Chapter 9
Transportation & Technology

APO
SAINT CLOUD | AREA PLANNING ORGANIZATION

LOOKING AHEAD 2050

Chapter 9: Technology and Transportation Contents

Introduction

Technological changes to the transportation industry are on the horizon. With the growing public adoption of alternative fuel vehicles (such as electric vehicles (EVs)), the continued advancement in vehicle automation, and the promise of connected vehicle technology, all levels of the transportation sector will need to adapt to these and other future changes.

As identified in Chapter 4: 2050 Regional Vision, the APO is committed to understanding and planning for future innovative transportation technologies and encouraging their presence and incorporation into the region's existing transportation network.

To ensure our region has a competitive edge when it comes to these new advances, we need to gain an understanding of what is currently out there. In addition, local transportation planners and engineers will need to evaluate our existing infrastructure to guarantee that when these changes reach Central Minnesota our system is equipped to handle them.

Electric Vehicles

As of the drafting of this plan, EVs make up a rather small percentage of registered vehicles within Minnesota with approximately 0.68% of registered light-duty vehicles (cars, trucks, vans, and SUVs) being EVs in 2023. However, that percentage has been slowly growing.

Figure 9.1: *Photo of an electric vehicle charging station near the River's Edge Convention Center in Saint Cloud.*
Photo courtesy of Saint Cloud APO.

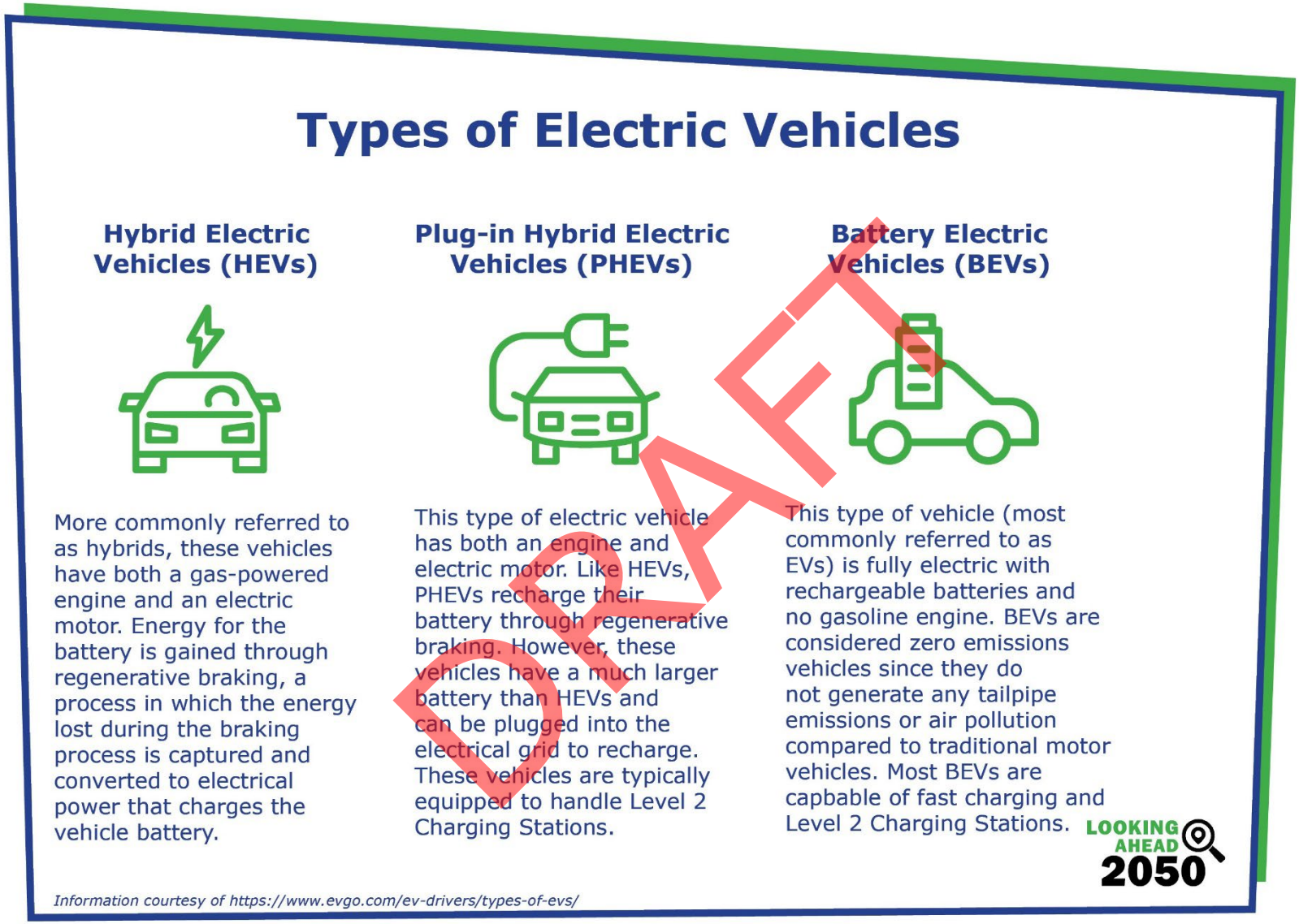

Figure 9.2: *Infographic on the types of electric vehicles.*

According to the Minnesota Department of Transportation's (MnDOT's) Office of Transportation System Management, the number of EVs registered in Minnesota has increased each year between 2016 to 2022 with fully electric vehicles (Battery Electric Vehicles (BEVs)) experiencing a 4,129.1% increase in registrations during that time period (from 543 BEVs in 2016 to 22,964 BEVs registered in 2022).

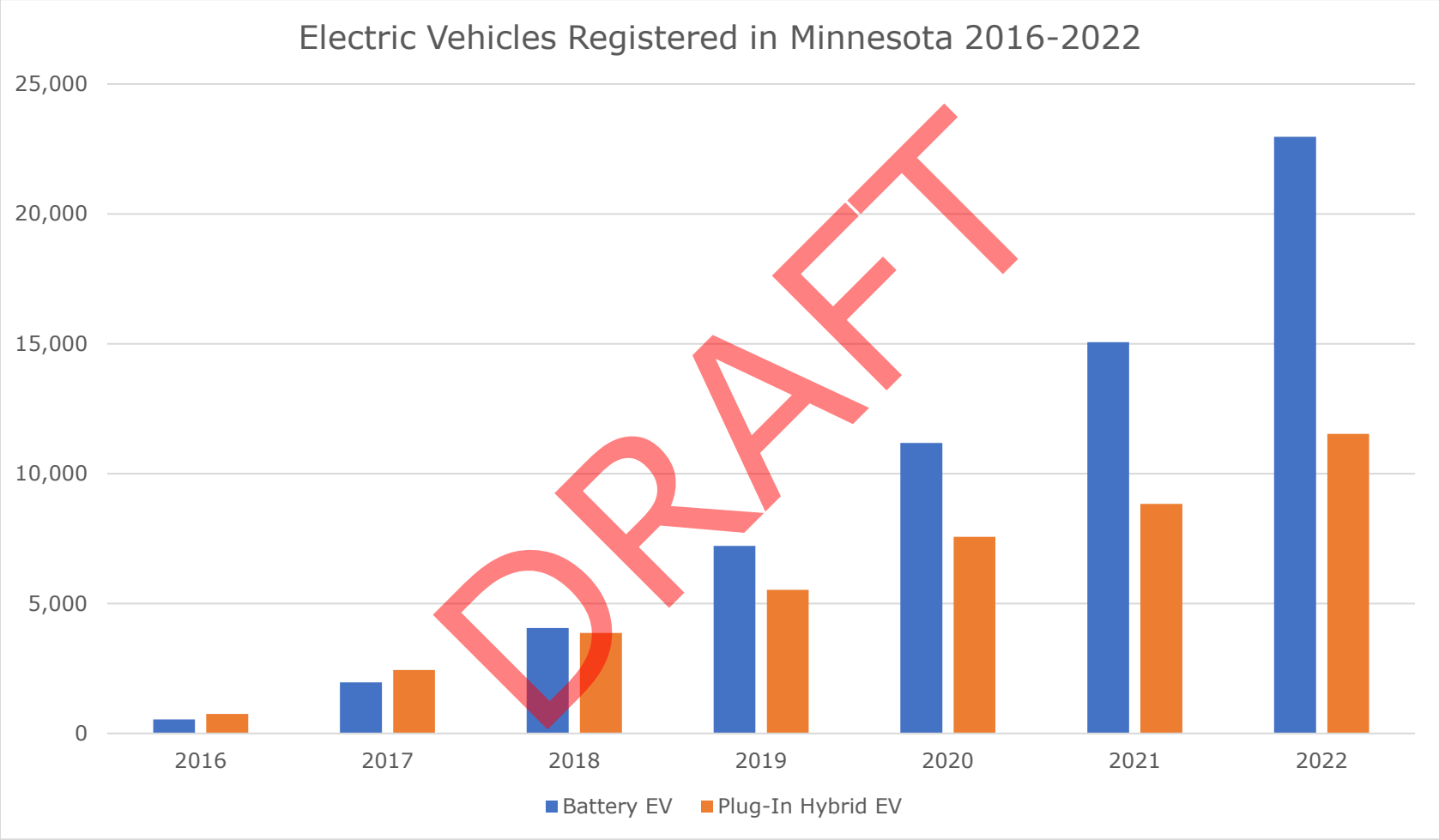

Figure 9.3: *The number of electric vehicles (battery EVs and plug-in hybrid EVs) registered in Minnesota between 2016 and 2022. Data courtesy of MnDOT.*

In 2022, MnDOT found EVs make up approximately 3.8% of all vehicle sales within the state. MnDOT is working to increase that percentage to 5% for light-duty vehicles by 2025, with a long-term goal of 65% of vehicles registered in Minnesota to be EVs by 2040.

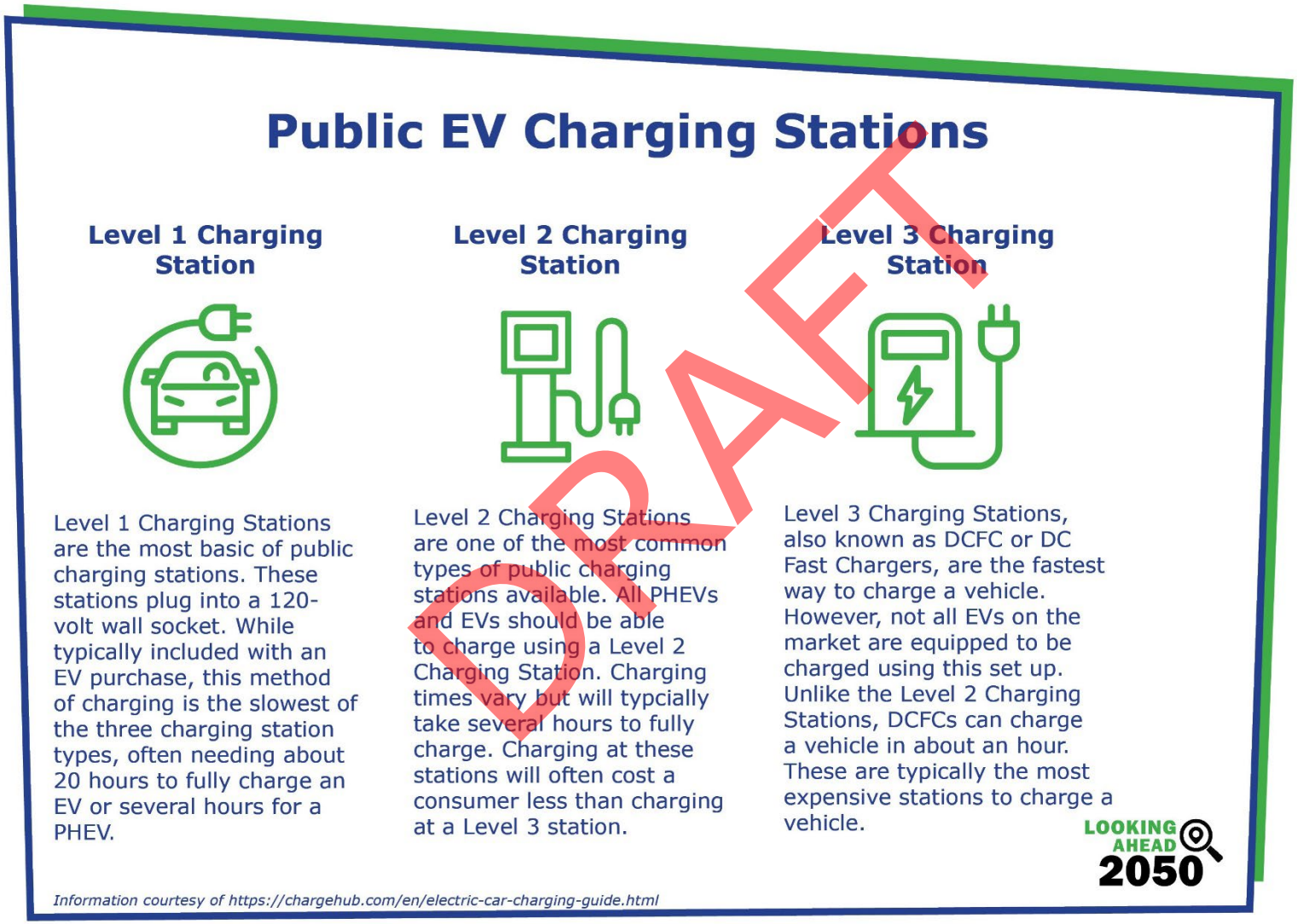

Figure 9.4: *Infographic on the types of publicly available EV charging stations.*

Within the Saint Cloud MPA, growth in EV adoption (either battery EV or plug-in hybrid EV) has also occurred. Between 2019 and 2022, the Minnesota Public Utilities Commission (PUC) estimates EV registrations in the MPA have increased by 283.5% (from 97 EVs registered in 2019 to 372 EVs registered in 2022).

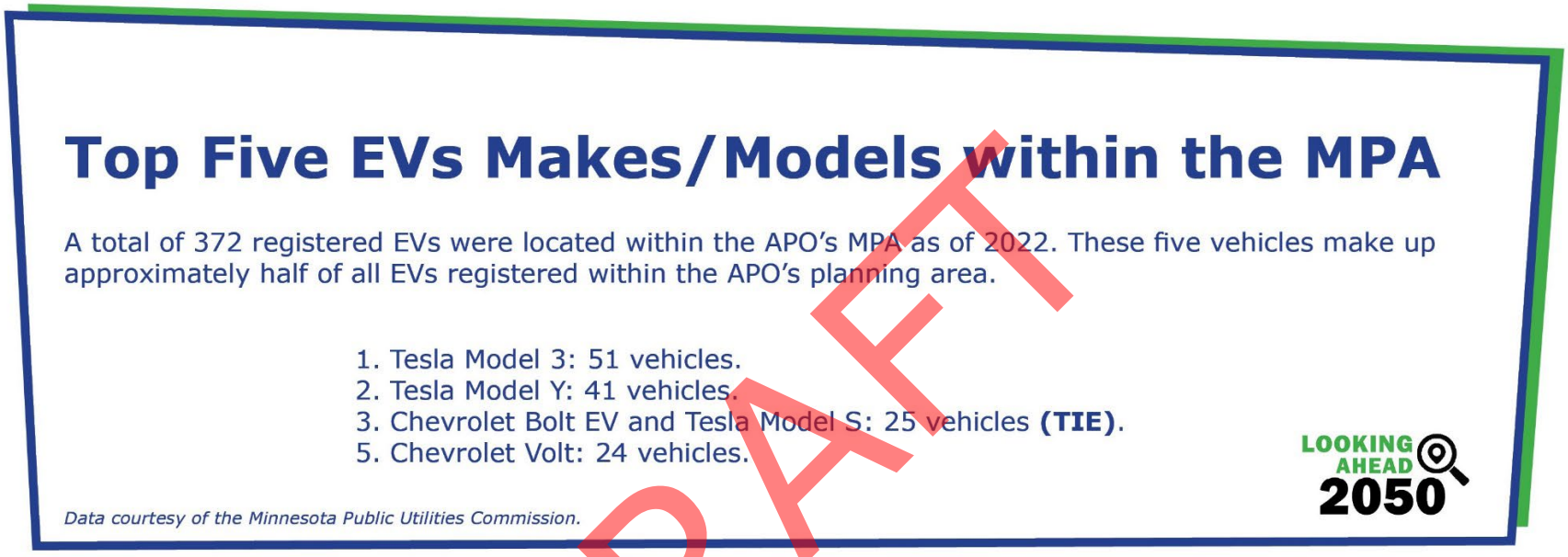

Figure 9.5: *Infographic detailing the top five EV makes and models registered within the Saint Cloud MPA.*

Among the member cities of the APO, the City of Saint Cloud has the most EVs registered within its jurisdiction. However, there are a growing number of EVs located within the cities of Sartell, Sauk Rapids, and Saint Augusta.

Jurisdiction	2019	2020	2021	2022
Saint Cloud	39	53	118	156
Sartell	20	27	50	73
Sauk Rapids	13	13	26	34
Saint Joseph	0	0	3	5
Saint Augusta	5	10	17	25
Waite Park	4	2	7	9
Other Cities and Townships within the MPA	16	12	44	70
Total	97	117	265	372
Year-over-Year Percent Change	N/A	21%	126%	40%

Figure 9.6: *Electric vehicle registration by jurisdiction within the Saint Cloud MPA. Data courtesy of the Minnesota Public Utilities Commission.*

Barriers to EV Ownership

While the number of EVs on the road today is growing, most registered vehicles driven today remain gas-powered engines. However, the potential market for EVs across the country (and even locally) is promising. According to a consumer survey conducted by AAA Car Club in 2022 (https://tinyurl.com/635tc3z9), approximately one in four Americans say they would be likely to buy a fully electric vehicle for their next vehicle purchase. Within the Saint Cloud MPA, that number is considerably higher. The 2021 Regional Household Travel Survey (RHTS) found approximately 41% of those completing the survey were considering purchasing an EV for their next vehicle purchase (see Appendix C).

However, as the AAA Car Club survey found, when it comes to making the switch from gas to full-electric vehicles, consumers have noted several concerns.

- **High Sale Price.** The AAA Car Club survey found 60% of consumers surveyed sighted the high sticker price as a hesitation in purchasing an EV. According to Kelley Blue Book (KBB) (https://tinyurl.com/yyph7k94), while a few EVs can be purchased for under $40,000 (in 2024 dollars), the vast majority cannot. In fact, the average cost for a new EV is around $55,000. While EVs may remain out of financial reach for several consumers, KBB states the initial high prices should come down in the near future.
- **Not Enough Places to Charge.** The AAA Car Club survey found that along with the cost of EVs, concern about charging availability was prevalent among survey participants (60%). While KBB states there are more than 60,000 public Level 2 and DCFC chargers throughout the US (and more being added), consumers especially outside of urban areas have expressed concerns about not having immediate access to chargers.
- **Range Anxiety.** Coupled with the notion of not having enough places to charge, AAA Car Club's

survey found 58% of respondents noted concerns about being stranded without access to a charging station. Despite the average range of fully charged EVs to be between 100 miles (for a Mazda MX-30) to 500+ miles (for a Lucid Air Dream Edition) concerns about running out of juice remain high among those considering making the switch to electric.

- **No Home Charging Options.** While many consumers who own their homes may be able to outfit their current house to accommodate a charging station, those who rent may not be so lucky. As stated in Chapter 2, there is a growing trend within the Saint Cloud MPA of residents who choose to rent versus own their own house. As a result, those renters may be at a disadvantage, according to KBB, since they would need to rely on building owners to install EV chargers.

Other contributing factors to the hesitation consumers have toward EVs include concerns about EVs not being suitable for long-distance travel, the high cost of battery repair and/or replacement, cold weather range concerns, and the availability of EV repair options.

"Deciding to make the leap to full electric may feel overwhelming for many consumers, and a hybrid option may be the way to bridge this gap," said Greg Brannon, AAA Director of Automotive Research in a June 6, 2024, press release (https://tinyurl.com/7xh5m4zr). "Consumer demand will ultimately dictate the future, and my prediction is that we will have a mix of EVs, hybrids, and internal combustion vehicles in dealerships and on the roads in the US for many decades ahead."

E-Bikes

In addition to the increase in electric vehicles, electric bikes (e-bikes) have also been gaining in popularity. While e-bikes have been around since the mid-1990s, it wasn't until the early 2020s that sales of e-bikes began to take off across the country.

According to the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (https://tinyurl.com/mszpw2bk), approximately 1.1 million e-bikes were sold within the U.S. in 2022, almost four times as many as were sold in 2019.

Figure 9.7: *Photo of e-bikes displayed at Saint Cloud's Granite City Days bike rodeo.*
Photo courtesy of Saint Cloud APO.

In an interview with PBS News (https://tinyurl.com/bde3vtar), *Bicycling* magazine writer-at-large Moly Hurford stated the explosion in e-bikes came as a result of people needing to find alternative ways to get around during the COVID-19 pandemic.

"You don't like to give COVID credit for anything, but we do have to say cycling just really exploded in popularity in 2020, 2021, especially e-bikes, partially because, especially in cities, people weren't comfortable using public transportation," she said. "You get an e-bike and suddenly it's much easier to make that 5, 10, 15-mile commute without showing up to work completely drenched in sweat."

Unlike a regular bicycle, an e-bike has a built-in or postproduction electronic motor that assists people with pedaling. E-bikes do not take the place of pedaling, but rather provide a little extra power behind each pedal stroke.

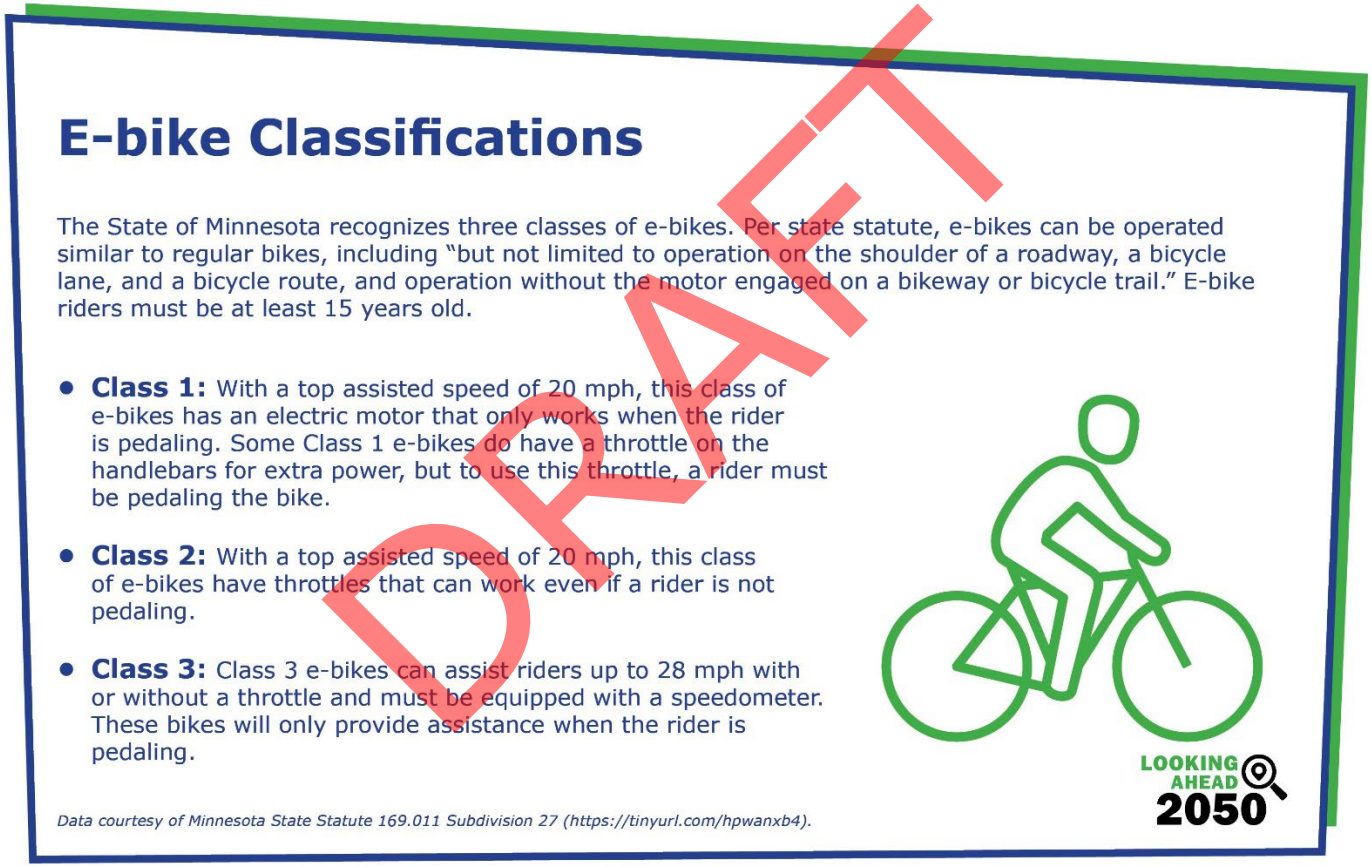

Figure 9.8: *Infographic on the classifications of e-bikes.*

Locally, no ordinances restricting the usage of e-bikes in certain areas – mainly on shared use paths or other trails – have been implemented as of the drafting of this plan. However, given the speed these bikes can travel (especially Class 3 e-bikes), coupled with the growing popularity of e-bikes in the state in part thanks to sizeable rebate offers provided by the state in 2024 and 2025, some cities within Minnesota have started to enforce speed limits on e-bikes (https://tinyurl.com/yemhfh4u) on regional and city trails.

Connected and Automated Vehicles (CAVs)

Over the past several years, the interest in developing and testing "self-driving" vehicles on roadways across the country has continued to grow thanks to developments in both the connected and automated vehicle technology industry.

Connected Vehicles

Connected vehicles use a variety of different technologies such as optical, ultrasonic, radar, and lidar to track objects over multiple fields of view. This technology essentially allows the vehicle to be able to better "observe" its surroundings as well as "communicate" with other vehicles and/or surrounding infrastructure.

Connected vehicle technology can be categorized into three different concepts according to the U.S. Department of Transportation (https://tinyurl.com/ymbyrj6m).

- **Vehicle-to-vehicle (V2V):** This form of connected vehicle technology allows vehicles to connect to each other and allow the sharing of critical information. For example, if a vehicle suddenly brakes, vehicles that are behind the braking vehicle will be able to receive a safety warning to slow down/apply the brakes before they get too close.
- **Vehicle-to-infrastructure (V2I):** This form of connected vehicle technology allows vehicles to connect to roadway infrastructure such as traffic signals, pedestrian crossing infrastructure, or roadway markings. With the increase of intelligent transportation systems (ITS) technology being incorporated into the transportation system (such as the placement of fiber optic lines along various corridors), it is the hope that V2I technology will be able to wirelessly relay roadway information (including construction zones and other roadway hazards) to prevent crashes.
- **Vehicle-to-everything (V2X):** This form of connected vehicle technology allows vehicles to connect to a multitude of objects including other vehicles and infrastructure. In addition to encompassing the V2V and V2I technology, V2X allows for vehicles to "see" other surroundings including pedestrians and bicyclists.

While full adoption of connected vehicle technology is still years away, several connected-vehicle pilot projects have been completed across the U.S. Most notably, connected vehicle technology has been utilized in the trucking industry through a practice known as platooning.

Truck platooning allows for trucks to travel together connected by a computer system which communicates with the trucks to align speed, acceleration, and braking. As of 2019, the State of Minnesota has adopted a statute (https://tinyurl.com/4p67r6ct) that allows for platoons of up to three trucks. Prior approval from MnDOT is required to operate a truck platoon on state roadways (platoons are limited to freeways and expressways on designated pre-approved routes). Within the Saint Cloud MPA, truck platooning is allowed on I-94, U.S. 10, and MN 23 (east of the US 10/MN 23 interchange to Foley). Various restrictions including time of operation for truck platooning along these corridors are in place as of the drafting of this plan.

Automated Vehicles

Automated vehicle technology in some form has been around for years. In fact, many vehicles on the roadway today have incorporated various forms of automation to assist drivers in performing basic vehicle functions such as lane keeping assist, adaptive cruise control, self-parking, and highway autopilot.

Vehicle automation is categorized into six different levels based on the amount of "self-driving" technology is present.

- **Level 0:** The human driver does all the driving.
- **Level 1:** An advanced driver assistance system (ADAS) on the vehicle can sometimes assist the human driver with either steering or braking/accelerating, but not both simultaneously.
- **Level 2:** An ADAS on the vehicle control both steering and braking/accelerating simultaneously under some circumstances. A human in the driver seat must continue to pay full attention monitoring the driving environment at all times and perform the rest of the driving tasks.
- **Level 3:** An automated driving system (ADS) on the vehicle perform all aspects of the driving task under some circumstances. In those circumstances, the human driver must be ready to take back control at any time with the ADS requests the human driver to do so. In all other circumstances, the human driver performs the driving task.
- **Level 4:** An ADS on the vehicle can itself perform all driving tasks and monitor the driving environment – essentially, do all the driving – in certain circumstances. It's not required that the human pay attention in those circumstances.
- **Level 5:** An ADS on the vehicle can do all the driving in all circumstances. The human occupants are considered passengers and don't need to be involved in driving.

According to the MnDOT Office of Connected and Automated Vehicles (CAV-X) (https://tinyurl.com/yc8zk8fd), as of the drafting of this plan Levels 0 through 2 are currently on roadways across Minnesota. However, pilot programs and limited deployments of more advanced automated vehicles have occurred beginning in the early 2020s.

Automated Vehicle Demonstration Projects

Med City Mover

This low-speed, automated, electric, multi-passenger shuttle research project ran from 2021 to 2022 in the City of Rochester. Two six-person shuttles drove a programmed route between the Mayo Clinic downtown campus, several residential neighbhorhoods, and other local businesses and hotels.

Bear Tracks

This self-driving shuttle project was deployed in the City of White Bear Lake between August 2022 and July 2023. This low-speed, self-driving, electric, multi-passenger shuttle provided a 1.5-mile long route connecting residential neighborhoods to various locations around the city.

goMARTI

This self-driving shuttle system was one of the larger deployments of automated vehicles in the state. Starting in 2022, this 18-month pilot program deployed five vehicles to cover approximately 17 square miles within the City of Grand Rapids. While the vehicles were considered self-driving, an operator was on board to ensure safe vehicle operation.

Data courtesy of MnDOT CAV-X.

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Figure 9.9: *A list of some of the automated vehicle demonstration projects that have occurred within the State of Minnesota. Data and photos courtesy of MnDOT CAV-X.*

Preparing for CAVs

While much of CAV technology relies on the private sector (i.e., automobile manufacturers), the public sector will need to be ready to adapt to these new vehicles.

Intelligent Transportation Systems (ITS)

As stated earlier, the investment in ITS is one way the state (and the region) can work to prepare for widespread deployment of CAVs. As noted, adding fiber optic lines along roadways is one example of ITS currently being utilized. However, ITS infrastructure encompasses a variety of technologies. According to the Minnesota Statewide Regional ITS Architecture Volume (2018) (https://tinyurl.com/zr4uwwrd), the state has outlined several short-, mid-, and long-term initiatives to help further advance transportation infrastructure technology in the state. Examples include:

- Enhancements to the MnDOT 511 app to allow for users to have a better view of the traffic flow map and improved road condition data information during inclement weather.
- Incorporation of rest area truck parking availability technology to determine the number of available truck parking spaces in real time.
- Improvement of traffic signal timing and control technology to improve travel time reliability. This also includes the consideration of adaptive signal control technologies to adjust the timing of signals to accommodate changing traffic patterns.
- Deploying active speed warning signs to help drivers understand their current traveling speeds compared to the posted speed limit.

Overall, the 2018 ITS plan outlined 64 short-term, 38 mid-term, and 12 long-term initiatives. If implemented, many of the strategies will not only improve the safety, operations, and mobility of the transportation system, but further assist the state (and other implementing jurisdictions and agencies) with the ability to accommodate CAV technology.

Drive MN

To understand the current readiness of Minnesota roadways for vehicle automation, MnDOT's Office of Research and Innovation, together with consulting firm Bolton & Menk, the University of Minnesota's Center for Transportation Studies and VSI Labs conducted a study to understand the potential issues current infrastructure would have in allowing for the presence of automated vehicles.

Figure 9.10: *One of the two Drive MN vehicles deployed during the 2022 study of Minnesota's infrastructure readiness for automated vehicles. Photo courtesy of Saint Cloud APO.*

In August 2022, Drive MN (https://tinyurl.com/6bydz5e3) set out on a 1,000+ mile trip around the state collecting data about the existing infrastructure as well as documenting changes that may be needed to allow for a smooth transition to vehicle automation. Two research vehicles outfitted with a drive-by-wire kit, numerous sensors, and computing power to collect and store data were deployed. Eight stops were made during this study, including one in Saint Cloud at the MnDOT Office on 12th Street N. A majority of the Drive MN research was conducted on the state trunk highway system (only 10-20% of the total route could be made on non-trunk highways). Researchers hoped they would then be able to take lessons learned from the trunk highway system's readiness and apply them to the local system.

During this evaluation, the data identified several key areas for consideration:

- **Freeway ramps and turn lanes:** The lack of continuous edge line guidance could result in a misdetection of the lane by an automated vehicle. This has the potential to cause the vehicle to follow an incorrect path despite the driver and/or routes intentions.
- **Poor lane line condition and visibility:** The lack of lane lines or the poor condition of those lane lines could result in a misdetection by an automated vehicle.
- **Construction zones or maintenance activities:** In areas where roadways are scarred (such as crack seals) or have "ghost markings" (remnants of previous roadway pavement markings), misdetections of the lane by automated vehicles could result in vehicles deviating from the desired travel lane.
- **Poor contrast:** Lighter colored pavement paint or faded/white pavement paint markings could result in an automated vehicle not detecting the confines of a travel lane.

Overall, the study recommended several action items that should be considered and implemented if the state were to make meaningful investments to ensure existing infrastructure was equipped to handle vehicle automation.

Transforming Transportation

Advances in vehicle and infrastructure technology will play a huge part in the future transportation network. In the years since the adoption of the APO's 2045 Metropolitan Transportation Plan (MAPPING 2045), the region has seen a 283.5% increase in the number of EVs registered in the area. Additionally, the region has seen an increase in publicly available charging infrastructure. This is on top of the consumer market explosion of e-bikes since the COVID-19 pandemic of 2020-2021.

With the continued advancements in both connected and automated vehicle and infrastructure technologies, the region's local transportation planners and engineers need to keep abreast of these changes to ensure Central Minnesota is keeping pace with the rest of the state. It is imperative that investments in future technology be at the forefront of infrastructure investment conversations. This will not only result in a more efficient and thoughtful use of taxpayer dollars but will also guarantee the region is prepared for the ever-evolving future of transportation.