Electric Mobility Opportunities for Brooklyn Park, Minnesota

January 2024

Dustin Weigl, Kaylyn Bopp, and Nicole Rosner

Produced for the U.S. Department of Energy by the National Renewable Energy Laboratory (NREL).

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National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401

303-275-3000 • www.nrel.gov

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List of Acronyms

BEV	battery electric vehicle
CV	conventional vehicle
DART	Dallas Area Rapid Transit
DCFC	direct current fast charge
EV	electric vehicle
FTA	Federal Transit Administration
HEV	hybrid electric vehicle
PHEV	plug-in hybrid electric vehicle
TOU	time-of-use

Communities LEAP (Local Energy Action Program) Pilot

About

The U.S. Department of Energy's (DOE) Communities LEAP pilot partners with low-income, energy-burdened communities that experience environmental justice challenges and/or direct economic impacts from reducing their historical reliance on fossil fuels to build community-driven action plans for clean energy-related economic development. Through this program, DOE provides customized, high quality technical assistance to competitively selected communities to develop clean energy-related economic development pathways. In each community, coalitions of local partners, including at least one local government partner and one community-based organization, contribute to project oversight and delivery. The National Renewable Energy Laboratory (NREL) is the primary technical assistance provider, delivering technical expertise and supporting community engagement, as well as managing the overall network of TA providers.

Executive Summary

Context

New technologies for mobility and electric vehicle (EV) deployment have rapidly expanded, and adoption of these new options will improve transportation outcomes for communities across the United States. The current energy transition—from fossil-fueled transportation toward zero-emissions mobility options—offers communities across the country opportunities for cleaner and more-equitable environmental outcomes. As adoption of electric mobility increases, the reduction of emissions from conventional vehicles (CVs)—fueled by gasoline or diesel—will reduce the health impacts of air pollution and transportation-based contributions to carbon emissions driving climate change. Furthermore, mobility is critical for increasing equitable access to services and resources such as gainful employment, education, and entertainment. Underserved communities and low-income households typically spend an outsized share of their income and time on transportation. This report outlines key steps of expanding mobility access for residents in Brooklyn Park, Minnesota, particularly for those residents most historically underserved. Additional information on transport electrification and how these new mobility offerings can be integrated with low-emission vehicles (such as EVs and electric bikes) is also included to inform the design and rollout of mobility enhancements in Brooklyn Park.

This report will support Brooklyn Park as it navigates changes in mobility technologies and approaches to best serve the transportation needs of its communities. The content details the advantages of electric mobility, reviews electric mobility options that meet diverse needs and constraints, and maps the benefits and limitations of these options in terms of available technologies, their uses, and incentives that aim to improve accessibility and affordability. Although personal EVs provide both individual and collective advantages to residents—from lowering the total cost of ownership over the lifetime of a vehicle to improving air quality in the surrounding environment by reducing tailpipe emissions—they may still be unaffordable and/or inaccessible to some households in Brooklyn Park. Therefore, this report provides an overview of other accessible and affordable electric mobility options, including electric carshares, e-micromobility (i.e., e-scooters, e-bikes), and on-demand services, as enabled by web-connected technologies and the proliferation of smartphones.

Electric Mobility Technologies Overview

Following is an overview of electric mobility technologies, their benefits, and opportunities for use in Brooklyn Park.

EVs:

Personal EVs: Although EVs have historically had a significantly higher upfront purchase price, their lower maintenance and operating costs can offset the higher purchase cost over the lifetime of the vehicle. In addition, new Minnesota EV tax incentives can be combined with federal incentives for up to a $10,000 credit for new or $4,600 for used EVs, lowering the barrier of the high purchase price.

Electric carshares: Carshare programs can provide supplemental mobility, especially in areas with lower personal vehicle ownership (Litman 2015). High-utilization carshare vehicles are useful targets for electrification because of lower operating and maintenance costs and a greater displacement of potential emissions from high annual mileage.

Brooklyn Park opportunity: EV adoption is hindered by the need for a robust public charging infrastructure network, especially for those with limited or no access to home-charging. Significant federal funding is available to incentivize building public EV chargers. HOURCAR has expanded services to include round-trip carshare services through new carshare hubs at multifamily housing complexes. Brooklyn Park is lower-density than St. Paul and Minneapolis, so it is well-suited to this hub-based carshare model (HOURCAR 2023).

On-demand services and microtransit:

Ride-hailing: An on-demand transportation service that enables riders to hire a personal driver, frequently via a smartphone app (e.g., Lyft and Uber). Some transportation network companies offer incentives for drivers to lease EVs (Lyft 2023). However, there are potential downsides to expanding ride-hailing: It may not be affordable for many residents without subsidies and can increase vehicle miles traveled and congestion compared to driving a personal vehicle.

Microtransit: Mobility services in this category use smaller vehicles requested by smartphone app or phone call rather than traditional "fixed-route" transit, where buses are on a set route and schedule. These types of services can benefit from vehicle electrification because vehicles are highly utilized.

Brooklyn Park opportunity: Case studies suggest that on-demand transit service with pooled rides could play a role in Brooklyn Park in addressing mobility accessibility. Creating a dedicated on-demand transit service in Brooklyn Park (including partnering with an existing ride-hailing service such as Lyft or Uber) could supplement existing transit to expand hours, service area, and reliability.

Electric Micromobility:

Shared e-micromobility: Shared-use fleets of small, partially human-powered vehicles such as e-bikes and e-scooters. They are generally rented through a mobile app or kiosk, can be picked up and dropped off in the public right-of-way or at a docking station, and are intended for short trips

(NACTO 2019). Safety improvements, expansion of bike lanes, signage, transit integration, and education campaigns will make the use of e-micromobility more attractive.

Private e-micromobility: Research has shown that shared e-micromobility users place the highest value on the cost and convenience of services; for those who own their e-bike or e-scooter, both can be maximized—however, the upfront cost can be a challenge (Fishman, Washington, and Haworth 2013).

Brooklyn Park opportunity: Deploying community-informed micromobility infrastructure (such as dedicated cycle tracks or bike lanes) could make electric micromobility more attractive for Brooklyn Park residents. The locations for safer infrastructure could be determined through stakeholder engagement meetings or an online interactive map to solicit feedback and suggestions. In May 2023, Minnesota approved a transportation omnibus bill (HF2887) that includes an electric-assisted bicycle rebate (Minnesota Legislature 2023). Outreach about e-micromobility could be paired with building awareness about this statewide incentive to Brooklyn Park residents.

Next Steps

Transportation plans in and around Brooklyn Park provide opportunities to expand all residents' access to mobility and the region's resources. The future buildout of the Blue Line light rail extension—with five stations planned for Brooklyn Park—represents a timely opportunity to plan for first- and last-mile transportation options. Prioritizing multiple options aside from single-occupancy personal vehicles for first- and last-mile access to the future Blue Line stations would provide more equitable mobility for Brooklyn Park residents by improving accessibility for residents without reliable access to a car. On-demand services, e-micromobility options, and electric carshares are three options for first- and last-mile mobility detailed in this report.

This report highlights two steps toward expanding equitable access to clean mobility in Brooklyn Park:

Ongoing engagement and education: The range of policies, programs, and methods outlined in this report would have varying benefits for providing mobility access to Brooklyn Park residents while potentially reducing traffic congestion, carbon emissions, local pollutant emissions, and income spent on mobility. Ongoing engagement enables residents to provide input on which policies, programs, and methods are pursued, according to their self-identified priorities. Once implemented, these programs will be more effective if residents are aware of their existence, their benefits, and how to best take advantage of them.

Expanding access to mobility options: Once the community's electric mobility priorities are identified, Brooklyn Park will be able to pursue funding opportunities and partnerships to implement policies, programs, and methods that expand access to electric mobility technologies. Several resources exist, including the U.S. Department of Energy's Alternative Fuels Data Center, which tracks federal and state laws and incentives for alternative fuels and vehicles, air quality, fuel efficiency, and other transportation-related topics.[1] Another resource is the U.S. Department of Transportation's Urban E-

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[1] Find federal and state laws and incentives for alternative fuels and vehicles, air quality, fuel efficiency, and other transportation-related topics here: https://afdc.energy.gov/laws.

Mobility Toolkit, which tracks federal funding for EV infrastructure and certain electric-mobility-related activities and provides project implementation guidance.[2]

[2] The Urban Electric Mobility Toolkit serves as a one-stop resource to help urban communities scope, plan, and identify ways to fund EV charging infrastructure and support diverse forms of electric mobility, including travel by personal vehicle, transit, micromobility (e.g., electric bicycles and scooters), and ride-sharing services: https://www.transportation.gov/urban-e-mobility-toolkit.

Table of Contents

List of Figures

List of Tables

Introduction

This report provides the city of Brooklyn Park, Minnesota, with an overview of innovative mobility and electric vehicle (EV) deployment options. The current energy transition from fossil-fueled transportation toward zero-emission mobility offers communities across the United States opportunities to provide their constituents with cleaner, more equitable environmental outcomes. As electric mobility increases, reduction of emissions from conventional vehicles (CVs)—fueled by gasoline or diesel—will improve air quality and reduce the related health impacts of air pollution. Furthermore, mobility is critical for increasing equitable access to services and resources such as gainful employment, education, and entertainment. Underserved communities and low-income households typically spend an outsized share of their income on transportation (26.9% of after-tax income, compared to 10.4% for high-income households in 2021 [Bureau of Transportation Statistics 2022]). In addition, the report provides information on transport electrification and how these new mobility offerings can be integrated with low-emission vehicles (including EVs and electric bikes).

The report is organized into two primary chapters. The first provides a foundation in EV technology to illuminate the benefits of the electric mobility options. The chapter describes the advantages of vehicle electrification and how Brooklyn Park residents could most benefit from passenger EVs in the community or navigate incentive policies for purchasing their own EVs. The second chapter moves beyond private EV ownership to the accessibility of electric mobility options. It describes the latest developments in electric mobility options—including electric carshare, e-micromobility, and on-demand services—as enabled by web-connected technologies and the proliferation of smartphones. This report is not meant to present recommendations for Brooklyn Park but rather to serve as a resource to evaluate options to improve mobility in the region.

Vehicle Electrification

Personal EVs provide individual and collective advantages to residents—from lowering the total cost of ownership over the lifetime of the vehicle to improving air quality in the surrounding environment by reducing tailpipe emissions. Currently, 93% of Brooklyn Park households have at least one vehicle (U.S. Census Bureau 2021). Appendices A and B detail types of EV and EV charging infrastructure technologies.

Current EV and Charger Availability

Many common passenger vehicle models can be purchased as a plug-in hybrid EV (PHEV) or battery EV (BEV). PHEVs use a mid-sized battery, typically 10–25 kWh, enabling 10–40 miles of electric range. The battery is supplemented by a gasoline-powered internal combustion engine, so when the battery is depleted, the vehicle continues operating with gasoline. This flexibility can be attractive to vehicle owners with range anxiety (the concern that a vehicle has insufficient range to reach its destination) or in locations where public charging is not available. Common vehicles in this category include the Toyota Prius Prime, Chevrolet Volt (discontinued in 2019), and the Jeep Wrangler 4xe. BEVs have a motor and a large battery (~50–100 kWh), typically enabling 150–350 miles of all-electric range; BEVs are charged by plugging into a household outlet or public charging station. Common vehicles in this category include all Tesla models, the Chevrolet Bolt, and the Nissan Leaf.

Between 2016 and 2022, EV and PHEV vehicle registrations in Brooklyn Park increased an average of 52% year over year; however, they still represent less than 1% of light duty vehicles in the city (see Figure 1).

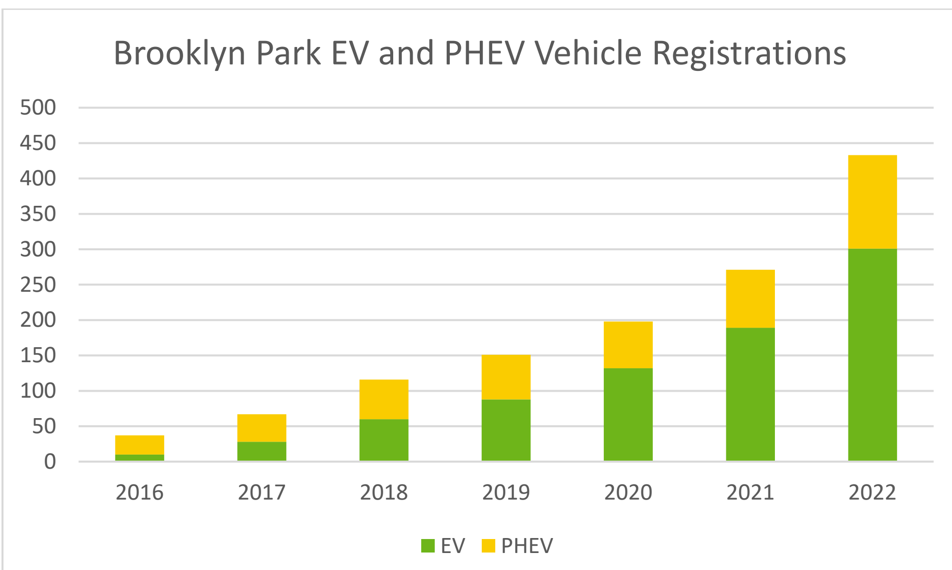

Figure 1. Number of EV and PHEV light-duty vehicle registrations in Brooklyn Park ZIP codes (55428, 55443, 55444, 55445) 2016–2022

Source: Experian Information Solutions and National Renewable Energy Laboratory 2023

Projections indicate that future vehicle models in the United States will trend toward longer-range BEVs. Responding to consumer demand in the United States for larger vehicles, automakers have released 40 electrified SUV models (including PHEVs) since 2018 (IEA 2023). This includes the Ford F150 Lightning, the fully electric version of the most popular vehicle model in the world. The breakdown in model offerings for EVs in the United States is shown in Figure 2.

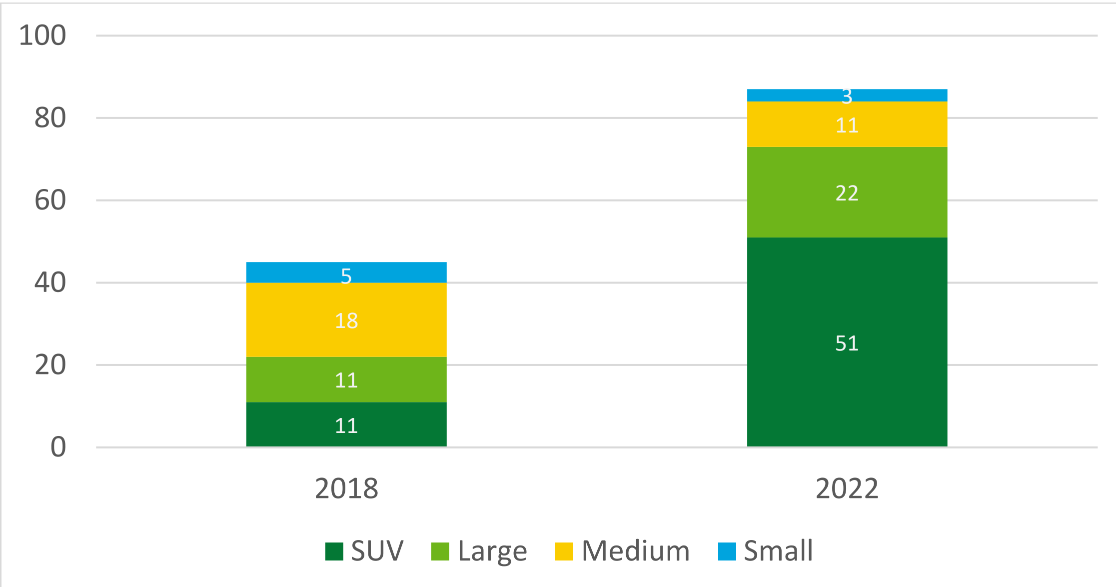

Figure 2. Number of EV models for sale in the United States in 2018 and 2022

Source: IEA 2023

The availability of home charging is a key driver of early EV adoption. At home, an EV owner can charge their vehicle while it is not in use. This can be more convenient for day-to-day driving than stopping at gas stations to refuel a CV. Charging at home generally costs less than using public charging stations, which often incur a service fee. Charging an EV at a lower power level (e.g., at home or public level 2) generally costs less than charging at a higher power level (e.g., DC fast charging [DCFC]) because of the higher cost of providing high-power charging services.

EV charging infrastructure deployment for apartment buildings or other types of multifamily housing can pose unique challenges, including electrical service access, parking access, and installation and operating costs. Although it can be expensive to upgrade electric infrastructure for the building to support multiple EV chargers, these costs can be offset by state and federal incentives. In addition, the installation of charging stations can be seen as an amenity that might attract residents. The construction of new multifamily housing can also be planned with EV charging infrastructure in mind, as it is significantly less expensive to build charging infrastructure during new construction than to add stations to an existing building.[3]

Access to home charging is especially critical in areas with few public stations, such as Brooklyn Park. Figure 3 shows the charging stations active as of May 2023—four of the seven stations are at car dealerships and may not be available for public use.

[3] Additional insights for enabling EV charging at multifamily housing are summarized on the Clean Cities website https://cleancities.energy.gov/project-lessons-multifamily-housing/.

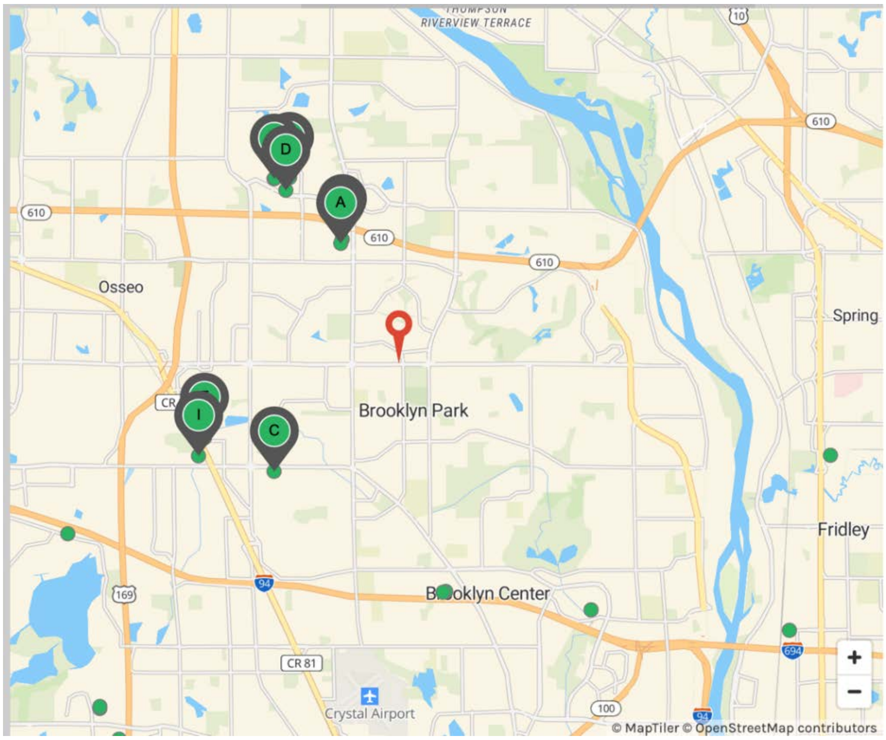

Figure 3. Map of EV charging stations around Brooklyn Park
Source: AFDC 2023a

Curbside charging is another type of EV charging infrastructure that can enable overnight charging for residents of multifamily housing or other vehicle owners without a dedicated parking space and home charger. These chargers can be installed on streets or sidewalks and may be attached to and wired via a streetlight or electrical pole.[4] With flexible installation locations, curbside charging can enable charging at (or near) the home without relying on typical public charging stations or dedicated home-charging availability.

EV Purchase Incentives

New EVs often have a higher average purchase price than similar CVs because of their expensive lithium-ion batteries, though the price of these batteries has decreased significantly in recent years—average battery costs in 2022 are 89% lower than in 2008 (Vehicle Technologies Office 2023). To make EVs more competitive in the marketplace, increase adoption, and reduce emissions from transportation, state and federal governments have enacted financial incentives.

Federal EV Incentives

[4] A range of technical and community considerations for the installation of curbside charging based on previous projects in different U.S. locations is summarized on the Clean Cities website: https://cleancities.energy.gov/project-lessons-curbside-charging/.

A federal tax credit is available for the purchase of certain new or used PHEVs or BEVs. Starting in 2024, the federal tax credit will effectively become a point-of-sale rebate. Before making a purchasing decision, prospective buyers should review the tax incentive qualifications and eligibility requirements. Additional details on these qualification requirements can be found at the Alternative Fuels Data Center[5] or Internal Revenue Service website (IRS 2023).

Qualifications for the up-to-$7,500 new clean vehicle federal tax credit are as follows:

- Vehicle has a battery capacity of least 7 kWh.
- Vans, SUVs, and pickup trucks must have a manufacturer's suggested retail price (MSRP) below $80,000; sedans must have an MSRP below $55,000.
- There are income limits of $300,000 (joint filing), $225,000 (heads of household), or $150,000 (other) above which the buyer does not qualify for the tax credit.
- Vehicles that meet the critical minerals requirement can qualify for half ($3,750) of the tax credit. Vehicles that meet the battery components requirement can qualify for the other half ($3,750). If a vehicle qualifies on both measures, the full $7,500 tax credit applies.

Qualifications for the $4,000 used vehicle tax credit are as follows:

- Vehicle has a battery capacity of least 7 kWh.
- The sale price must be less than $25,000.
- There are income limits of $150,000 (joint filing), $112,500 (heads of household), or $75,000 (other) above which the buyer does not qualify for the tax credit.
- The vehicle must have a model year at least 2 years earlier than the year it is bought.
- The used vehicle must be purchased from a certified car dealer.

Minnesota EV Tax Incentives

In May 2023, the Minnesota legislature approved an energy policy omnibus bill (HF2310) with funding for a similar EV incentive at the state level. Rebate amounts will be up to $2,500 for a new EV and $600 for used. New EV price must be under $55,000, used priced under $25,000. Rebates may be applied at point of sale or lease, and there is a limit of one rebate per person or business per year. The rebate program will be administered through the Minnesota Department of Commerce; a process to administer and apply for rebates is being established (State of Minnesota Congress, House 2023). This law also establishes several other EV-related incentives and programs. First, $1 million in grant funding is available for automotive dealers to offset the costs to obtain necessary training and equipment required by EV manufacturers to certify a dealer to sell EVs. The law also includes a provision requiring state automotive dealers that sell EVs to have at least one employee complete a Minnesota motor vehicle dealership association training course on EVs.

[5] The Inflation Reduction Act of 2022 amended the Clean Vehicle Credit and added a new requirement for final assembly in North America. The amount of the credit will depend on whether the vehicle meets new critical minerals and battery components requirements for vehicles placed in service after April 17, 2023. For more information, visit: https://afdc.energy.gov/laws/409.

EV Charger Incentives

EV adoption is partially hindered by the need for a robust public charging infrastructure network. However, this is a "chicken-or-egg" problem in which demand for charging by EV owners drives investment in EV charging infrastructure, but demand for EVs is partially driven by the availability of public charging. Therefore, the federal government and many states have set up policies to incentivize building public EV charging infrastructure to reach transportation electrification goals.

Federal EV Charging Infrastructure Policies

The federal government has a range of incentives and grant opportunities for EV charging infrastructure deployment that are accessible to communities across the United States. The Alternative Fuel Infrastructure Tax Credit can provide individuals with up to a $1,000 tax credit for the purchase of a qualified home EV charger (AFDC 2023b). The same regulation provides up to a 30% credit for businesses for the installation of alternative fuel infrastructure, including EV charging stations. The 2021 Bipartisan Infrastructure Law and 2022 Inflation Reduction Act created multiple new funding opportunities for EV charging infrastructure.

Two relevant funding programs from the Bipartisan Infrastructure Law are the U.S. Department of Transportation's National Electric Vehicle Infrastructure Formula Program and the Charging and Fueling Infrastructure Discretionary Grant Program.[6] The National Electric Vehicle Infrastructure Formula Program allocated $68 million to Minnesota through a formula over the 5 years of the program (2022–2026) and required an additional $17 million nonfederal match (Minnesota Department of Transportation 2023). Program funding must be used first to deploy DCFCs every 50 miles along designated interstate highway corridors; when those are built out, funds may be used to expand community charging. Minnesota has identified three interstate exits along I-94 near Brooklyn Park at which to install a DCFC station (Minnesota Department of Transportation 2022). Separately, the Charging and Fueling Infrastructure Discretionary Grant Program allocates $2.5 billion nationwide over 5 years to strategically deploy EV charging infrastructure and other fueling infrastructure projects in urban and rural communities in publicly accessible locations. Both programs include provisions that target the deployment of EV charging infrastructure in underserved or disadvantaged communities. The U.S. Department of Transportation allows applicants to identify disadvantaged communities using several tools, including Argonne National Laboratory's EV Charging Justice40 Map Tool (Argonne National Laboratory 2023). Several census tracts in and near Brooklyn Park qualify, as shown in Figure 4.

[6] For more information, see the National Electric Vehicle Infrastructure Program or Charging and Fueling Infrastructure Discretionary Grant Program's website: https://www.fhwa.dot.gov/environment/.

Figure 4. Disadvantaged census tracts identified in the EV Charging Justice40 Map tool

Source: Argonne National Laboratory 2023

Minnesota Charger Incentives

Incentives for the buildout of the charging network also exist at the state level in Minnesota. Rebates and incentives for EV charging infrastructure installation and time-of-use (TOU) rates are provided by several Minnesota utilities, including Xcel Energy and Minnesota Power.[7] In addition, the Minnesota Electric Vehicle Infrastructure Plan highlights the state's commitment to equitably prioritizing the buildout of EV stations, including direct outreach to disadvantaged communities[8] (Minnesota Department of Transportation 2022).

One example of the programs implemented by some utilities is providing a level 2 residential charger to EV owners in exchange for their opting into TOU electricity rates. TOU rates are set up to reflect supply and demand related to the use of electricity in each service area—when demand is high in an area, the price to charge increases—and the price goes down when demand is low. The TOU mechanism is used to reduce the impact on the electrical grid from EV charging but can also reduce the cost of residential charging for individual EV owners if they have flexibility in the time they charge their vehicle as well as awareness of the rate structure. A generalized TOU rate structure from Xcel Energy is shown in Figure 5.

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[7] More detail on these Minnesota incentive programs, including income-qualified rebates, can be found at the Alternative Fuels Data Center's laws and incentives database: https://afdc.energy.gov/laws.
[8] Minnesota's Electric Vehicle Infrastructure Plan details where and how the state will deploy National Electric Vehicle Infrastructure Formula Program-funded stations: https://www.dot.state.mn.us/nevi/.

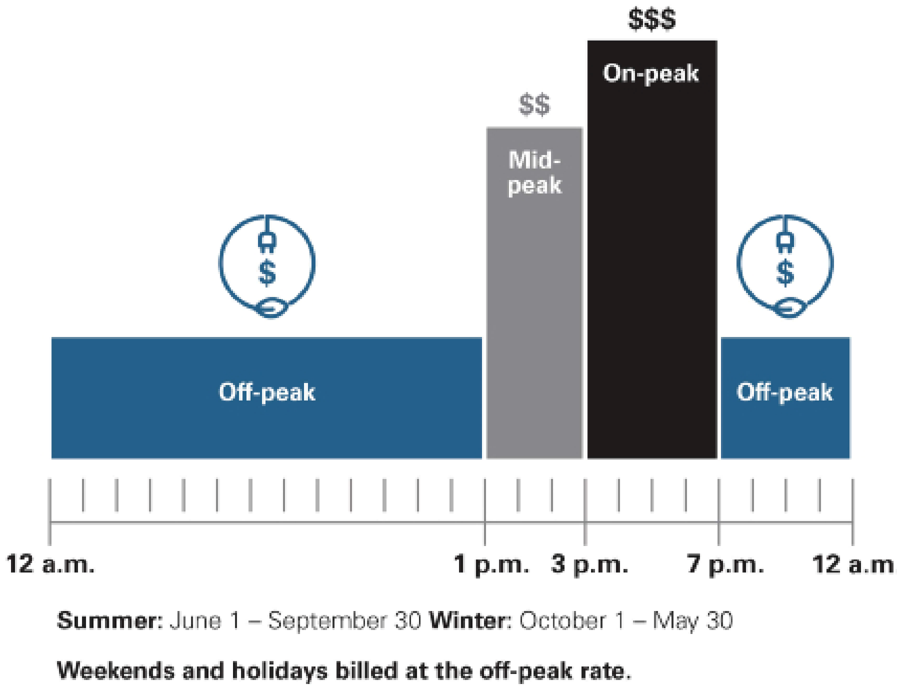

Figure 5. Xcel Energy sample TOU electricity pricing

Source: Xcel Energy 2023

Benefits of Vehicle Electrification

Several environmental benefits are associated with vehicle electrification that are driving the international transition from fossil fuel-based transportation to EVs. However, there are also benefits to the EV owner.

Emissions Reductions

Two types of emissions are produced by fossil fuel CV travel: 1) greenhouse gas emissions such as carbon dioxide (also more generally called carbon emissions) that contribute to global climate change and 2) local pollutants (such as sulfur dioxide) linked to adverse local health effects if above the recommended concentration. The quantity and mix of emissions produced vary based on the vehicle and fuel type; more recent model years produce less of both emissions per mile than older vehicles because of advances in combustion engine technology.

In contrast, vehicles driven using electricity do not produce tailpipe emissions. The American Lung Association estimates that a transition to 100% electrified passenger vehicle sales and renewable energy by 2035 could result in $1.2 trillion in accumulated public health benefits between 2020 and 2050 (American Lung Association 2022). Although no emissions are produced by driving the vehicle, the production of the electricity required to charge the EV battery produces greenhouse gas emissions—as do the supply chain, manufacturing, and disposal processes associated with vehicle production and discard. However, driving an EV results in far fewer emissions on a per-mile basis because of the transition toward renewable electricity generation and because EVs are much more efficient in their conversion of electricity into forward motion. As the grid relies less on fossil fuels for electricity production, the emissions associated with driving EVs will continue to decrease. Projections of the life cycle emissions from driving internal combustion engine vehicles, hybrid electric vehicles (HEVs), PHEVs, or BEVs under two scenarios are shown in Figure 6.

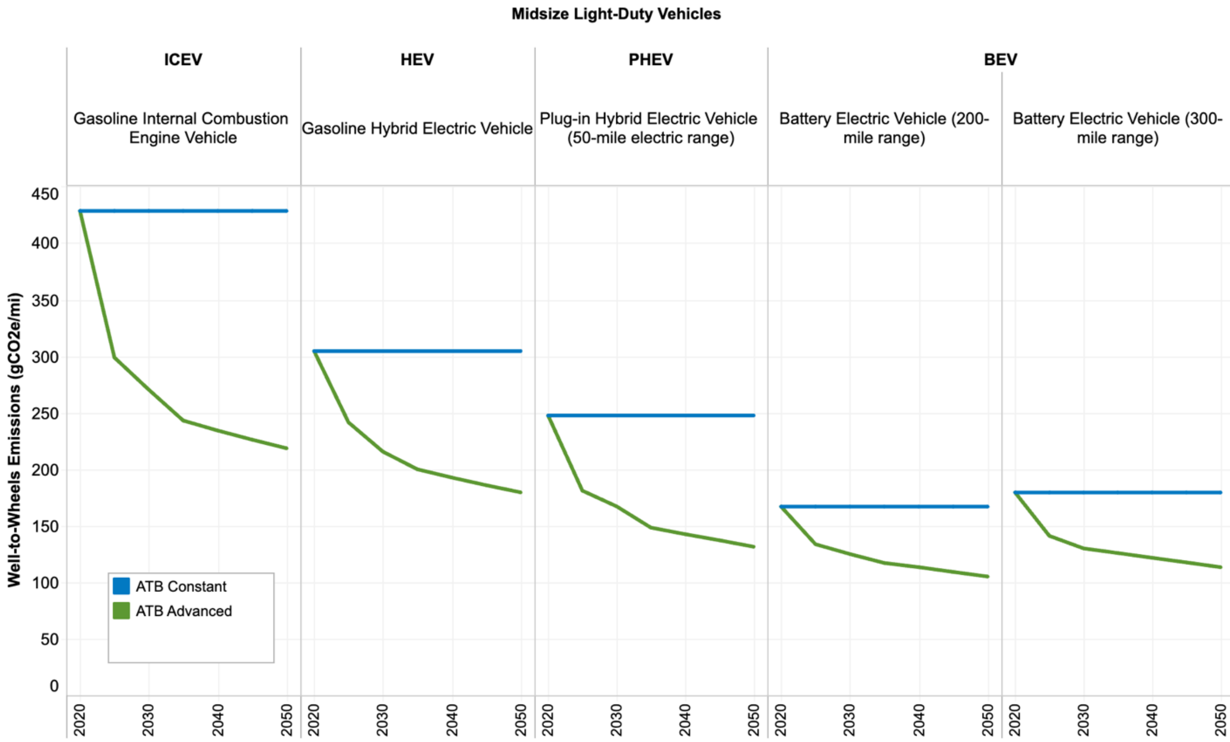

Figure 6. A projection of the emissions from the transportation Annual Technology Baseline (ATB) in which technology and electricity generation mix does not change and an advanced Annual Technology Baseline scenario in which electricity generation transitions rapidly toward renewable sources and engine technology continues to improve.

Source: NREL 2020

Cost of Vehicle Ownership

Short-range (~200-mile) BEVs and HEVs generally have a lower cost of ownership than CVs. Although they have historically had a significantly higher upfront purchase price, their lower maintenance and operating costs can offset the higher purchase cost over the lifetime of the vehicle. A long-range 300-mile BEV averages $0.048 and $0.050 per mile for maintenance and fuel costs, respectively, while a gasoline CV averages $0.094 and $0.087 per mile for maintenance and fuel (Burnham et al. 2021). When the purchase price of the vehicle is included to calculate the total cost of vehicle ownership, a long-range BEV (300 miles+) is more expensive on a per-mile basis over its lifetime for private ownership ($0.516/mile compared to $0.473/mile for a CV), yet battery prices are expected to continue to decline and significantly reduce the purchase price of long-range BEVs. In comparison, BEVs with smaller batteries (~200-mile range) are already less expensive to own over their lifetime than CVs ($0.451/mile vs. $0.473/mile).

More details on the cost breakdowns for vehicles across different powertrains for the vehicle lifetime and on a per-mile basis are listed in Table 1 and Table 2. As mentioned, much of the cost savings that offset the higher purchase price for BEVs are realized through lower operating costs. These cost savings are realized faster for highly used vehicles, making EVs attractive for replacing CVs used as taxis or delivery vehicles that are driven much more than the average number of miles per year. Although the average private vehicle in the United States is driven 13,476 miles/year (varying across the country based on the age of the vehicle, the driver, and the location [FHWA 2022]), some vehicles are driven two to three times as much annually—these vehicles will have the shortest payback period when investing in an EV vs. a CV.

Table 1. Projected Total Lifetime Costs of Ownership for a 2025 Model Year Small SUV

Source: Burnham et al. 2021

Lifetime Costs	CV	HEV	PHEV50	BEV200	BEV300
Vehicle	$26,051	$27,419	$34,505	$37,621	$46,031
Financing	$2,884	$3,019	$3,584	$3,818	$4,672
Fuel	$17,488	$12,433	$11,981	$8,770	$9,254
Insurance	$13,289	$13,376	$12,667	$12,349	$12,870
Maintenance	$16,302	$14,518	$13,968	$8,920	$8,920
Repair	$6,990	$6,543	$6,959	$5,694	$6,808
Tax and Fees	$5,244	$5,460	$6,356	$6,991	$7,741
Total	$88,248	$82,768	$90,020	$84,164	$96,295

Table 2. Projected Lifetime Costs of Ownership for a 2025 Model Year Small SUV on a Per-Mile Basis

Source: Burnham et al. 2021

Per- Mile Costs	CV	HEV	PHEV50	BEV300	BEV200
Vehicle	$0.140	$0.147	$0.185	$0.247	$0.202
Financing	$0.015	$0.016	$0.019	$0.025	$0.021
Fuel	$0.094	$0.067	$0.064	$0.050	$0.047
Insurance	$0.071	$0.072	$0.068	$0.069	$0.066
Maintenance	$0.087	$0.078	$0.075	$0.048	$0.048
Repair	$0.037	$0.035	$0.037	$0.037	$0.031
Tax and Fees	$0.028	$0.029	$0.034	$0.042	$0.037
Total	$0.473	$0.443	$0.482	$0.516	$0.451

Note: Green cells show lower costs; red cells show higher comparative costs.

These values can also vary based on the charging behavior of the vehicle owner and differences in other assumptions. Researchers have estimated that savings in fuel costs from a CV to a BEV can vary from $555 to $16,141 over the lifetime of the vehicle based on the cost of charging equipment, the annual miles driven, the price of gasoline, and the price of electricity (Borlaug et al. 2020).

The Carbon Counter tool shown in Figure 7 is useful for evaluating differences across powertrains in terms of their carbon emissions and cost of ownership. The inputs can be changed to reflect the conditions in the state in which the vehicle is operating, including fuel prices, electricity prices, sales tax, how carbon-emission-intensive the electric grid is, and whether federal or state tax incentives for EV purchases apply. The screenshot shown is customized across these parameters for Minnesota. As an example, the Tesla Model 3 Performance BEV is highlighted (#1 red dot) and has one of the lowest carbon emissions per mile of any vehicle model. This can be compared to dot #2, the Tesla Model S Long Range Plus, which is also relatively efficient but has a high purchase price—which pushes it far to the right on the x-axis (cost per month). Finally, the Nissan Leaf is highlighted as dot #3 and has a lower purchase price than the Model 3. Note that some of the values in the tool shown will differ from those shown in Table 1 and Table 2 based on differences in assumptions. Finally, there are two dotted lines showing the 2030 and 2040 emissions targets for average vehicle on the road in the United States. Although almost every BEV falls below the 2030 target shown, the penetration of renewables in the electric grid must increase and/or other life cycle emissions must decrease (e.g., through smaller, more-efficient vehicle sizes) for more of these vehicles to meet the 2040 target.

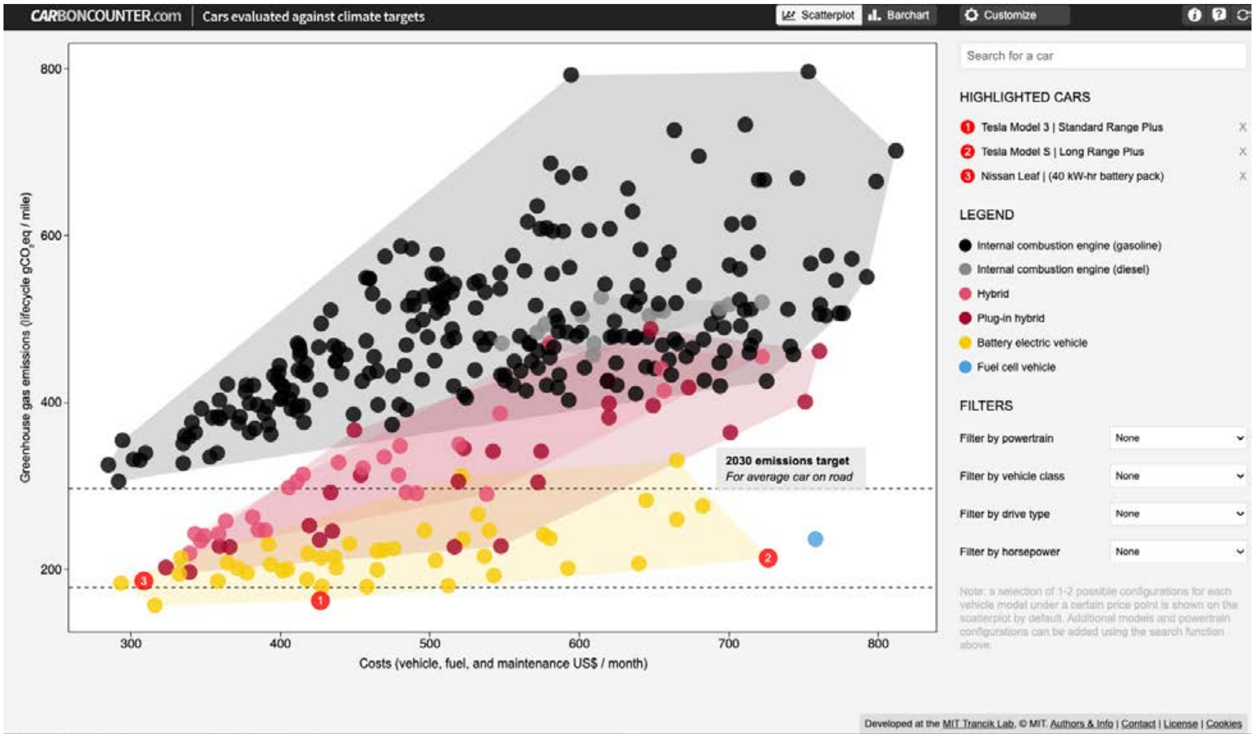

Figure 7. Screenshot from the CarbonCounter.com tool, which can be used to evaluate the greenhouse gas emissions and cost of ownership ($/month) for a range of vehicle models and powertrains.

Source: Miotti 2021

Increasing Mobility for Residents

In 2022, Hennepin County approved an extension of the Blue Line Metro out to Brooklyn Park. This project would enable a direct transit trip for residents for shopping trips at stores in Brooklyn Park, downtown Minneapolis, and the airport—significantly increasing access to the city's offerings, including employment and entertainment. Five Brooklyn Park stations at the end of the Blue Line are planned for construction by 2027. Although those stations could easily be reached with a private car, prioritizing other options for first- and last-mile access would improve accessibility for residents without reliable access to a car. The options outlined in this section focus on increasing access to mobility within Brooklyn Park, including greater accessibility to the new Metro stations when they are completed (Figure 8). Although walking is not included in the modes of transportation detailed next, safe pedestrian access to and from the Metro stations and surrounding destinations will be critical to ensuring that all Brooklyn Park residents can use this new transit option.

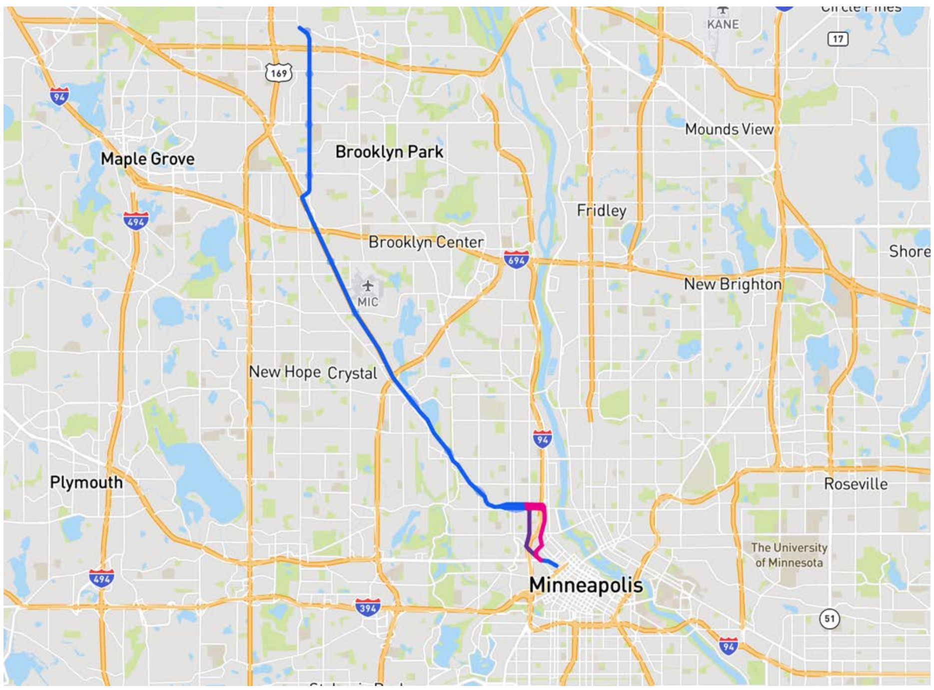

Figure 8. Planned route for the Blue Line Metro extension with five stations at the end of the line located in Brooklyn Park

Source: Kimley Horn 2023

Electric Carshare

There are significant mobility benefits to the deployment of carshare operations, as demonstrated by the proliferation of ZipCar and other carshare vehicle providers in cities across the country over the past two decades. High-utilization vehicles, such as shared cars, are great targets for electrification because of lower operating and maintenance costs, less-frequent maintenance, and a greater displacement of potential emissions from high annual mileage. Two main operational models exist for carshare: round-trip services (in which shared cars are accessed and returned to a centralized hub or charging station) and one-way services (in which shared cars are accessed and returned anywhere within a defined service area). Electrified carshare programs can provide supplemental mobility, especially in areas with lower personal vehicle ownership (Litman 2015). Local ownership, control, and/or support of carshares can increase the odds that the services are targeted toward increasing mobility for community members who will benefit the most. These services have grown in popularity across the United States in a variety of communities.[9]

In addition to the benefits to the service itself from vehicle electrification, EV carshare can kickstart the buildout of new EV stations in an area, further enabling private EV adoption. Carshare vehicles are also highly visible to the public, frequently decorated with clear branding and driven by various users. Therefore, EV carshares can build consumer awareness of vehicle electrification and provide an opportunity to experience driving and charging them outside of a car dealership or ride-and-drive event.

EV Carshare Examples

Evie Carshare (St. Paul-Minneapolis)

The cities of St. Paul and Minneapolis have owned a floating EV carshare program, Evie Carshare, since February 2022. The service is operated by HOURCAR, and vehicles can be driven without restriction if they are returned to a parking space inside the 35-square-mile home zone (HOURCAR 2023a). The vehicle fleet comprises 150 Chevrolet Bolt and Nissan Leaf BEVs and can charge at Evie-branded stations, which can also be used by the public to charge personal EVs (Figure 9). In months 3–6 of operations, the fleet averaged 1.7 trips per day (Streets.mn 2022). If this service area expanded to Brooklyn Park, residents could take one-way car trips into downtown Minneapolis without owning a personal car. This access to the city could be especially desirable while the Blue Line extension project is in progress. Of note, the Access Plus rate plan establishes a significantly discounted membership rate for income-qualified users (household income 50% or less of the Area Median Income) (HOURCAR 2023a). HOURCAR also runs a program called the Multifamily Electric Vehicle Carshare Pilot Project to install charging hubs and provide carshare services for qualified low-income multifamily housing units (HOURCAR 2023b). The Evie-branded charging stations, Evie Carsharing Service, and the Multifamily EV Carshare Pilot were funded, in part, by the Department of Energy's Vehicle Technologies Office through the FY 2020 competitive Funding Opportunity Announcement (DOE 2022).

[9] Additional lessons learned from past EV carshare projects are summarized on the Clean Cities Coalitions website with recommendations for program models, vehicle and charging stations, equity, and community engagement: https://cleancities.energy.gov/project-lessons-car-share/.

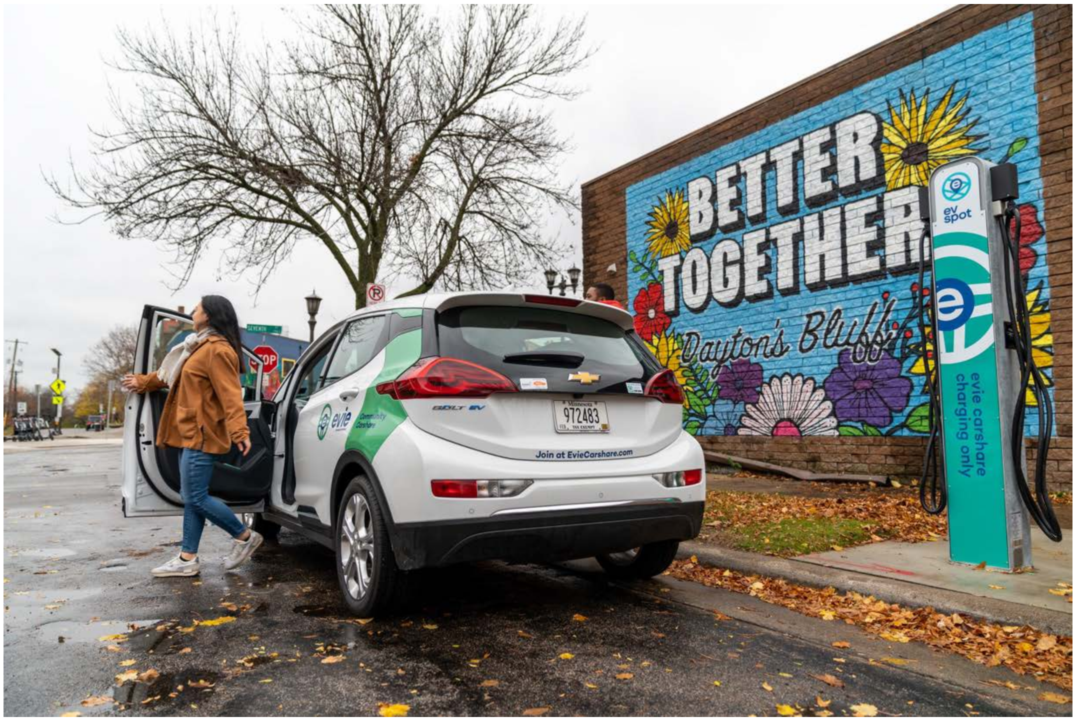

Figure 9. An Evie Chevrolet Bolt preparing to charge at a public Evie charging station.

Photo from Evie Carshare

Colorado CarShare (Denver/Boulder)
The Colorado CarShare service is a nonprofit based in Denver and Boulder, Colorado, that allows customers to select from multiple membership plans and select from a range of vehicles, including HEVs and BEVs, parked around the downtown urban cores (Colorado CarShare 2023). Low-income residents registered in a qualified affordable housing program can also receive significantly subsidized rates. Colorado CarShare has prioritized low-income access to its membership and piloted multimodal benefits for low-income residents, such as combining CarShare memberships with transit passes.

BlueLA (Los Angeles)
BlueLA is an electric-car-sharing service based in Los Angeles and operated by Blink Mobility (owned by Blink Charging) with 40 vehicle pickup and drop-off locations around the city (Blue LA 2023). The service began in 2018 based on a grant from the California Air Resources Board and serves disadvantaged communities around Los Angeles. Membership is $5/month plus $0.20 per minute of vehicle use for standard customers, and income-qualified customers can be members for $1/month and $0.15/minute; 3- and 5-hour rental pricing is also available without membership requirements.

BlueIndy (Indianapolis)
The BlueIndy electric carshare program operated from 2015 to 2020 in downtown Indianapolis, Indiana, but failed to continue because of a lack of subscriptions and issues related to customer service quality. The carshare program began with 50 BEVs, 25 charging stations, and 125 charging ports before expanding to 280 vehicles and 85 charging stations by 2017 (Hwang and Hays 2019). The service was priced at $8 for 20 minutes of driving plus $0.40 for each minute beyond 20 for nonmembers, or $9.99/month to become a member and benefit from a 50% discount. The service had 11,000 users and 180,000 rides while it was active.

On-Demand Services

With the rapid development of connected technologies over the past decade, there has also been a boom in the spectrum of transportation options. Ride-hailing, where a vehicle can be hailed via a smartphone app, is an example of on-demand transportation service. Uber holds the largest market share in ride-hailing globally with 7.6 billion trips in 2022 (Uber 2023a); Lyft is its main competitor in the United States. Because of the relatively high expense per trip and negative externalities, such as traffic from “deadhead miles” when vehicles are driven without a passenger, pure ride-hailing is not the optimal transportation option for daily use.

However, innovative ride-hailing case studies are emerging that might provide sustainable, scalable, and affordable transportation. These options are also known as “microtransit” for their strategic use of smaller vehicles than typically used in traditional “fixed-route” transit, where buses are on a set route and schedule. In an optimized microtransit system, vehicles are in use only when requested for a trip, the system can operate more efficiently than ride-hailing because all trips can be pooled (whereas traditional ride-hailing allows for private rides), and vehicles are right-sized based on demand. These types of services tend to be highly utilized, maximizing the benefits of electrified transportation.

This section describes on-demand microtransit service designs that could be applied in Brooklyn Park to offer residents affordable mobility and first-/last-mile connections to the upcoming Blue Line stations.

Wilson, North Carolina, Microtransit

The RIDE service in Wilson, North Carolina, began in September 2020 as a replacement for a fixed-transit service and provides subsidized on-demand trips for the city’s 50,000 residents (City of Wilson 2022). The service is managed by the mobility software platform Via, and residents can request a trip from a city-owned minivan through the RIDE app on their phone, booking on the web or by phone (Via 2023). The service operates from 7:30 a.m. to 5:00 p.m. Monday–Friday and 7 a.m. to 6 p.m. Saturday, providing trips for $2.50 with discounts for qualified residents. Riders are required to opt in to having their trips pooled, increasing the efficiency per trip and lowering operational overhead costs to town without lowering the quality of service.

Since its inception, RIDE has grown significantly while meeting more than 95% of requested trips across all but 3 months of its operation (Figure 10). The city also conducted a survey in 2022 (91 participants) and found that more than half of respondents had incomes below $25,000 and that 86% did not have access to a personal vehicle (Jones 2022). Based on these metrics and on user feedback, the RIDE service has successfully provided quality mobility service for residents. The service was established with funding from the Federal Transit Administration’s (FTA’s) Accelerating Innovative Mobility Fund and has since secured funding for continued operation and expansion from additional sources, summarized on the Shared Use Mobility Center website (SUMC 2023; FTA 2021). Independence from these one-time grant funding sources is cited as one of the largest challenges for the service.

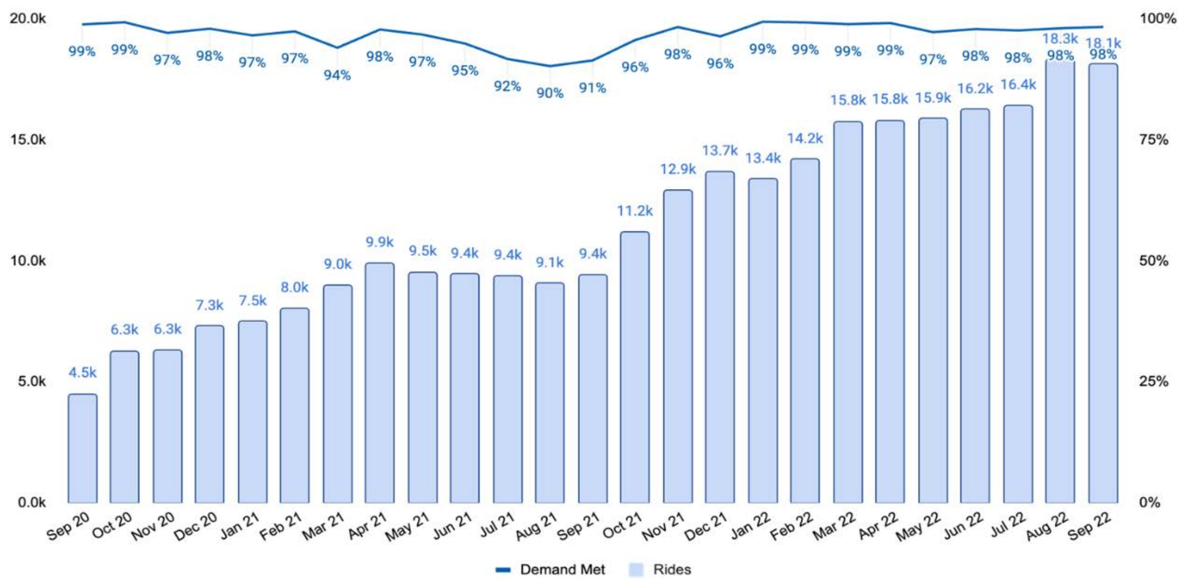

Figure 10. Number of rides per month and percentage of trip demand met by the RIDE platform from its inception through September 2022.

Source: Jones 2022

Innisfil, Ontario, Uber Partnership

Innisfil, Ontario, is a relatively low-density town of 40,000 residents approximately 100 km north of Toronto. The town was considering implementing a one- or two-bus fixed-transit system for residents but decided to partner with Uber to provide subsidized on-demand trips. Innisfil Transit, as the service was named, began in 2017 and operated similarly to the standard Uber app, with gig workers driving their own vehicles and paid/coordinated using Uber's algorithm. Innisfil Transit can be used through its dedicated smartphone app or a toll-free phone number and offers residents a maximum of 30 rides per month for $4–$6 to key destinations or a fare subsidized by $4 to other destinations. Eligible riders can also benefit from a 50% discount on Innisfil Transit fares.

One of the most significant differences between the operation of the standard Uber service and Innisfil Transit is that all riders must opt in to having their rides pooled (although not every trip will be matched for pooling). Innisfil found that prior to the COVID-19 pandemic (November 2019), more than 50% of trips were pooled—significantly higher than the 17% match rate for traditional ride-hailing operations in Chicago, despite the larger city's higher population density (Weigl et al. 2022). Analysis of Innisfil Transit performance compared to estimated bus system performance found that the partnership with Uber resulted in significantly higher quality of service at a lower cost and with reduced emissions per trip. These benefits will extend further when all Uber vehicles are electrified, based on the company's commitment to 100% EVs on the platform by 2030. In addition, and in contrast to the United States, Uber drivers in Canada are beginning to receive some level of benefits with the job (United Food and Commercial Workers Canada 2023).

Dallas Area Rapid Transit (DART) First- and Last-Mile Solution

This transit implementation is an FTA mobility on-demand demonstration project. The effort was initiated to connect missing links in the Dallas/Fort Worth bus network while maintaining service frequency with a rapidly expanding regional population. The primary change in DART service involved integrating the region's on-demand shuttle service GoLink Uber into the DART app. The service is also integrated with Uber, and riders can be automatically matched with an Uber or GoLink vehicle based on availability. This helps seamlessly connect riders to transit stops with first-/last-mile pooled rides. According to Uber, the GoLink service is now North America's largest operating example of microtransit (Uber 2023b). Findings during evaluation of the initial few years of these changes indicated improved customer satisfaction with DART (as seen in Figure 11), on-demand costs competitive with low-ridership fixed-route bus service, and additional benefits in terms of accessibility for disabled riders and first-/last-mile connectivity (Martin et al. 2021).

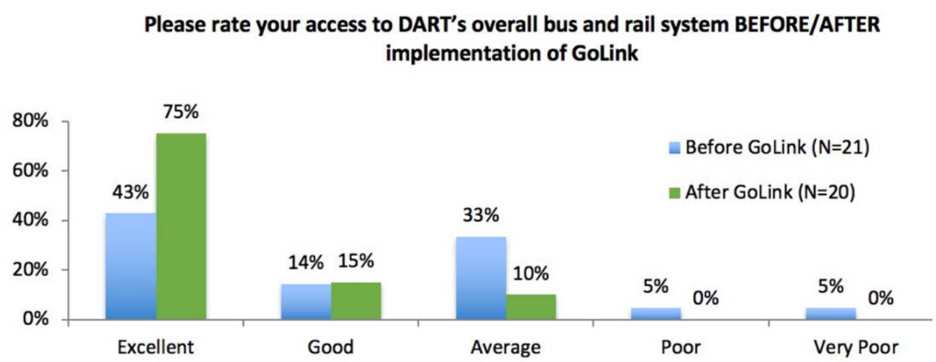

Figure 11. Reporting on the satisfaction of users with mobility devices for their access to DART services before and after the start of the GoLink on-demand shuttle integration.

Source: Martin et al. 2021

Implications for Brooklyn Park

Metro Transit is running a 1-year pilot program for on-demand microtransit using five mini buses in a small service zone at the north end of Minneapolis (Metro Transit 2023). Trips can be ordered through the Metro Transit app or by phone and cost the same as a bus trip. Although the service area is near downtown Minneapolis and may have different operating requirements, this demonstration project could help inform a similar pilot for Brooklyn Park.

Although Innisfil and Wilson both have much lower population density than Brooklyn Park (200–400 vs. ~3,300 residents per square mile, respectively), these case studies suggest that on-demand transit service could play a role in Brooklyn Park addressing mobility accessibility challenges. Partnership with an on-demand service provider in Brooklyn Park could supplement existing transit to expand hours, service area, and frequency. Implementing an on-demand service in Brooklyn Park with appropriately sized vehicles and pooled rides could affordably and efficiently improve mobility access.

Additional findings from the 11 mobility on-demand Sandbox projects run by FTA are summarized in its report (Martin and Shaheen 2023). The primary takeaways from this investigation relate to the benefits realized following the implementation of on-demand mobility as well as the challenges communities faced and the lessons learned. The reporting on these projects is extensive and would well inform planning an on-demand service for Brooklyn Park.[10]

Electric Micromobility Opportunities

Electric micromobility includes the use of small vehicles and active transportation such as bicycles, electric scooters, e-bikes, and small mopeds. These vehicles could be privately owned, part of a shared network using docking stations, or free-floating and unlocked using a smartphone app. Micromobility is best used for short trips within the service area (approximately 3 miles or less, though longer with e-bikes), enabling convenient and affordable first- and last-mile connections to the planned new Blue Line extension stations in Brooklyn Park. Travel with e-micromobility also produces few emissions; active transportation (such as biking or push scooters) can also have health benefits, reduce traffic and car noise, and reduce demand for parking if the trips would otherwise have been made in a CV.

The National Association for City Transportation Officials (NACTO) released a guide for implementing shared micromobility with recommendations for ensuring appropriate investment in infrastructure (such as docking stations and safe routes), equitable access to service considering underserved communities, operational requirements, and public engagement, among other topics. The document highlights recommended best practices and would be useful for planning the expansion of both shared and private e-micromobility in Brooklyn Park.[11] NACTO also keeps statistics on micromobility usage over time, with the latest data from 2020 to 2021 showing the change in average trip price, distance, and duration from 2018 to 2021 (Figure 12). These averages can be useful for selecting the type of micromobility used in an area and guiding expectations for how those vehicles might be used. For example, docked pay-per-ride bikeshare services are most attractive for longer trips because of their relatively low cost, whereas dockless services (bike or scooter) are more convenient for shorter trips despite the higher cost per mile.[12]

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[10] Additional lessons learned from 11 mobility on-demand projects run by FTA are summarized on the FTA website: https://www.transit.dot.gov/research-innovation/mobility-demand-mod-sandbox-program.

[11] NACTO's Guidelines for Regulating Shared Micromobility outlines best practices for cities and public entities regulating and managing shared micromobility services on their streets: https://nacto.org/sharedmicromobilityguidelines/.

[12] Design guides such as NACTO's Bike Share Station Siting Guide or Urban Bikeway Design Guide may be useful when implementing micromobility-friendly infrastructure https://nacto.org/publications/#design-guides-design-guidance

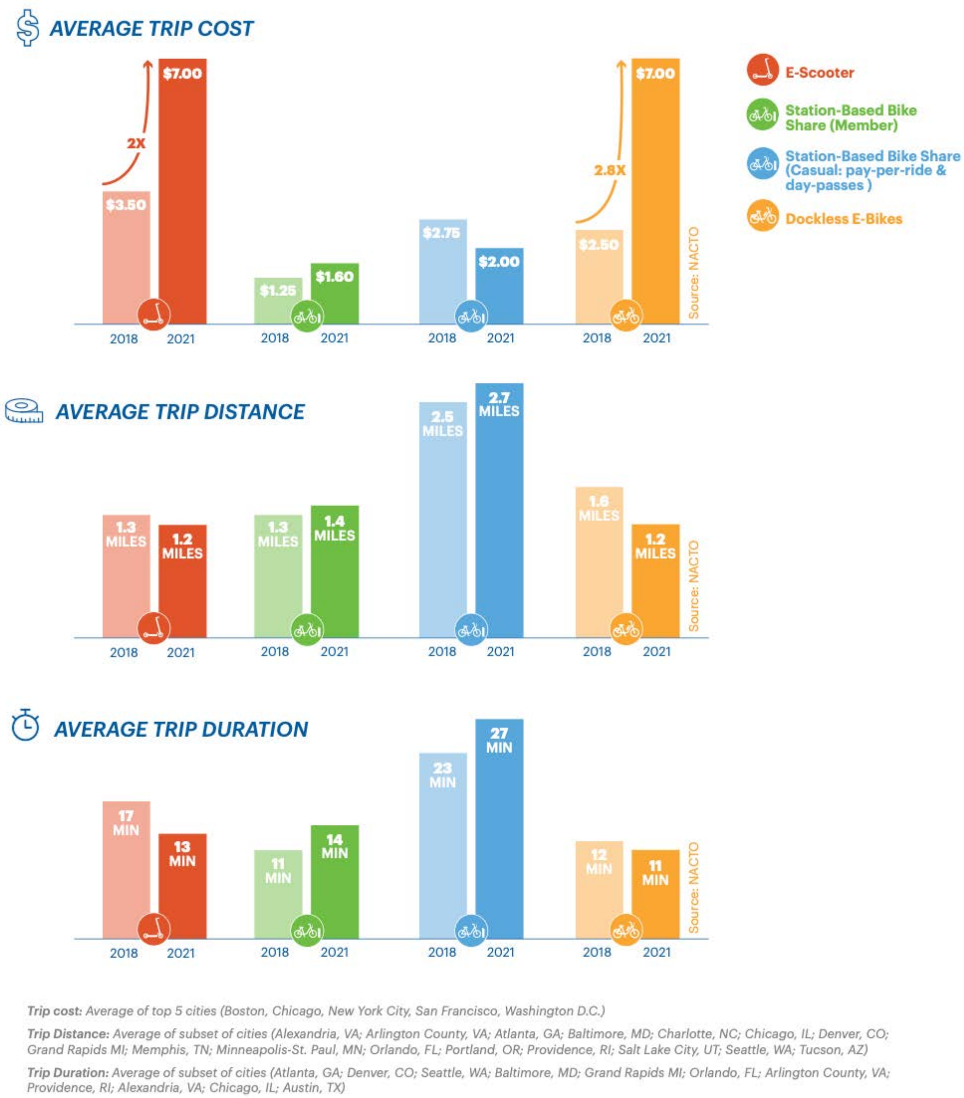

Figure 12. Average statistics for shared micromobility trips in 2018 and 2021 across some of the largest urban deployments in the United States.

Source: NACTO 2022

Shared Micromobility and Bird Scooters in Brooklyn Park

Starting in 2021, Brooklyn Park contracted with Bird to deploy 25 shared electric scooters around the city for use within the city boundary. Although Bird filed for bankruptcy in December 2023, resulting in the removal of Brooklyn Park's only shared micromobility service, lessons can inform deployment of future services. Usage statistics from summer and fall 2021 showed that 65% of trips started and/or ended north of Highway 610, suggesting that there are more users on the north side of the city where there is a higher median household income (Brooklyn Park 2022). Reasons for this concentration of trips could include the barrier of the 610 Highway making north-south trips much more difficult (with just 4.5% of trips making a crossing, as seen in Figure 13) or the nightly rebalancing of scooters being skewed toward the north side of the city. Holding stakeholder engagement meetings or providing an online portal to solicit feedback on the most critical areas for developing safer infrastructure for travel by micromobility (such as dedicated cycle tracks and protected bike lanes and intersections) could also make these types of trips more attractive for all Brooklyn Park residents.

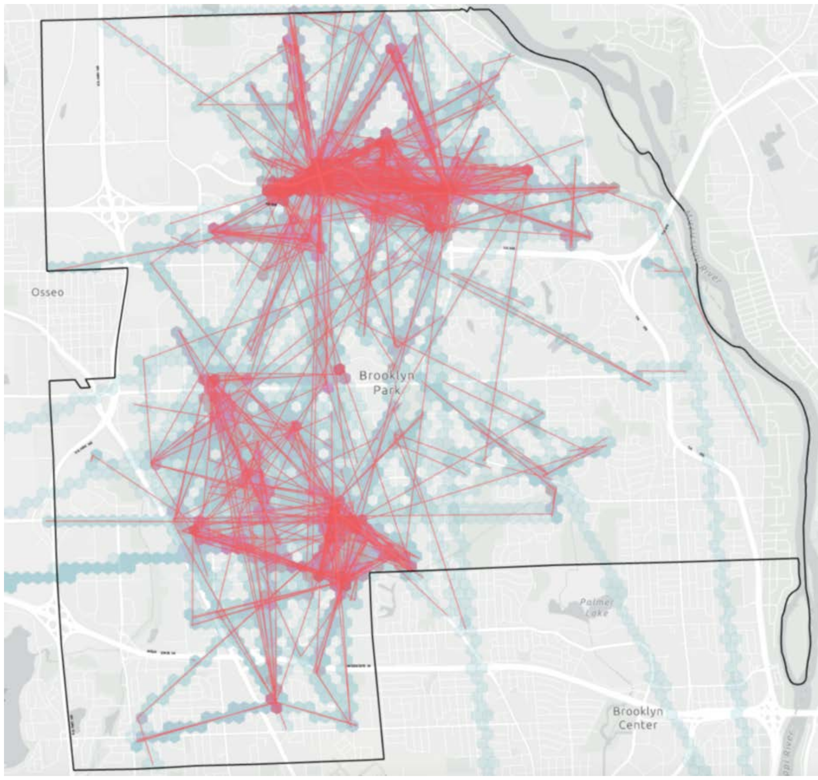

Figure 13. Start and end points of Bird scooter trips in Brooklyn Park from July to November 2021.

Source: Brooklyn Park 2022

Research has also shown that shared micromobility is most frequently used by those with college educations, middle- to high-income, aged 21–45 years old, without children, and with limited car access (Shaheen, Cohen, and Broader 2022). It would be useful to learn more about the usage patterns of other demographic groups in Brooklyn Park (specifically residents on the south side of Highway 610) through the data set shared by Bird or targeted surveys/interviews. Those learnings could be applied to strategically shift the service structure and provide education or other resources. For example, ensuring that qualified low-income residents are aware of the 50% trip discount could help lower the barrier to adoption for that demographic group. As mentioned in the city's study from the first 4 months of service, the city could require that Bird's nightly rebalancing of scooters distribute some share (e.g., 50%) of scooters in low-income areas (Brooklyn Park 2022).

Shared e-micromobility in Brooklyn Park could also grow with the introduction of new services. As shown in Figure 12, different types of shared vehicles can lend themselves to different travel patterns with trade-offs between cost, convenience, speed, and effort (electrified vs. conventional bicycles, for example). Deployment of these services in tandem with neighboring cities could also maximize connections and enable car-free travel from those cities to the Blue Line stations planned for Brooklyn Park.

Private Electric Micromobility

Safety improvements, the expansion of protected bike lanes, signage, transit integration, and education campaigns will make private e-micromobility more attractive. Research has shown that shared micromobility users place the highest value on the cost and convenience of services, which can be maximized by those who own their bike or scooter (unless a one-way trip is more convenient) (Fishman, Washington, and Haworth 2013). Therefore, private ownership can be an attractive option. The same study found that most micromobility trips replaced trips by sustainable modes such as transit or walking, but that is perhaps less likely to be the case in Brooklyn Park—where most trips are car-based. Separate research in Portland, Oregon, indicates that the use of e-bikes may significantly reduce carbon emissions by shifting travel away from cars (McQueen, MacArthur, and Cherry 2020).

Although e-bikes offer an additional level of convenience for the rider, the upfront cost can be a challenge. However, in May 2023, Minnesota approved a transportation omnibus bill (HF2887) that includes an electric-assisted bicycle rebate (Minnesota Legislature 2023). This rebate is modeled after a similar e-bike rebate program in Colorado. The bill establishes rebates of 75% of eligible expenses up to $1,500 for the individual purchase of e-bikes; the rebates will be available through June 30, 2026. An eligible individual may apply to the commission for a rebate certificate to use at eligible retailers. The rebate includes income-based requirements that must be met to qualify for the maximum rebate amount:

- 75% of expenses is reduced by 1 percentage point (down to a minimum of 50%) for each $4,000 of the eligible individual's adjusted gross income more than $50,000 for a married taxpayer filing jointly and $25,000 for all other filers.
- Rebates are available beginning July 1, 2024, on a first-come, first-served basis; 40% of certifications are reserved for low-income taxpayers (married filing jointly with adjusted gross income less than $78,000 or any other filer with adjusted gross income less than $41,000).

According to the legislation, a qualifying individual applies to the commissioner of transportation for the rebate and then assigns the rebate certificate to an eligible retailer at the time of purchase. Rebate certificates must be used within 2 months of the certificate's issue date and cannot be transferred to other individuals. Eligible retailers must reduce the price of the electric-assisted bicycle by the rebate amount at the time of sale. These retailers then can apply to the commissioner for the rebate amount within 1 month of the date of sale. The process for an individual to apply to the commission for rebate certificates and for eligible retailers to receive the rebate from the commissioner is still being established at the time of report publication.

Denver, Colorado, began offering a similar annual rebate program for e-bike purchases in April 2022, where city residents can receive $300 toward the purchase of an e-bike or $500 toward an e-cargo bike. Income-qualified residents can receive rebates of $1,200 or $1,400 for an e-bike or e-cargo bike, respectively. The program is funded through the city's Climate Protection Fund and has been wildly popular, with the waivers claimed quickly and more than 5,500 e-bikes purchased. Of those who purchased e-bikes through the program (of whom 67% were income-qualified) and responded to a follow-up survey, 65% rode their bike daily and 90% rode weekly (City of Denver 2023). The average trip length was 3.3 miles compared to an average of 1.6 miles for the city's shared e-bike system over the same period. This finding gives some credence to different use cases for private vs. shared micromobility. At the national level, the E-BIKE Act, proposed March 2023 in the United States Congress, would provide up to $1,500 in tax credits for the purchase of qualified e-bikes if it is passed (Panetta 2021). This program would function similarly to the tax credits for EV purchases described previously.

Mobility Education and Equity

The mobility policies, programs, and methods outlined in this document would all benefit Brooklyn Park residents while potentially reducing traffic congestion, carbon emissions, local pollutant emissions, and income spent on mobility. However, the programs are less effective if residents are not aware of their existence or how to best take advantage of them.

The Center for Neighborhood Technology estimates that households should spend at most 45% of their income on housing and transportation combined and offers tools to calculate those costs for neighborhoods to evaluate trade-offs (CNT 2018). With mobility closely linked to gainful employment—and disadvantaged and low-income households typically spending an outsized share of money and time on transportation—it is important to inform those groups of new mobility options that might reduce that time or cost burden. Low-income households are also less likely to have a private vehicle available for use by each adult (Figure 14).[13]

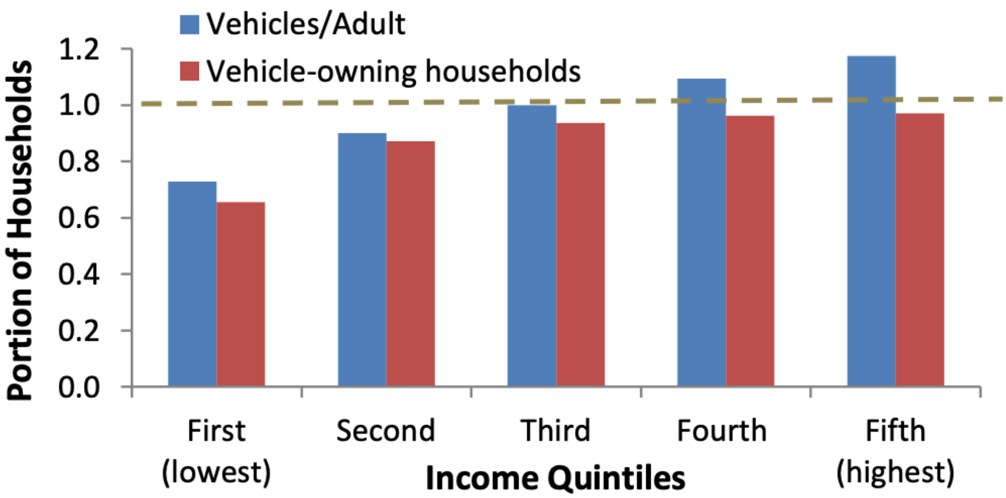

Figure 14. Measure of vehicle ownership level by income bracket (quantile).

Source: Litman 2023

Consumer awareness programs for EVs—including how they operate, their benefits over CVs at global and local levels, and their capabilities and reliability as personal vehicles—are key components driving early EV adoption (Jin and Slowik 2017). A common form of EV education is a ride-and-drive event where government fleet EVs or private vehicles from volunteer owners are shown and the public can ask questions, sit in the vehicles, and learn how EV ownership compares to CV ownership. Studies have shown that regularly scheduled events can result in as many as 15% of attendees purchasing an EV within 6 months (Jin and Slowik 2017). Additional promotional materials can be provided at these events to inform attendees of the benefits of EVs, such as emission reductions or lower cost of ownership, and educate about incentive policies such as the federal tax credit.[14]

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[13] The Victoria Transport Policy Institute offers a guide on integrating transportation equity into transportation planning; the document highlights the importance of inclusive transportation planning across different types of disadvantaged individuals and communities: https://vtpi.org/equity.pdf.

[14] Drive Electric Minnesota has resources to help plan and carry out successful ride-and-drive events: https://driveelectricmn.org/.

Consumer awareness and educational campaigns about the safety measures and advantages of e-micromobility and on-demand transit systems would provide several benefits to Brooklyn Park and support a sustainable paradigm shift toward shared mobility. Benefits include "reducing traffic congestion, pressure on parking, and the use of raw materials and associated waste streams" (DOT 2023b) as well as reduced greenhouse gas emissions and increased affordability compared to personal CVs or even EVs (ibid). Safety awareness includes educating riders and other sidewalk and road users about safely operating and sharing infrastructure, using protective equipment such as helmets, and advocating for investment in more protected infrastructure (Shadel Fischer 2020). Social media awareness campaigns regarding on-demand transit systems have also been shown to support the use of more sustainable and accessible mobility options. Through these campaigns, the public learns that on-demand transit systems can 1) provide solutions to first- and last-mile connectivity issues for public transportation users, 2) offer services to people with disabilities, 3) develop mobile apps that integrate public and private transportation services into a singular user system to streamline transfers, and 4) provide discounts to promote more equitable access and use (Patel et al. 2022). These electric mobility on-demand and micromobility options are particularly effective when they are integrated into public transit systems to provide more access to flexible mobility options, including first- and last-mile connectivity.

Conclusion

With the availability of new transportation technologies—including EVs, on-demand mobility services, and micromobility, many avenues can enable greater access to mobility in Brooklyn Park and strengthen connections to surrounding cities. Mobility enables access to essential and nonessential services and resources such as gainful employment, education, health care, and entertainment. Given that disadvantaged and low-income households typically spend a disproportionately higher share of their income on transportation (DOT 2022), providing new mobility options can be an important step toward reducing the time and cost burden of transportation for those households.

Existing transportation plans in and around Brooklyn Park provide opportunities to expand all residents' access to mobility and the region's resources. The future buildout of the Blue Line extension—with five stations planned for Brooklyn Park—represents an opportunity for first- and last-mile transportation options to enable residents to use the new link to downtown Minneapolis and the airport. It also offers opportunities for education, employment, entertainment, and economic development. Importantly, prioritizing first- and last-mile access to future Blue Line stations would provide more equitable mobility options for Brooklyn Park residents without reliable access to a car.

Aligning these new transportation options and opportunities with local community needs and priorities is an important next—and ongoing—step. Engaging with climate-vulnerable Brooklyn Park communities as part of the U.S. Department of Energy's Communities LEAP project will provide community-grounded direction for future projects and support. Analysis of engagement results will include community-identified electric mobility priorities that can help the city determine how to best serve its most historically underserved residents. Although the accessibility and affordability of electric mobility continue to be practical challenges for many communities, the options provided in this report—and the community-identified barriers, needs, and priorities revealed by the Communities LEAP engagement process—can ground the city as it charts pathways toward electric mobility that serve all its residents.

References

AFDC (Alternative Fuels Data Center). 2023a. "Alternative Fuels Data Center: Alternative Fueling Station Locator." U.S. Department of Energy. Alternative Fuels Data Center: Alternative Fueling Station Locator. https://afdc.energy.gov/stations/.

———. 2023b. "Alternative Fuels Data Center: Electric Vehicle (EV) and Fuel Cell Electric Vehicle (FCEV) Tax Credit." https://afdc.energy.gov/laws/409.

American Lung Association. 2022. "Zeroing in on Healthy Air." https://www.lung.org/getmedia/13248145-06f0-4e35-b79b-6dfacfd29a71/zeroing-in-on-healthy-air-report-2022.pdf.

Argonne National Laboratory. 2023. "Electric Vehicle Charging Equity Considerations | Argonne National Laboratory." 2023. https://www.anl.gov/esia/electric-vehicle-charging-equity-considerations.

Blue LA. 2023. "Blink Mobility : Los Angeles, CA Electric Car Sharing Service." https://blinkmobility.com/.

Borlaug, Brennan, Shawn Salisbury, Mindy Gerdes, and Matteo Muratori. 2020. "Levelized Cost of Charging Electric Vehicles in the United States." *Joule* 0. https://doi.org/10.1016/j.joule.2020.05.013.

Brooklyn Park. 2022. "Bird in Brooklyn Park." ArcGIS StoryMaps. August 31, 2022. https://storymaps.arcgis.com/stories/5e2f70ef2d9f412686e7975c059e7236.

Bureau of Transportation Statistics. 2022. "Transportation Economic Trends: Transportation Spending - Average Household." https://data.bts.gov/stories/s/Transportation-Economic-Trends-Transportation-Spen/ida7-k95k/.

Burnham, Andrew, David Gohlke, Luke Rush, Thomas Stephens, Yan Zhou, Mark Delucchi, Alicia Birky, et al. 2021. "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains." Argonne, IL: Argonne National Laboratory. ANL/ESD-21/4, 1780970, 167399. https://doi.org/10.2172/1780970.

City of Denver. 2023. "Denver's 2022 Ebike Incentive Program Results and Recommendations." https://5891093.fs1.hubspotusercontent-na1.net/hubfs/5891093/Denvers%202022%20Ebike%20Incentive%20Program%20Results%20and%20Recommendations.pdf?__hstc=137334191.07ca637465fe27471dd91406e4ffe8a1.1684967007346.1684967007346.1684967007346.1&__hssc=137334191.1.1684967007346&__hsfp=2084468048&hsCtaTracking=f6c129d8-5739-4033-ae8d-38d8a4d7d52b%7C4d3304a1-3f00-438b-b2bd-bd69b50cfdb9.

City of Wilson. 2022. "RIDE | Wilson, NC." RIDE- Wilson, NC. https://www.wilsonnc.org/residents/all-departments/public-works/wilson-transit-ride-wilson-industrial-air-center/ride.

Colorado CarShare. 2023. "Colorado CarShare - Local, Nonprofit Car Sharing in Denver and Boulder." Colorado CarShare. 2023. https://carshare.org/.

CNT (Center for Neighborhood Technology). 2018. "Center for Neighborhood Technology. Housing Transportation (H+T) Affordability Index." 2018. https://htaindex.cnt.org/.

DOE (Department of Energy Office of Energy Efficiency & Renewable Energy Vehicle Technologies Office"). 2022. Technology Integration 2021 Annual Progress Report". https://www.energy.gov/sites/default/files/2022-10/VTO_2021_APR_TechnologyIntegration_092222.pdf

DOT (Department of Transportation) Bureau of Transportation Statistics. 2022. *Transportation Economic Trends*. Washington, D.C.: DOT. www.bts.gov/product/transportation-economic-trends.

DOT. 2023a. “Charger Types and Speeds | US Department of Transportation.” https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds.

DOT. 2023b. “Charging Forward: A Toolkit for Planning and Funding Urban Electric Mobility.” Washington, D.C.: DOT. https://www.transportation.gov/sites/dot.gov/files/2023-06/Charging%20Forward-Urban%20Toolkit-June%202023-508%20compliant.pdf.

Experian Information Solutions and National Renewable Energy Laboratory. 2023. “Derived Annual Registration Counts by the National Renewable Energy Laboratory.”

FHWA (Federal Highway Administration). 2022. “Average Annual Miles per Driver by Age Group.” Washington, D.C.: U.S. Department of Transportation Federal Highway Administration. https://www.fhwa.dot.gov/ohim/onh00/bar8.htm.

Fishman, Elliot, Simon Washington, and Narelle Haworth. 2013. “Bike Share: A Synthesis of the Literature.” *Transport Reviews* 33 (2): 148–65. https://doi.org/10.1080/01441647.2013.775612.

FTA. 2021. “FY20 Accelerating Innovative Mobility (AIM) Project Selections | FTA.” October 22, 2021. https://www.transit.dot.gov/research-innovation/fy20-accelerating-innovative-mobility-aim-project-selections.

HOURCAR. 2023a. “Meet Evie.” Evie Carshare. https://eviecarshare.com/.

———. 2023b. “Multifamily EV Carshare Pilot Program – HOURCAR.” https://hourcar.org/multifamily/.

Hwang, Kelly, and Holly V. Hays. 2019. “BlueIndy: Indianapolis Electric Car-Sharing Program to Shut Down.” *The Indianapolis Star*. December 20, 2019. https://www.indystar.com/story/news/local/transportation/2019/12/20/blueindy-indianapolis-electric-car-sharing-program-shuts-down/4259749002/.

International Energy Agency (IEA). 2023. *Global EV Outlook 2023: Catching up with Climate Ambitions.* https://www.iea.org/reports/global-ev-outlook-2023.

Internal Revenue Service (IRS). 2023. “Used Clean Vehicle Credit | Internal Revenue Service.” https://Www.Irs.Gov/Credits-Deductions/Used-Clean-Vehicle-Credit. April 28, 2023. https://www.irs.gov/credits-deductions/used-clean-vehicle-credit.

Jin, Lingzhi, and Peter Slowik. 2017. “Literature Review of Electric Vehicle Consumer Awareness and Outreach Activities.”

Jones, Gronna. 2022. “TRB Webinar: Microtransit - Innovation in Rural Mobility.” Presented at the Transportation Research Board, October 20, 2022. https://onlinepubs.trb.org/onlinepubs/webinars/221020.pdf.

Kimley Horn. 2023. “Metro Blue Line Extension: Public Coordinate.” https://app.publiccoordinate.com/#/projects/BLRT/map.

Litman, Todd. 2015. “Evaluating Carsharing Benefits.” *Transportation Research Record: Journal of the Transportation Research Board* 1702 (1): 31–35. https://doi.org/10.3141/1702-04.

Litman, Todd. 2023. “Evaluating Transportation Equity.” *Victoria Transport Policy Institute*, May. https://www.vtpi.org/equity.pdf.

Lyft. 2023. "Our commitment to achieve 100% electric vehicles across the Lyft platform by 2030." https://www.lyft.com/impact/electric.

Martin, Elliot, and Susan Shaheen. 2023. *Synthesis Report: Findings and Lessons Learned from the Independent Evaluation of the Mobility on Demand (MOD) Sandbox Demonstrations.* U.S. Department of Transportation Federal Transit Administration. https://www.transit.dot.gov/sites/fta.dot.gov/files/2023-02/FTA-Report-No-0242.pdf.
Martin, Elliot, Adam Stocker, Adam Cohen, Susan Shaheen, Les Brown, and Berkeley. Transportation Sustainability Research Center University of California. 2021. *Mobility on Demand (MOD) Sandbox Demonstration: Dallas Area Rapid Transit (DART) First and Last Mile Solution Evaluation Report.* FTA Report No. 0195. https://doi.org/10.21949/1520681.
McQueen, Michael, John MacArthur, and Christopher Cherry. 2020. “The E-Bike Potential: Estimating Regional e-Bike Impacts on Greenhouse Gas Emissions.” *Transportation Research Part D: Transport and Environment* 87 (October): 102482. https://doi.org/10.1016/j.trd.2020.102482.
Metro Transit. 2023. “Metro Transit Micro Project.” 2023. https://www.metrotransit.org/micro-project.
Minnesota Legislature. 2023. “HF 2887 Status in the House for the 93rd Legislature (2023 - 2024).” https://www.revisor.mn.gov/bills/bill.php?b=house&f=HF2887&ssn=0&y=2023.
Minnesota Department of Transportation. 2023. "2023 Minnesota Electric Vehicle Infrastructure
Plan" July 2023. https://www.dot.state.mn.us/nevi/.
Minnesota Department of Transportation. 2022. “2022 Minnesota Electric Vehicle Infrastructure Plan,” July. https://www.lrl.mn.gov/docs/2022/other/221021.pdf.
Miotti, Marco. 2021. “Carbon Counter.” 2021. https://www.carboncounter.com/#!/explore.
NACTO (National Association of City Transportation Officials). 2019. “National Association of City Transportation Officials: Guidelines for Regulating Shared Micromobility.” https://nacto.org/wp-content/uploads/2019/09/NACTO_Shared_Micromobility_Guidelines_Web.pdf.
———. 2022. “National Association of City Transportation Officials: Half a Billion Trips on Shared Micromobility Since 2010.”
———. 2023. “NACTO Publications.” National Association of City Transportation Officials. https://nacto.org/publications/.
NREL (National Renewable Energy Laboratory). 2020. “ATB | NREL.” 2020 Annual Technology Baseline. https://atb.nrel.gov/.
Panetta, Jimmy. 2021. “H.R.1019 - 117th Congress (2021-2022): E-BIKE Act.” Legislation. 2021-02-11. February 11, 2021. http://www.congress.gov/bill/117th-congress/house-bill/1019.
Patel, Ronik Ketankumar, Roya Etminani-Ghasrodashti, Sharareh Kermanshachi, Jay Michael Rosenberger, and Ann Foss. 2022. “Mobility-on-Demand (MOD) Projects: A Study of the Best Practices Adopted in United States.” *Transportation Research Interdisciplinary Perspectives* 14 (June): 100601. https://doi.org/10.1016/j.trip.2022.100601.
Shadel Fischer, Pam. 2020. *Understanding and Tackling Micromobility: Transportation’s New Disruptor.* Washington, D.C.: Governors Highways Safety Association. https://transportation.org/sharedmobility/wp-content/uploads/sites/82/2023/05/GHSA_MicromobilityReport_Final_1.pdf.

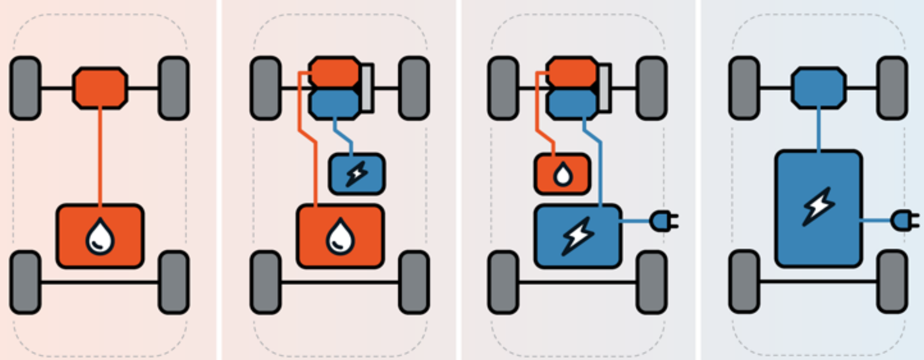
Shaheen, Susan, Adam Cohen, and Jacquelyn Broader. 2022. “Shared Micromobility: Policy, Practices, and Emerging Futures.” https://escholarship.org/uc/item/8xc1k3rw.
Streets.mn. 2022. “What Is Evie Carshare and Is It a Good Option for the Twin Cities?” Streets.Mn. December 5, 2022. https://streets.mn/2022/12/05/what-is-evie-carshare/.
SUMC (Shared Use Mobility Center). 2023. “Take a RIDE with Me: Highlighting the Adoption of Citywide Microtransit in Wilson, NC.” *Mobility Learning Center* (blog). April 17, 2023. https://learn.sharedusemobilitycenter.org/casestudy/take-a-ride-with-me-highlighting-the-adoption-of-citywide-microtransit-in-wilson-nc/.
Uber. 2023a. “Uber Announces Results for Fourth Quarter and Full Year 2022.” https://s23.q4cdn.com/407969754/files/doc_financials/2022/q4/Uber-Q4-22-Earnings-Press-Release.pdf.
———. 2023b. “Case Study: DART Goes Big in 30 Zones.” Uber Blog. March 6, 2023. https://www.uber.com/blog/case-study-dart-goes-big-in-30-zones/.
United Food and Commercial Workers Canada. 2023. “Uber Canada Driver Resources.” 2023. https://uber.ufcw.ca/en/driver-resources/benefits.
U.S. Census Bureau. 2021. "American Community Survey 5-Year Estimates Data Profiles." https://data.census.gov/table/ACSDP5Y2021.DP04?g=160XX00US2707966_040XX00US27&hidePreview=true
Vehicle Technologies Office. 2023. “FOTW #1272, January 9, 2023: Electric Vehicle Battery Pack Costs in 2022 Are Nearly 90% Lower than in 2008, According to DOE Estimates.” Energy.gov. January 9, 2023. https://www.energy.gov/eere/vehicles/articles/fotw-1272-january-9-2023-electric-vehicle-battery-pack-costs-2022-are-nearly.
Via. 2023. “Public Mobility Solutions. | Via Transportation.” 2023. https://ridewithvia.com/.
Weigl, Dustin, Josh Sperling, Alejandro Henao, Andrew Duvall, and Stanley Young. 2022. “Sustainability, Scalability, and Resiliency of the Town of Innisfil Mobility-on-Demand Experiment: Preliminary Results, Analyses, and Lessons Learned.” In *International Conference on Transportation and Development 2022*, 239–50. Seattle, Washington: American Society of Civil Engineers. https://doi.org/10.1061/9780784484340.022.
Xcel Energy. 2023. “Time of Use (TOU).” 2023. https://co.my.xcelenergy.com/s/billing-payment/residential-rates/time-of-use-pricing.

Appendix A. Types of Electric Vehicles

The term electric vehicle (EV) refers to certain categories of vehicle powertrains that are common in their use of a battery to store electric energy, which drives an electric motor. The primary categories include BEVs, PHEVs, and HEVs. These are differentiated from CVs, which are fueled by gasoline or diesel and powered by an internal combustion engine (sometimes also referred to as internal combustion engine vehicles). Hydrogen fuel cell electric vehicles are also considered EVs but are unlikely to be widely sold as passenger vehicles in the near term. HEVs are driven primarily using an engine fueled by gasoline but also have a small battery that can be charged when the vehicle brakes. This regenerative braking is also featured in other EVs, but HEVs cannot be plugged into an external charging source.

The differences between these categories are described next and shown in Figure A-1.

Vehicle Technology Types	Conventional Vehicle (CV)	Hybrid Electric Vehicle (HEV)	Plug-In Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)



	Conventional Vehicle (CV)	Hybrid Electric Vehicle (HEV)	Plug-In Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)
Vehicle Type	All	Passenger, Buses, Trucks	Passenger	Passenger, Buses, Trucks, Two-wheelers
Fuel Source	Gasoline	Gasoline, Regenerative Braking	Gasoline, Electricity from Grid, Regenerative Braking	Electricity from Grid, Regenerative Braking
Propulsion Mechanism	Gasoline Engine	Gasoline Engine, Electric Motor	Gasoline Engine, Electric Motor	Electric Motor
Plug in?	No	No	Yes, but not necessary	Yes

Fuel Tank & Gasoline Engine — Battery & Electric Motor

Regenerative braking allows electric motors to recover some of the kinetic energy which is then stored in the battery and used at a later time, maximizing fuel efficiency.

Figure A-1. Types of EV powertrains.

Illustration by Christopher Schwing, NREL

Appendix B. Types of Electric Vehicle Chargers

EV charging infrastructure can be grouped into several categories; the most critical is how quickly it can recharge the EV battery (the power of the charger, measured in kilowatts [kW]) and its location—at home, in public, or at the workplace. More detail on the different types of chargers is given in Table B-1.

Table B-1. Overview of Types of EV Charging Infrastructure

Sources: DOT 2023a; Borlaug et al. 2020

	Level 1	Level 2	DCFC
Voltage	120 V AC	208–240 V AC	400–1,000 V DC
Power (kW)	1 kW	7–9 kW	50–350 kW
Estimated Driving Range Added per Hour	2–5 miles	10–20 miles	180–240 miles
Locations Chargers are Installed	Home	Home, Public, Work	Public
Purchase and Installation Cost	$0	Home: $1,836/plug Public/Work: $6,000/plug	50 kW: $58,000/plug 150 kW: $150,000/plug

Low-power chargers (levels 1 and 2) are typically installed where an EV is likely to be parked for longer periods of time and does not need a shorter charging time. Home and workplace charging are ideal locations for these chargers because an EV is generally parked for a long period during the workday or overnight. Level 1 charging can be done directly from a standard 120-V outlet available in residential and business settings. An EV can also plug directly into a standard 240-V outlet (a circuit often used for a home washer and dryer) for level 2 charging, or a stand-alone charger device can be purchased and installed on a dedicated circuit.

DCFCs provide the added convenience of charging an EV battery in 20–30 minutes. These chargers cost more to install than levels 1 or 2 and typically cost more to use (for public chargers) because of the additional electrical generation and distribution infrastructure required. These chargers are commonly installed at desirable public locations, on long-distance travel corridors, or in high-traffic areas. Level 1 and 2 charging uses alternating current, whereas DCFC uses direct current.

For more information about
Communities LEAP, visit:
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