North Mankato Future Transportation Preparedness Study:

Preparing North Mankato for Increased Electric and Autonomous Vehicle Usage

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Transportation Today: Where is Transportation Today in terms of electric/autonomous vehicles?

Nationally, transportation is an integral part of city's drive to meet climate goals and successfully serve their community. 6% of cities direct general spending budgets are used on roads and transportation every year (US Census Bureau, 2019). Fossil Fuels being a finite resource, the world of the automobile has been looking for alternative solutions to the standard gasoline engine. The most common and growing piece is the Electric Vehicle (EV). Companies have been designing and promoting new models of EVs and cities and businesses are trying to establish the best method of providing infrastructure the way that gas stations and fossil fuel infrastructure has been created.

In addition to EV's, the desire to eliminate fatalities and complaints of standard road use, like traffic congestion, accidents, and lost time have spurred another form of alternative transportation. Scientists, engineers and manufacturers have promoted the design and creation of Autonomous Vehicles (AV). AV's allow a vehicle to move about the built environment without 100% of control by the operator. AV's have the potential to be more efficient, safer, and open a pathway to future transit where less time, energy and resources are spent driving.

The team of Graduate students from Minnesota State University, Mankato, have examined both technologies and how they can affect a city like North Mankato. The team reviewed research data from across all sectors, examining EV trends, charging, funds and infrastructure. Similarly, the team evaluated the status of AV's estimating how North Mankato will need to prepare and be ready for this technological advancement.

The team's research and recommendations will help the City of North Mankato prepare and plan appropriately for accommodating future transportation. The team has identified recommendations and examples taken on by similarly sized cities and other communities.

Based on our research the team discovered 4 key initiatives goals, and policy changes North Mankato should take:

1. **Work with businesses to encourage charging at their site.**

Develop an outreach program to inform local businesses of the benefits of providing charging for employees, customers, and fleets. See the Recommended Policies and Goals and Objectives for helpful information.

2. **Purchase EVs for the City of North Mankato fleet.**

Develop asset management criteria that demonstrate higher purchase cost but reduced operating expenditures over time. As vehicles in the city fleet approach the end of their life cycle, the city shall consider replacing them with EVs. The city shall also install chargers at locations where city vehicles are kept.

3. **Update and redeploy the community survey every two years to gauge how many residents are considering purchasing an electric vehicle in the near future.**

Hold an engagement event or survey to allow residents to provide feedback on whether they plan to drive an electric vehicle, and what capacity the North Mankato charging network must support for them to make the switch. It would also be helpful to know if residents plan to use home chargers.

Through the report the team has identified steps to take and help meet these goals. The team recommends a multi phased approach. This will allow North Mankato to take small steps to encourage more businesses to install their own EV chargers and taking the burden off the city. This would allow North Mankato to focus on other initiatives like turning their Fleet vehicles into EV's and research more on autonomous vehicles. The recommendations will be listed in boxes like the example below which are then summarized at the end of the report.

Phase 1: Recommendation
Example Recommendation

Part 1: Electric Vehicle (EV) Trends & Forecasted Demand

Over 6.5 million electric vehicles (EV's) were sold globally in 2021 which represents more than double the 3.1 million sold in 2020. In the U.S., about 322,000 EV's were sold in 2020 while in 2021 over 310,000 electric vehicles were sold in the first six months of the year. California alone added 121,000 EVs in the same six-month period (Jalopnik, 2022). Electric vehicle sales in the United States also doubled in 2021 compared with 2020, and car buyers in 2022 will have twice as many electric models from which to choose. In total automakers are planning to put nearly 1 million new electric vehicles on American roads in 2022 (Pew Trusts, 2022). Federally the government is providing tax breaks and incentives to EV car buyers for both Car purchase price and in some cases even alleviating parking fees/registration (Dept of Energy, 2022). Equally important is that EV's are charging ahead in the state legislature as well. Minnesota's most recent bonding bill included $2 million for EV charging infrastructure on state-owned property (Drive Electric Minnesota, 2020). This funding will go directly towards the installation of fast charging and level 2 charging at state-owned facilities, such as government buildings, state parks, rest stops and more.

There are four primary factors that impact growth in the EV markets:

1. Changing consumer sentiment towards EV's – As EV technology progresses, the barriers to EV adoption are being removed.
2. Policy and legislation – Increasing fuel economy and lower emission targets, along with financial incentives are driving EV adoption.
3. Original Equipment Manufacturers (OEM) Vehicle Strategy – Today prominent OEM's such as Tesla, VW, Toyota, Volvo, and Ford have announced new EV models and also increased production and sales targets exponentially in the past few years.
4. The role of business - By exploring broader mobility options, businesses are finding value not just in emissions reduction, but in cost savings and improved employee satisfaction (Deloitte, 2020).

In 2019, the MN Department of Transportation (MnDOT), MN Pollution Control Agency, and the Great Plains Institute partnered to create *Accelerating Electric Vehicle Adoption: A Vision for Minnesota,* the first coordinated attempt to outline a statewide vision for increasing EV use. *The Vision* describes strategies for achieving the goal of powering 20 percent of the light-duty cars in the state with electricity by 2030 (MnDOT, MPCA, Great Plains Institute, 2019).

While it seems inevitable that EV's will become more prominent on roadways, one issue that remains unclear is how cities will be able to handle the impact to infrastructure needed to power the

influx of EV's. The average electric vehicle requires 30 kilowatt-hours to travel 100 miles — the same amount of electricity an average American home uses each day to run appliances, computers, lights, and heating and air conditioning (Pew Trusts, 2020). A U.S. Department of Energy study found that increased electrification across all sectors of the economy could boost national consumption by as much as 38% by 2050, in large part because of electric vehicles (Utility Dive, 2018). Many states predict they can boost power production, however, whether electric vehicles will become an asset or a liability to the grid largely depends on when drivers charge their cars. Electricity demand fluctuates throughout the day; demand is higher during daytime hours, peaking in the early evening. If many people buy electric vehicles and mostly try to charge right when they arrive home from work — as many currently do — the system could become overloaded or force utilities to deliver more electricity beyond their capacity (Pew Trusts, 2020).

Literature on future trends and forecasted demand of EV's points to a few challenges lawmakers and manufactures ought to be aware of. Kapustin & Grushevenko (2020) predict that, depending on the scenario, EVs could secure an 11–28% share of the global road transport fleet which could lead to an additional increase in global electricity consumption of 11–20% by 2040. The challenge is the adaptation of the power grid to the growing demand peaks due to EV's charging patterns. To maintain the course on "green" energy, global leaders in EV adoption need to double the efforts on development and implementation of energy storage technologies, otherwise, the spread of electric cars will lead to more fossil fuel consumption (Grushevenko, 2020).

Other research points to the vulnerability of EV deployment due to the critical mineral supply. EV batteries require a variety of precious metals and minerals such as graphite, lithium, cobalt, nickel, and manganese, amongst others (Picarsic, 2020). In fact, as recently as this year, Tesla signed a deal to purchase 75,000 metric tons of nickel concentrate from a mine in Tamarack, MN (Thiede, 2022). While the U.S. does have some supply of these precious minerals, much of the mining for lithium, cobalt and nickel does occur in limited areas of the Democratic Republic of Congo and China (Thiede, 2022). These supply chain limitations are going to be a reality for everything we use today, Cell Phones, Computers, and Gas-powered cars, GM and Ford have been experiencing chip delays as recently as this year for their production lines (Heilweil, 2022).

Despite these more global issues that could impact the future production of EVs, trends still indicate that vehicle manufacturers will continue increasing production. Local governments should be proactive by continually reviewing new trends in automobile technologies to appropriately plan for

future transportation infrastructure needs. However, it's worth noting that as EV technology develops cities should consider these resource and infrastructure challenges.

Optimal Charging Services

Types of Chargers

In recent times, EVs have advanced significantly. For the use of EVs to be successful, government organizations will need ensure utility companies and the private sector work together to install charging infrastructure that is accessible, easy to use, and inexpensive. Without an accessible infrastructure that can re-charge an EV in a reasonable period, most motorists will be unwilling to purchase one, even if it is cheaper and its performance is better (Lee & Clark, 2017).

Unlike gasoline or compressed natural gas vehicles, which must travel to a gas station to recharge, EVs may charge wherever gasoline vehicles cannot—at people's homes, workplaces, retail locations, dedicated recharging stations, and even gasoline stations. EVs can also be charged at various power rates, using both alternating current (AC) and direct current (DC) electricity (Fitzgerald & Ningthoujam, 2020). Each vehicle has an onboard charger that converts AC to DC and can receive AC power ranging from 0–25 kW and DC power ranging from 3–150 kW, with up to 500 kW in some heavy-duty vehicle applications, depending on battery capacity, battery chemistry, and onboard electronics. The range of power means charging sessions can be as short as 15 minutes to more than 8 hours depending on battery size and charging power (Fitzgerald & Ningthoujam, 2020). One of the ideas that has been investigated is EV Battery Swapping. However, the infrastructure and difficulties in doing this have made this approach infeasible(Ulrich, 2020). As chargers have improved with their smaller footprint, staffing and designing battery swapping vehicles just is not as economical for the possible 15 minutes of time saved.

There are two types of charging equipment which will be referred to as "electric vehicle supply equipment" (EVSE). The first, which includes "Level 1" and "Level 2" EVSE, uses AC and can draw power from the local distribution system. All Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) include a limited capacity on-board inverter that converts AC power DC, which is needed to charge the battery. The second type, "Level 3" and higher, uses DC

charging, which eliminates the need for an inverter by charging the battery directly, allowing for substantially more power to be delivered. Aside from that, there is no significant difference between the AC and DC charging processes.

Level 1, providing 1.4 kW of power in the U.S., is simply a conventional wall socket, and requires no additional circuitry, aside from the adapters required to connect the EV to the socket. In theory, Level 1 charging can be used anywhere, although in practice it takes place primarily at the EV owners' homes.

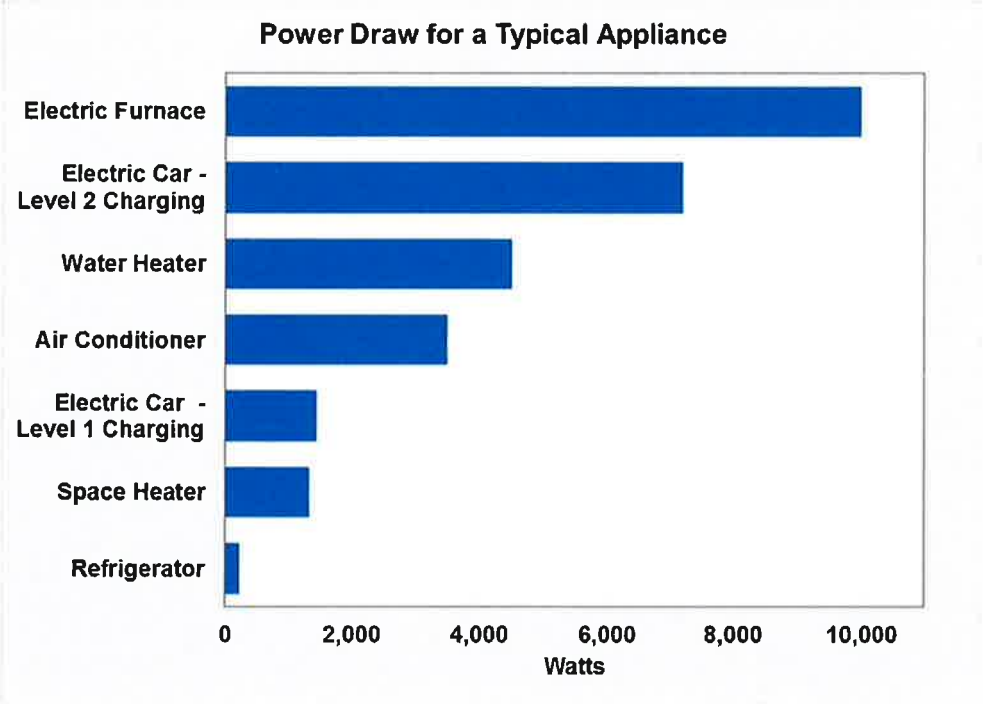

Figure 1: Example KW usage of appliances (U.S. Department of Energy, 2022)

Level 2 charging operates on the same upgraded 220-volt outlets, required by washing machines and clothes driers, and can easily be installed. More modern houses typically have these outlets, while older houses may require electrical upgrades. Depending on the home's electrical infrastructure, this can involve upgraded circuitry, wiring extensions to reach the charging location, or, even in rare cases, an upgraded transformer. Level 2 charging can also be provided at workplace locations, other business locations (hotels, gas stations, private parking lots), and public locations (on-street parking space, garages, streets, public parking lots)—wherever cars are likely to be stationary for hours at a time. Level 2 charging starts at a power rating of 6.6 kW, increasing to 19.2 kW depending on the level of current that the supporting circuitry can sustain. Most home Level 2 charging, and almost all commercial Level 2 charging,

is limited to 6.6kW because (a) the onboard inverter on most existing EVs cannot handle significantly more than this level and (b) boosting the current typically requires the installation of more expensive higher-capacity circuitry.

Direct current charging can produce substantially higher levels of electrical power because it bypasses an EV's inbuilt inverter to charge the battery directly. This sort of charger is known as a Direct Current Fast Charger (DCFC) and is exclusively seen in business establishments. While studies show that persistently high DCFC consumption accelerates battery capacity degradation over time, for the great majority of users, capacity degradation is more closely connected with overall usage than charging patterns. According to NREL research, "estimated Direct Current Fast Charger utilization rates do not appear to be frequent enough to meaningfully affect battery life," implying that the battery's heat management systems are a more critical driver.

Variants and charging characteristics of EV chargers, assuming power usage of 0.37 kWh per mile.

Charger Type	Current Type	Average Power Delivered (kW)	Time taken to replenish daily usage (13.65 kW)	Time taken to charge 100 miles (37 kWh)	Range added per minute (miles)
Level 1	AC	1.4	9h 45m	26h 26m	0.06
Level 2 [standard]	AC	6.6	2h 4m	5h 36m	0.30
Level 2 [maximum]	AC	19.2	43m	1h 55m	0.86
Level 3	DC	50.0	16m	44m	2.25
Level 4	DC	150.0	5m	15m	6.76
Level 5	DC	350.0	2m	6m	15.77

Table 1: Time to charge Source: Lee, Henry, & Alex Clark. Charging the future: Challenges and Opportunities for Electric Vehicle Adoption. "HKS Faculty Research Working Paper Series RWP18-026, September 2018.

As Technology improves the current range of an EV is around 300 miles on a charge (Jalopnik, 2022). This increased range from the original townie EV has increased the desire for people to travel with their EV vehicle. Even with ultra-fast Level 5 charging, it takes six minutes to half-fill a 75 kWh battery, and it would take twelve minutes or more to fully recharge from empty, as shown in Table 1. These charging periods will increase as batteries become larger, reaching 100-150 kW. The time it takes to repower an

EV, even with Level 5 charging, which adds 15.8 miles of range each minute, is not comparable to traditional gasoline refueling. To achieve the 300 miles per hour refueling speed of a 30 mpg ICE refueling at 10 gallons per minute, a charger 19 times more powerful, or 6.7 MW, would be required. This is much

Capital Costs	Residential		Commercial			
	Level 1	Level 2	Level 2	Level 3	Level 4	Level 5
Installation (per charger)[A]	$0	$1,354	$3,108	$22,626	$22,626	$22,626
Site preparation (per charger)	0	0	3,000[B]	12,500[C]	12,500	12,500
Utility service (per station)	0	0	4,000	17,500[D]	17,500	17,500
Transformer (per station)	0	0	5,698[E]	32,500[F]	40,000[G]	40,000
Equipment (per charger)	0	1,000[H]	3,842[I]	35,000[J]	50,000	100,000

above what is now conceivable, and it is likely to remain that way for the foreseeable future.

Table 2 : Lee, Henry, & Alex Clark. "Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption. "HKS Faculty Research Working Paper Series RWP18-026, September 2018

A. Idaho National Laboratory. 2015c. "Plugged In: How Americans Charge Their Electric Vehicles. Findings from the largest plug-in electric vehicle infrastructure demonstration in the world." https://avt.inl.gov/ sites/default/files/pdf/arra/PluggedInSummaryReport.pdf
B. Logios Consulting. 2013. "Lessons From Early Deployments of EV Charging Stations: Case Studies from the Northeast and Mid-Atlantic Regions." Prepared for the Transportation and Climate Initiative. https:// www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Lessons-Early-Deployments-of-EVSE.pdf
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I. Smith, M. and J. Castellano. 2015. "Costs Associated with Non-Residential Electric Vehicle Supply Equipment."
J. Clint, J., et al. 2015. "Considerations for Corridor Direct Current Fast Charging Infrastructure in California."

EV Environmental Impacts

When accounting for manufacturing, the greenhouse gas emissions produced by an electric vehicle are often lesser than those produced by a regular gasoline-powered vehicle. According to some

studies, manufacturing a typical electric vehicle (EV) emits more CO2 than manufacturing a gasoline vehicle. This is due to the increased energy required to produce the battery for an electric vehicle. Yet, overall greenhouse gas (GHG) emissions connected with manufacturing, charging, and operating an electric vehicle are often lower than total GHGs associated with a gasoline automobile over the course of the vehicle's lifetime. This is because electric vehicles have no tailpipe emissions and emit substantially fewer greenhouse gases while in use. Researchers at Argonne National Laboratory, for example, calculated emissions for a gasoline automobile and an electric vehicle with a 300-mile range. While GHGs from EV manufacturing are higher, total GHGs for the EV are still lower than for a gasoline car, according to their calculations.

Also, EVs have no tailpipe emissions. Generating the electricity used to charge EVs, however, may create carbon pollution. The amount varies widely based on how local power is generated, e.g., using coal or natural gas, which emit carbon pollution, versus renewable resources like wind or solar, which do not. Even accounting for these electricity emissions, research shows that an EV is typically responsible for lower levels of greenhouse gases (GHGs) than an average new gasoline car. To the extent that more renewable energy sources like wind and solar are used to generate electricity, the total GHGs associated with EVs could be even lower.

Given that this is a new technology there are often complaints about the effectiveness of these devices helping the environment. Cars remain one of the top exporters of greenhouse gases and carbon emissions into the air. EV's are a tool to greatly reduce our carbon footprint. One of the complaints is that it simply is pushing the carbon use up the chain often called the "long Tailpipe". This is an issue when a large majority of power plants are still burning coal, however, Xcel and other power companies are producing more of their energy with clean renewable sources. EVs are more efficient at processing electricity than gas cars are at fossil fuels, see the table below. Tesla has taken the stance that eventually the power grid will be cleaner as well as more affordable to everyone, which is why they started with a luxury vehicle that was exponentially more efficient than even the most efficient hybrid.

Car	Energy Source	CO_2Content	Efficiency	CO_2Emissions
Honda CNG	Natural Gas	14.4 g/MJ	0.32 km/MJ	45.0 g/km
Honda FCX	Nat Gas-Fuel Cell	14.4 g/MJ	0.35 km/MJ	41.1 g/km
Toyota Prius	Oil	19.9 g/MJ	0.56 km/MJ	35.8 g/km
Tesla Roadster	Nat Gas-Electric	14.4 g/MJ	1.14 km/MJ	12.6 g/km

Table 3: Efficeincy of vehicles energy use (tesla, 2017)

Many Life Cycle Assessment (LCAs) of Battery–Electric Vehicles (B-EV) technologies find that battery production is potentially responsible for the largest proportion of energy use and subsequent environmental effects that occur during the manufacturing stage. Estimates range between 10% to 75% of manufacturing energy and 10% to 70% of manufacturing GHG emissions, depending on the approach taken and the electricity generation source (e.g., coal-fired, natural gas-fired, or renewable). As for other BEV components, LCAs estimate contributions from the electric motor production to be 7% to 8% of total production-related emissions (including raw material extraction and processing) due to a high copper and aluminum content; and from the power train production to be 16% to 18% due to a high aluminum content. (Richard K. Lattanzio & Corrie E. Clark, 2020).

The graph below shows the **Life Cycle Assessment of Global Warming Potential** (Comparison of Internal Combustion Engine Vehicles (ICEV), Plug-in Hybrid Engine Vehicles (PHEV), and B-EV for U.S. and California Electricity Grid, 2017 Average)

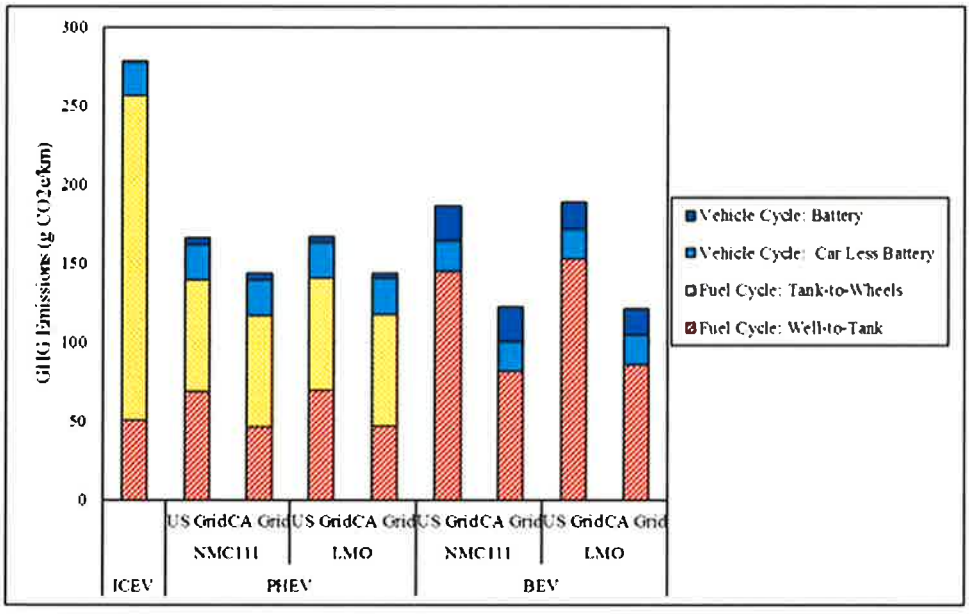

Figure 2 Source: J. B. Dunn, L. Gaines, J. C. Kelly, C. James, C., and K. G. Gallagher, "The Significance of Li-ion Batteries in Electric Vehicle Life-Cycle Energy and Emissions and Recycling's Role in Its Reduction," Energy and Environmental Sciences, 2015.

Life Cycle Assessment: Total Energy Consumption

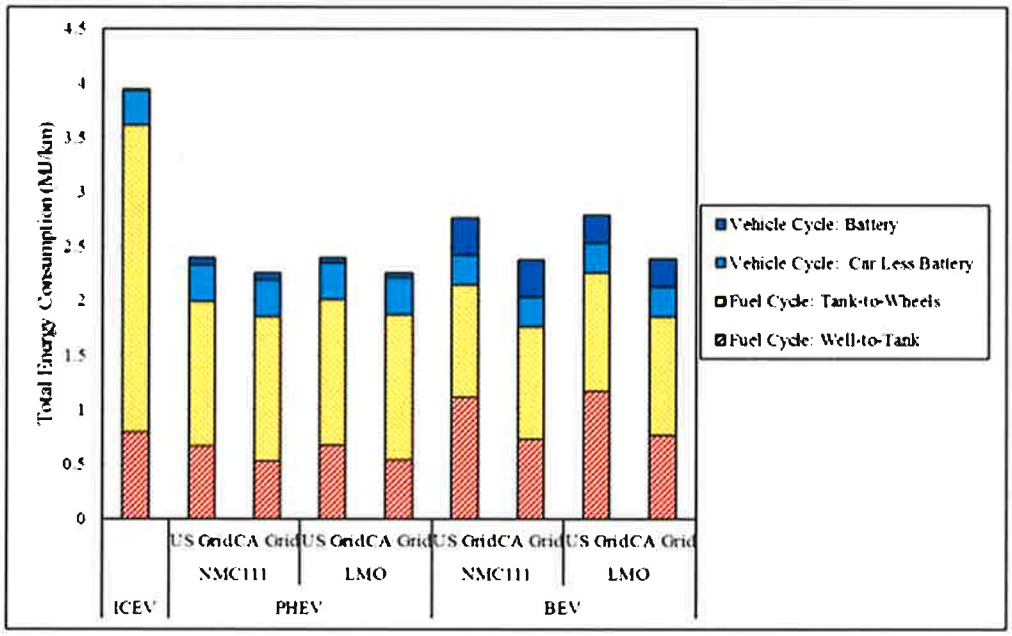

Figure 3 Source: Dunn et al., 2015.

Additionally, there are concerns around the longevity and repair of the vehicle. While valid, the automotive industry and local shops are catching up in repair of EV vehicles and as with all changes they adapt. There is a lot more electricity and computer chips in your car today that can no longer be repaired in your garage.

A common argument is that the mining of cobalt and lithium is dirtier than the emissions of fossil fuel burning vehicles. A major issue with the comparison to fossil fuels is the data does not add in the long-term effects of the Gasoline industrial complex and how much Co2 emissions the pumping, transport, and refining of gasoline does and adds to the equation.

Optimal Locations – General

The research mentions several ways to track the optimal locations. Calculations around traffic flow and analysis, by population centers, and points of interest are all methods used. One of the most common simple methods is tracking where cars are parked for long periods of time, sit down restaurants, the office, and apartments. More advanced models track density both of residential areas and high traffic business areas. Even more advanced models try and predict needed trips that residents would do daily and triangulates them to either charging at home or if they would need to at a store.

Considerations for Locating Charging Infrastructure in North Mankato

Transportation and land use are inextricably connected. People's travel habits are influenced by where they reside in relation to where they work, shop, socialize, and relax. The features of a place and the efficiency of its transportation network can both be influenced by land use.

Kato Engineering, Mankato Clinic, Precision Press, South Central College, MICO, Inc., and other major employers in the Mankato-North Mankato area are located on or around the Lookout Drive corridor. On Lookout Drive, these huge industrial and manufacturing enterprises generate a lot of traffic, especially truck traffic.

In addition to automobile traffic producers, the corridor is surrounded by a number of major bicycle and pedestrian traffic generators. Hoover Elementary and Dakota Meadows Middle schools are located east of Lookout Drive and require children to walk, ride, or be dropped there by a caretaker if they reside within one mile for kindergarten through 5th grade and two miles for 6th grade to 8th grade, respectively. People are more likely to walk or bike to Benson Park, Caswell Park, Reserve Park, Casey's, and several houses of worship (see **Figure 4**).

The table below shows the number of charging infrastructure in North Mankato.

LOCATION	TIME TAKING TO CHARGE	CHARGE POINT	CHARGER TYPE	NUMBER OF PLUGS
1. 1895 Howard Dr. North Mankato	2hr	6.6kw	Level 2 (J-17772)	2 plugs
2. 1875 Carlson	2hr	6.6kw	-Level 2 (J-17772)	2 plugs
3. 1765 Commerce-MGM Wine	15 Minutes (L3) 2 hr (L2)	50kw	Level 2 (J-17772) Level 3 (Chademo)	2 plugs 2 plugs

Table 4: North Mankato Chargers

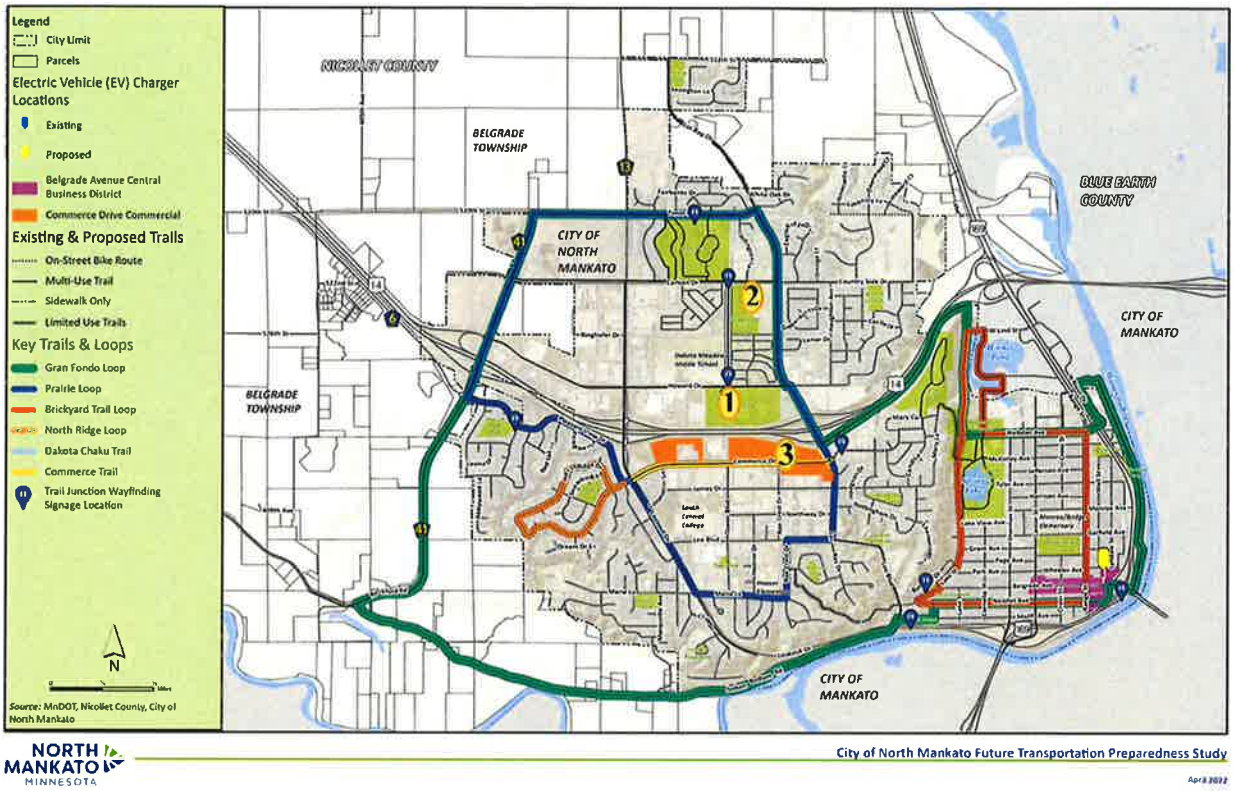

Figure 4: City of North Mankato

Electric Vehicle Grant Opportunities

In the coming months and years there will be a variety of grant opportunities available to the City of Mankato for electric vehicle infrastructure. There are also cities in Minnesota and across the country who are finding innovative ways to stay ahead of the EV curve. These opportunities and project examples are highlighted below.

Minnesota Pollution Control Agency (MPCA)

Beginning in 2018 and lasting through 2028, Minnesota will receive a total of $47 million from Volkswagen's (VW) Emissions Standards & Clean Air Act violations settlement. The Minnesota Pollution Control Agency is the designated state agency responsible for managing these funds. The settlement funds are being distributed in three phases:

- Phase 1 (2018-2019): $11.75 million (25% of overall funds)
- Phase 2 (2020-2023): $23.5 million (50%)
- Phase 3 (2024-2027): $11.75 million (25%)

At the time this study was developed, All of Phase 1 and a portion of Phase 2 funds were already distributed. North Mankato will have the opportunity to apply for additional grants as part of the Phase 2 rollout. Information about Phase 2 grant opportunities and requests for proposals will be posted https://www.pca.state.mn.us/air/apply-grant as they become available and are highlighted below.

Summer 2022

- **Electric heavy-duty equipment and on-road vehicles:** Replace old diesel heavy duty vehicles and equipment with new, cleaner electric models
- **Cleaner fuels heavy-duty on-road vehicles:** Replace old diesel vehicles with new, cleaner versions powered by diesel, propane, natural gas, and fuel/electric hybrids
- **Clean diesel heavy-duty off-road vehicles and equipment:** Replace old diesel heavy duty diesel equipment and off-road vehicles with new electric, clean diesel, or other fuels.

Fall 2022

- **Electric vehicle charging stations:** Install Level 2 Chargers at multiunit dwellings and locations within communities.[14]

Spring 2023

- **Electric school bus:** Replace old, diesel school buses with new, cleaner electric models

Additional EV Grants through federal agencies include the U.S. Dept of Energy Incentive Programs Page. https://afdc.energy.gov/laws/state_summary?state=MN

Roadway Infrastructure Implications of EV infrastructure

Other City Projects / Resources

Cities and regional transit authorities are preparing for EVs in multiple ways with a wide range of initiatives. The following Minnesota cities have taken steps to prepare for increased EV usage:

- St. Louis Park, MN
    - The City of St. Louis Park's comprehensive plan incorporates several EV initiatives, including a kick-start project to install EV charging infrastructure in public parking lots and actions toward increasing EV adoption to meet the city's goal to reduce vehicle emissions by 25 percent by 2030.
- Plymouth, MN
    - The City of Plymouth is set to begin installing over 100 electric vehicle charging stations at multiple public parking lots throughout the city, which will be available for community use.
- Shakopee, MN
    - The City of Shakopee is installing three dual-port electric vehicle (EV) charging stations in 2022.

- Elk River, MN
    - Information compiled from Elk River draws on the city's experience integrating electric vehicles into the city fleet. This fleet guide is an excellent starting point for fleet managers who want to learn about the benefits of electric vehicles.
- Red Wing, MN
    - Public-Private Partnership to install a Level 2 Direct Current Fast Charger in Downtown.

These projects help kick off the cities involvement for Installing EV chargers. This involvement is ideally just the nudge, to increase the usage and feasibility of EVs in their city, and to garner tourist increases. These projects will allow help the cities to educate and encourage private sector investment in installing EV chargers. Large businesses such as Target in St. Louis Park, MN have already begun providing EV chargers onsite for patrons.

Statewide Roadway Implications

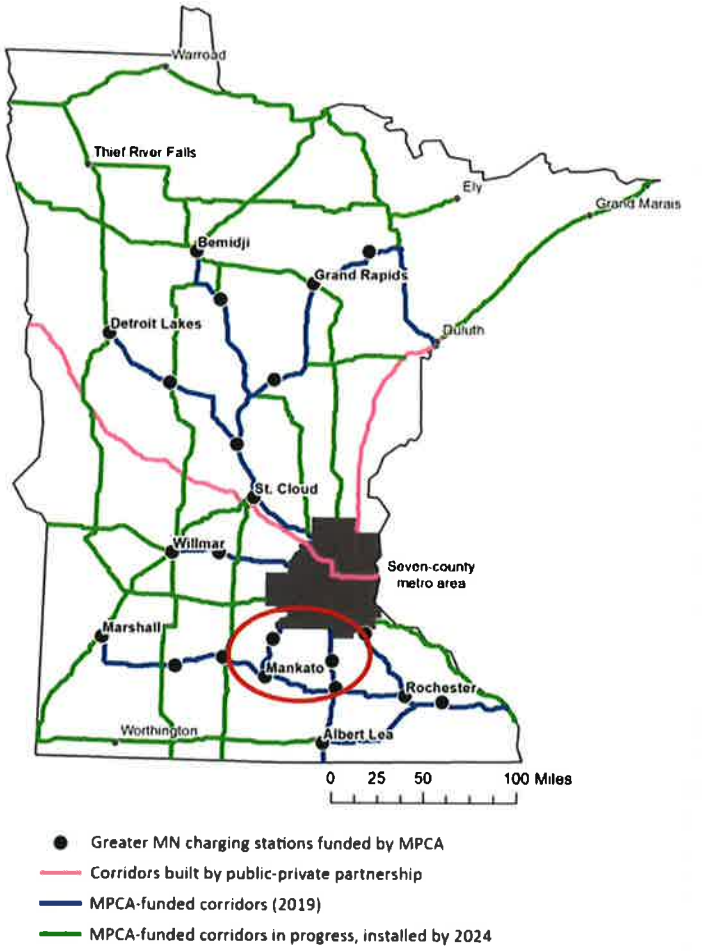

Figure 5: Source: (Minnesota Pollution Control Agency, 2022)

Minnesota dedicated 15% of the $47 million received as part of Phase I funds from the Volkswagen settlement (the maximum allowed by the settlement) to help build out a statewide network of electric vehicle charging stations. This provides a broader EV charging infrastructure supporting further travel along the state highway system for EV owners. MnDOT and the state have prioritized corridors based on highway and commerce travel. As you can see in figure 5 the pink corridors were the first established for their interstate commerce benefits. Noth Mankato and Mankato were included in the next 'blue' wave of prioritization for their intra state commerce importance.

Transportation focused business Implications

The process of implementing electric vehicle infrastructure can be accelerated by private investment from commercial industries. EVs can provide value and new opportunities to businesses, however, it will be necessary to partner with EV industry experts to implement these changes.

It is likely that the EV charging industry will convert to the private sector when there are more electric vehicles in circulation, increasing both the demand for charging and the industry's profitability. The public sector can help the private sector prepare for this by driving competition between utility providers. Strategies, such as having frequent and recurring bidding processes for different EV projects and adding incentives to subsidies for innovative features and technology, can encourage private industry leaders to build new capacities that will lower implementation costs and find new stores of value within the EV charging industry (Hall & Hutsey, 2017).

The most obvious store of value is the sale of electricity. However, the private sector might also consider that EV chargers, which require drivers to stop and spend time at a location, are a way for retailers to bring in new customers and increase retail sales. Furthermore, similar to advertising displays on gas pumps, EV charging stations present a comparable opportunity that may be used to help offset costs. Auto manufacturers, as well, have identified a new store of value in attempting to drive sales by funding charging stations that provide special perks such as pre-paid charging credits, preferred pricing, and mobile app solutions specifically for their customers (Hall & Hutsey, 2017).

The City of North Mankato has worked with Xcel Energy through their pilot program to identify optimal locations for EV chargers and to install electrical infrastructure to support charging stations. The city has also partnered with Benco Electric in the past to install infrastructure for EV chargers in the area known as Upper North Mankato. This includes chargers serving City vehicles and chargers at both

Caswell Park facilities for public use. Private donors have also contributed to the installation of EV charging stations in the community.

Public-private partnerships will be essential to the successful implementation of electric vehicle infrastructure. It is the City's role to assist the private sector in their pursuit of EV related initiatives, with the intention of weaning the industry off of public subsidies over time. To do this, charging must become a profitable industry. North Mankato should seek to help by encouraging competition and promoting new value propositions for charging providers.

Phase 2 Recommendation
Encourage businesses to have chargers installed in their parking lots.

E-bikes and E-Scooters

Micro mobility has been a key piece in increasing the electrification of transportation. An integral part of encouraging sustainable transportation is increasing the range and ability of users to travel the last mile without specifically using the vehicle (Caulfield, 2016). E-bikes and e-scooters are a solution that have taken hold worldwide. Additionally, electric car shares have provided an outlet to the car poor, or carless to get in on the EV game. Part of the hurdles for North Mankato and similar municipalities is developing solutions to common issues. Electrification helps solve problems like the last mile problem, trying to get people to take trips under 10-15 minutes via other methods then the car (McKenzie, 2020). A widespread problem when adding additional mobility is the education of drivers that there will be other road users who have just as much of a right to space as they do. Additionally, providing public/private partnerships is integral to encouraging success.

Figure 6: Bird Scooters Next to Transit Stop Nashville Tn (Bird, 2022)

Increasing the electrification of transit in North Mankato can be done by allowing e-scooters and e-bike shares. E-bike shares are one of the fastest growing transit methods in the world (Caulfield, 2016). Considered smaller cities by the study standards, Cork IRE or Tampa FL have around 20-30 stations with 300 bikes (Caulfield, 2016). The bike shares help to decrease the amount of last mile and short trips made by personal automobiles. North Mankato has two distinct regions that e-bikes could take advantage. Most trips taken in smaller cities are under 20 minutes and with appropriately placed docking stations or docking zones users pay for 30-minute chunks of time. The traditional bike share involved docking charging stations but as technology advances they can be left anywhere and still be tracked by an app.

Phase 2: Recommendation

Goal: The downtown corridor could be connected to Spring Lake Park and the river with docking stations in a triangle letting people park downtown, and bike along the river or to the park. Similarly, a station at Caswell Park, the College and by the Kwik Trip/Caribou Coffee up the hill will provide visitors with easy access to an e-bike. A consideration will be the job of redistributing the bikes on a weekly basis. Cities with elevation changes may find that the bikes end up at the bottom of the hill and need to be spread back around.

Similarly, e-scooters have taken the U.S. and Europe by storm. Both methods increase the range a user is willing to go without getting in a single person vehicle. Studies have shown in cities like Washington D.C. Micro mobility trips can be both faster and more efficient then driving and ride hailing services, Bike services like Jump and Scooter services like Lime being responsible for over half a million trips a month averaging 1.5 miles and 15 minutes (Mckenzie 2020). Both e-scooters and e-bikes have a private- public partnership method, with companies like Lyft and Ford partnering with major cities to help provide installation costs and maintenance. Lyft and Lime are companies that offer both and are a one stop shop to city's to allow them to implement one contract for both.

Phase 2: Recommendation

Goal: North Mankato could partner with a major subsidized partner like Lyft and allow 1-2 other companies to operate e-bikes and e-scooters in the city. Mankato currently has Bird scooters. North Mankato can take the initiative in having the scooters deployed on their terms.

Another entry into the EV realm is providing EV car shares. EV car shares like Hour Car and Evie (https://eviecarshare.com) provide an outlet to users to take advantage of a sustainable means of travel without the high cost of ownership. Users only pay for the time and distance they use similar to e-scooters and bring it back to the charging point or zone when they are done. This is a great option to serve those that make fewer car trips and who would like to help the environment. Many are placed in urban core centers where people may not have a vehicle.

With the increase in EV car shares, e-scooters and e-bikes, cities have had to start putting in regulations and ordinances to help keep up with the influx. Some municipalities have put in time restrictions on e-scooters and e-bikes like eliminating the ability to use them at night when they are harder to see, or users are more likely to be intoxicated (Caulfield, 2016). Others have implemented restrictions like requiring helmets, a driver's license, and appropriate parking etiquette (Caulfield, 2016). Cities often have formed partnerships with specific companies, whether they were early adopters like Bird and Lime, or if the company was more willing to adhere to their parking and fine restrictions. A positive effect of scooter and bike shares is that it enhances a planner's view of mobility around the city, The companies provide data that help planners see how people are traveling (Li, 2022). An example of an extensive ordinance is Bloomington[1], whose ordinance applies to trail bikes, mini-bikes, go-carts, scooters, and power skateboards with motors of 25 cc or less and a maximum speed of over 20 mph (Minnesota House of Representatives, 2004).

Figure 7: EV Car share in Minneapolis

- The devices are prohibited from sidewalks and publicly owned lands such as school grounds and parks,
- Allowed on public streets only if licensed.
- No one under age 14 may cross a street on one of these vehicles.
- They may be operated only from 8 a.m. to 10 p.m.
- Equipment requirements include brakes, mufflers, headlamps, and taillight.

[1] https://codelibrary.amlegal.com/codes/bloomington/latest/bloomington_mn/0-0-0-92256

Phase 1:Recommendation

Regulation: North Mankato should consider establishing a baseline of ordinances for the E-bikes and E-scooters. The city shall determine whether ordinances are more restrictive or open. Scooter use is regulated by Minnesota State Statute 169.225. In general, people riding scooters follow the same rules of the road as people using bicycles. Scooters are allowed to operate on any street, and users should ride on the right hand side of the street. Scooters are also allowed in bike lanes and bike trails.

Part 2: Autonomous Vehicles (AVs)

AV Operations

AVs are going to be a big part of transportation in the future. There are two main types of vehicles that fall under the autonomous category. The first use sensors and cameras to monitor and drive the car independently with different levels of autonomy needing only limited human interactions. The second type is Connected Autonomous Vehicles (CAV) which function the same as AV's but are connected to a network that gathers real time information from the vehicle to improve the driving of the autonomous software and to also relay information about road hazards and traffic conditions for other vehicles to be aware of. The implementation of these vehicles in the future will improve the daily lives of people everywhere.

There are currently six different levels of automation defined by standard J3016 of the Society of Automotive Engineers (SAE) . Here are summaries of the different levels.

- Level 0 (No automation) – The driver is in complete control of the vehicle and monitoring roadway safety at all times. This level aids the driver through warnings such as forward collision and blind spot monitoring.
- Level 1 (Driver Assistance) – This level involves specific controls that are automated but are independent from each other, but the driver still has overall control of the vehicle. Types of function specific automated systems are adaptive cruise control, automatic braking, and lane keeping assistance.
- Level 2 (Partial Driving Automation) – Automation at this level consists of two specific controls that work together to relieve the driver of certain functions while still being able to always take control. One example of this type is the combination of adaptive cruise control and lane

keeping assistance which allows the driver to take his or her hands off the steering wheel and off the pedal at the same time.

- Level 3 (Conditional Driving Automation) – Drivers can give up complete control over a vehicle under certain traffic and weather conditions which the vehicle will continue to monitor while in control. When conditions can no longer support automation of the vehicle the driver is alerted to retake control within a safe amount of time.
- Level 4 (High Driving Automation) – At this level the vehicle is performing all safety-critical operations and monitoring roadway safety at the same time with no supervision from the driver. The vehicle has control over the entirety of a trip unless the driver is prompted to retake control in situations where the limit of the autonomous technology is met.
- Level 5 (Full Driving Automation) – At this level all actions are taken by the vehicle, the driver does not need to do anything.

Some vehicles on the road can operate at Level 3 autonomy, while the rest have combined functions from levels 1 and 2 for partial driving and added safety. Autonomous vehicles at levels 3, 4, and 5 are still in the early stages of development.

As the technological changes to full AV implementation, issues are solved, and AV's become more prevalent, it's important that cities address the pending legal, social, and transportation issues related to AV's. Some important questions planners and municipal leaders need to address include the following:

- How will AV's change the way we design transportation infrastructure?
- Will AV's lead to more or fewer cars on roads?
- Will AV's exacerbate or mitigate symptoms of urban sprawl?

AV Roadway Infrastructure

The implementation of autonomous vehicles is going to mean changes to are current road and highway infrastructures (Ethrington, 2019). There are currently four categories of different AV roadway infrastructure:

- Class 1- Currently accounts for 100% of all road infrastructure (retaining walls, median cables, pavement markings, traffic signs, curbs, etc.)
- Class 2- Implements new types of physical change to current infrastructure to support AV's (dedicated lanes for AV's, improved road surfaces and markings)

- Class 3- This class is highly dedicated to AV's using in pavement and sign mounted sensors.
- Class 4- Roadways will either have reduced or increased dimensions of road lanes, shoulder widths, thicker pavement in wheel tracks and the amount of road signs will be reduced.

Once Level 5 autonomy is reached present or traditional roadway infrastructures will be obsolete and no longer useful. When Level 5 is reached traditional signs and markings that normally need to be interpreted by humans vision and language, will be all digitized or broadcast directly to the vehicles, them making the split second decisions without the time that a human reaction would take.

For the initial deployment of AV's enhanced road markings are going to be needed such as highly reflective and all-weather pavement markings.

In the beginning phases road signs will also need to be updated to be more visible and legible for the vehicles advanced sensors to interpret them.

Updates to current infrastructure is going to take several years and a lot of funding. One approach to infrastructure change is limiting variables especially soft targets, like cyclists and walkers from the travel lanes, or making them more predictable. One of the ways to do this is to put roads through a road diet (figure 8) this allows more predictable methods for cars to be turning as well as for bikes to be on the side vs in the traffic lane (Ross, 2019). Road diets also allow the area for pedestrians to cross to be smaller and slower, making them more readily picked up by autonomous sensors.

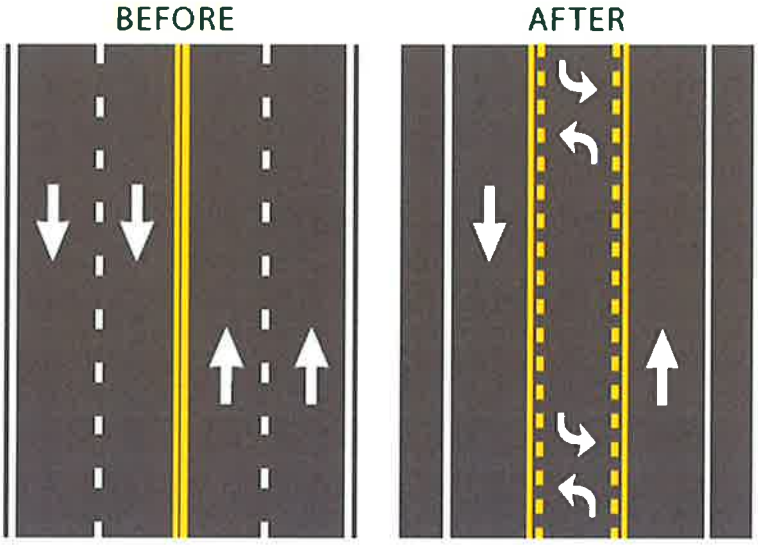

Figure 8: 4-3 Road Diet (MnDoT, 2022)

Phase 2:Recommendation

Goal: As AV technology advances, North Mankato should consider taking steps to advance street infrastructure as necessary to accommodate new technologies.

AV Trends & Forecasted Demand

The one trend that remains consistent with both the autonomous and electric vehicle market today is growth. While equal in their potential to shape transportation planning moving forward, each of these technologies will impact American roadways differently. Planners and municipal leaders alike can expect to begin addressing the challenges and providing solutions in the coming years as technological advances become more and more prominent.

Looking at AV's the US AV market was valued at over $3 billion in 2020 and it is expected to reach over $8 billion by 2026 (PR Newswire, 2020). More than 1,400 self-driving cars, trucks, and other vehicles are currently in testing by more than 80 companies across 36 US states and Washington DC (Etherington, 2019). Recently, companies like Lyft and Aptiv have successfully provided 100,000 commercial robotaxi rides in Las Vegas. In 2020, around 11.2 million cars were sold with level 2 features, which is an increase of 78% from 2019. Although Level 4 and Level 5 (as scaled by Society of Automobile Engineers) autonomous cars are unlikely to reach wide acceptance, by 2030, there will be rapid growth for Level 2 and Level 3 autonomous cars, which have advanced driver assistance systems, like collision detection, lane departure warning, and adaptive cruise control (Mordor Intelligence, 2020). Despite the market growth, cities are still a long way from having their roadways dominated by driverless vehicles. So when it comes to planning for the next 10-20 years it's important for planners to understand that current policies relating to AV's mainly focus on Level 3 automation.

From a policy perspective, the AV market saw several advancements in 2021. It began in January 2021 with the United Nations Economic Commission for Europe (UNECE) allowing the use of "automated lane keep assist" on public roads. Both Japan and Germany officially approved 'conditional eyes-off' Level 3 autonomous driving on public roads. Meanwhile, the UK and more EU countries are expected to follow Germany and Japan's lead in passing similar legislation in 2022.

AV Commerce

Research from MnDOT has found that one of the areas that will be first affected by AV transition is the freight commerce industry. MnDOT has several initiatives to promote AV adoption. North Mankato can take part and encourage large corporations in North Mankato to take advantage of the AV Options, including the Connected AV challenge and the Rural Freight Pilot.

Freight Traffic has increased 38% on urban freeways over the past 10 years, with the increase in delivery needs (Bronzini, 2012). The increase has led to MnDOT and other organizations taking steps to integrate AVs into their freight network. MnDOT is working with farmers in Rural areas to develop AV routes with limited decisions to help move produce and other needed materials (Andrusko, 2022).

MnDOT sees an opportunity to start to show the feasibility of AVs so that then there is more adoption by large businesses that have their home base in Minnesota. This is the role that North Mankato could play. At the time this study was developed, MnDOT was hosting a Connected AV Challenge request for proposals (http://www.dot.state.mn.us/automated/cavchallenge.html) to allow municipalities and businesses to submit ideas for AV projects in their area. Surveying residents and businesses and encouraging them to apply will ensure North Mankato is on the leading edge of AV adoption.

Phase 1 Recommendation
Goal: Surveying residents and businesses and encouraging them to apply to MNdot's CAV initiative will encourage more people to be involved in the AV future and will ensure North Mankato is on the leading edge of AV adoption.

Recommended Actions for North Mankato: Community Suitability Assessment

The Project team reviewed and toured the existing EV charger infrastructure in March of 2022. Comparing the research with the existing infrastructure as well as the proposed lots for EV chargers, there are several next steps that North Mankato could take for both AV and EV implementation.

1. **Existing chargers in North Mankato**: The existing EV chargers are an important first step. Despite not being profitable, the chargers at MGM *Figure 9* get some use, especially now that a fast charger has been installed. These chargers along with the chargers at the Caswell Sports complexes could encourage attendees to bring EVs. The MGM lots which are used by plugshare.com users can be designed in a way to encourage more use at these locations. This would include ADA accessibility; as

Figure 9: MGM Location Chargers

indicated in the photo there is no separation between the spaces, and the poles make the chargers difficult to access. The area around the chargers should be enhanced by concrete around the charging base and a ramped curb to allow easier access. Additionally, the lot has a warning sign about parking for non-customers; putting an EV clause on that sign would ensure there is no risk of being towed. The location has multiple pros of having a convenience store (KwikTrip), a liquor store (MGM), and a gym within easy walking distance. A few modifications and advertising could help increase use.

2. Downtown North Mankato: EV expansion downtown has the most potential impact. The proposed lot on Wheeler and Wall St. *Figure 10* is close to multiple restaurants, bars, and shops. Additionally, it is in a dense population area and serves the population in Lower North Mankato and those traveling on Highway 169. Fast chargers would encourage travelers and local residents purchasing coffee or a drink to charge in an easily accessible location.

Figure 10: Proposed location for Downtown North Mankato Level 3 Charger at the Wheeler/Wall intersection.

Phase 2: Recommendation
Downtown: Install Charging Level 3 in the main public parking lot at the Wheeler/Wall intersection.

3. Norwood Inn property on Range Street: The city currently owns and operates the hotel as a lodging establishment housing migrant workers employed at a pork processing plant in Windom, MN. The City anticipates this property will either be refranchised as a hotel and renovated as such or will be sold to a developer with a broader vision for retail, housing, and/or other uses. If redeveloped, this location could have potential to accommodate multiple EV chargers. It's proximity to Highway 169 makes this an ideal location that would serve an array of users including potential residents in new multi-family, travelers on the highway, and those accessing area recreation. If the Lots can be used for multifamily Two level 3 chargers at this location would help satisfy some of the equity concerns around renter charger access.

Figure 11: Webster Avenue mixed use development with chargers

Phase 3: Recommendation

Webster Avenue: Encourage the installation of Level 3 charging infrastructure if mixed-use development is pursued.

5. **Grocery Store EV Chargers:** One of the Requests of North Mankato Residents is to have a grocery store in Upper North Mankato. While up to the developers and land use, North Mankato can encourage/incentivize developers with discounts on taxes or grants to sway grocery stores to provide chargers. Target, Hy-Vee, and others are now including that in their standard package in Cities like Oakdale, Eagan, and Minneapolis.

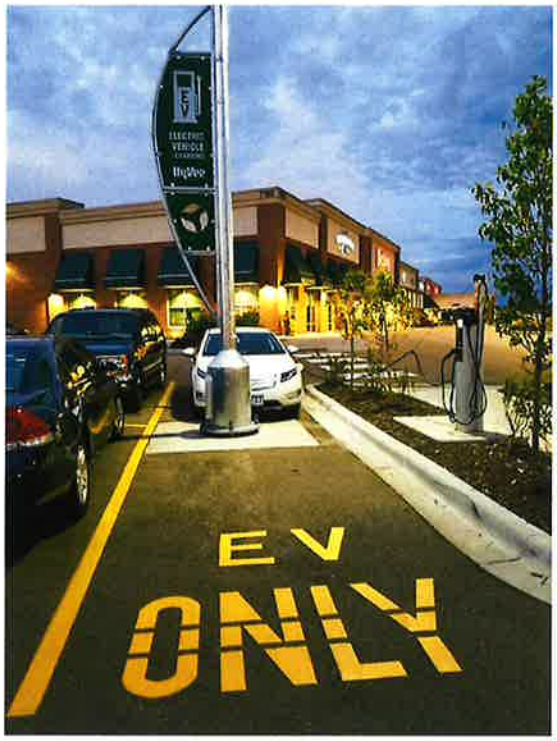

Figure 12: Hy-Vee parking lot (Pioneer press,2019)

Phase 1: Recommendation

Incentivize New development with state and federal tax breaks if they include EV charging, as well as Reducing other requirements such as lot size and parking minimums. For instance, North Mankato may choose to incentivize the installation of EV Chargers by providing a bonus, such as additional floor area or reduced parking requirements, in exchange for including EV Chargers in new construction.

Goal: Incentivize EV chargers in New construction.

Regulation: § XXX.XXX OFF-STREET PARKING AND LOADING.

(k) Each EV spot added to a site plan will count as three parking stalls as required by the table in section (G)

Regulation: For each EV parking space utilized Business owners are able to apply for a bonus in square footage to their original zoned area.

6. **Vacant lots close to the intersection of Marie Lane and Lookout Drive**: The study team does not recommend this site for installation of an EV charger unless mixed-use or multi-family development occurs where there is higher potential for a critical mass of potential users. The location's distance from Highway 14 and surrounding low-density residential uses make it unlikely to generate much use. North Mankato should focus charger installation in closer proximity to the major highway interchanges and business districts where many potential users pass through and can spend some time shopping or eating while waiting for the charge to complete. As EV production and usage increases, the City should periodically examine the zoning code to assess if requirements for charger installation in new development are warranted.
7. **AV recommendations:** Since Minnesota and other states are still developing and testing, North Mankato can take part in those tests. In the meantime, continuing to adapt the streets to be safer now will make the transition to AVs more streamlined. Reducing decision points for AVs is an important factor in the design. One way to do that is by following present day traffic calming techniques, requiring 4-3 lane reduction in the downtown area or on lookout drive will both slow down present-day traffic as well as pave the way for AVs that can operate more safely in the area.

Implementation Plan:

Equity

A key discussion piece with any comprehensive plan is the equity effects of implementing and upgrading the EV/AV infrastructure in North Mankato. A review of the Census data and North Mankato's Comprehensive plan helped the team to analyze goals and the community. A field review of the city also provided the team with a lens to both the technical and the breakdown of the community. Research and local nonprofits have provided a solid direction of steps for cities to take to further equitable development.

North Mankato Census data provides the economic breakdown and population of the community. In the table below North Mankato does have a higher median household income then neighboring communities, however it still has 30% of the population renting. Through the research EV's and AVs traditionally have a higher ownership in more affluent income brackets (Egbue, 2012).

Fact	2020 North Mankato city, Minnesota
Population, Census,	14,275
Owner-occupied housing unit rate, 2015-2019	**71.90%**
Households, 2015-2019	5,827
Mean travel time to work (minutes), workers age 16 years+, 2015-2019	17
Median household income (in 2019 dollars), 2015-2019	**$67,278**
Per capita income in past 12 months (in 2019 dollars), 2015-2019	$36,821
Persons in poverty, percent	8.20%
Population per square mile, 2010	2,283.10
Land area in square miles, 2010	5.87

Table 5 Population table

Household Income	Geography
$62,843	United States
$71,306	Minnesota
$57,429	Blue Earth County, MN
$67,399	Nicollet County, MN
$67,278	North Mankato, MN
$60,827	Mankato-North Mankato, MN
$60,322	Mankato City PUMA (Public Use Microdata Area), MN

Table 6: Income Comparison 2019

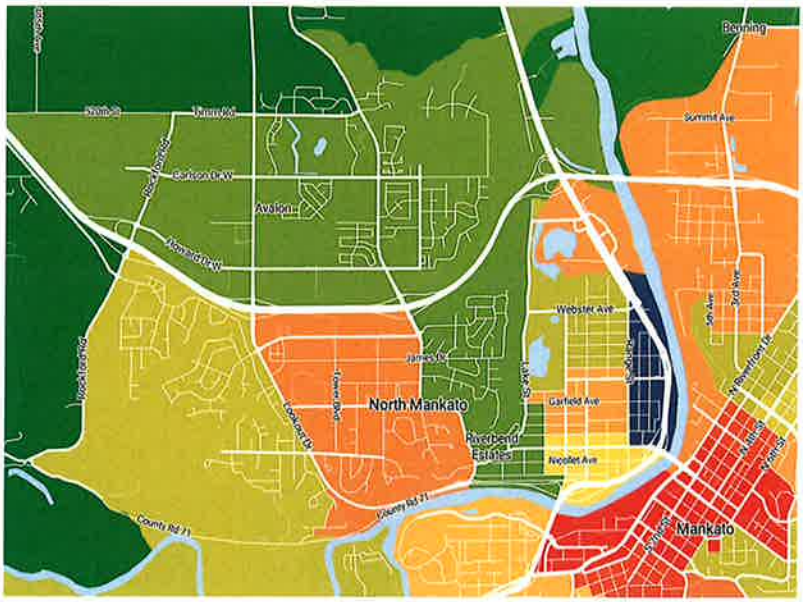

Figure 13: Owner to Renter Comparison North Mankato https://bestneighborhood.org/owner-occupied-north-mankato-mn/

The funding and incentives mentioned above are a good start, but education along with advertising them also help spread the EV/AV equity. Xcel has programs that incentivize property owners to install chargers. This will help the 30% of residents of North Mankato that are renters. Educating businesses and property owners is an effective strategy to continue to promote EV/AV adoption. Letting businesses know that the city is invested in helping them and that they will generate more business with a charger forward mentality will help encourage more adoption. Additionally, potential future zoning and ordinance changes may help incentivize businesses to make it a part of their business plans moving forward.

Phase 1 Recommendation
Goal: Encourage and educate property owners on incentives from Xcel and other agencies to install chargers on their property. Provide the information and links on a single page.

Zoning

The team spent time reviewing zoning and ordinances to inform the City of North Mankato of how some cities are preparing for increased EV usage. Nationally, ordinances have been recommended to mark successful EV integration. Looking at more research there is some flexibility in these ordinances and a combination of them with appropriate funding could enhance the equity as well as business profitability/success in a community.

Local Minnesotan cities have several zoning and ordinance stances that promote the use of EVs. The list in table 7 includes the requirements organizations must adhere to meet the American's with Disabilities Act (ADA). This is a commonly overlooked issue with EVs just having space next to an EV is insufficient to meet all users' needs. Cities like Red Wing and Edina have worked with the Great Plains Institute to develop use cases for their businesses and City Fleet vehicles to become electrified. One way to build into the building code is by incentives; Golden Valley encourages EV chargers by assigning a point system to approving development, and one way to get the required 5 'points is to have EV chargers account for 5% of parking (Golden Valley, 2022). The Great Plains Institute also provides a list of ideal EV ordinance inclusions:

1. Electric Vehicle Charging Stations as Permitted Land Uses.
2. Electric Vehicle Make-Ready Standards
3. Electric Vehicle Supply Equipment Standards
4. Electric Vehicle Parking Space Design and Location

5. Required EV Parking Capacity & Minimum Parking Requirements
6. Electric Vehicle-Designed Parking Use Standards and Protections
7. Signage, Safety, and Other Standards

The team has Provided some key examples in the Appendix B, and the Minnesota ADA Guidelines for AVs in Appendix C.

Figure 14: An example of an inaccessible EV charging station (Irish Wheelchair Association, 2018)

EV Ordinance Examples:

- Great Plains Institute: Summary of Best Practices for Electric Vehicle Ordinances
  Provides a summary of example Ordinances some of which are included in the Appendix.
  Great Plains Institute: https://www.betterenergy.org/wp-content/uploads/2019/06/GPI_EV_Ordinance_Summary_web.pdf
- In Minnesota, the cities of St Louis Park and Golden Valley have a very advanced set of EV zoning and are great examples to pattern policy off of and combining land use.
  St Louis Park:
  https://www.stlouispark.org/home/showpublisheddocument/21697/637699151527900000
  Golden Valley:
  https://library.municode.com/mn/golden_valley/codes/code_of_ordinances?nodeId=PTIILADE_CH113ZO_ARTIIIZODI_DIV3PLUNDEOVDI_S113-123PLUNDE
- Redlands California also has progressive advanced EV zoning policies and they also have a great Review process for ensuring Charging station uniformity.

Redlands California: https://static.business.ca.gov/wp-content/uploads/2020/02/Fresno-Ordinance.pdf

Phased Implementation:

From the listing of recommendations so far the Project team recommends a phased implementation plan. Many of the Recommendations can be initiated and kicked off in the next couple of months to a year, that we will list as Phase 1. Phase 2 Implementations are longer range and involve more of an investment with local businesses and the community. Phase 3 are recommendations that can be integrated into the North Mankato Comprehensive Improvement Plan or Environmental Plans.

Phase 1 Recommendation	
Awareness Infrastructure: EV (Scooter/Bike)	Continue to Conduct a Community Survey every two years to gauge how many residents are considering purchasing an electric vehicle in the near future: Questionnaire is in the appendix
Awareness	Surveying residents and businesses and encouraging them to apply to MNdot's CAV initiative will get more people involved in the AV future and will ensure North Mankato is on the bleeding edge of AV adoption.
Awareness	Work with businesses to encourage charging at their site. Educate businesses and promote the increased traffic and consumer spending they will get by installing chargers. Educate property owners on incentives from Xcel to install chargers on their property. Provide the information and links on a single information page.
Ordinance	**Ordinance:** North Mankato should consider establishing a baseline of ordinances for the E-bikes and e-scooters. The city can determine whether ordinances are more restrictive or open. Scooter use is regulated by Minnesota State Statute 169.225. In general, people riding scooters follow the same rules of the road as people using bicycles. Scooters are allowed to operate on any street, and users should ride on the right hand side of the street. Scooters are also allowed in bike lanes and bike trails.

Awareness	- Provide information to North Mankato residents about all the subsidies and ways to get into an EV. This will increase ridership and demand from local businesses. - Educate property owners on incentives from Excel to install chargers on their property. Provide the information and links on a single page.
Policy and Ordinance	**Policy**: Consider incentivizing new development with state and federal tax breaks if they include EV charging, as well as Reducing other requirements such as lot size and parking minimums. For Instance North Mankato may choose to incentivize the installation of EV Chargers by providing a bonus, such as additional floor area or reduced parking requirements, in exchange for including EV Chargers in new construction. **Goal:** Incentivize EV chargers in New construction. **Ordinance/Regulation**: § XXX.XXX OFF-STREET PARKING AND LOADING. (k) Each EV spot added to a site plan will count as three parking stalls as required by the table in section (G) Policy: For each EV parking space utilized Business owners are able to apply for a bonus in square footage to their original zoned area.

Phase 2 Recommendation	
Infrastructure: EV	Downtown: Install Charging Level 3 in the main public parking lot at the Wheeler/Wall intersection.
Infrastructure: AV	As AV technology advances, North Mankato should consider taking steps to advance street infrastructure as necessary to accommodate new technologies.
Infrastructure: EV (Scooter/Bike)	The downtown corridor could be connected to Spring Lake Park and the river with docking stations in a triangle letting people park downtown, and bike along the river or to the park. Similarly, a station at Caswell Park, the College and by the Kwik trip/caribou up the hill will provide visitors with easy access to an e-bike. A consideration will be the job of redistributing the bikes on a weekly basis.

	Cities with elevation changes, like Seattle or North Mankato find that the bikes end up at the bottom of the hill and need to be spread back around.
Infrastructure: EV (Scooter/Bike)	North Mankato should explore partnering with a major subsidized partner like Lyft and allow 1-2 other companies to operate e-bikes and e-scooters in the city. Mankato currently has Bird scooters. North Mankato can take the initiative in having the scooters deployed on their terms.

Phase 3 Recommendation	
Infrastructure: EV	Update North Mankato's Fleet vehicles to EV's *Green Fleet Policy - Minneapolis, MN* Minneapolis is implementing a Green Fleet Policy*(PDF)* to minimize the greenhouse gas (GHG) emissions and economic costs associated with current and future fleet vehicles. The overall objectives of the policy include: • Measure and report fleet-wide GHG emissions; • Optimize fleet size through the elimination or reassignment of under-used vehicles; • Reduce tailpipe emissions through advanced emissions controls; • Purchase, when necessary, new vehicles that provide the best available net reduction in vehicle fleet emissions, taking life-cycle economic and environmental impacts into consideration; and • Encourage and educate city staff on eco-driving best practices and promote carpooling across departments.
Infrastructure: EV	Range Street/Webster Avenue: Install Charging Level 3 if Multiuse development is pursued

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Appendix:

Appendix A: Survey Questions

City of North Mankato, MN

E-Automobile, E-Scooter, E-Bike and Autonomous Vehicle Survey.

The city of North Mankato is conducting research to ensure it is prepared for advances in Electric and Autonomous vehicle technologies. These technologies are quickly integrating into daily life and the City hopes to understand potential impacts to existing transportation infrastructure and economic development.

The Federal and state government have provided funding to municipalities to plan for this form of transportation. The purpose of this survey is to obtain your input regarding the use of these vehicles. You can take the survey anonymously. This survey should take no more than 10 minutes to complete.

Question 1: Do you own an Electric Automobile currently?

1. Yes
2. No

If you answered no to question 1, how likely are you to purchase an Electric Automobile (E-Automobile) in the future?

1. I'm planning to purchase an E-Automobile in within a year
2. I'm planning to purchase an E-Automobile in the next 5 years
3. I may eventually, but don't have plans to now
4. I'm not interested in purchasing an E-Automobile

If your response was "3" or "4", what conditions would have to exist for you to purchase one?

_____

_____

Question 2: Would you ever participate in a share program for electric vehicles?

1. Yes, I would use shared electric bikes (E-bikes)
2. Yes, I would use shared electric scooters (E-scooters)
3. Yes, I would participate in E-Automobile sharing
4. Yes, I would participate in all E-vehicle sharing
5. I'm interested, but not sure
6. No, I prefer to have my own
7. No, I will not use any E-vehicles

If you answered "1-4" to Question 2, how often would you utilize the services?

1. Daily
2. Weekly
3. Occasionally
4. Never
5. Not Sure

Question 3: If you were to purchase an E-Automobile, where would you prefer to charge the vehicle?

1. At Home

2. At Work
3. At a City Facility (i.e. public parking lot, public park, etc.)
4. At a Commercial Facility (i.e. business like a gas station, restaurant, strip mall, etc.).
5. Other:_____

Question 4: If you own a business, how likely are you to have an Electric Vehicle charging station on your site?

1. I currently have a charging station on my site.
2. I'm planning to have a charging station on my site.
3. I may eventually, but don't have plans to install a charging station now.
4. I'm not interested in having a charging station on my site.

If your response was "4" to Question 4, what conditions would have to exist for you to consider having a charging station onsite?

_____

_____

Question 5: If you own a business and could potentially receive a tax break and/or a subsidy to install a charging station, would you consider it?

1. Yes
2. No.

Question 6: Are you aware that businesses which install charging stations have seen an increase in revenue and traffic to their business?

1. Yes
2. No

Question 7: If you were to purchase a new vehicle today, how important are autonomous vehicle features (such as self-steering and acceleration) when considering the purchase of a new vehicle?

1. Very Important
2. Somewhat Important
3. Neutral
4. Somewhat Unimportant
5. Unimportant

Question 8: How likely are you to purchase a vehicle with autonomous features?

1. I'm planning for my next car to have autonomous features
2. I may eventually, but don't have plans to now
3. I'll never purchase an Autonomous vehicle.

If your response was "3", what conditions would have to exist for you to purchase one?

_____

_____

Question 9: If you own a business, how likely are you to use an Autonomous Vehicle for freight transport?

1. I currently use an Autonomous Vehicle.
2. I'm planning to use an Autonomous Vehicle in the future.
3. I may eventually, but don't have plans to use an Autonomous Vehicle now
4. I'll never use an Autonomous Vehicle.

If your response was "4", what conditions would have to exist for you to use an autonomous vehicle?

_____

_____

Question 10: Would you ever be interested in owning a fully Autonomous Vehicle as technology improves and they become available?

1. Yes
2. No
3. Not Sure

If you answered "No" or "Not Sure" to Question 10, please explain your reasoning?

Question 11: How would you classify your Ethnic/Racial background?

1. White
2. Latino/Hispanic
3. Black
4. Asian
5. Biracial
6. Other_____

Question 12. What is your Gender?

1. Male
2. Female
3. Other

Question 13: Which age bracket do you fall in?

1. 20 - 29
2. 30 - 39
3. 40 - 49
4. 50 - 59
5. 60 - 69
6. 70 - 79
7. > 100

Question 14: What Part of North Mankato do you reside in?

1. Lower North Mankato
2. Upper North Mankato – North of Highway 14
3. Upper North Mankato – South of Highway 14

Question 15: If you're a business owner, where in North Mankato is your business?

1. Webster Avenue Industrial/Commercial Area
2. Central Business District (Belgrade Avenue)
3. Lor Ray Drive north of Highway 14
4. Northport Industrial Park
5. Upper North Mankato, South of Highway 14

Question 16: Do you own or rent your primary residence?

1. Own
2. Rent

Question 17. What is your annual income?

1. Less than $10,000

2. $10,000 to $14,999
3. $15,000 to $24,999
4. $25,000 to $34,999
5. $35,000 to $49,999
6. $50,000 to $74,999
7. $75,000 to $99,999
8. $100,000 to $149,000
9. $150,000 to $199,999
10. $200,000 or more

Question 18. Is there anything else you'd like to share regarding Electric and Autonomous vehicles?

Thank you for your feedback!

Appendix B: Zoning Ordinances and Regulation

1. Electric Vehicle Charging Station as Permitted Land Uses	
Chelan, WA	"Level 1 and 2 electric vehicle charging stations are a permitted use in all zoning districts… Level 3 electric vehicle charging stations are a permitted use in the Warehouse and Industrial (WI), Highway Service Commercial (C-HS),…, zoning districts"
Des Moines, WA	"Levels 1, 2, and 3 electric vehicle charging stations are allowed in all zoning designations."
New Orleans, LA	"No property or parcel may have more than one electric vehicle charger installed in the right-of-way adjacent to such property or parcel."
2. Electric Vehicle Make-Ready Standards	
Howard County, MD	"For new occupancies subject to this section: at least 1 parking space for each 25 residential units shall feature energized outlets; and a residential unit with a garage, carport, or driveway shall feature appropriate electric vehicle supply equipment consisting of conductors, connectors,[…] so that an energized outlet may be added in the future."
St. Louis Park, MN	"Multiple-Family Residential Land Uses: all new, expanded and reconstructed parking areas shall provide the electrical capacity necessary to accommodate the future hardwire installation of Level 2 EVCSs for a minimum of 10% of required parking spaces."
St. Louis Park, MN	"Non-Residential Land Uses: all new, expanded and reconstructed parking areas shall provide the electrical capacity necessary to accommodate the future hardwire installation of Level 2 or DC 8 EVCSs for a minimum of 10% of required parking spaces."
Auburn Hills, MI	"it is strongly encouraged, but not required, that all new and expanded non-residential development

	parking areas provide the electrical capacity necessary to accommodate the future hardwire installation of Level-2 electric vehicle charging stations. It is recommended that a typical parking lot (e.g., 1,000 or less parking spaces) have a minimum ratio of 2% of the total parking spaces be prepared for such stations."
3. Electric Vehicle Supply Equipment Standards	
Montgomery County, MD	"Battery charging station outlets and connector devices shall be no less than 36 inches and no higher than 48 inches from the surface where mounted."
St. Louis Park, MN	"EVCS pedestals shall be designed to minimize potential damage by accidents, vandalism and to be safe for use in inclement weather."
St. Louis Park, MN	"Battery charging station outlets and connector devices shall be mounted to comply with state code and must comply with all relevant Americans with Disabilities Act (ADA) requirements."
4 Electric Vehicle Parking Space Design and Location	
St. Louis Park, MN	"The EVCSs shall be located in desirable and convenient parking locations that will serve as an incentive for the use of electric vehicles."
St. Louis Park, MN	"General Requirements for Single-Family Residential Zoning Districts…EVSE shall be located in a garage, or on the exterior wall of the home or garage adjacent to a parking space."
Montgomery County, MD	"Adequate battery charging station protection, such as concrete-filled steel bollards shall be used. Curbing may be used in lieu of bollards, if the battery charging station is setback a minimum of 24 inches from the face of the curb."
Des Moines, WA	"The city manager or designee is authorized to develop and maintain standards for the design and construction of electric vehicle charging stations."

<table>
<tr><td></td><td></td></tr>
<tr><td colspan="2">5. Required EV Parking Capacity & Minimum Parking Requirements</td></tr>
<tr><td>Montgomery County, MD</td><td>"The minimum number of electric vehicle charging stations required is 1 electric vehicle charging station per 50 parking spaces."</td></tr>
<tr><td>Mountlake Terrace, WA</td><td>"The first column in Table 1 shows the type of land use for which electric vehicle charging stations shall be provided, pursuant to this section. The second column shows the minimum percentage of the facility's parking spaces that shall provide a connection to electric vehicle charging stations."
<table>
<tr><th>Land Use Type</th><th>Percent Parking Spaces</th></tr>
<tr><td>Multi-household Res</td><td>10%</td></tr>
<tr><td>Lodging</td><td>3%</td></tr>
<tr><td>Retail, eating and drinking</td><td>1%</td></tr>
<tr><td>Office, medical</td><td>3%</td></tr>
<tr><td>Industrial</td><td>1%</td></tr>
<tr><td>Institutional, Municipal</td><td>3%</td></tr>
<tr><td>Recreation/Entertainment/Cultural</td><td>1%</td></tr>
<tr><td>Other</td><td>3%</td></tr>
</table></td></tr>
<tr><td>St. Louis Park, MN</td><td>"All new or reconstructed parking structures or lots with at least 50 parking spaces, or expanded parking structures or lots that result in a parking lot with 50 or more parking spaces, shall install EVSE as required below. 1. Multiple-family residential land uses shall have 10% of required parking as Level 1 stations for
resident parking, and one Level 2 station for guest parking. At least one handicapped accessible parking space shall have access to an EVCS. 2. Non-residential land uses with parking spaces available for use by the general public shall have at least 1% of required parking as Level 2 stations with a minimum of two spaces served by Level 2 charging, with at least one station adjacent to an accessible parking space. In non-residential zoned districts, DC charging stations may be installed to satisfy the EVCS requirements described above on a one-for-one basis."</td></tr>
</table>

Middletown, CT	"Any new development that requires 25 or more parking spaces, as calculated by Section 40.04 of these regulations, shall have a minimum of 1 charging space or 3% of the total number of spaces allocated to Electric Vehicles (EVs) (whichever is greater) and must have a Level 2 or 3 charging station/connection per EV parking space."
Duluth, MN	"A minimum of 2% of required automobile parking spaces are signed and reserved for hybrid/electric/low energy vehicles in preferred locations near the primary building entrance."
Signage, Safety, and Other Standards	
Atlanta, GA	"Way finding signs, if installed, shall be placed to effectively guide the motorists to the electric vehicle parking space and/or charging station. Private regulatory signage shall be placed in a manner that shall not interfere with any parking space, drive lane or exit."
St. Louis Park, MN	"Site lighting shall be provided where an electric vehicle charging station is installed, unless charging is for daytime purposes only."
Kansas City, MO	"Property owners are not restricted from collecting a service fee for the use of an electric vehicle charging station."
St. Louis Park, MN	"The EVCS must be operational during the normal business hours of the use(s) that it serves. EVCS may be de-energized or otherwise restricted after normal business hours of the use(s) it serves."
Ordinance: 169.225 MOTORIZED FOOT SCOOTER. Minnesota Statute	
169.225 MOTORIZED FOOT SCOOTER. Subdivision 1.Application of traffic laws. Every person operating a motorized foot scooter shall have all rights and duties applicable to the operator of a bicycle, except in respect to those provisions relating expressly to motorized foot scooters and in respect to those provisions of law that by their nature cannot reasonably be applied to motorized foot scooters. Subd. 2.Sidewalk and passenger prohibition.	

No person may operate a motorized foot scooter upon a sidewalk, except when necessary to enter or leave adjacent property. No person may operate a motorized foot scooter that is carrying any person other than the operator.
Subd. 3.Minimum age for operator.

No person under the age of 12 years may operate a motorized foot scooter.
Subd. 4.Protective headgear.

No person under the age of 18 years may operate a motorized foot scooter without wearing properly fitted and fastened protective headgear that complies with standards established by the commissioner of public safety.
Subd. 5.Required lighting equipment.

A motorized foot scooter must be equipped with a headlight and a taillight that comply with standards established by the commissioner of public safety if the vehicle is operated under conditions when vehicle lights are required by law.
§
Subd. 6.Operation requirements and prohibitions.

(a) A person operating a motorized foot scooter on a roadway shall ride as close as practicable to the right-hand curb or edge of the roadway, except in the following situations:
(1) when overtaking and passing another vehicle proceeding in the same direction;
(2) when preparing for a left turn, in which case the operator shall stop and dismount at the right-hand curb or right edge of the roadway, and shall complete the turn by crossing the roadway on foot, subject to restrictions placed by law on pedestrians; or
(3) when reasonably necessary to avoid impediments or conditions that make it unsafe to continue along the right-hand curb or edge, including, but not limited to, fixed or moving objects, vehicles, bicycles, pedestrians, animals, surface hazards, or narrow lanes.
(b) A person may operate a motorized foot scooter on a bicycle path, bicycle lane, bicycle trail, or bikeway that is not reserved for the exclusive use of nonmotorized traffic, unless the local authority or governing body having jurisdiction over that path, lane, trail, or bikeway prohibits operation by law.

Appendix C: MN ADA Guidelines

MN ADA EV Guidelines.
4% (e.g., 1 in 25 spaces) but no less than one of electric vehicle (EV) charging spaces, in any given parking facility, must b e accessible compliant. These spaces are accessible electric vehicle (EV) charging spaces, not ADA parking spaces. Parking stall11 feet minimum wide by 18 feet minimum long. Maneuvering clearance width Minimum 36 inches wide, hash-marked, at the top of the parking space between the charging station and the vehicle.
Accessible route slope/ cross slope: Accessible Route Slope and Cross Slope Maximum 1:20 (5 percent) running slope and 1:48 (2%) cross slope; Accessible vehicle spaces 1:48 (2%) in all directions. A ramp or curb-cut must be accessible in order to establish an accessible route to and operation of charging station. Side access aisle
Side access aisle of 60 inches minimum in width to allow space for wheelchair and equipment in and out of space. (When paired with an 11-foot wide accessible parking stall this is both van and car accessible).
Reach range: The front and side of the EVSE must have 48 inches of space to allow reach to all operable parts from a wheelchair. Accessible controls Operable with one hand and not requiring tight grasping, pinching, twisting of the wrist or force more than 5 pounds .
Cord Length / Cord Management system: Cord Length must be a minimum of 20 feet long. The EVSE must incorporate a cord management system or method to eliminate potential for cable entanglement, user injury or connector damage from lying on the ground.
Posted signage: "Accessible EV Charging Station" signs shall be centered at the head end of the parking space a maximum of 96 inches from the head of the spaces and be mounted 60 inches minimum and 66 inches maximum from the floor of the space. "Electric Vehicles only" stenciled graphics are required on each of the parking pad.

Appendix D: Proposed North Mankato Goals and Policies

Goals and Policies
1. **Goal 1**: Establish North Mankato as a leader in EV and AV preparedness - **Policy 1.1**: Conduct an annual survey of residents gauging interest in EV / AV adoption - **Policy 1.2**: Identify zoning and building code regulations favored by the public and city councilmembers - **Policy 1.3**: Consider EV's when bidding for new city vehicle purchases - **Policy 1.4**: Establish an EV task force to evaluate and report on the emissions saved by the shift to EV's.
1. **Goal 2**: Promote new vehicle technology in ways that ensure economic viability for the City of North Mankato. - **Policy 2.1**: Apply for grants where appropriate. - **Policy 2.2**: Create engagement initiative to educate businesses on benefits of installing EV charging.
2. **Goal 3**: Establish Bike and Scooter Share Program in North Mankato - **Policy 3.1:** Any Scooter/Bike share business must register for a permit to operate within the North Mankato City limits. - **Policy 3.1.2:** Any Scooter/Bike Share must follow Minnesota State Statute 169.225. In general, people riding scooters follow the same rules of the road as people using bicycles. Scooters are allowed to operate on any street, and users should ride on the right-hand side of the street. Scooters are also allowed in bike lanes and bike trails.

Appendix E: Red Wing Public Private Partnership for DC Fast Charger

Project Description

The purpose of the project was to build support for installing a Direct Current Fast Charger (DCFC) charger in Red Wing, MN and secure funding to support the project.

Project Highlights

- The Red Wing Sustainability Commission and Red Wing Area Chamber of Commerce forged a unique collaboration between city and private partners to fund and install a DCFC in downtown Red Wing.
- The charger was the first municipally- installed DCFC in Minnesota.
- The DCFC is free for users.
- A grant from Clean Energy Resource
- Teams (CERTs) gave the project credibility in the eyes of decision-makers, which helped the project get off the ground.