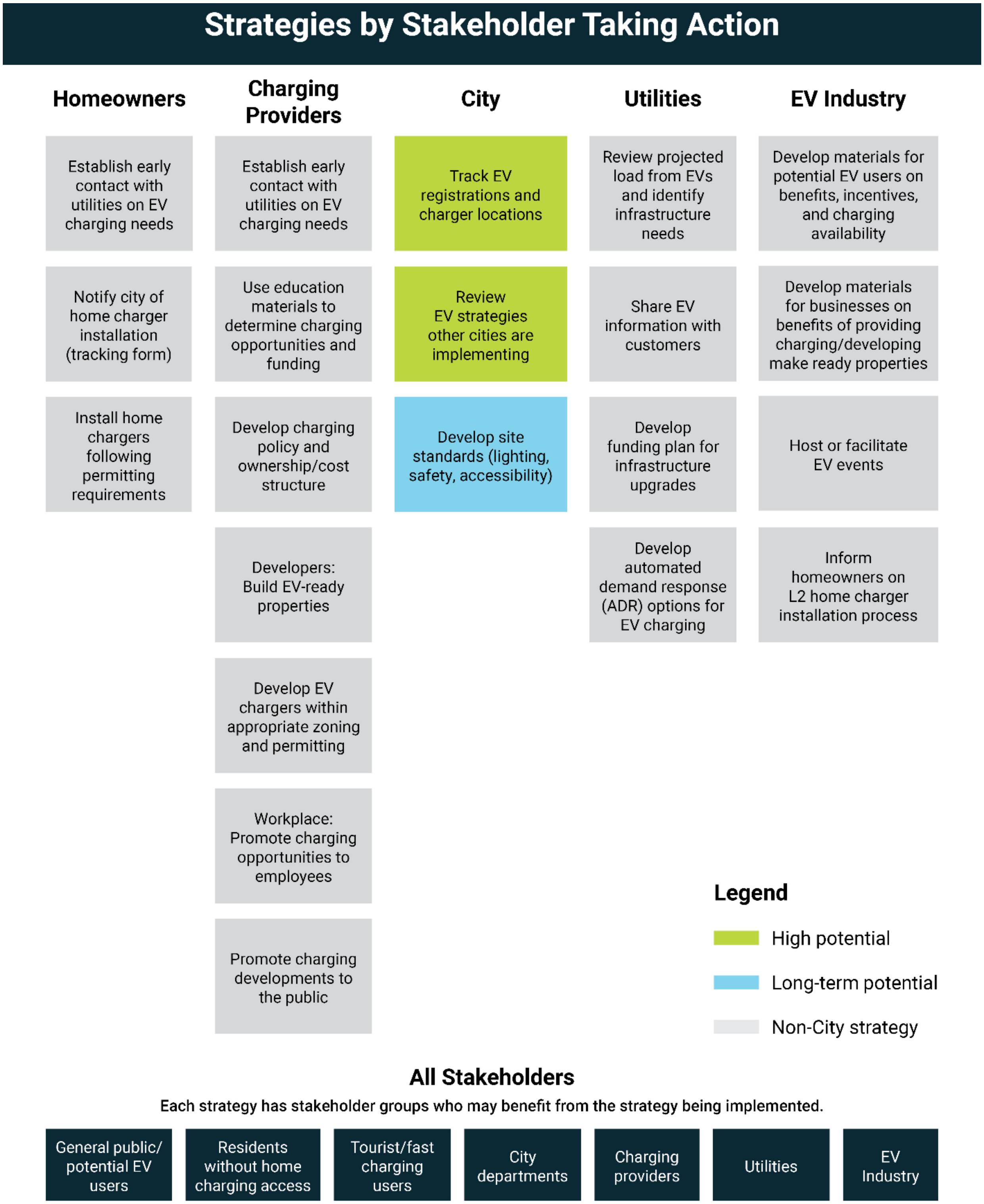

Figure 40: Strategies Overview

Each strategy includes:

- Responsible party
  - Who is executing the strategy?
- Description
  - How is the strategy implemented?
- Who benefits
  - Which stakeholders benefit from the strategy being implemented?
- Desired outcome
  - What is the intended result for each stakeholder involved?

City Departments

High Potential

Track EV Registrations and Charger Locations

Responsible Party: City

Description: Work with the South Dakota Department of Revenue (SDDOR) to receive recurring (at least annually) updates on the number of EVs registered within Sioux Falls. SDDOR publishes registration data at the state and county level monthly[47], but data at the city level must be requested. This data is strictly the total number of vehicles registered; no private information is shared. Also, work with residents and charger providers to track charger installations within the City. This also includes tracking the EV market on a regional and national scale to follow what changes might affect local EV adoption.

Who benefits:

- City
- Charging Providers
- General public/potential EV users
- Utilities

Desired outcome: The City tracks the growth of EVs and chargers to understand EV demand to the available supply of publicly accessible EV charging infrastructure. Potential charging providers use the data to determine if there is enough demand for charging investments and keep investments up with demand. Geographic and customer group coverage can be analyzed to determine underserved areas. Utilities can monitor EV registrations for load growth implications. Sioux Falls Fire and Rescue will be aware of the presence of chargers when responding to incidents and can bring appropriate fire and life safety equipment.

[47] South Dakota Registration Statistics

Review EV Strategies Other Cities are Implementing

Responsible Party: City

Description: In addition to tracking industry best practices, this can include peer exchanges with other local municipalities and also browsing national databases that track EV-related strategies such as the Alternative Fuel Data Center.

Who benefits:

- All stakeholder groups

Desired outcome: Successful strategies are considered that prepare utility service providers, charging providers, and other stakeholders in a well-planned orderly fashion. The City can learn best practices from peer agencies and what to consider when implementing strategies. The EV ecosystem benefits as a whole for the most productive strategies being pursued.

Longer Term Potential

Develop Charging Site Standards and Share them with Charging Providers

Responsible Party: City

Description: These standards can include guidelines on lighting, safety, and accessibility while integrating with and emphasizing existing building, fire, and electrical codes.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: Potential charging site hosts are aware of what is required when developing a charging site. This awareness can be incorporated into the materials for potential site hosts. Well planned standards benefit all stakeholders.

Homeowners

Establish Early Contact with Utilities on EV Charging Needs

Responsible Party: Homeowners

Description: Work with utilities to determine the best option for home charging needs and the programs available to make it as cost-effective as possible.

Who benefits:

- Homeowners
- Utilities

Desired outcome: Homeowners have a smooth process of installing a home charger and are aware of the rate structures available. Utilities are confident that the charger was installed correctly and power supply is available.

Notify City of Level 2 Home Charger Installation

Responsible Party: Homeowners

Description: The City will release an online survey for homeowners to fill out that informs the City of where L2 home chargers are located. Homeowners will complete the survey when they get a L2 charger installed at their home or retroactively if a charger is already installed.

Who benefits:

- City
- General Public
- Utilities

Desired outcome: The fire department is aware of whether a Level 2 home charger is present in case of a fire at a residence. The general public benefits from advancing fire and life safety in preparation for a possible vehicle fire. Utilities will have the opportunity to understand potential distribution impacts to trends in Level 2 home charger use.

Install Home Chargers Following Permitting Requirements

Responsible Party: Homeowners

Description: Obtain a building permit and install the Level 2 Charger following applicable building codes.

Who benefits:

- Homeowners
- Utilities

Desired outcome: Homeowners experience an efficient process to install a L2 home charger and confirm it is installed safely, meeting the applicable building codes. Utilities are confident that the charger was installed correctly and power supply is available.

Charging Providers

Establish Early Contact with Utilities on EV Charging Needs

Responsible Party: Charging Providers

Description: Coordinate with utilities on plans for installing EV charging including type and quantity of chargers, so that necessary electrical upgrades can be completed if necessary.

Who benefits:

- Charging Providers
- Utilities

Desired outcome: The process for installing chargers is sped up for charging providers by having early contact with the utilities. Utilities can plan for load growth and respond as needed.

Use Education Materials to Determine Charging Opportunities and Funding

Responsible Party: Charging Providers

Description: Review available materials to determine if charging makes sense for their site. Learn what types of opportunities exist and any incentive funding available for charger installation.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: Potential charging providers can learn about EV charging opportunities and make an informed decision about whether to invest in EV charging at their site. If this education leads to more sites adding charging to their properties, all EV owners benefit from the increase in charging availability and variety.

Develop a Charging Policy and Ownership/Cost Structure

Responsible Party: Charging Providers

Description: For employers and multi-unit property owners, develop if and how charging will be provided at sites, which can include a survey to gather interest in charging being offered. For all charging providers, determine an ownership and cost (both expenses and revenue) structure that can clearly be communicated to users and can sustainably support site charging for the long term.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: Employers and multi-unit property owners have an understanding of the interest level in hosting charging on their properties and have a plan developed to address the interest if it is there. All potential charging providers understand the different ownership and cost structures available to them and have selected structures that make the most sense for their business.

Develop EV-Ready Properties

Responsible Party: Charging Providers (specifically developers/builders)

Description: There are three levels of EV charger development: EV-capable, EV-ready, and EV-installed. For developers/builders developing single-family and multi-family properties, invest in the properties being built so that they are at least EV-capable, meaning sufficient panel capacity installed and availability to support future charging and a dedicated circuit/raceway from panel to parking area. EV-Ready is preferred, which means including the wiring installed from the panel and terminated in a 240V outlet or junction box. EV-installed includes a Level 2 charger, which is more likely for multi-family properties but is an excellent feature if charging demand is expected.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access

Desired outcome: Developers and builders understand the market benefit of developing EV-ready properties. Homeowners can purchase homes that are EV-ready and residents without home charging access have the opportunity to gain home charging access. Potential EV users know that they will be able to gain home charging access at their residence if they purchase an EV.

Develop EV Chargers within Appropriate Zoning and Permitting Policies

Responsible Party: Charging Providers

Description: The location and siting within the site are important factors for effective and beneficial charging stations. Charging providers should examine the surrounding zoning and land use to determine what amenities will draw customers to charge at their site. Work with the city and utilities to follow permitting processes.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: Charging providers can operate financially sustainable charging stations that bring value to EV owners. All EV owner types can charge in public at locations convenient to them that have services to use while charging.

Promote Charging Opportunities to Employees

Responsible Party: Charging Providers (specifically employers)

Description: This strategy involves employers gauging the interest of employees for workplace charging. Promoting charging opportunities can include charging offered on-site or nearby charging that employers could use during the workday.

Who benefits:

- Charging Providers (specifically employers)
- Residents without home charging access
- General public/potential EV users

Desired outcome: Employers understand the level of interest in charging at their workplace. Residents without home charging access are confident that they can charge at or near work and potential EV users know their employers are thinking about the charging needs of employees.

Promote Charging Developments to the Public

Responsible Party: Charging Providers

Description: Due to the variety of locations where chargers get installed, sometimes the public is not aware of what charging locations are available. When public access chargers are installed, work with various information channels such as traditional and social media and charger location applications to promote the charging station so that the public is aware of the chargers.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: All EV owner types are aware when new charging locations open and charging providers see an increase in customer demand resulting from the awareness.

Utilities

Review Projected Load from EVs and Identify Needs in Generation, Distribution, and Transmission

Responsible Party: Utilities

Description: Use the forecasts developed in this study and other internal data to review what projected load from EVs could be in the future to be ready for EV growth. Apply these projections to determine where infrastructure needs are. Share with the public how the utility is preparing for EV growth.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: Utility providers are able to plan and meet the anticipated demand as efficiently and cost effectively as possible. All EV owner types and the public are confident the grid will be able to support EV growth in Sioux Falls.

Share EV Information with Customers

Responsible Party: Utilities

Description: Educate customers on EV incentives and rate plans for both home and commercial charging.

Who benefits:

- Homeowners
- Charging providers
- Utilities

Desired outcome: Homeowners are aware of incentives and rate plans and can make an informed decision about purchasing an EV/installing an L2 home charger. Charging providers are aware of incentives and rate plans and can make an informed decision about investing in charging infrastructure. Utilities benefit through customer satisfaction and increased power use – with well-informed decisions on the impact on the grid.

Develop Funding Plan for Infrastructure Upgrades

Responsible Party: Utilities

Description: Determine how infrastructure upgrades will be funded. The complexity with EV demand is that the vehicles are now widely available, so demand can grow with each individual's decision to purchase a vehicle – but the supply of power from the grid is developed over a much longer period. Utilities that control power generation and transmission should investigate the increased opportunity to seek federal funding through grants or as a public-private partnership to establish needed growth to support end-user demand and distribution systems. Utilities focused on distribution must tailor funding plans to link EV-needed funding with a combination of customer revenue and grant funding or public-private partnership opportunities. In all cases, consideration should be given to avoiding speculative rate increases – as this may lead to primarily non-EV-owning customers' revenue paying for EV-driven upgrades.

Who benefits:

- General public/potential EV users

Desired outcome: Utility providers are able to plan and meet the anticipated demand as efficiently and cost effectively as possible. The general public benefits from grid resiliency, while avoiding burdens of the cost of EV-related infrastructure upgrades without commiserate benefits. Utilities can find funding to build upgrades and support customer growth and satisfaction.

Develop automated demand response (ADR) options for EV charging

Responsible Party: Utilities

Description: Automated demand response allows consumers to automatically reduce their energy consumption during peak demand periods. ADR is common in households that use smart thermostats and is an effective strategy for reducing strain on the grid.

Who benefits:

- Homeowners
- Charging providers
- Utilities

Desired outcome: Homeowners and charging providers can charge overnight in a cost-effective manner that distributes the grid impacts of home charging throughout the night, instead of having large peaks when plugging in early in the evening. Utilities avoid costly demand spikes that trigger the purchase of higher-cost energy from suppliers or planning expensive upgrades for emergency demand that is not used regularly.

EV Industry

Develop Materials for Potential EV Users on Benefits, Incentives, and Charging Availability

Responsible Party: EV Industry

Description: These materials can include the latest industry information as well as voluntary testimonies of Sioux Falls EV owners who are willing to share their ownership experiences, such as their driving habits and associated savings as well as their charging experiences and cold weather range performance.

Who benefits:

- General public/potential EV users

Desired outcome: Residents interested in EVs can learn directly from other Sioux Falls residents about what it is like to own an EV in the city and the associated benefits/challenges.

Develop Materials for Businesses on the Benefits of Providing Charging/EV-Ready Sites and Funding Available

Responsible Party: EV Industry

Description: These materials can be focused on areas where charging has been requested by the public or locations where the analysis in this study has recommended chargers. They can also include example charging applications with relevant case studies of successful charging locations.

Who benefits:

- Charging Providers
- Homeowners
- General public/potential EV users
- Residents without home charging access
- Tourists/fast-charging users

Desired outcome: Potential charging providers are aware of the options available for establishing charging at their business and understand the benefits, costs, and any incentives available to them. If charging locations are developed out of this outreach, all EV owner types benefit from increased charging availability.

Host or Facilitate EV Events

Responsible Party: EV Industry

Description: Getting consumers into an EV plays a key role in purchase considerations. Just 12% of consumers who have no personal experience with an EV say they're "very likely" to consider one, while that percentage more than doubles to 25% among those who have simply ridden in an EV as a passenger.[48] EV events with test rides available for different EV models are a great way for those interested in EVs to experience driving them.

Who benefits:

- General public/potential EV users

Desired outcome: Potential EV users can ask questions about EVs and experience what they are like all in one place and can then make an informed decision about whether to purchase an EV as their next vehicle.

Inform Homeowners on Level 2 Home Charger Installation Process

Responsible Party: EV Industry

Description: Promote homeowner education so they are aware of any permits or inspections required to install an L2 home charger. Other cities have needed to develop such material to promote safe and efficient homeowner practices with electrical installations – but no such concerns are present in Sioux Falls at this time.

Who benefits:

- Homeowners

Desired outcome: Homeowners are aware of what is needed to install a Level 2 home charger and the process is efficient.

[48] 2023 U.S. Electric Vehicle Consideration (EVC) Study | J.D. Power (jdpower.com)

Next Steps

Many stakeholders were involved in developing the strategies contained in this study. The city will share the information developed so that all stakeholders can understand the expected growth of EV ownership. Through awareness of this market driven growth, stakeholders can determine how best to meet those needs. Through collaboration and coordination across the stakeholder groups, EV readiness can be advanced in Sioux Falls.