MILWAUKEE COUNTY

2024

MILWAUKEE COUNTY

OFFICE OF SUSTAINABILITY

VEHICLE ELECTRIFICATION GUIDEBOOK

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Introduction

This comprehensive guidebook on vehicle electrification has been prepared by the Milwaukee County Office of Sustainability, as of May 2024. As Milwaukee County navigates the evolving landscape of transportation, embracing electric vehicles (**EVs**) stands as a pivotal step towards sustainable and equitable mobility solutions. This guidebook serves as a roadmap for departments within Milwaukee County and other local organizations, offering insights into various facets of vehicle electrification.

With a profound focus on environmental stewardship, public health, and racial equity, this guidebook delves into critical aspects such as the types of electric vehicles, access to EV chargers within Milwaukee County, existing infrastructure, relevant legislative frameworks, and funding opportunities. Moreover, it explores the profound environmental and health impacts associated with vehicle electrification, ranging from reduced greenhouse gas emissions to mitigating air and noise pollution. Recognizing the barriers and gaps in Electric Vehicle Supply Equipment (**EVSE**) implementation, the guidebook provides recommendations tailored to address access, affordability, safety, consumer-awareness, construction, design, and accessibility concerns. By incorporating case studies for potential EV charger locations, public-private partnerships, and performance metrics, the guidebook aims to empower stakeholders in realizing the full potential of EV adoption while fostering a healthier and more sustainable Milwaukee County for all.

This guidebook aims to pave the way for a future where electrified transportation not only transforms Milwaukee County's landscape but also enriches the lives of all its residents, fostering a legacy of sustainability, equity, and health.

Acronym List

ABA	Architectural Barriers Act
ADA	American Disabilities Act
APIs	Application Programming Interfaces
BECP	Building Energy Codes Program
BEV	Battery Electric Vehicle
BIL	Bipartisan Infrastructure Law
BIPOC	Black, Indigenous, People of Color
CO	Carbon Monoxide
CO2	Carbon Dioxide
COPD	Chronic Obstructive Pulmonary Disease
CRC	Milwaukee County Community Reintegration Center
DC	Direct Current
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCEV	Fuel Cell Electric Vehicle
GHG	Greenhouse Gas
ICE	Internal Combustion Engine
IECC	International Energy Conservation Code
ISA	International Symbol of Accessibility
KPI	Key Performance Indicator
LDV	Light-duty Vehicle
LED	Light Emitting Diode
MCDOT	Milwaukee County Department of Transportation
MCSO	Milwaukee County Sherriff's Office
MCTS	Milwaukee County Transit System
MKE	Milwaukee Mitchell International Airport
MUTCD	Manual on Uniform Traffic Control Devices
NEVI	National Electric Vehicle Infrastructure
NO2	Nitrogen Dioxide
NOx	Nitrogen Oxides
OCPP	Open Charge Point Protocol
PEV	Plug-In Electric Vehicle
PHEV	Plug-In Hybrid Electric Vehicle
PM	Particulate Matter
PM2.5 and PM10	Fine Particulate Matter
PPPs	Public-Private Partnerships
PTSD	Post Traumatic Stress Disorder
R&D	Ride and Drive
VOCs	Volatile Organic Compounds
WEVI	Wisconsin Electric Vehicle Infrastructure
WisDOT	Wisconsin Department of Transportation

Background

Vehicle Types

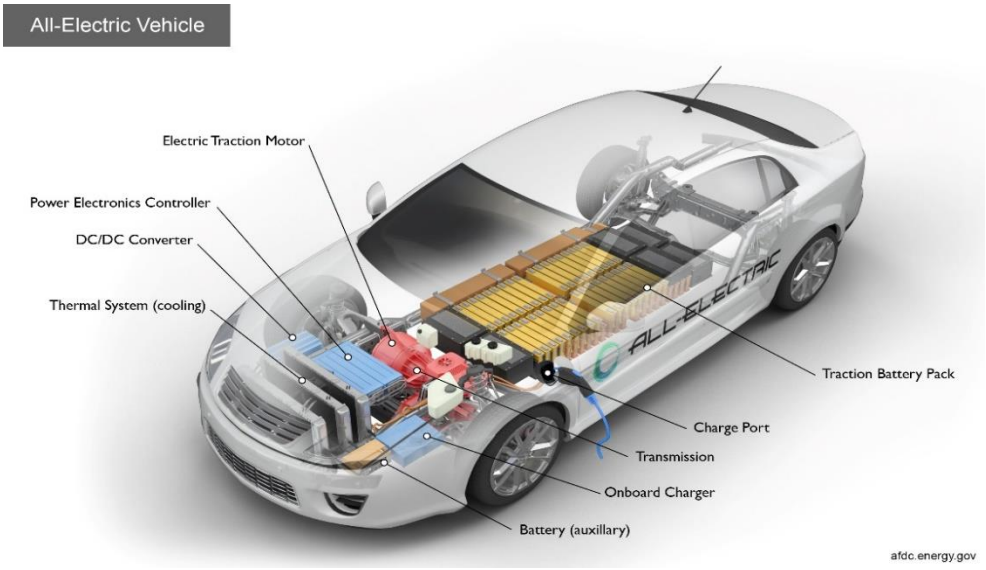
Battery Electric Vehicles (BEVS):

Description: BEVs, commonly known as “all-electric vehicles”, operate exclusively on electricity and are replenished from an external power source.[1] They are propelled by one or more electric motors powered by rechargeable battery packs.[2] They do not have an internal combustion engine (**ICE**), making them emissions-free during operation.[3]

Range: Nearly all new BEVs offer a significant all-electric range, typically exceeding 100 miles on a single charge.[4] While technology in continuing to advance, some new models entering the market provide ranges of 200 to 300 miles or more.[5]

Charging: BEVs are recharged by plugging them into an external power source. Charging times depend on the charger type, with Level 1 being the slowest and direct current (**DC**) fast charging being the fastest.[6]

Figure 1 – Battery Electric Vehicle (BEV)



Alternative Fuels Data Center: All-Electric Vehicles (energy.gov)

[1] U.S. Department of Transportation. (2020). Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure Charging Forward

[2] Ibid.

[3] California Center for Sustainable Energy; San Diego Association of Governments. (2014). San Diego Regional Plug-In Electric Vehicle (PEV) Readiness Plan Preparing the San Diego Region for Plug-In Electric Vehicles. San_Diego_PEV_Readiness_Planning_Guide-2013.pdf (energycenter.org)

[4] Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure

[5] U.S. Department of Energy. (2024). Alternative fuel and advanced vehicle search. Alternative Fuels Data Center: Vehicle Search. Alternative Fuels Data Center: Vehicle Search (energy.gov)

[6] Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure

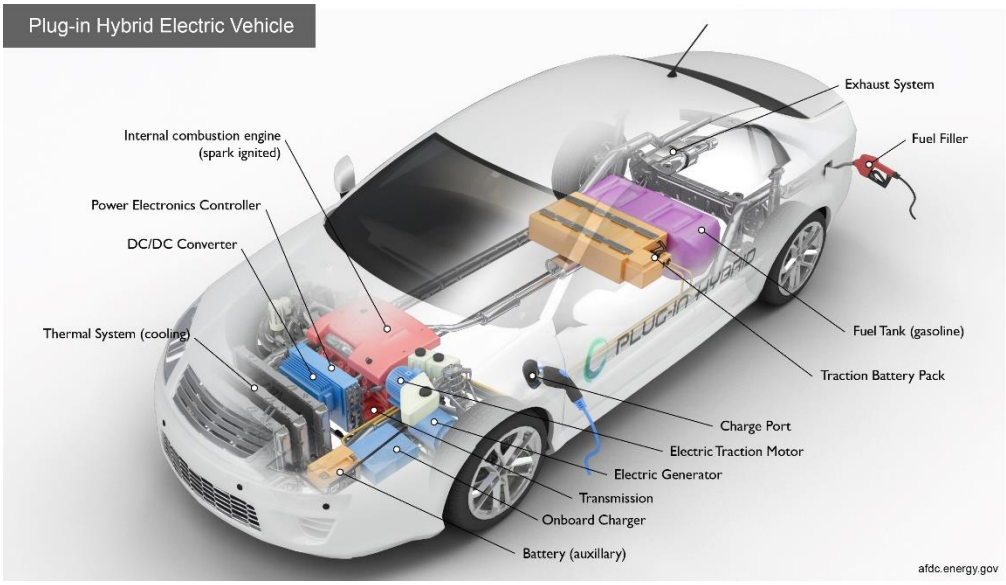
Plug-In Hybrid Electric Vehicles (PHEVs):

Description: PHEVs also utilize batteries to drive an electric motor and can be recharged externally. However, they incorporate a smaller ICE, which serves to recharge the battery or, in certain models, directly power the wheels for further driving ranges.[7] This means that PHEVs can operate in an all-electric mode, drawing power from the battery, and switch to the ICE when the battery becomes exhausted, offering flexibility and extended range.[8] This feature significantly reduces gasoline consumption and emissions during shorter trips.[9] PHEVs demonstrate a fuel efficiency improvement of 14 to 47 percent compared to conventional vehicles when their batteries are fully charged.[10]

Range: PHEVs typically have a shorter all-electric range compared to BEVs, ranging from 20 to 50 miles on average.[11] The ICE provides additional range for longer trips.

Charging: PHEVs can be charged from an external power source, and their charging times are influenced by factors such as the battery size within the vehicle and the type of charger being used.[12]

Figure 2 – Plug-In Hybrid Electric Vehicle (PHEV)



Alternative Fuels Data Center: Plug-In Hybrid Electric Vehicles (energy.gov)

[7] Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure
[8] Ibid.
[9] Popular Vehicle Trips Statistics. U.S. Department of Transportation Federal Highway Administration. (2024). National Household Travel Survey (ornl.gov)
[10] Plötz, P., Moll, C., Bieker, G., Mock, P., Li, Y. (2020). Real-World Usage of Plug-In Hybrid Electric Vehicles Fuel Consumption, Electric Driving, and CO2 Emissions. The International Council on Clean Transportation. Real-world usage of plug-in hybrid electric vehicles: Fuel consumption, electric driving, and CO2 emissions. International Council on Clean Transportation (theicct.org)
[11] U.S. Department of Energy. (2024). Alternative fuel and advanced vehicle search. Alternative Fuels Data Center: Vehicle Search. Alternative Fuels Data Center: Vehicle Search Alternative Fuels Data Center: Plug-In Hybrid Electric Vehicles (energy.gov)
[12] Plug-In Electric Vehicle (PEV) Readiness Plan

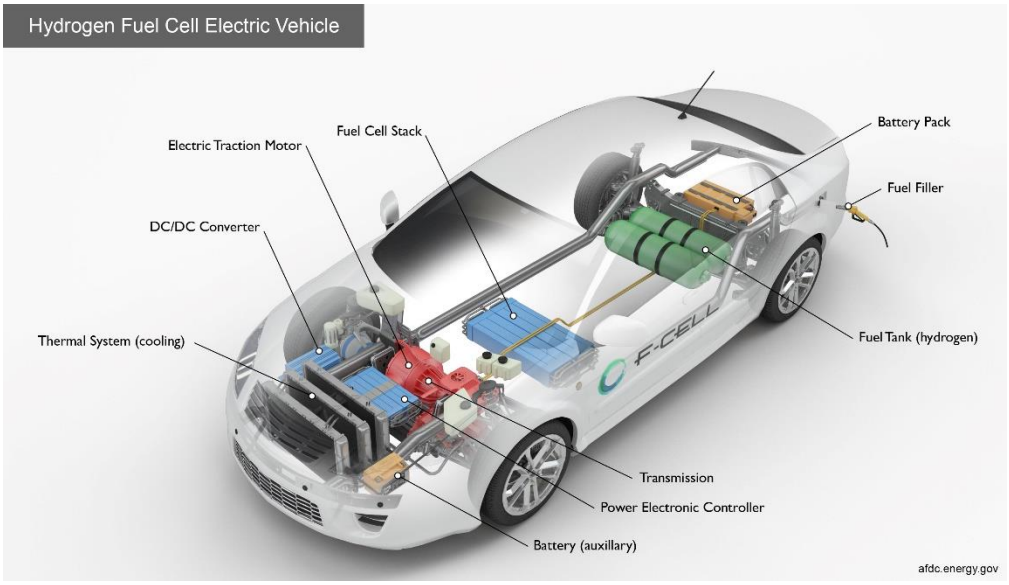
Fuel Cell Electric Vehicles (FCEVs):

Description: Employing a highly effective electrochemical process, FCEVs use a fuel cell to convert hydrogen into electricity to drive an electric motor.[13] FCEVs do not have a traditional battery that is recharged externally. Rather, these vehicles store compressed hydrogen gas in a tank and generate electricity on demand.[14]

Range: FCEVs can fuel in about 5 minutes, similar to the amount of time to fill the gas tank of conventional vehicles with ICEs.[15] FCEVs can carry enough hydrogen fuel for a range of more than 300 miles.[16]

Charging: FCEVs do not plug in for recharging like BEVs and PHEVs.[17] They are refueled with compressed hydrogen gas, and the fuel cell generates electricity for the vehicle's operation.[18]

Figure 3 – Fuel Cell Electric Vehicle (FCEV)



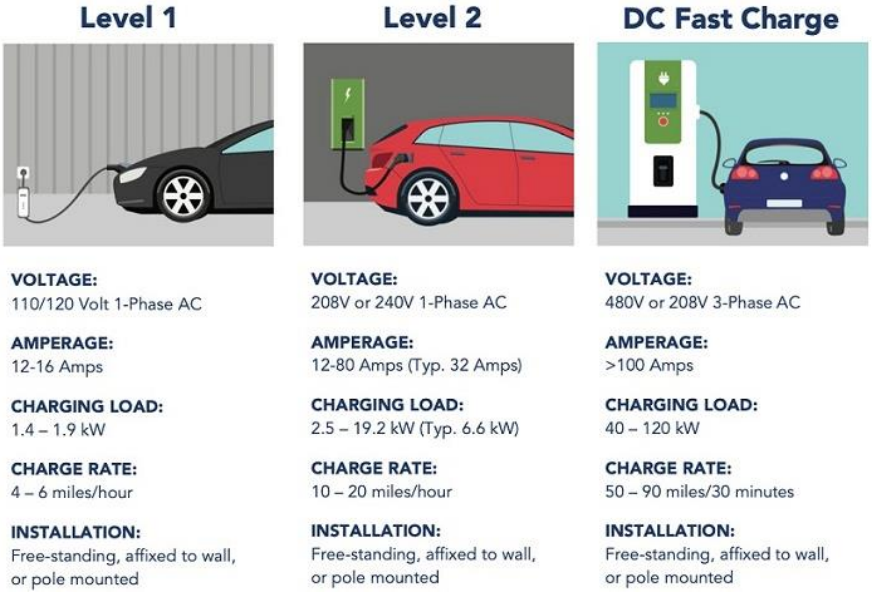
Alternative Fuels Data Center: Fuel Cell Electric Vehicles (energy.gov)

Charger Types and Connectors

Electric Vehicle Supply Equipment (**EVSE**) plays a crucial role in facilitating the transfer of energy from a power source to a Plug-In Electric Vehicle (**PEV**). It ensures a safe and appropriate flow of electricity to the vehicle's battery, allowing for efficient charging. EVSE comes in various types, each designed with distinct charging capabilities and applications.

[13] Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure
[14] Ibid.
[15] U.S. Department of Energy. (2024). Fuel Cell Electric Vehicles. Alternative Fuels Data Center: Fuel Cell Electric Vehicles. Alternative Fuels Data Center: Fuel Cell Electric Vehicles Alternative Fuels Data Center: Fuel Cell Electric Vehicles (energy.gov)
[16] Ibid.
[17] Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure
[18] Ibid.

Figure 4 – Types of EV Chargers



An Overview of Electric Vehicles and Charging Stations - Advanced Energy

Level 1 Charger:

Level 1 charging utilizes a standard wall outlet (120 Volt) and provides relatively slow rate of charging, with a charging speed typically providing 2 to 5 miles of range per hour of charging.[19] Charging through a standard residential 120-Volt AC outlet, Level 1 charging equipment can require 40 to 50+ hours to charge a BEV to 80 percent from empty and 5 to 6 hours for a PHEV.[20] With no installation required, every EV comes equipped with a Level 1 charger, making it ideal for overnight charging and low-mileage daily driving, especially suitable for PHEVs. The connector options include J1772 or Tesla connectors specific to the vehicle, offering convenience for users.[21]

Figure 5 – Level 1 EV Charger

Electric Vehicle Charging Guide - Solar United Neighbors

[19] U.S. Department of Energy. (2012). Plug-In Electric Vehicle Handbook for Public Charging Station Hosts. Plug-In Electric Vehicle Handbook for Public Charging Station Hosts (Brochure), NREL (National Renewable Energy Laboratory)

[20] Charger Types and Speeds. U.S. Department of Transportation. (2023). Charger Types and Speeds | US Department of Transportation

[21] Plug-In Electric Vehicle Handbook for Public Charging Station Hosts

Level 2 Charger:

With Level 2 charging, a 240-Volt or a 208-Volt AC power source is employed, requiring dedicated charging equipment.[22] This results in a faster charging rate, delivering about 15 to 35 miles of range per hour of charging.[23] Providing higher-rate AC charging through either a 240-Volt (for residential use) or 208-Volt (for commercial applications) electric services, Level 2 chargers can charge a BEV to 80 precent from empty in 4 to10 hours and a PHEV in 1 to 2 hours.[24] Level 2 chargers are most commonly installed as public charging stations, encompassing charging locations such as workplaces, retail venues, and community spaces, accommodating users who require a quicker charge during the day.[25] This type of charging using the same J1772 connector as in level 1 charging unless the vehicle is a Tesla model in which it would use its own model-specific connector.[26]

Figure 6 – Level 2 EV Charger

ChargePoint CT4021-GW1 Gateway Unit (smartchargeamerica.com)

Direct Current (DC) Fast Charging:

Level 3, commonly known as DC Fast Charging, utilizes a direct current power source, significantly reducing charging times. DC Fast Charging stands out as the fastest EV charging option, offering 250 miles of range per hour of change, depending on the vehicle and the charging equipment.[27] DC Fast Charging equipment can charge a BEV from empty to 80 percent in just 20 minutes to an hour, making it ideal for facilitating long-distance driving, road trips, or quick recharges.[28] DC Fast Charging equipment are often located along heavy-traffic corridors and at strategic points such as public fueling stations.[29] These charging stations are strategically positioned to facilitate rapid charging for EVs, particularly during longer journeys. While most non-Tesla chargers utilize the CCS/SAE Combo connector, it is important to note that Tesla DC Fast Chargers are exclusive to Tesla vehicles.[30]

[22] Plug-In Electric Vehicle Handbook for Public Charging Station Hosts
[23] Electric car charging overview. DriveCleanCA.gov. (2024). Electric Car Charging Overview | DriveClean
[24] Charger Types and Speeds
[25] Ibid.
[26] Plug-In Electric Vehicle Handbook for Public Charging Station Hosts
[27] Types of electric vehicle chargers. Duke Energy. (2023). Types of Electric Vehicle Chargers - Duke Energy (duke-energy.com)
[28] Charger Types and Speeds
[29] Charging Forward a Toolkit for Planning and Funding Rural Electric Mobility Infrastructure
[30] Types of electric vehicle chargers

Figure 7 – DC Fast Charger

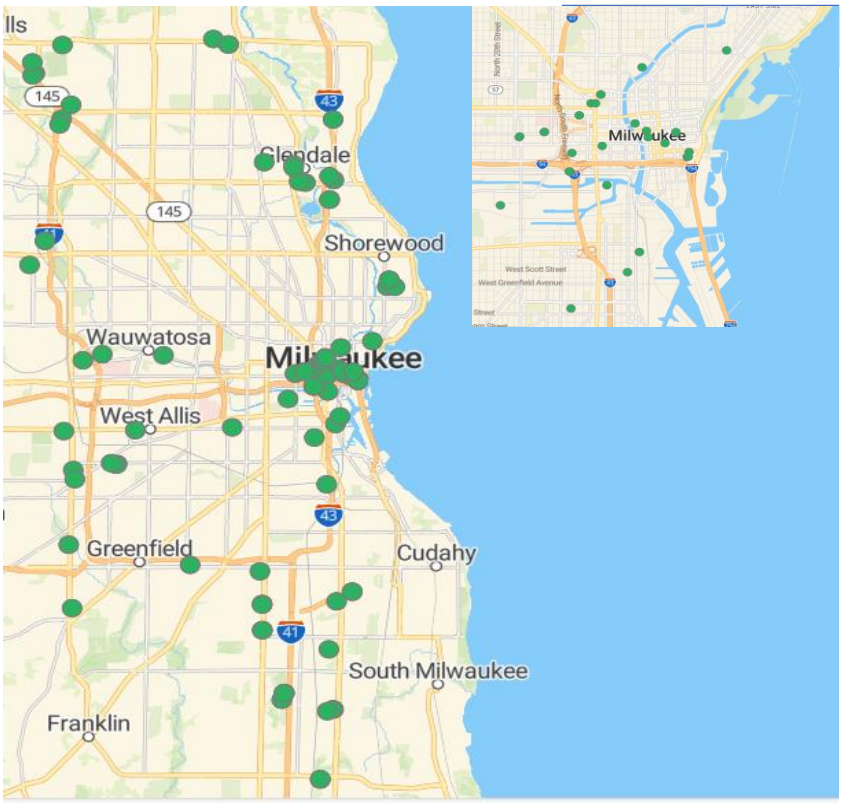
https://smartchargeamerica.com/electric-car-chargers/commercial/tritium-veefil-pk350/

Current E-Mobility Landscape and Predictions

Charging Stations Distribution: Currently, Wisconsin has a total of 600 public electric vehicle (**EV**) charging locations, comprising of 1,444 charging ports, distributed throughout the state according to the U.S. Department of Energy Alternative Fuel Data Center.[31] The EVSE in Milwaukee County encompasses a network of 91 public charging stations, as of April 2024.[32] These charging stations are distributed throughout the region, with 51 charging stations located within the City of Milwaukee and an additional 40 spread across other areas within Milwaukee County.[33] There is a concentration of charging stations in key locations such as the central business district, near the interstate system, and at the Milwaukee Mitchell International (**MKE**) Airport.[34] Notably, the 3 EV chargers located on the property of the MKE Airport are currently the only charging stations that are owned and operated by Milwaukee County.[35] The current public charging stations are designed for places of interest and destinations where individuals are expected to spend a considerable amount of their day.

[31] U.S. Department of Energy. (2024). Alternative Fueling Station Locator. Alternative Fuels Data Center: Alternative Fueling Station Locator. Alternative Fuels Data Center: Alternative Fueling Station Locator Alternative Fuels Data Center: Alternative Fueling Station Locator (energy.gov)
[32] Ibid.
[33] Ibid.
[34] City of Milwaukee Preliminary Electric Vehicle Readiness Plan (Project No. 31000432.003). (2023). City of Milwaukee Environmental Collaboration Office. (City of Milwaukee Preliminary EV Readiness Plan)
[35] U.S. Department of Energy. Alternative Fueling Station Locator

Figure 8 – Map of Existing Public EV Chargers in Milwaukee County



Alternative Fuels Data Center: Electric Vehicle Charging Station Locations (energy.gov)

Charging Station Types: The existing public charging stations in Milwaukee County offer a variety of charging options to accommodate different EV models and charging needs. It is important to note that while these chargers are located within Milwaukee County, they are not owned and operated by Milwaukee County or located on county-owned properties, excluding the 3 publicly accessible chargers at MKE Airport.[36] The infrastructure within the county primarily consists of Level 2 chargers, supplemented by additional options such as Level 3 fast charging plugs, Level 1 chargers, and Tesla chargers.[37] Each type of charger is designed to provide varying charging speeds and range capabilities, catering to the diverse requirements of EV users in the area.

Current Capacity and EV Adoption: In less than a decade, Wisconsin has witnessed a surge in the number of EV and hybrid vehicles, doubling from 44,178 registrations in 2013 to 102,492 in 2021 – a remarkable 132% increase, as reported by the Wisconsin Department of Transportation (**WisDOT**).[38] Although these vehicles still constitute as less than 2% of total registered vehicles in the state, their exceptional growth is evident in both urban counties, such as Dane and Milwaukee, and in rural counties.[39] The hybrid-electric trend in Wisconsin is primarily driven by hybrid vehicle registrations, outnumbering EVs by over tenfold. Hybrid

[36] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[37] U.S. Department of Energy. Alternative Fueling Station Locator
[38] Wisconsin Electric Vehicle Infrastructure Plan. (2023). Wisconsin Department of Transportation. Wisconsin Electrification Initiative. Wisconsin Electric Vehicle Infrastructure Plan Update 2023. Wisconsin Electric Vehicle Infrastructure Plan Update 2023 (wisconsindot.gov)
[39] Ibid.

vehicle registrations experienced a notable 13.7% growth in 2021, marking their largest annual increase since 2014.[40] While EV registrations increased at a faster pace, rising by an average of 51.9% annually in the state since 2013, they still represent less than 0.2% of the total passenger vehicle registrations in the state.[41] Specifically, as of May 2022, EVs constitute 0.11% of all registered vehicles in Wisconsin, totaling 6,310 EVs.[42] Wisconsin's charging infrastructure operates at a capacity 15 public charging ports per 100 EVs as of May 2022.[43] This metric indicates the current capacity relative to the rising number of registered electric passenger and commercial vehicles in the state. The adoption of EVs by residents of Milwaukee County follow a similar consistent upward trajectory from 2019 to 2022, with increase of 668 to 1,921 registered EVs, respectively.[44] These local adoption trends, in conjunction with statewide EV growth, emphasize the importance of continued efforts to enhance EVSE and meet the rising demand for EVs in Wisconsin and Milwaukee County specifically.

Table 1 – Registered EVs in Milwaukee County by Year

Total Electric Vehicle Registrations – Milwaukee County				
Year	**2019**	**2020**	**2021**	**2022**
Vehicles Registered	668	879	1,320	1,921

Source: WisDOT (City of Milwaukee Preliminary EV Readiness Plan)

Anticipated Growth and Projections: Projections from the Wisconsin Electric Vehicle Infrastructure Plan indicate an optimistic outlook for EV adoption in Milwaukee County. Based on the increasing trend in EV registrations in Wisconsin, Wisconsin anticipates a substantial rise in the prevalence of electric light-, medium-, and heavy-duty vehicles.[45] From this, The Wisconsin Department of Transportation forecasts **a significant increase, with an anticipated total of more than 334,000 EVs on Wisconsin's roads by 2030 and 1,863,585 by 2050**.[46] This forecast suggests an **increase from the current 0.1% of the total registered fleet to an estimated 31% by the year 2050**.[47] These projections suggest a promising trajectory for the continued growth of the EV market in the region. According to local data from the 2018 Report, Plugging In: Readying America's Cities for the Arrival of Electric Vehicles, there is projected to be 17,000 EVs within the city limits by 2030. Given this, the estimated charging infrastructure needed in the City of Milwaukee by 2030 consists of 381 Level 2 charging ports in workplaces, 237 Level 2 charging ports in public places, and 27 public DC Fast Charging ports.[48]

Finding and Access to Public EVSE

The accessibility of public charging infrastructure plays a pivotal role in facilitating convenient and widespread EV adoption. Drivers seeking public charging stations can leverage various

[40] Wisconsin Electric Vehicle Infrastructure Plan
[41] Ibid.
[42] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[43] Ibid.
[44] Ibid.
[45] Wisconsin Electric Vehicle Infrastructure Plan
[46] Ibid.
[47] Ibid.
[48] Plugging In Readying America's Cities for the Arrival of Electric Vehicles. (2018). Frontier Group. WISPIRG Foundation. Plugging In (publicinterestnetwork.org)

online resources and mobile applications, such as those offered by charging networks like Blink, ChargePoint, and eVgo.[49] These networks, each with its dedicated application, allow members to locate network-specific charging points. Current collaborative efforts aim to foster cross-network compatibility, such as CollaboratEV with an effort to unify the two largest charging networks, ChargePoint and Blink.[50]

Access to these public charging stations often involves membership requirements managed by the service members, such as ChargePoint and Blink.[51] Open standards for EVSE, like the Open Charge Point Protocol (**OCPP**), aim to promote the interoperability between charging stations and networks by enabling an EV driver to charge and any charger using any network's membership card, eliminating the need for proprietary hardware.[52]

Legislation (Senate Bill 791)

Senate Bill 791, introduced in Wisconsin and passed on March 12, 2024, aims to streamline the process for expanding EV charging infrastructure in the state while addressing regulatory and taxation aspects.[53] The bill proposes several key provisions that affect EVSE and EV charging operations.

One significant aspect of the bill involves exempting individuals supplying electricity through EV charging stations from being regulated as public utilities.[1] However, this exemption applies only if the electricity supplied originates from the person's own utility or electric cooperative. This exemption seeks to encourage private investment in EV charging infrastructure by reducing regulatory hurdles.

Most pertinent to this report, the bill also outlines regulations regarding EV charging stations owned or operated by local governmental units and state agencies. It restricts these entities from owning or operating public EV charging stations, except under certain conditions. For instance, local governments can operate private charging stations for their own vehicles or authorize others to operate public ones. Specifically, "The bill also prohibits a local governmental unit that does not operate an electric utility from owning, operating, managing, or leasing an electric vehicle charging station at which Level 1 or Level 2 chargers are available to the public, unless all Level 1 or Level 2 charges are available for public use free of any charge. However, the bill also allows a local governmental unit to own, operate, manage, or lease an electric vehicle charging station containing a Level 1, Level 2, or Level 3 charger if the charger is not available to the public and is used solely to charge vehicles owned or leased by the local governmental unit."[54]

Furthermore, the bill addresses taxation by imposing an excise tax on electricity delivered by EV charging stations, excluding residential stations.[55] This tax, set at 3 cents per kilowatt-hour, is intended to support the expansion of EVSE and fund transportation initiatives.[56] Additionally, the

[49] Charging Networks. U.S. Department of Transportation. (2023). Charging Networks | US Department of Transportation
[50] San Diego Regional Plug-In Electric Vehicle (PEV) Readiness Plan
[51] Ibid.
[52] Ibid.
[53] Wisconsin S.B. 791, Reg. Sess. 2023-2024 (2024). (23-2813/1) (wisconsin.gov)
[54] Wisconsin S.B. 791
[55] Ibid.
[56] Ibid.

bill provides exemptions from sales and use taxes for electricity sold through EV charging stations.[57]

To ensure compliance and oversight, the bill introduces a permit requirement for individuals delivering electricity through EV charging stations for compensation, except at residential locations.[58] This requirement helps regulate commercial charging operations and ensures that operators meet certain standards and obligations.

These provisions aim to provide regulatory clarity, establish taxation mechanisms, and promote private investment in EV charging infrastructure in Wisconsin.

Funding

The National Electric Vehicle Infrastructure (**NEVI**) program, a federal initiative, aims to bolster the development and expansion of EVSE across the United States. With a total allocation of $7.5 billion from the Bipartisan Infrastructure Law (**BIL**) in November 2021, $5 billion is earmarked for the NEVI program.[59] Under NEVI, states like Wisconsin receive funding to implement their own EVSE initiatives, such as the Wisconsin Electric Vehicle Infrastructure (**WEVI**) program. However, WEVI funding is currently not available for Milwaukee County or other Wisconsin local governments.

The WEVI program operates within the framework of the NEVI initiative and focuses specifically on deploying EV charging stations throughout Wisconsin. With approximately $78 million allocated over five years, NEVI funds support the installation, operation, maintenance, and reporting of EV charging stations under the WEVI Program.[60] During its durations, the WEVI Program aims to establish about 65 charging locations along designated transportation systems, including five Interstates, seven U.S. highways, and one state highway.[61]

Equity and community engagement are central to the NEVI and WEVI programs. NEVI funding emphasizes the equitable deployment of EV charging infrastructure, prioritizing locations that positively impact disadvantaged communities. Similarly, the WEVI Program encourages proposers to consider sites in Justice40 areas, where at least 40% of federal investment benefits are directed toward disadvantaged communities.[62] This focus ensures that underserved communities have access to EV charging infrastructure and can benefit from the transition to electric transportation.

To apply for WEVI funding, applicants need to put together detailed proposals with all the necessary documents, and then proposals are submitted online through WisDOT's portal. WisDOT carefully reviews each proposal, looking at things like how much the project will cost, where the charging stations will be located, and how they will involve the community.[63] If a proposal is chosen, the applicants are informed, and a list of selected projects is published. Chosen applicants then work with WisDOT to finalize agreements and move forward with

[57] Wisconsin S.B. 791
[58] Ibid.
[59] Wisconsin Electric Vehicle Infrastructure Plan
[60] Ibid.
[61] Ibid.
[62] Ibid.
[63] Ibid.

factors like getting environmental approval, building the charging stations, and ensuring that they are up and running efficiently. Throughout the process, applicants can ask for reimbursement for certain expenses, given they follow all the rules and regulations. Ultimately, the goal is to make electric vehicle charging more accessible across Wisconsin.

In summary, the NEVI program provides substantial funding support for nationwide EVSE development, while initiatives like the WEVI program in Wisconsin focus on deploying charging stations within the state. NEVI funding covers various aspects of the WEVI program, including installation, operation, maintenance, and reporting, with a strong emphasis on equity and community engagement.

Environmental and Health Impacts

Reduced GHG Emissions

Within Milwaukee County, transportation, the second largest sector of community emissions, made up 30% of total greenhouse gas (**GHG**) emissions in 2018.[64] EVs play a pivotal role in reducing GHG and carbon emissions in the transportation sector. They achieve this by mitigating direct emissions associated with traditional ICE vehicles, reducing dependence on fossil fuels, and enabling cleaner energy sources to power transportation. Here is a breakdown of how EVs contribute to emission reductions:

Tailpipe Emissions: EVs produce zero tailpipe emissions during operation, unlike ICE vehicles that emit pollutants like carbon dioxide (**CO_2**), nitrogen oxides (**NO_X**), and particulate matter (**PM**).[65] In the United States, light-duty vehicles accounted for 58% of emissions in 2021, a significant portion of which comes from tailpipe emissions.[66] As EVs continue to replace conventional vehicles, especially in areas with low-carbon electricity grids, the reduction in tailpipe emissions from transportation can contribute substantially to the reduction of GHG emissions on a broader scale.[67] Life cycle emissions of EVs refer to the GHG emissions produced throughout the vehicle's entire life cycle, encompassing manufacturing, operation, and eventual disposal or recycling. While acknowledging that emissions associated with EV manufacturing are higher than those of conventional vehicles, as EV technology advances and production becomes more efficient, these emissions are expected to decrease significantly over time.[68] The life cycle emissions of EVs are notably lower than those of traditional ICE vehicles owing to their absence of tailpipe emissions during operation.[69]

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[64] Milwaukee County, WI 2018 Community Greenhouse Gas Emissions Inventory (2020). Milwaukee County. ICLE Local Governments for Sustainability. county.milwaukee.gov
[65] Leard, B., & McConnell, V. (2020). Progress and Potential for Electric Vehicles to Reduce Carbon Emissions (Report 20-24). Resources for the Future. EV_Report (rff.org)
[66] U.S. Environmental Protection Agency. (2021). Fast Facts on Transportation Greenhouse Gas Emissions. Fast Facts on Transportation Greenhouse Gas Emissions | US EPA
[67] Progress and Potential for Electric Vehicles to Reduce Carbon Emissions
[68] Ellingsen, L. A.-W., Singh, B., & Strømman, A. H. (2016). The size and range effect: lifecycle greenhouse gas emissions of electric vehicles. Environmental Research Letters, 11(5), 054010. https://iopscience.iop.org/article/10.1088/1748-9326/11/5/054010
[69] Ibid.

Reduction in Greenhouse Gases: The transition from gasoline or diesel vehicles to EVs decreases GHG emissions. On average, EVs produce approximately 50-70% fewer greenhouse gas emissions than traditional internal combustion engine vehicles over their entire lifecycle when charged with a mix of electricity from various sources, including renewable energy.[70] In Wisconsin throughout 2022, PHEVs generated 56% less and all electric vehicles generated 70% less carbon emissions than traditional Internal combustion engine vehicles.[71] Replacing all US light-duty vehicles (**LDVs**) with a combination of BEVs and PHEVs could potentially reduce GHGs by 25% and oil consumption by 24%.[72] Moreover, replacing all LDVs with hydrogen-powered FCEVs could achieve a greater reduction in GHGs by 44% and nearly eliminate oil consumption.[73] The operation of EVs does not produce direct emissions of GHGs or local pollutants.[74] While emissions might occur indirectly in the case of EVs due to electricity generation, the overall impact is significantly lower compared to ICEVs, particularly when the electricity is sourced from low-carbon or renewable energy sources.[75] Overall, the adoption of electric vehicles is a critical component in the efforts to reduce GHG emissions from the transportation sector. As technology improves, costs decrease, and policy support strengthens, the role of EVs in achieving substantial emission reductions becomes more prominent.

Reduced Noise Pollution

Noise pollution's profound impact on health reveals multifaceted implications on various aspects of well-being. Consistent findings highlight the detrimental effects on cardiovascular health, with prolonged exposure to high noise levels correlating significantly with hypertension, irregular heart rate, and heightened risks of severe cardiac events like heart attacks or stroke.[76,77]

Mental well-being emerges as another prominent domain affected by noise pollution, contributing to an array of psychological issues such as nervousness, depression, and disruptions in overall mental equilibrium.[78,79] Sleep disturbances resulting from noise interference further compound these mental health challenges.[80]

Noise pollution's tangible impact on physical health is evident in the decline of hearing ability due to prolonged exposure to high sound levels, accompanied by other health concerns like headaches, distractions, and hypertension. Further, children, notably vulnerable to its effects,

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[70] The size and range effect: lifecycle greenhouse gas emissions of electric vehicles
[71] U.S. Department of Energy. (2022). Emissions from Electric Vehicles. Alternative Fuels Data Center. Alternative Fuels Data Center: Emissions from Electric Vehicles (energy.gov)
[72] Weiss, M., Dekker, P., Moro, A., Scholz, H., & Patel, M. K. (2015). On the electrification of road transportation – A review of the environmental, economic, and social performance of electric two-wheelers. Transportation Research Part D: Transport and Environment. https://doi.org/10.1016/j.trd.2015.09.007
[73] Thomas, C. E. S. (2012). How green are electric vehicles? International Journal of Hydrogen Energy, 37(7), 6053-6062. https://doi.org/10.1016/j.ijhydene.2011.12.118
[74] On the electrification of road transportation
[75] Ibid.
[76] Geravandi, S., Takdastan, A., Zallaghi, E., Vousoghi Niri, M. J., Saki, H., & Naiemabadi, A. (2015). Noise pollution and health effects. Jundishapur Journal of Health Sciences, 7(1). https://doi.org/10.5812/jjhs.225357
[77] Stansfeld, S. A., & Matheson, M. P. (2003). Noise Pollution: Non-auditory effects on health. British Medical Bulletin, 68(1), 243-257. https://doi.org/10.1093/bmb/ldg033
[78] Jariwala, H. J., Syed, H. S., Pandya, M. J., & Gajera, Y. M. (2017). Noise Pollution & Human Health: A Review. L.D. College of Engineering, 1-4. https://www.researchgate.net/publication/319329633_Noise_Pollution_Human_Health_A_Review
[79] Wokekoro, E. (2020). Public awareness of the impacts of noise pollution on human health. World Research Journal and Review (WJRR), 10(6), 27-32. (wjrr.org)
[80] Noise Pollution & Human Health

exhibit compromised cognitive performance and increased stress levels due to chronic exposure to noise.[81,82] Furthermore, noise pollution disrupts communication, induces aggressive behavior, and fosters social conflicts, impairing social interactions.[83]

The collective evidence underscores the urgency of implementing robust measures to mitigate noise pollution's pervasive and detrimental impacts on public health, emphasizing the need for comprehensive strategies encompassing noise control and heightened public awareness.

EVs offer a significant potential for reducing noise pollution, and potentially related adverse health impacts, in urban environments owing to their operational quietness.[84] These vehicles operate silently due to their electric engines, ultimately reducing noise emissions compared to traditional ICEs.[85] Therefore, the absence of engine noise significantly decreases overall vehicle-generated noise, particularly in high-traffic urban areas.[86] Therefore, EV's quiet operation and reduced mechanical noise at lower speeds typical of city driving suggest a promising approach for mitigating urban noise pollution.[87] From this, EVs represent a hopeful solution for curbing noise pollution and contributed adverse health impacts in high-traffic areas, fostering quieter surrounding and contributing to a more peaceful urban environment.

Climate Change Impacts

Climate change is already impacting Milwaukee County, with flooding and extreme heat events becoming more frequent and intense, posing a significant threat to the region. The County's Climate Action 2050 Plan Vulnerability Assessment highlights how historically low exposure to extreme heat does not insulate the county from the rising risks.[88] Heat waves have emerged as a critical concern due to their immediate impact on human health.[89] The assessment underscores that vulnerable populations, including older adults, low-income individuals, and those with limited access to resources and infrastructure like air conditioning, face the highest risk during extreme heat events. This increased risk is compounded by existing systemic inequities, including disparities in access to cooling centers and healthcare services, exacerbating the health impacts on underserved communities.[90]

Moreover, the assessment warns of increased mortality and morbidity linked to extreme heat, projecting a potential rise in heat-related deaths by significant numbers annually if measures are not taken to address the issue.[91] The interplay between social vulnerabilities and the physical consequences of climate change is crucial in understanding the compounded risks during extreme temperature events in Milwaukee County. Susceptible infrastructure, such as old

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[81] Noise Pollution: Non-auditory effects on health
[82] Noise Pollution & Human Health
[83] Ibid.
[84] Patella, S. M., Aletta, F., & Mannini, L. (2019). Assessing the impact of autonomous vehicles on urban noise pollution. Noise Mapping, 6(1), 72-82. https://doi.org/10.1515/noise-2019-0006
[85] Campello-Vicente, H., Peral-Orts, R., Campillo-Davo, N., & Velasco-Sanchez, E. (2017). The effect of electric vehicles on urban noise maps. Applied Acoustics, 116, 59-64. https://doi.org/10.1016/j.apacoust.2016.09.018
[86] Assessing the impact of autonomous vehicles on urban noise pollution
[87] Ibid.
[88] Milwaukee County Department of Administrative Services. (2023). Milwaukee County Climate Action 2050 Plan Vulnerability Assessment. Milwaukee County Department of Administrative Services. Milwaukee County Climate Action 2050 Plan Vulnerability Assessment
[89] Ibid.
[90] Ibid.
[91] Ibid.

buildings and limited green spaces, contributes significantly to the formation of urban heat islands, creating localized areas with higher temperatures.[92] These pockets of heat often align with neighborhoods where social vulnerabilities are more pronounced.[93]

Another concerning impact highlighted in the assessment is acute air quality hazards. Climate change is expected to worsen air quality, particularly with the rise in ground-level ozone due to increased heat and sunny days.[94] This poses a serious threat, especially for vulnerable groups with respiratory conditions and limited access to healthcare. Further, the proximal location of neighborhoods to high traffic areas that generate greater rates of air pollution, such as highways and interstates, poses a greater threat to communities residing nearby. These neighborhoods often have compounded vulnerabilities such as being categorized as lower-income and having inadequate infrastructure.[95] The concentration of vulnerable populations in areas most affected by urban health island effects compounds those risks, revealing an intersection between social vulnerabilities and the environmental impacts of climate change.

Climate change also poses a multifaceted challenge to mental health. Ecological disruptions triggered by climate change, such as extreme weather events, environmental degradation, and forced migration, significantly impact mental well-being. These disruptions disproportionately affect vulnerable populations, intensifying psychological distress and contributing to a myriad of mental health challenges.[96,97] The psychological toll of climate change is evident, as responses to severe climate-related life altering occurrences, encompassing elements like loss of life, resources, social networks, and substantial relocation, manifest as post-traumatic stress disorder (**PTSD**), depression, heightened general anxiety, elevated substance use, and suicidal thoughts.[98] Furthermore, climate induce migration exacerbates the mental health burden, amplifying the feelings of displacement, loss, and uncertainty, leading to heightened psychological distress and trauma.[99]

In addressing the impacts of climate change on both human health and the environment, a holistic approach merging infrastructure adaption and social vulnerabilities emerges Milwaukee County's cornerstone for safeguarding community well-being.

EVs represent a pivotal solution in mitigating climate change effects.[100,101]EVs have emerged as a compelling tool in reducing direct emissions from the transportation sector, notably cutting down on CO_2 emissions compared to traditional ICEs. The widespread adoption of EVs could

[92] Milwaukee County Climate Action 2050 Plan Vulnerability Assessment
[93] Ibid.
[94] Ibid.
[95] Ibid.
[96] Cianconi, P., Betrò, S., & Janiri, L. (2020). The Impact of Climate Change on Mental Health: A Systematic Descriptive Review. Frontiers in psychiatry, 11, 74. https://doi.org/10.3389/fpsyt.2020.00074
[97] Hrabok, M., Delorme, A., & Agyapong, V. I. O. (2020). Threats to Mental Health and Well-Being Associated with Climate Change. Journal of anxiety disorders, 76, 102295. https://doi.org/10.1016/j.janxdis.2020.102295
[98] U.S Global Change, Research Program. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Washington: U.S Global Change Research Program (2016). The Impacts of Climate Change on Human Health: A Scientific Assessment (globalchange.gov)
[99] Palinkas, L. A., & Wong, M. (2020). Global climate change and mental health. Current opinion in psychology, 32, 12–16. https://doi.org/10.1016/j.copsyc.2019.06.023
[100] Li, C., Cao, Y., Zhang, M., Wang, J., Liu, J., Shi, H., & Geng, Y. (2015). Hidden benefits of electric vehicles for addressing climate change. Scientific reports, 5, 9213. https://doi.org/10.1038/srep09213
[101] Desreveaux, A., Bouscayrol, A., Trigui, R., Hittinger, E., Castex, E., & Sirbu, G.M. (2023). Accurate energy consumption for comparison of climate change impact of thermal and electric vehicles. Energy. https://doi.org/10.1016/j.energy.2023.126637

significantly contribute to this emissions reduction by leveraging the advancements in technology, transitioning from fossil fuel-driven vehicles to electric one.[102] However, the efficacy on EVs in curbing climate change relies heavily on the decarbonization of the power sector that energizes these vehicles.[103] While EVs themselves generate minimal or zero emissions during use, the source of electricity powering them determines the overall impact on emissions. This interdependence between the transportation sector and energy systems underscores the necessity of parallel efforts: not only electrifying transport but also ensuring a transition to low-carbon renewable energy sources. Such a transition is crucial in effectively reducing the total GHG emissions associated with transportation.[104] Moreover, stringent policies and incentives aimed at boosting EV adoption play a significant role in accelerating the transition away from fossil-fuel dependent transportation methods, aligning with goals to mitigate climate change.[105] While EVs offer a promising avenue for reducing direct emissions from the transportation sector, their full potential in mitigating climate change hinges upon the broader transportation of the energy landscape toward cleaner and more sustainable sources.

Air Pollution

ICEs, commonly found in vehicles and machinery, contribute significantly to air pollution by emitting various harmful pollutants. These engines burn fossil fuels, releasing carbon monoxide (**CO**), NO_X, volatile organic compounds (**VOCs**), PM, and hydrocarbons into the atmosphere.[106] When these pollutants are released into the air, they undergo chemical reactions. For instance, NO_X can react with other compounds in the presence of sunlight to form ground-level ozone, a major component of smog.[107] VOCs, when exposed to sunlight and other pollutants like NO_X, can also contribute to the formation of ground-level.

These reactions ultimately create secondary pollutants that exacerbate air quality issues, impacting both human health and the ecosystem.[108] The harmful effects of these emission on health are widespread, impacting various systems within the human body. These adverse health outcomes attributed to air pollution include, but are not limited to:

Respiratory System Effects

I. Respiratory Infections: Air pollutants, particularly PM and NO_X, can irritate the respiratory tract, making it more susceptible to infections. These pollutants compromise the body's

[102] Hidden benefits of electric vehicles for addressing climate change
[103] Zhang, R., & Fujimori, S. (2020). The role of transport electrification in global climate change mitigation scenarios. Environmental Research Letters, 15. https://iopscience.iop.org/article/10.1088/1748-9326/ab6658
[104] Cornell, R. (2019). The Climate Change Mitigation Potential of Electric Vehicles as a Function of Renewable Energy. The International Journal of Climate Change: Impacts and Responses. Global climate change mitigation potential from a transition to electric vehicles (theicct.org)
[105] Accurate energy consumption for comparison of climate change impact of thermal and electric vehicles
[106] Gaidar, S., Karelina, M., Laguzin, A., & Quang, H. D. (2020). Impact of operational factors on environmental safety of internal combustion engines. Transportation Research Procedia, 50, 136-144. https://doi.org/10.1016.j.trpro.2020.10.017
[107] Kelly, F. J., & Fussell, J. C. (2015). Air Pollution and Public Health: Emerging Hazards and improved understanding of risk. Environmental Geochemistry and Health, 37(4), 631-649. https://doi.org/10.1007/s10653-015-9720-1
[108] Almetwally, A. A., Bin-Jumah, M., & Allan, A. A. (2020). Ambient air pollution and its influence on human health and welfare: An overview. Environmental Science and Pollution Research, 27 (20), 24815-24830. https://doi.org/10.1007/s11356-020-09042-2

natural defense mechanisms in the respiratory system, increasing vulnerability to infections such as bronchitis and pneumonia.[109]

II. Exacerbation of Asthma: For individuals with asthma, exposure to air pollution can trigger inflammation and airway constriction, leading to asthma. Pollutants like ozone and PM are known to worsen asthma symptoms as well. These pollutants contribute to increased asthma severity, more frequent attacks, a decline in lung function over time, and even a higher risk of developing asthma in the first place.[110]

III. Chronic Respiratory Diseases: Long-term exposure to pollutants like fine particulate matter (**$PM_{2.5}$**) and nitrogen dioxide (**NO_2**) is associated with the development and exacerbation of chronic respiratory conditions such as chronic bronchitis, emphysema, and chronic obstructive pulmonary disease (**COPD**).[111]

Cardiovascular System Effects

I. Heart Diseases: Air pollutants can enter the bloodstream through the lungs, causing inflammation and oxidative stress, which contribute to the development of heart diseases. Long-term exposure to pollutants like $PM_{2.5}$ is linked to an increased risk of heart attacks, strokes, and cardiovascular mortality.[112]

II. Hypertension: Exposure to air pollution, especially traffic-related pollutants such as $PM_{2.5}$ and PM_{10}, has been associated with and increased risk of high blood pressure, or hypertension, potentially contributing to cardiovascular issues.[113]

Cancer

I. Lung Cancer: Prolonged exposure to carcinogenic air pollutants like $PM_{2.5}$, NO_2, VOCs, and benzene increase the risk for developing lung cancer.[114] These pollutants can damage lung tissue and lead to the growth of cancerous cells over time.[115] This relationship is paramount, as lung cancer not only stands as one of the most prevalent cancers diagnosed globally but is also the leading cause of all cancer deaths.[116]

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[109] Santos, U. P., Arbex, M. A., Braga, A. L. F., Mizutani, R. F., Cançado, J. E. D., Terra-Filho, M., & Chatkin, J. M. (2021). Environmental air pollution: respiratory effects. Jornal brasileiro de pneumologia : publicacao oficial da Sociedade Brasileira de Pneumologia e Tisilogia, 47(1), e20200267. https://doi.org/10.36416/1806-3756/e20200267

[110] Tiotiu, A. I., Novakova, P., Nedeva, D., Chong-Neto, H. J., Novakova, S., Steiropoulos, P., & Kowal, K. (2020). Impact of Air Pollution on Asthma Outcomes. International journal of environmental research and public health, 17(17), 6212. https://doi.org/10.3390/ijerph17176212.

[111] Viegi, G., Maio, S., Pistelli, F., Baldacci, S., & Carrozzi, L. (2006). Epidemiology of chronic obstructive pulmonary disease: health effects of air pollution. Respirology (Carlton, Vic.), 11(5), 523–532. https://doi.org/10.1111/j.1440-1843.2006.00886.x

[112] Ambient air pollution and its influence on human health and welfare

[113] Qin, P., Luo, X., Zeng, Y., Zhang, Y., Li, Y., Wu, Y., Han, M., Qie, R., Wu, X., Liu, D., Huang, S., Zhao, Y., Feng, Y., Yang, X., Hu, F., Sun, X., Hu, D., & Zhang, M. (2021). Long-term association of ambient air pollution and hypertension in adults and in children: A systematic review and meta-analysis. The Science of the total environment, 796, 148620. https://doi.org/10.1016/j.scitotenv.2021.148620

[114] Hvidtfeldt, U. A., Severi, G., Andersen, Z. J., Atkinson, R., Bauwelinck, M., Bellander, T., Boutron-Ruault, M. C., Brandt, J., Brunekreef, B., Cesaroni, G., Chen, J., Concin, H., Forastiere, F., van Gils, C. H., Gulliver, J., Hertel, O., Hoek, G., Hoffmann, B., de Hoogh, K., Janssen, N., … Fecht, D. (2021). Long-term low-level ambient air pollution exposure and risk of lung cancer - A pooled analysis of 7 European cohorts. Environment international, 146, 106249. https://doi.org/10.1016/j.envint.2020.106249

[115] Ibid.

[116] Leiter, A., Veluswamy, R. R., & Wisnivesky, J. P. (2023). The global burden of lung cancer: current status and future trends. Nature reviews. Clinical oncology, 20(9), 624–639. https://doi.org/10.1038/s41571-023-00798-3

Neurological Effects

I. Cognitive Decline: Studies suggest that long-term exposure to air pollution, particularly $PM_{2.5}$ and other traffic-related pollutants, may contribute to cognitive decline and impairment, impacting memory, attention, and overall brain health.[117] Some research indicates and association between air pollution and an increased risk of neurodegenerative diseases such as Alzheimer's and Parkinson's.[118]

Reproductive Health Impacts

I. Adverse Birth Outcomes: Air pollutants, such as $PM_{2.5}$ and ozone, can deeply penetrate the respiratory system, entering the bloodstream and affecting fetal development. These pollutants trigger inflammation and oxidative stress in the mother's body, leading to complications in the placenta, restricting oxygen and nutrients to the developing fetus.[119] This disruption can impair fetal growth, increase the risk of preterm birth, and contribute to low birth weight or stillbirth due to compromised oxygen transport and placental damage.

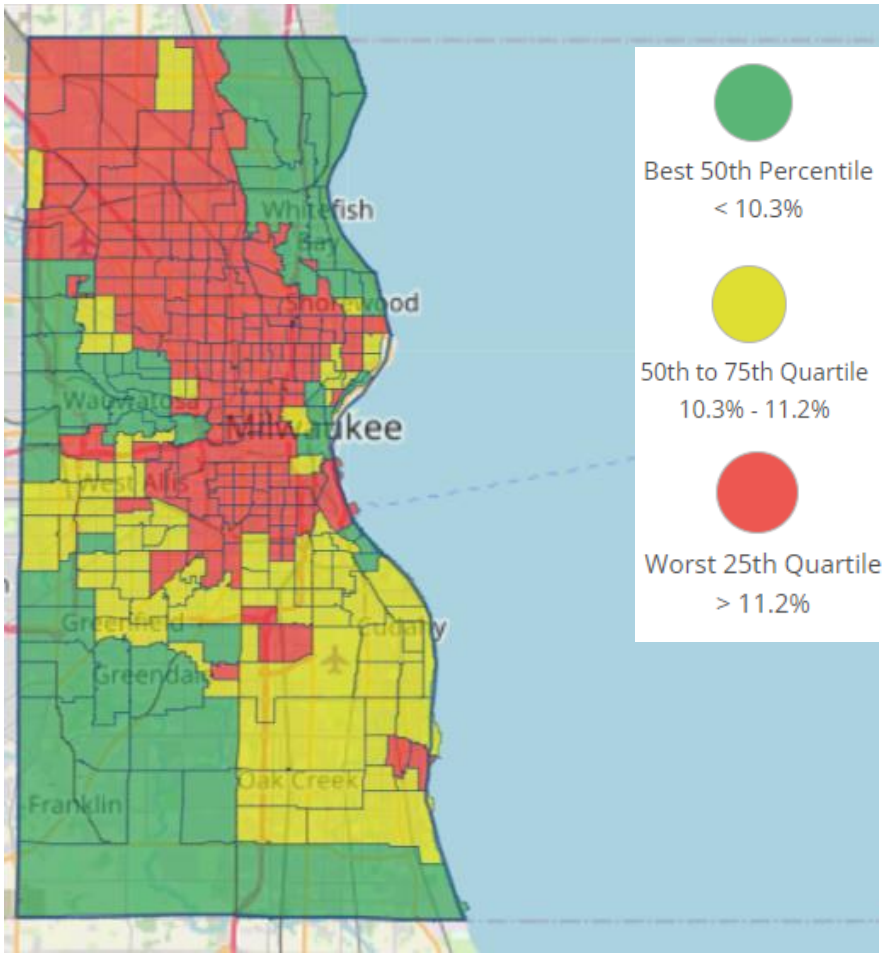
Deploying a widespread network of EVs holds promise of addressing local air pollution, particularly in Milwaukee County, where communities of color and underserved population face disproportionate impacts.[120] Research has revealed that Wisconsin's people of color, especially in Milwaukee, experience substantial disparities in exposure to $PM_{2.5}$, ranking among the highest nationwide.[121] The primary source of $PM_{2.5}$ pollution in Milwaukee stems from transportation and industrial activity.[122] Transitioning to electrified transportation not only plays a vital role in reducing GHG emissions but also serves a critical purpose in mitigating harmful air pollution in Milwaukee County, particularly in underserved neighborhoods with residents of color, often situated near major transportation routes.

The excessive exposure to $PM_{2.5}$ pollution, along with other pollutants such as ozone, contributes to poor air quality county-wide. In 2021, Milwaukee ranked fourth among the top 10 "Asthma Capitals" in the United States, with the highest asthma prevalence in the entire Midwest according to the Asthma and Allergy Foundation of America.[123] These pollutants have been identified as contributors to heightened asthma severity, more frequent attacks, a gradual decline in lung function, and an elevated risk of developing asthma.[124] Milwaukee experiences elevated rates of asthma-related emergency hospital visits, particularly among Black children, whose rates were nearly double those of Hispanic, Asian, and White children combined.[125] The

[117] Schikowski, T., & Altuğ, H. (2020). The role of air pollution in cognitive impairment and decline. Neurochemistry international, 136, 104708. https://doi.org/10.1016/j.neuint.2020.104708
[118] Delgado-Saborit, J. M., Guercio, V., Gowers, A. M., Shaddick, G., Fox, N. C., & Love, S. (2021). A critical review of the epidemiological evidence of effects of air pollution on dementia, cognitive function and cognitive decline in adult population. The Science of the total environment, 757, 143734. https://doi.org/10.1016/j.scitotenv.2020.143734
[119] Bekkar, B., Pacheco, S., Basu, R., & DeNicola, N. (2020). Association of Air Pollution and Heat Exposure With Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review. JAMA network open, 3(6), e208243. https://doi.org/10.1001/jamanetworkopen.2020.8243
[120] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[121] Tessum, C. W., Paolella, D. A., Chambliss, S. E., Apte, J. S., Hill, J. D., & Marshall, J. D. (2021). PM2.5 polluters disproportionately and systemically affect people of color in the United States. Science advances, 7(18), eabf4491. https://doi.org/10.1126/sciadv.abf4491
[122] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[123] Ibid.
[124] Impact of Air Pollution on Asthma Outcomes
[125] City of Milwaukee Preliminary Electric Vehicle Readiness Plan

transition to EVs is expected to reduce sources of air pollution, benefiting low-income individuals and Black, Indigenous, People of Color (**BIPOC**) living in neighborhoods with poor air quality.[126]

Figure 9 – Adults with Asthma in Milwaukee County by U.S. Census Tract (2021)



Health Compass Milwaukee :: Indicators :: Adults with Current Asthma

As EVs become more prevalent, the replacement of traditional ICE vehicles is anticipated to contribute to improved air quality, ultimately benefiting the health of Milwaukee County residents, including those vulnerable to respiratory issues such as asthma.

Gaps and Barriers to EVSE Implementation

The transition to widespread EV adoption is pivotal for sustainable and environmentally conscious transportation. The following section explores key gaps and barriers to EVSE implementation.

[126] City of Milwaukee Preliminary Electric Vehicle Readiness Plan

Access

As the growth of EV adoption continues, ensuring equitable access to charging infrastructure emerges as a critical concern. Disparities in EV charging infrastructure access contribute significantly to social inequity, creating hurdles for certain communities in embracing widespread EV adoption[127,128]. The uneven distribution of charging infrastructure can have profound consequences. Communities that lack sufficient charging points face practical challenges, such as limited accessibility and inconvenient locations of public charging stations.[129] This results in residents encountering difficulties in finding suitable places to charge their EVs, potentially leading to longer travel distances for charging purposes. Moreover, the scarcity of charging infrastructure in these areas can contribute to increased costs associated with reaching available public charging points.

The impact of these challenges is particularly pronounced in communities that are already facing socio-economic difficulties, as a pronounced imbalance exists in the distribution of public EV charging stations within urban landscapes[130]. Despite efforts to expand the deployment of EV charging infrastructure, access remains significantly influenced by socio-demographic factors[131,132]. The distribution of EV charging stations is notably skewed, revealing lower accessibility in low-income, Black-identifying, and disinvested neighborhoods[133]. From this, residents in underserved areas may find it harder to transition to EVs based on the limited access to EVSE these neighborhoods, perpetuating existing disparities in transportation options.[134] The inability to access the necessary charging infrastructure ultimately becomes a barrier that hinders the benefits of EV adoption from reaching this population.[135]

This discrepancy in EVSE access is further exacerbated by a positive correlation with the presence of highways and traffic corridors in specific areas, indicating that certain communities are being left behind in the broader push for EV adoption.[136] There is a rural-urban divide in EVSE, revealing a concentration of charging stations in urban, costal states across the United States, such as California.[137] In contrast, rural America and areas with lower population density face challenges in establishing adequate public EV charging infrastructure.[138]

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[127] Shi, L., Hao, Y., Lv, S., Cipcigan, L., & Liang, J. (2021). A comprehensive charging network planning scheme for promoting EV charging infrastructure considering the chicken-eggs dilemma. Research in Transportation Economics, 88. https://doi.org/10.1016/j.retrec.2020.100837
[128] Li, G., Luo, T., & Song, Y. (2022). Spatial equity analysis of urban public services for electric vehicle charging—implications of Chinese cities. Sustainable Cities and Society, 76. https://doi.org/10.1016/j.scs.2021.103519
[129] Krishna, G. (2021). Understanding and identifying barriers to electric vehicle adoption through thematic analysis. Transportation Research Interdisciplinary Perspectives, 10. https://doi.org/10.1016/j.trip.2021.100364
[130] Khan, H. A., Price, S., Avraam, C., & Dvorkin, Y. (2021). Inequitable access to EV charging infrastructure. The Electricity Journal, 35(3). https://doi.org/10.1016/j.tej.2022.107096
[131] Inequitable access to EV charging infrastructure
[132] Farr, S. (2023). Infrastructure challenges facing widespread EV adoption. WardsAuto. Industry-Watchers See Better Times Ahead for Automotive (wardsauto.com)
[133] Ibid.
[134] Inequitable access to EV charging infrastructure
[135] Ibid.
[136] Inequitable access to EV charging infrastructure
[137] Infrastructure challenges facing widespread EV adoption
[138] Ibid.

These disparities underscore the importance of addressing the inequities in charging infrastructure distribution, as it is imperative for promoting social equity in the adoption of EV technology and implementation.

Vehicle Cost and Affordability

The perceived high cost of EVs remains a significant obstacle to their widespread adoption.[139] Despite a gradual reduction in EV prices and the anticipation of price parity with ICE vehicle in the next 5 to 10 years, potential buyers are often deterred by the upfront investment required for purchase even while acknowledging the long-term operational cost benefits associated with EVs.[140,141] Additionally, concerns about the total cost of ownership, including maintenance and charging expenses, may deter potential buyers, particularly those who are not accustomed to considering long-term costs when purchasing a vehicle.[142] This financial apprehension acts as a substantial barrier to EV adoption, limiting the accessibility of EVs to a broader consumer base.[143] The absence of a mature second-hand market and low resale values compared to ICE vehicle alternatives also contribute to this financial barrier for potential EV buyers.[144] Subsidies for new vehicles exist, but the lack of incentives for second-hand EVs limits accessibility for a considerable portion of the population.[145] Bridging the affordability gap is crucial to expanding the consumer base for EVs.

Infrastructure Implementation Costs

The establishment and expansion of EV charging infrastructure face challenges related to the overall cost of deployment. The process of increasing the capability of the electric network within a particular area to accommodate EV charging infrastructure incurs costs that are distributed across all electricity users.[146] This distribution of costs could potentially have delayed impacts on households with lower incomes, as those in this population tend to be late adopters of EVs.[147] Despite the existence of measures to mitigate risks for energy providers and to decrease market prices, there remains an affordability gap preventing the most economically disadvantaged consumers from accessing cheaper electricity. Additionally, disparities in the availability of charging infrastructure due to implementation and associated costs contribute to social inequity, as certain communities may lack the necessary infrastructure to support widespread EV adoption.[148]

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[139] Krishna, G. (2021). Understanding and identifying barriers to electric vehicle adoption through thematic analysis. Transportation Research Interdisciplinary Perspectives, 10. https://doi.org/10.1016/j.trip.2021.100364
[140] Ibid.
[141] Lee, R., & Brown, S. (2021). Social & Locational impacts on electric vehicle ownership and charging profiles. Energy Reports, 7, 42–48. https://doi.org/10.1016/j.egyr.2021.02.057
[142] Implementation challenges and evolving solutions for Rural Communities. U.S. Department of Transportation. (2023). Implementation Challenges and Evolving Solutions for Rural Communities | US Department of Transportation
[143] Understanding and identifying barriers to electric vehicle adoption through thematic analysis
[144] Berkeley, N., Jarvis, D., & Jones, A. (2018). Analysing the take up of Battery Electric Vehicles: An investigation of barriers amongst drivers in the UK. Transportation Research Part D: Transport and Environment, 63, 466–481. https://doi.org/10.1016/j.trd.2018.06.016
[145] Social & Locational impacts on electric vehicle ownership and charging profiles
[146] Ibid.
[147] Ibid.
[148] Hopkins, E., Potoglou, D., Orford, S., & Cipcigan, L. (2023). Can the equitable roll out of electric vehicle charging infrastructure be achieved? Renewable and Sustainable Energy Reviews, 182. https://doi.org/10.1016/j.rser.2023.113398

Safety Concerns

Safety concerns regarding EV charging stations, particularly among women, present a significant barrier to widespread EV adoption. Research indicates women express apprehensions about the safety of charging locations, highlighting the need for well-lit and less remote stations to alleviate these concerns.[149] One key aspect of these safety concerns is the perception of charging station locations. Individuals who identify as women may feel uncomfortable using charging stations in poorly lit or remote areas, especially during nighttime charging sessions.[150] The lack of visibility and isolation in such locations can contribute to feelings of vulnerability and raise safety apprehensions.[151] Furthermore, the presence of adequate security measures around charging stations is crucial for addressing safety concerns. Women may prioritize charging locations with increased security measures, such as surveillance cameras or security personnel, to ensure their safety while charging their EVs.[152]

Overall, addressing safety concerns related to EV charging stations is essential for promoting EV adoption, particularly among women. Providing well-lit, easily accessible charging locations with adequate security measures can help alleviate apprehensions and create a safer environment for all users, thus encouraging more individuals to consider EVs as their next vehicle option.[153]

Consumer-Awareness and Education

Consumers in various regions exhibit lack of familiarity with EV technology. Current research indicates that a substantial portion of the population is not well-versed in the fundamentals of EVs. Moreover, there is an evident gap in awareness concerning the available incentives and the broader benefits associated with EVs.

Lack of consumer awareness and education can act as a significant barrier to EV adoption. This gap in knowledge was displayed by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's Vehicle Technologies Office by initiating three projects aimed at organizing PEV showcases. These showcases were designed to demonstrate available technologies and offer a hands-on consumer experience at various locations, ranging from long-term stationary storefront settings to one- or two-day events at regional venues.[154] One of the regions was the Midwest region, which included Wisconsin, and was the focal point of the American Lung Association's initiative known as the Midwest (EVOLVE) Electric Vehicle Opportunities: Learning, eVents, Experience project.[155] Attendees had the opportunity to engage with the technology through ride-and-drives and extended test drives. Respondents expressed concerns and misconceptions about various aspects of EV technology, such as overall vehicle performance, charging infrastructure availability, and the cost-effectiveness of EV

[149] Study reveals safety concerns may be hindering EV adoption by women. Geotab. (2023). Study reveals safety concerns may be hindering EV adoption by women | Geotab
[150] Study reveals safety concerns may be hindering EV adoption by women
[151] Ibid.
[152] Ibid.
[153] Ibid.
[154] Ride & Drive Roadshow Design, Impact & Practitioner's Guide (2020). SMRT Columbus. Ride n Drive Final Report 2019 A Practitioner's Guide to Ride N Drives
[155] Ibid.

ownership.[156] These concerns likely stem from a limited understanding of EVs and their benefits among consumers.

Figure 10 – Midwest EVOLVE Ride & Drive with Static Car Display

Midwest EVOLVE – Wisconsin Clean Cities (wicleancities.org)

Before participating in events and educational programs, respondents may have held certain misconceptions about EVs, contributing to their reluctance to consider purchasing one.[157] These misconceptions could include doubts about EV performance, concerns about charging infrastructure availability, and skepticism about the economic viability of EV ownership.[158] Education initiatives can play a crucial role in addressing these misconceptions by providing accurate information about EV technology, debunking myths, and showcasing the capabilities and benefits of EVs through real-world experiences.[159]

Findings from this also highlight that respondents' top reasons for considering PEVs included environmental impact and fuel costs.[160] However, these reasons were not always fully understood or appreciated by all respondents [1]. Education initiatives can help consumers better understand the environmental and economic benefits of EVs, such as reduced greenhouse gas emissions and lower operating costs over the vehicle's lifetime.[161] Providing concrete examples and data on cost savings and environmental impact can help consumers grasp the value proposition of EVs more effectively.

Furthermore, concerns about charging infrastructure availability decreased after participation in events, indicating that lack of awareness about charging infrastructure may have been a barrier

[156] Ride & Drive Roadshow Design, Impact & Practitioner's Guide
[157] Ibid.
[158] Ibid.
[159] Ibid.
[160] Ibid.
[161] Ibid.

to adoption for some respondents.[162] Education initiatives can inform consumers about the growing network of charging stations, advancements in charging technology (such as fast-charging options), and the convenience of home charging. Providing maps or directories of charging stations and highlighting their accessibility can address concerns about charging infrastructure and alleviate range anxiety among potential EV buyers.

Respondents' concerns about overall vehicle performance and charging time also indicate a lack of understanding about EV technology and its advancements.[163] Education initiatives can educate consumers about the latest advancements in EV technology, such as improvements in battery range, charging speed, and vehicle performance. Hands-on demonstrations, workshops, and informational materials can help consumers feel more comfortable with EV technology and its capabilities, ultimately encouraging them to consider EVs as viable alternatives to traditional vehicles.[164]

Education initiatives have the potential to address the lack of consumer awareness and education regarding EVs, thereby overcoming significant barriers to adoption. By providing accurate information, dispelling myths, and showcasing the benefits and capabilities of EVs, education initiatives can empower consumers to make informed decisions about transitioning to electric mobility, ultimately contributing to the acceleration of EV adoption.

Recommendations

EV Charger Standards

According to recent provisions made to the 2021 International Energy Conservation Code (**IECC**), developed by the Building Energy Codes Program (**BECP**) within the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, outlined requirements for new construction to accommodate EVs will provide information and guidance for spaces equipped with electrical infrastructure for EV charging.[165] The code mandates the inclusion of EV-ready spaces with specific electrical circuits and labeling to facilitate future installation of EV chargers[166].

This code describes EVSE as the components, including wiring conductors, connectors, plugs, outlets, and other devices, installed specifically to transfer energy between the building's electrical system and the electric vehicle[167]. According to this code, an EV-capable space is a designated parking area equipped with the necessary electrical infrastructure, including panel capacity and raceways, for installing EVSE, to support each electric vehicle parking space.[168] An EV-ready space is defined as a designated parking spot provided with a dedicated electrical

[162] Ride & Drive Roadshow Design, Impact & Practitioner's Guide
[163] Ibid.
[164] Ibid.
[165] 2021 Electric Vehicles and Building Codes: A Strategy for Greenhouse Gas Reductions. International Code Council. (2021). 2021 ELECTRIC VEHICLES AND BUILDING CODES: A STRATEGY FOR GREENHOUSE GAS REDUCTIONS | ICC DIGITAL CODES (iccsafe.org)
[166] Ibid.
[167] Ibid.
[168] Ibid.

circuit capable of handling a minimum 40-ampere, 208/240-volt load for future installation of Level 2 EV charging equipment.[169] The circuit must terminate at a suitable point, such as a receptacle, junction box, or EV charging station, situated near the intended EV parking area[170]. It should have no other outlets, be protected by an over-current device, and have adequate capacity in the service panel, located nearby, to support the circuit and protective device.[171]

From this, the code specifies the minimum number of EV-ready and EV-capable spaces based on the total number of parking spaces in the building. These recommendations for number of spaces with EVSE installed, EV-ready spaces, and EV-capable spaces for commercial buildings are as follows[172]:

- **Total Number of Parking Spaces:** 1
    - Minimum Number of Spaces with EVSE Installed: 1
    - Minimum Number of EV-Ready Spaces: 1
    - Minimum Number of EV-Capable Spaces: -
- **Total Number of Parking Spaces:** 2 – 10
    - Minimum Number of Spaces with EVSE Installed: 1
    - Minimum Number of EV-Ready Spaces: 2
    - Minimum Number of EV-Capable Spaces: -
- **Total Number of Parking Spaces:** 11 – 15
    - Minimum Number of Spaces with EVSE Installed: 1
    - Minimum Number of EV-Ready Spaces: 2
    - Minimum Number of EV-Capable Spaces: 1
- **Total Number of Parking Spaces:** 16 – 19
    - Minimum Number of Spaces with EVSE Installed: 1
    - Minimum Number of EV-Ready Spaces: 2
    - Minimum Number of EV-Capable Spaces: 2
- **Total Number of Parking Spaces:** 21 – 25
    - Minimum Number of Spaces with EVSE Installed: 2
    - Minimum Number of EV-Ready Spaces: 3
    - Minimum Number of EV-Capable Spaces: 2
- **Total Number of Parking Spaces:** 26 or more
    - Minimum Number of Spaces with EVSE Installed: 5% of total parking spaces
    - Minimum Number of EV-Ready Spaces: 10% of total parking spaces
    - Minimum Number of EV-Capable Spaces: 10% of total parking spaces

These requirements are aimed at supporting the growing trend of EV adoption, reducing greenhouse gas emissions, and ensuring that the infrastructure keeps pace with the increasing number of EVs on the road. While these provisions may increase construction costs, they are more cost-effective when implemented during new construction compared to retrofitting existing buildings.

[169] 2021 Electric Vehicles and Building Codes
[170] Ibid.
[171] Ibid.
[172] Ibid.

Case Studies

MCTS Administrative Offices (1942 N 17th St, Milwaukee, WI 53205, United States)

The Milwaukee County Transit System (**MCTS**) is a $163 million not-for-profit public transportation network operating in Wisconsin, covering 242 square miles across 18 municipalities.[173] MCTS operates over 318 clean-diesel buses and employs approximately 1,000 staff members, including drivers, mechanics, and administrative personnel.[174]

MCTS provides transportation services for residents across the region, facilitating travel to various destinations such as work, school, medical appointments, and entertainment venues. The transit system plays a crucial role in connecting people from diverse backgrounds and communities, bridging geographical distances, and providing mobility options for millions of riders annually. MCTS operates an extensive route network, offering coverage throughout Milwaukee County and beyond.[175] This network serves as a vital link for residents, providing access to essential services and opportunities across urban centers, suburban neighborhoods, and rural areas.

Figure 11 – MCTS Administrative Offices Building

Contact MCTS (ridemcts.com)

Looking ahead, MCTS continues to focus on modernizing its operations and infrastructure to better meet the evolving needs of the community, making it a viable location for the recommendation of EVSE implementation. Specifically, the MCTS Administrative Offices, located at 1942 N 17th St, provides an optimal location for the implementation of publicly accessible EV chargers. Its aptness stems from several advantageous features and amenities tailored to meet the needs of EV drivers and the surrounding community.

Firstly, this location employs various safety measures that help foster a confident charging environment. The presence of a security vehicle patrolling the parking lot from 8:00am to 4:00pm ensures a safe and secure environment for EV users and their vehicles. In addition, the

[173] 2022 Annual report MILWAUKEE COUNTY TRANSIT SYSTEM. Milwaukee County Transit System. (2022). 2022-Annual-Report.pdf (ridemcts.com)
[174] Ibid.
[175] Ibid.

advanced lighting structure within the parking lot, featuring light-emitting diode (**LED**) lighting from newly installed light posts, contributes to enhanced visibility and safety, facilitating charging activities even during nighttime hours. Moreover, the presence of surveillance cameras in the parking lot and on the top of the building further bolsters security measures. These security measures instill confidence in users and helps deter potential safety concerns, enhancing EV users overall charging experience.

Beyond this, the parking lot at the MCTS Administrative Offices is in excellent condition, providing ample space and accessibility for installation of EV charging stations. With well over 100 parking sports available, there is sufficient capacity to accommodate both charging infrastructure and other parking needs, ensuring convenience for users.

The location of the MCTS Administrative offices also serves as an asset to the implementation of EV charging infrastructure. With two access points to the parking lot from the road, this location ensures easy entry and exit for EV drivers. Furthermore, the proximity to a Bublr bike station across the street, along with multiple bus stops around the parking lot, allows users to access nearby services such as stores and restaurants while their vehicles are charging, maximizing the efficiency of their time. The presence of Johnsons Park across the street also adds to the appeal of the location, providing additional amenities for EV users and their families during charging sessions.

Based on standards for EV charging stations from the IECC, a proposal for the MCTS Administrative Offices location to designate at least 6 parking spaces for the implementation of EVSE consisting of 3 dual-port DC Fast Chargers is recommended.[176]

Further, it is advisable to designate at least 8 parking spaces as EV-Ready, according to the specifications outlined in the 2021 IECC [2]. It is also recommended that these EV charging spaces be located within the lot so they can be seen from W Fond Du Lac Avenue, W Vine Street, and N 17th Street to ensure safety and visibility. Further, it is recommended that these spaces be located near an access point to enhance accessibility and convenience for EV drivers.

Wilson Park Senior Center (2601 W Howard Ave, Milwaukee, WI, 53221, United States)

The Wilson Park Senior Center is a welcoming hub for older adults in suburban Milwaukee, offering convenient access to diverse activities and amenities, including exercise classes, social programs, and educational workshops, fostering community connection and personal growth for its members aged 50 and above.[177]

The Wilson Park Senior Center boasts a range of amenities and surrounding attractions designed to cater to the diverse needs and interests of its members.[178] With a focus on promoting physical health, mental well-being, and social connection, the Wilson Park Senior Center offers a variety of daily activities and programs, such as exercise classes and educational workshops. The center prides itself on fostering a diverse and inclusive environment where older adults of all backgrounds feel valued and respected [1].

[176] 2021 Electric Vehicles and Building Codes
[177] Senior Centers - Wilson Park Senior Center. Serving Older Adults. (2024). Serving Older Adults
[178] Ibid.

Figure 12 – Wilson Park Senior Center Building

Senior center on Milwaukee's south side (fox6now.com)

The Wilson Park Senior Center presents an optimal location for EVSE due to several factors. Firstly, the large parking lot estimated to have around 200 spots offers ample space for the installation of multiple EVSE units, accommodating the potential demand from EV drivers visiting the center. Nearby conveniences such as a grocery store and recreation center offer opportunities for leisure and relaxation. Additionally, the center's proximity to a hospital ensures easy access to healthcare services when needed. Furthermore, considering the presence of amenities such as the pool, park, and baseball field in Wilson Park on the same property, installing EVSE at the senior center will encourage visitors to utilize electric transportation while enjoying these recreational facilities, promoting sustainability and environmental stewardship within the community.

Based on the standards outlined for EV charging stations in the 2021 IECC, a proposal is put forth for the Wilson Park Senior Center to allocate designated parking spaces for the implementation of EVSE. [179] It is recommended that a minimum of 6 parking spaces be designated for this purpose, accommodating the installation of 3 dual-port DC Fast charging stations[180]. It is also recommended that a minimum of 10 parking spaces be deemed EV-Ready, as defined by the 2021 IECC.[181] These charging spaces should be strategically located within the parking lot to ensure visibility and safety for EV drivers and other visitors.

However, to better suit the installation of EVSE and infrastructure, several recommendations can be made. Firstly, addressing the maintenance of the parking lot, such as repairing potholes, cracks in cement, and repainting parking lines, will enhance the overall accessibility and safety of the area for both EV drivers and other visitors.

Moreover, upgrading the lighting in the parking lot to LED fixtures not only improves visibility and safety but also contributes to energy efficiency and cost savings in the long term.

[179] 2021 Electric Vehicles and Building Codes
[180] Ibid.
[181] Ibid.

Additionally, installing lighting along the access road leading to the senior center will address safety concerns and improve accessibility, especially during evening hours.

Overall, by implementing these recommendations, the Wilson Park Senior Center can become a more welcoming and accessible location for EV drivers, supporting the transition to electric transportation and fostering a sustainable environment for all visitors.

Fleet Garage & Milwaukee County Department of Transportation Headquarters (10320 W Watertown Plank Rd, Milwaukee, WI, 53226, United States)

The Milwaukee County Department of Transportation (**MCDOT**) is an organization dedicated to providing accessible, reliable, and safe transportation services while enhancing the quality of live for the communities it serves.[182] MCDOT's vision is to achieve racial equity. Aiming to make Milwaukee the healthiest county in Wisconsin.[183] This vision aligns with its mission to deliver an accessible transportation system that is fiscally secure, dependable, and ensures the safety of the travelling public.[184]

MCDOT comprises of five divisions: Airport, Highway Maintenance, Fleet Management, Transit/Paratransit System, and the Director's Office.[185] The Fleet Management Division is responsible for procuring, maintaining, and managing the vehicles and equipment used by various county departments, including the sheriff's office, medical examiner, county zoo, park system, and highway department.[186]

The Fleet Management Division operates with a focus on efficiency, cost-effectiveness, and sustainability.[187] They prioritize user departments' needs, regularly assessing equipment functionality and usage to optimize the fleet size and composition.[188] The Fleet Management Division also emphasizes collaboration and engagement, involving staff members in decision-making processes and fostering a culture of loyalty and teamwork. Recognized as one of the top 100 fleets in North America, the division's achievements reflect its commitment to accountability, efficiency, and staff development. [189]

Overall, MCDOT and its Fleet Management Division play crucial roles in ensuring the smooth functioning of Milwaukee County's transportation infrastructure, contributing to the community's wellbeing.[190]

[182] Milwaukee County Department of Transportation | MCDOT. Milwaukee County Department of Transportation. (2024). county.milwaukee.gov
[183] Ibid.
[184] Ibid.
[185] Ibid.
[186] Harris, J. (2017, January 12). Milwaukee County Department of Transportation Fleet Management Division. Transportation and Logistics International. Milwaukee County Department of Transportation Fleet Management Division - Transportation and Logistics International (tlimagazine.com)
[187] Ibid.
[188] Ibid.
[189] Ibid.
[190] Milwaukee County Department of Transportation Fleet Management Division

Figure 13 – Fleet Garage & MCDOT Headquarters Building

10320 W Watertown Plank Rd - Google Maps

The Fleet Garage and MCDOT Headquarters present a strategically located facility with various amenities and potential for future enhancement. The location has measured employed to promote EV drivers' safety with ample LED lighting and security cameras in the parking lot, along with the presence of sheriff vehicles on the property. The parking lot is also visible from major roads such as W Watertown Plank Rd, N Swan Blvd, and Interstate-41. Further, the proximity to key facilities such as the Medical College of Wisconsin, Froedtert Hospital, Mayfair Mall, various cafes and convenience stores, and the Watertown Plank Park and Ride adds to its appeal.

Given the promising visibility of electrical infrastructure on-site, the location provides a notable opportunity for the implementation of EVSE. Considering the parking lot size and location, it is recommended that a minimum of 6 parking spaces be designated for EV charging, consisting of 3 dual-port DC Fast chargers to cater to the growing demand for faster public charging options.[191] Additionally, at least 8 parking spaces should be made EV-Ready, as defined by the 2021 IECC.[192]

To facilitate public access to EV charging, a portion of the employee parking lot could be designated for this purpose. Ideally, this area would be located in the front portion of the lot for easy accessibility. Adequate signage should also be installed to clearly mark these spaces for public use, thereby minimizing confusion and ensuring a smooth experience for EV users.

By integrating EV charging infrastructure into its operations, the Fleet Garage and MCDOT Headquarters can not only enhance accessibility and convenience but also contribute to sustainable transportation practices. This initiative aligns with the department's commitment to promoting safety, inclusivity, and environmental responsibility within the community it serves.[193]

[191] 2021 Electric Vehicles and Building Codes
[192] Ibid.
[193] Milwaukee County Department of Transportation

Community Reintegration Center (8885 S 68th St, Franklin, WI 53132, United States)

The Milwaukee County Community Reintegration Center (**CRC**) serves as the county's house of correction, providing programming and resources to promote successful community reintegration for individuals sentences in Milwaukee County and other jurisdictions, in compliance with Wisconsin Statutes.[194]

The CRC is pivotal in the criminal justice system, focusing on rehabilitating and reintegrating incarcerated individuals.[195] The CRC prioritizes addressing root causes of criminal behavior, offering tailored programs to equip residents for successful reentry into society. These programs encompass education, vocational training, substance abuse treatment, mental health counseling, job readiness, and life skills development, providing essential support systems for community reintegration.[196]

With an average population of 978.5 residents and an average of 950 days served, the CRC aims to provide a safe and supportive environment for residents, fostering positive change and growth.[197] Through a staff of dedicated professionals, the CRC serves as a crucial link between incarceration and community reintegration.[198] Through its comprehensive approach to rehabilitation, the CRC contributes to public safety and the overall well-being of the community.

Figure 14 – Milwaukee County Community Reintegration Center Building

MKE County: Community Reintegration Center » Urban Milwaukee

Situated adjacent to the Sheriff Department training academy, the CRC enhances the safety of the surrounding area while also ensuring security through ample LED overhead lighting in the parking lot. However, due to its location and nature, it is recommended that the CRC implements both public and private EVSE charging. This dual approach will not only benefit employees by allowing them to charge their vehicles during work hours but also provide

[194] Milwaukee County 2024 Adopted Operating Budget . Milwaukee County Community Reintegration Center. (2024). county.milwaukee.gov
[195] Milwaukee County Community Reintegration Center Facility Master Plan. Department of Administrative Services Milwaukee County. (2023). Milwaukee-County-CRC-facility-master-plan-RFP.pdf
[196] Ibid.
[197] Ibid.
[198] Ibid.

essential charging facilities for visitors and rural community members. Further, this public-private approach can also support the growth of Milwaukee County Sherriff's Office (**MCSO**) electric squad vehicles, as there is an expected increase in privately owned EVSE need as squad vehicles transition to EVs.

In line with these recommendations, it is proposed that at least 4 parking spaces be designated for public EV charging, comprising 2 dual-port DC fast chargers in the lot adjacent to S 68th St. Additionally, a minimum of 8 spaces should be designated as EV ready, conforming to the 2021 IECC.[199] Furthermore, to cater to employee needs, at least 4 spaces in the employee parking lot located at the back of the building should be designated for employee EV charging, featuring 2 dual-port level 2 chargers. Moreover, at least 10 spaces in the employee parking lot should be EV ready as per the 2021 IECC.[200]

By implementing these recommendations based on the 2021 IECC, the CRC can enhance accessibility, promote sustainable transportation options, and contribute to a greener and more inclusive community in rural Milwaukee County.

Public EV Charging Infrastructure Locations

The growth EV adoption in Milwaukee County necessitates a strategic approach to the expansion of EV charging infrastructure.[201] The locations recommended for the implementation of EVSE aim to focus on enhancing accessibility, promoting equity, and ensuring scalability of the infrastructure.

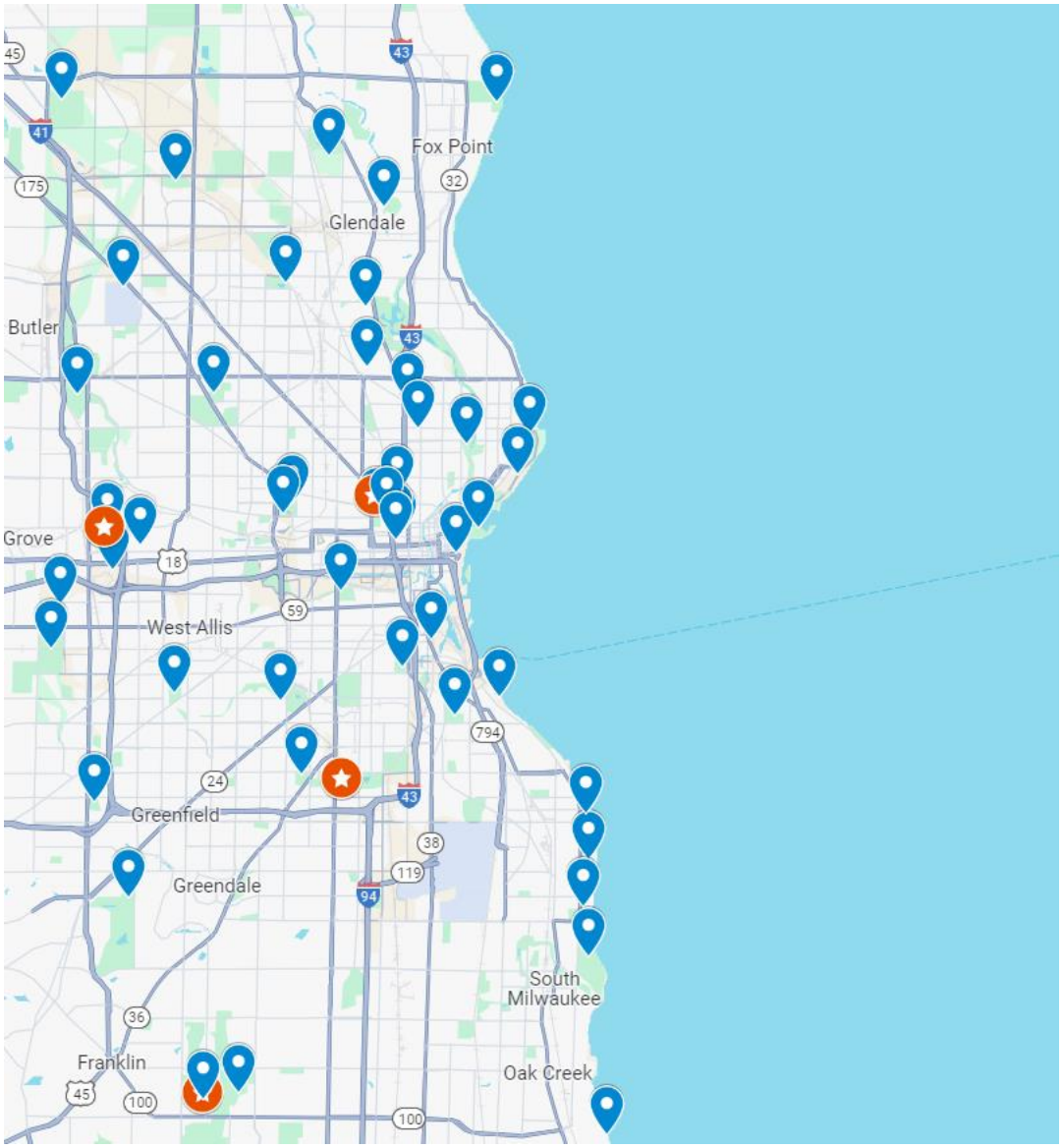
An increase in publicly available EV charging stations is crucial to support the growing number of EV owners and visitors in Milwaukee. While early adopters often have private charging options, the broader community requires accessible charging infrastructure.[202] The County recognizes the importance of public charging stations for residents, visitors, and the tourism industry. Deploying EV charging infrastructure aligns with broader goals of reducing air pollution and GHG emissions, promoting equity, and fostering sustainable transportation options.[203]

The EV charging location plan integrates diverse criteria to identify suitable sites for the deployment of public charging infrastructure. By prioritizing accessibility, equity, and potential for future expansion, Milwaukee aims to support widespread EV adoption and contribute to sustainable transportation solutions for its residents and visitors.

Given this, 52 additional locations owned by Milwaukee County have been deemed to have potential for future EVSE installation. These locations have been selected based on the following criteria: location, parking lot condition, annual visits, traffic data, racial/ethnic demographics, median household income, and average vehicles per household. However, greater research and evaluation would have to be completed to create a strategic and detailed plan for EVSE implementation and operation. Please see Appendix A for list of locations for feasible future EVSE installation.

[199] 2021 Electric Vehicles and Building Codes
[200] Ibid.
[201] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[202] Ibid.
[203] Ibid.

Figure 15 – Recommended Locations for Potential EVSE Installation



EVSE Recommended Locations - Google My Maps

Public-Private Partnerships

The passage of Senate Bill 791 on March 20th, 2024, in Wisconsin marks a significant shift in the regulatory landscape for EVSE. By exempting entities supplying electricity through EV charging stations from regulation as public utilities, the bill encourages private sector involvement in deploying charging infrastructure.[204] This deregulation paves the way for public-private partnerships (**PPPs**) an opportunity to play a crucial role in expanding EV charging networks across the state, and therefore throughout Milwaukee County.

At the federal level, the Infrastructure Bill, signed into law by President Biden, allocates $7.5 billion specifically for EV charging stations as part of a broader effort to modernize

[204] Wisconsin S.B. 791, Reg. Sess. 2023-2024 (2024). (23-2813/1) (wisconsin.gov)

transportation infrastructure.[205] This funding represents a major step forward in realizing the vision of a comprehensive national network of EV charging stations, with the goal of deploying at least 500,000 stations nationwide. The bill also provides additional funding for transportation and transit systems, creating opportunities for supplementary components, including EV charging infrastructure.[206]

Private companies would help take the lead in implementing EV charging projects, drawing on their expertise and resources in the field. They would be responsible for deploying advanced charging technologies, such as Level 2 and DC fast chargers, to enhance the efficiency and convenience of EV charging. Meanwhile, Milwaukee County would provide support in securing permits, land acquisition, and regulatory compliance to expedite project implementation.[207]

Revenue generation is a key aspect of PPPs for EVSE. Private companies can earn their investment through user fees or charging costs, while local governments may benefit from revenue-sharing agreements or lease arrangements for hosting charging stations on public property.[208] This financial sustainability ensures the long-term viability of EV charging infrastructure and incentivizes continued private sector investment.

Community engagement is essential in the PPP model, ensuring that EV charging infrastructure meets the needs of residents and businesses within the neighborhoods they are implemented.[209] Stakeholder consultations, public forums, and feedback mechanisms can help facilitate the identification of demand, address concerns, and foster acceptance of EV technology.[210] By actively involving the community, PPPs can build trust and support for sustainable transportation initiatives.

PPPs for EVSE offer a collaborative approach to accelerating the deployment of charging infrastructure in Milwaukee and beyond. By combining public funding, private sector operation, and community engagement, these partnerships can overcome regulatory barriers, leverage financial resources, and drive the widespread adoption of electric mobility.

Design of Public EV Charging Infrastructure

Construction Considerations

Implementing EV charging stations involves several critical construction considerations to ensure their effectiveness, safety, and compliance with regulations. Firstly, assessing the existing electrical capacity and infrastructure is essential. This evaluation helps determine if upgrades or modifications are necessary to support EV charging stations adequately.[211] It involves installing dedicated circuits and appropriate wiring to accommodate the power

[205] Alfert, R. (2022). *Public-private partnership as a tool for EV Infrastructure*. American City and County. Public-private partnership as a tool for EV infrastructure - American City and County
[206] Ibid.
[207] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[208] Plug-In Electric Vehicle Handbook for Public Charging Station Hosts
[209] McLean, D. (2022). *Building EV charging through public-private partnerships*. Smart Cities Dive. Building EV charging through public-private partnerships | Smart Cities Dive
[210] Ibid.
[211] Cooke, C., & Ross, B. (2019). Summary of Best Practices in Electric Vehicle Ordinances. Great Plains Institute. GPI_EV_Ordinance_Summary_web.pdf (betterenergy.org)

requirements of charging stations. Additionally, ensuring proper grounding and electrical safety measures are in place is crucial to prevent hazards such as electric shocks or fires.[212]

Location and site planning are equally important aspects of constructing EV charging stations. Selecting suitable locations within parking lots or structures that are convenient for users and comply with regulations regarding spacing, accessibility, and proximity to amenities is essential.[213] Factors like visibility, ease of access, traffic flow, and pedestrian access should be considered when determining the placement of charging stations.

Further, Milwaukee County should conduct thorough assessments to identify government-owned properties and other suitable sites that meet federal and state siting criteria.[214] Collaboration with community-based organizations and stakeholders can provide valuable insights into community needs and preferences, facilitating the selection of sites that align with equity and accessibility goals.[215] Additionally, incentivizing site hosts and providing funding opportunities can encourage the deployment of charging infrastructure in underserved areas, promoting equitable access to EV charging services.[216]

Regarding physical infrastructure, it's vital to install charging equipment securely on stable foundations or mounts to withstand environmental conditions and prevent damage or theft. Providing weatherproof enclosures or shelters to protect charging equipment from exposure to elements like rain, snow, and sunlight is also essential.[217] Additionally, installing bollards or other protective barriers can safeguard charging stations from vehicle impacts and unauthorized access.[218] These shelters must be strategically positioned to avoid obstructing access to charging stations or interfering with accessibility features.[219]

When integrating EV charging stations into parking lots structures, the location of existing electrical infrastructure, such as transformers and electrical panels, is important as this can significantly impact installation costs and feasibility[220]. Additionally, the layout of parking spaces, especially in sloping areas or basements, must be carefully evaluated to ensure accessibility for all users, including those with disabilities.[221]

Lighting considerations are also essential for both safety and security in EV charging infrastructure. Adequate illumination levels must be maintained to ensure visibility during nighttime charging sessions and prevent potential tripping hazards caused by dim lighting. Furthermore, supplementary lighting may be necessary to enhance security and deter vandalism or theft of EV supply equipment.[222]

Effective signage placement is vital for directing users to EV charging stations and conveying essential information about parking regulations and accessibility. Following federal and local

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[212] Summary of Best Practices in Electric Vehicle Ordinances
[213] Ibid.
[214] Local Government Playbook. Electrification Coalition. (2022). Local-Government-Playbook_Reader-file.pdf (electrificationcoalition.org)
[215] Ibid.
[216] Ibid.
[217] Summary of Best Practices in Electric Vehicle Ordinances
[218] Ibid.
[219] Ibid.
[220] Mayfield, D. (2012) Site Design for Electric Vehicle Charging Stations. Sustainable Transportation Strategies. EV_Z_sitedesignchargingstations.pdf (solarroadmap.com)
[221] Site Design for Electric Vehicle Charging Stations
[222] Ibid.

signage standards, such as the Manual on Uniform Traffic Control Devices (**MUTCD**), ensures clarity and consistency in messaging, improving user experience and compliance with regulations.[223]

Furthermore, prompt snow removal around charging stations is crucial to facilitate access for individuals with mobility impairments, as plowed snow should not impede access or use of the charging station[224]. Proper engagement with both the building tenant and Operations and Maintenance staff should be prioritized to reach a mutual understanding for these services. Additionally, in regions with extreme sun/heat, precautions should be taken to prevent black charging cables from becoming hot enough to burn individuals with limited sensation, which may involve providing adequate shading or covering for the charging cables.[225] During the construction phase, shelter supports such as columns and pylons must be carefully designed and placed to ensure they do not obstruct vehicle charging spaces, access aisles, clear floor or ground space, and accessible routes.[226]

Further, adherence to the American Disabilities Act (**ADA**) and Architectural Barriers Act (**ABA**) Accessibility Standards is paramount to ensure inclusivity in design and operation. Operational elements such as connectors, card readers, and electronic interfaces must align with reachable heights and operable force requirements.[227] These specifications are critical for accommodating users with varying levels of mobility and ensuring equitable access to charging facilities.

According to the City of Milwaukee Preliminary EV Readiness Plan, specific dimensions and layout of EV charging spaces, each standard charging space should have a minimum width of nine feet and a length of 18 feet.[228] For accessible charging spaces, a minimum width of 11 feet and a length of 20 feet is required, accompanied by a five-foot wide access aisle.[229] This access aisle must be connected to an accessible route leading to the associated facility, potentially requiring a curb ramp for mobility from ground level to the sidewalk.[230]

Regarding charger installation, for standard charging spaces, the charger can be placed at least 12 inches behind the curb, provided that protective bollards are positioned at least six inches away from the front of the charger.[231] The accessible charger should be installed at the same grade level as the ADA charging spaces to facilitate mobility-impaired access, with its front facing the access aisle for easy operation.[232] Bollards for ADA charging spaces must be within ten inches of the charger, with a maximum separation of five feet between each pair, ensuring proper accessibility and safety measures.[233]

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[223] Site Design for Electric Vehicle Charging Stations
[224] Design Recommendations for Accessible Electric Vehicle Charging Stations. U.S. Access Board. (2023). usab-evse-guide.pdf (access-board.gov)
[225] Ibid.
[226] Ibid.
[227] Ibid.
[228] City of Milwaukee Preliminary Electric Vehicle Readiness Plan
[229] Ibid.
[230] Ibid.
[231] Ibid.
[232] Ibid.
[233] Ibid.

ADA Recommendations

In constructing EV charging infrastructure, strict adherence to the ADA guidelines is indispensable to ensure optimal accessibility for all users. One pivotal recommendation is the designation of a "reasonable number" of accessible charging spaces, even in the absence of specific scoping requirements within the ADA standards.[234] These accessible spaces must not only meet technical specifications but also be designed to effectively accommodate users with disabilities.

Furthermore, the adoption of a "use last" model for accessible charging spaces presents a practical solution to enhance utilization and flexibility.[235] This approach involves designing more charging spaces with accessible features and allowing them to be used by non-disabled individuals when other spaces are occupied.[236] By creating more charging spaces with accessible features and permitting their use by non-disabled individuals when other spaces are in use, this approach fosters greater accessibility and inclusivity within the charging infrastructure.

To navigate the complexities of ADA compliance effectively, leveraging technical assistance resources provided by the Access Board is essential. The Access Board offers valuable guidance and support through its helpline and email assistance, aiding stakeholders in ensuring their EV charging projects align with ADA accessibility guidelines.[237]

Moreover, while signage requirements for accessible EV charging spaces may vary by jurisdiction, it is generally advisable to refrain from using the International Symbol of Accessibility (**ISA**) unless mandated by local regulations. Instead, innovative signage solutions such as the proposed "use last" sign can provide clear guidance on the availability and accessibility of charging spaces without causing confusion about usage rights.[238] Collaboration with relevant authorities is essential to ensure compliance with state and local signage regulations while incorporating innovative signage solutions to enhance accessibility.

Compliance with state and local accessibility requirements extends to signage regulations. Engaging with regulatory authorities and seeking technical assistance can aid in navigating these requirements effectively and ensuring that signage meets accessibility standards. By integrating clear and informative signage solutions into EV charging infrastructure, facilities can enhance user experience and promote inclusivity for individuals with disabilities.

To meet ADA requirements for EV charging spaces, the following standards should be adhered to:

1. **Accessible Route**: Ensure that an accessible route is provided from accessible parking spaces to the EV charging station. This route should be firm, stable, and slip-resistant, with a minimum width of 36 inches.[239]

[234] Design Recommendations for Accessible Electric Vehicle Charging Stations. U.S. Access Board (2023). Design Recommendations for Accessible Electric Vehicle Charging Stations (access-board.gov)
[235] Ibid.
[236] Ibid.
[237] Ibid.
[238] Ibid.
[239] Site Design for Electric Vehicle Charging Stations

2. **Parking Space Dimensions**: Designate accessible parking spaces that comply with ADA standards, including a minimum width of 96 inches and an adjacent access aisle of at least 60 inches wide for van-accessible spaces or 36 inches for other accessible spaces.[240]
3. **Vertical Clearance**: Ensure a minimum vertical clearance of 114 inches for van-accessible parking spaces to accommodate lift-equipped vehicles.[241]
4. **Proximity to Accessible Route**: Situate accessible EV charging spaces within close proximity to accessible routes, ensuring ease of access for individuals with disabilities.[242]
5. **Ground Surface**: Ensure that the ground surface of the accessible route and parking spaces is firm, stable, and slip-resistant to facilitate safe maneuvering for individuals with mobility aids.[243]
6. **Access Aisle**: Maintain an access aisle adjacent to accessible parking spaces, allowing sufficient space for vehicle transfers and maneuvering of mobility devices.[244]
7. **Accessibility Features**: Design EV charging stations with accessible mobility features, such as operable parts within reach ranges and communication features for individuals with sensory impairments.[245]

By adhering to these standards, EV charging facilities can ensure compliance with ADA requirements and provide equitable access for individuals with disabilities. Construction and implementation considerations for EV charging infrastructure should encompass adherence to accessibility standards outlined in various articles. Attention to operational elements, signage design, and regulatory compliance are essential aspects of creating an inclusive and user-friendly charging environment.

Education and Outreach

Ride and Drive (**R&D**) events represent one of the most common and most effective forms of education and outreach initiative aimed at promoting EV adoption and awareness.[246] R&D events serve as a vital tool for EV education and outreach due to their ability to provide firsthand experience to participants. By offering individuals the opportunity to test drive EVs, these events help dispel myths and misconceptions surrounding electric vehicles. Participants can directly experience factors like performance and range, addressing concerns such as range anxiety.[247] This hands-on experience is invaluable in educating consumers about the practicality and benefits of EVs, fostering a deeper understanding and confidence in their viability as everyday vehicles.

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[240] Ada compliance brief: Restriping Parking Spaces. ADA.gov. (2024). ADA Compliance Brief: Restriping Parking Spaces | ADA.gov
[241] Ibid.
[242] Design Recommendations for Accessible Electric Vehicle Charging Stations
[243] Ibid.
[244] Ibid.
[245] Ibid.
[246] Singer, M. (2020). Plug-In Electric Vehicle Showcases: Consumer Experience and Acceptance. National Renewable Energy Laboratory. Plug-In Electric Vehicle Showcases: Consumer Experience and Acceptance (energy.gov)
[247] Ibid.

Moreover, R&D events have a broad geographic reach, attracting drivers from various locations across the United States.[248] This diverse participation demonstrates the events' effectiveness in reaching a wide audience. However, it's crucial to recognize that despite this broad outreach, there are segments of the population, particularly in regions not directly targeted by the program, who may still lack awareness of EVs and their benefits.[249] To address this, there is a need for widespread educational campaigns that extend beyond major metropolitan areas, reaching rural communities and smaller cities where EV awareness may be lower.

Additionally, R&D events play a role in addressing demographic disparities in EV awareness and interest. While attracting participants from diverse backgrounds, the data reveals disparities, such as a correlation between higher education, higher income, and opt-ins for dealer contact.[250] This suggests that certain demographic groups may be more receptive to EV education initiatives. By tailoring educational strategies to resonate with different demographic segments, such as through targeted advertising campaigns and community workshops, R&D events can help bridge these disparities and ensure broader access to EV education.[251]

Furthermore, the significant proportion of participants who opt to be contacted by dealerships for more information about the vehicles they test drove underscores the importance of post-test drive follow-up.[252] R&D events can leverage these opt-ins to provide additional resources, such as personalized EV purchasing guides and information sessions. This follow-up not only sustains consumer interest but also facilitates informed decision-making, addressing any lingering concerns or questions participants may have about EVs.[253]

Smart Columbus is another educational outreach initiative proven to be successful in not only increasing EV knowledge and awareness but also increasing interest in EV adoption.[254] Smart Columbus is a collaborative initiative involving public and private sectors, aiming to accelerate EV adoption in the Columbus, Ohio region. It began after winning the U.S. Department of Transportation's Smart City Challenge in 2016, securing $10 million to boost the EV market [2]. Initially, only 0.38% of new car sales in Columbus were EVs.[255] Smart Columbus set out to increase ownership by nearly 500% to 1.8% of new vehicle purchases by 2020, a goal it has surpassed, with EV sales exceeding 2% of vehicles sold by 2018.[256] The initiative focuses on EV education, awareness, and incentives.

Key strategies include partnering with large employers to promote EV adoption among their workforce, offering education, R&D events, and incentives through various programs.[257] Financial incentives motivate associates to choose EVs, with notable success stories like Alliance Data and American Electric Power.[258] Workplace charging infrastructure has been

[248] Plug-In Electric Vehicle Showcases: Consumer Experience and Acceptance
[249] Ibid.
[250] Ibid.
[251] Ibid.
[252] Ibid.
[253] Ibid.
[254] Davis, J. (2024). Columbus Ohio's bold goal: Increasing EV adoption: SmartColumbus. Smart Columbus. Columbus Ohio's Bold Goal: Increasing EV Adoption | SmartColumbus
[255] Ibid.
[256] Ibid.
[257] Ibid.
[258] Ride & Drive Roadshow Design, Impact & Practitioner's

expanded, making charging more accessible, while the R&D Roadshow has exposed more people to EVs, changing perceptions positively.[259]

Collaborative efforts with large employers, workplace charging infrastructure expansion, and initiatives like the R&D Roadshow have raised awareness and interest in EVs.[260] The Electrified Dealer program also empowers local dealerships to better serve EV shoppers, enhancing the overall purchasing experience. Smart Columbus serves as a model for promoting sustainable mobility solutions through partnerships and innovative initiatives, offering lessons for other cities and regions aiming to drive EV adoption.

Overall, education and outreach initiatives play a pivotal role in accelerating the adoption of EVs and shaping positive attitudes towards sustainable transportation. By providing firsthand experiences through test drives, these initiatives dispel myths and misconceptions surrounding EVs, addressing concerns like range anxiety and fostering confidence in their viability. Moreover, they reach a broad audience, including diverse demographic segments, thus bridging disparities in awareness and interest. Furthermore, post-event follow-up and tailored educational strategies sustain consumer interest and facilitate informed decision-making. The success of initiatives like Smart Columbus underscores the effectiveness of collaborative efforts and innovative approaches in promoting EV adoption. As Milwaukee County continues to implement sustainable mobility solutions, investing in comprehensive EV education and outreach initiatives remains crucial for driving widespread adoption and building a greener, more sustainable future.

Progress and Outcome Metrics

As the adoption of EVs continues to rise, it is essential to assess the progress and outcomes of EV initiatives. By examining progress and outcome metrics, stakeholders can gain insights into the effectiveness of EV programs and identify areas for improvement.[261] Monitoring progress and outcomes through established metrics is also vital for evaluating the success of EV initiatives.

Performance Metrics:

1. **Charging Station Utilization:** Measures the percentage of time that charging stations are in use. High utilization rates indicate high demand and potential expansion needs.[262] Utilization rates above 20% may indicate the need for network growth to accommodate growing customer needs.[263]

2. **Charging Session Duration:** Monitoring the typical duration of charging sessions assists operators in estimating the duration of each charging event.[264] This data enables the optimization of charging station availability and facilitates planning for maintenance activities.

[259] Ride & Drive Roadshow Design, Impact & Practitioner's
[260] Columbus Ohio's bold goal: Increasing EV adoption
[261] EV Charging Platform Analytics: Measuring Performance Metrics. EV Auto Software. (2023). EV Charging Platform Analytics: Measuring Performance Metrics - EV Auto Software
[262] Ibid.
[263] Top Metrics to Measure the Performance of Your EV Charging Stations. EV Charging Summit Blog. (2023). Top Metrics to Measure the Performance of Your EV Charging Stations - EV Charging Summit Blog
[264] EV Charging Platform Analytics: Measuring Performance Metrics

3. **Charging Speed:** Charging speed refers to the rate at which EVs charge may fluctuate based on factors like the vehicle's battery capacity and the power output of the charging station.[265] Keeping track of charging speed metrics enables operators to verify that charging stations are meeting the anticipated charging rates.

Key Performance Indicators (KPIs):

1. **Charging Station Availability:** This KPI quantifies the proportion of time during which charging stations are functional and accessible for usage.[266] Elevated availability rates signify a dependable charging infrastructure, whereas lower rates may signal the presence of maintenance or technical challenges requiring prompt resolution.[267] Uptime, the term used to represent the availability of charging services throughout the year, is critical for customer satisfaction. Meeting uptime targets, set at 97% annually by federal regulations, enhances station dependability and business sustainability.[268]

2. **Customer Satisfaction:** Gauges user experience to pinpoint areas for improvement. Tracking customer satisfaction via surveys or feedback ratings enables operators to comprehend the charging experience from the user's viewpoint.[269]

3. **Revenue Generation:** Assesses financial viability and identifies growth opportunities. Analyzing revenue streams on daily, weekly, or monthly bases helps identify opportunities for maximizing profitability, sealing revenue leaks, and enhancing revenue growth.[270] It is important to note that due to Senate Bill 791, EV chargers owned and operated by Milwaukee County would not be allowed to generate revenue on publicly accessible chargers, however, PPPs could allow for potential revenue generation.

To gather and assess essential performance metrics and KPIs, charging platform operators frequently utilize data Application Programming Interfaces (**APIs**).[271] These APIs facilitate smooth integration with the platform's backend systems, enabling the retrieval and analysis of real-time data. Leveraging the charging platform data API enables operators to obtain valuable insights and generate customized reports tailored to their specific requirements.[272]

Moreover, the data API can streamline the incorporation of charging platform analytics with other software systems, such as those for energy management or billing.[273] This integration fosters a comprehensive approach to EV charging operations, thereby improving overall efficiency.

Assessing performance metrics and KPIs is crucial for enhancing the efficiency of EV charging platforms. By monitoring metrics such as charging station utilization, session duration, and charging speed, operators can pinpoint areas for enhancement. Key performance indicators like availability, customer satisfaction, and revenue generation offer a holistic perspective on the platform's effectiveness. With the assistance of a charging platform data API, operators can

[265] EV Charging Platform Analytics: Measuring Performance Metrics
[266] Ibid.
[267] Ibid.
[268] Top Metrics to Measure the Performance of Your EV Charging Stations
[269] EV Charging Platform Analytics: Measuring Performance Metrics
[270] Top Metrics to Measure the Performance of Your EV Charging Stations
[271] EV Charging Platform Analytics: Measuring Performance Metrics
[272] Ibid.
[273] Ibid.

gather and analyze real-time data, empowering them to make informed decisions and improve the charging experience for EV users. By prioritizing performance metrics, EV charging businesses can thrive, maintain a positive reputation, and sustain profitability amidst industry growth.

Future Goals

To achieve carbon neutral operations[274], Milwaukee County will likely need to transition its fleet to low- to no-emission county vehicles by 2050. The County should aim to reflect this growth of EV adoption, not only from county-owned vehicles but also from the growing number of residential EV users, through apt EVSE implementation. By embarking on this journey, Milwaukee County endeavors to pave the way towards a sustainable and carbon-neutral future.

As Milwaukee County progresses with EVSE implementation and operation, it ought to remain steadfast in its commitment to achieving carbon neutrality by 2050. Through collaborative efforts with public and private stakeholders, continuous monitoring of EV adoption trends, and strategic investments in infrastructure and outreach, the county should aspire to foster widespread adoption of electric vehicles and pave the way towards a healthier, more sustainable future for all residents.

[274] Milwaukee County Legistar. (2021, May 7). A resolution committing Milwaukee County to becoming carbon neutral by 2050 and requesting the Director of Sustainability, Department of Administrative Services, develop and administer a strategic plan to achieve carbon neutrality in Milwaukee County facilities and operations by 2050. Milwaukee County - File #: 21-389 (legistar.com)

Appendix A

Property	Address	Annual Visits	Milwaukee County Department Owner	Median Household Income	Ethnicity	Average Vehicles Per Household
MCTS Administrative Offices	1942 N 17th St, Milwaukee, WI 53205, United States	853.1k	Department of Transportation	$37,249.85	Black: 57.6% White: 19.3% Hispanic: 15.6% Other: 3.3% Asian: 4.2%	1.2
Wilson Park Senior Center	2601 W Howard Ave, Milwaukee, WI 53221, United States	1.4M	Administrative Services and Fiscal Affairs	$48,729.17	Black: 15.7% White: 44.1% Hispanic: 33.0% Other: 3.3% Asian: 3.8%	1.5
Fleet Garage & MCDOT Headqtrs.	10320 W Watertown Plank Rd, Milwaukee, WI 53226, United States	1.3M	Fleet Management	$55,258.28	Black: 26.6% White: 51.5% Hispanic: 14.8% Other: 3.3% Asian: 3.8%	1.48
Milwaukee County Community Reintegration Center	8885 S 68th St, Franklin, WI 53132, United States	301.8k	Sheriff's Department	$56,137.88	Black: 16.1% White: 53.8% Hispanic: 23.9% Other: 3.0% Asian: 3.2%	1.56
Mitchell Park	524 S Layton Blvd, Milwaukee, WI 53215, United States	441.9k	Parks Department	$53,297.98	Black: 26.0% White: 51.0% Hispanic: 15.9% Other: 3.4% Asian: 3.7%	1.45
McGovern Park Senior Center	4500 W Custer Ave, Milwaukee, WI 53218, United States	604.9k	Administrative Services and Fiscal Affairs	$35,113.27	Black: 75.5% White: 11.8% Hispanic: 4.9% Other: 3.4% Asian: 4.5%	1.19
Sports Complex	6000 W Ryan Rd, Franklin, WI 53132, United States	341k	Parks Department	$53,755.41	Black: 11.5% White: 51.9% Hispanic: 30.3% Other: 3.1% Asian: 3.2%	1.51

Marcia Coggs Human Services Ctr.	1220 W Vliet St, Milwaukee, WI 53205, United States	170.2k	Administrative Services and Fiscal Affairs	$39,529.14	Black: 55.7% White: 25.5% Hispanic: 11.4% Other: 3.5% Asian: 3.9%	1.2
Grant Park	215 Lake Dr , South Milwaukee, WI 53172, United States	312.6k	Parks Department	$55,395.39	Black: 13.1% White: 57.5% Hispanic: 22.3% Other: 3.4% Asian: 3.8%	1.47
Bradford Beach	2400 N Lincoln Memorial Dr, Milwaukee, WI 53211, United States	955k	Parks Department	$45,345.78	Black: 37.8% White: 36.3% Hispanic: 18.8% Other: 3.3% Asian: 3.8%	1.32
South Shore Park	2900 S Shore Dr, Milwaukee, WI 53207, United States	609.2k	Parks Department	$52,290.68	Black: 16.2% White: 52.6% Hispanic: 24.5% Other: 3.4% Asian: 3.3%	1.42
Milwaukee County Zoo	10001 W Bluemound Rd, Milwaukee, WI 53226, United States	557.7k	Zoological Department	$59,648.52	Black: 19.9% White: 59.9% Hispanic: 13.5% Other: 3.2% Asian: 3.5%	1.56
CFSPM (Center for Forensic Science and Preventative Medicine)	9400 W Doyne Ave, Wauwatosa, WI 53226, United States	49.6k	Administrative Services and Fiscal Affairs	$52,268.85	Black: 30.0% White: 46.1% Hispanic: 17.1% Other: 3.4% Asian: 3.5%	1.46
Clinton Rose Senior Center	3047 North Doctor Martin Luther King Junior Drive, Milwaukee, WI 53212, United States	499.7k	Administrative Services and Fiscal Affairs	$38,262.62	Black: 60.9% White: 24.4% Hispanic: 7.1% Other: 3.4% Asian: 4.2%	1.15
Veterans Park	1010 N Lincoln Memorial Dr, Milwaukee, WI 53202, United States	492.4k	Parks Department	$52,366.86	Black: 29.5% White: 47.4% Hispanic: 15.9% Other: 3.5% Asian: 3.7%	1.43

O'Donnell Park	910 E Michigan St, Milwaukee, WI 53202, United States	296.7k	Parks Department	$54,704.12	Black: 25.2% White: 51.7% Hispanic: 16.0% Other: 3.4% Asian: 3.7%	1.46
Washington Senior Center	4420 W Vliet St, Milwaukee, WI 53208, United States	279.5k	Administrative Services and Fiscal Affairs	$43,702.32	Black: 46.4% White: 32.3% Hispanic: 13.8% Other: 3.5% Asian: 4.0%	1.26
Boerner's Botanical Gardens	9400 Boerner Drive, Hales Corners, WI 53130, United States	258.3k	Parks Department	$59,445.76	Black: 17.6% White: 59.0% Hispanic: 16.1% Other: 3.3% Asian: 4.0%	1.55
Jackson Park	3500 W Forest Home Ave, Milwaukee, WI 53215, United States	226.9k	Parks Department	$47,613.74	Black: 15.6% White: 36.1% Hispanic: 40.9% Other: 3.2% Asian: 4.3%	1.47
Kelly Senior Center (incl Nutrition Building)	6100 S Lake Dr, Cudahy, WI 53110, United States	173.1k	Administrative Services and Fiscal Affairs	$55,513.31	Black: 6.9% White: 54.5% Hispanic: 32.9% Other: 2.9% Asian: 2.8%	1.61
Timmerman Field	9305 W Appleton Ave, Milwaukee, WI 53225, United States	N/A	Department of Transportation	N/A	N/A	N/A
Lake Park	3233 E Kenwood Blvd, Milwaukee, WI 53211, United States	147.8k	Parks Department	$50,996.21	Black: 30.7% White: 44.5% Hispanic: 17.8% Other: 3.3% Asian: 3.7%	1.37
Greenfield Park	2028 S 124th St, Milwaukee, WI 53227, United States	138.8k	Parks Department	$55,464.22	Black: 18.2% White: 54.9% Hispanic: 19.6% Other: 3.3% Asian: 3.9%	1.49

Kosciuszko Community Center	2201 S 7th Street, Milwaukee, WI 53215, United States	133.2k	Parks Department	$39,377.75	Black: 18.0% White: 24.3% Hispanic: 52.0% Other: 2.8% Asian: 2.9%	1.42
Zablocki Park	3717 W Howard Ave, Milwaukee, WI 53221, United States	123.4k	Parks Department	$49,517.57	Black: 11.4% White: 42.7% Hispanic: 11.4% Other: 2.9% Asian: 3.4%	1.51
Bender Park	4600 E Oakwood Road, Oak Creek, WI 53154, United States	117.2k	Parks Department	$59,079.74	Black: 5.3% White: 58.6% Hispanic: 29.5% Other: 3.1% Asian: 3.6%	1.65
Lincoln Park	1301 W Hampton Ave, Milwaukee, WI 53209, United States	106.6k	Parks Department	$41,585.09	Black: 54.7% White: 29.1% Hispanic: 8.7% Other: 3.5% Asian: 4.0%	1.26
Brown Deer Park	7835 N Green Bay Road, Milwaukee, WI 53209, United States	96.6k	Parks Department	$51,220.75	Black: 43.9% White: 40.5% Hispanic: 7.1% Other: 3.4% Asian: 5.1%	1.36
Doctors Park	1870 E Fox Ln, Milwaukee, WI 53217, United States	92.9k	Parks Department	$58,032.69	Black: 27.5% White: 53.5% Hispanic: 9.8% Other: 3.6% Asian: 5.6%	1.38
Dineen Park	6901 W Vienna St, Milwaukee, WI 53216, United States	85.3k	Parks Department	$37,300.75	Black: 72.2% White: 14.4% Hispanic: 5.1% Other: 3.5% Asian: 4.4%	1.22
Kletzsch Park	6560 N Milwaukee River Pkwy, Milwaukee, WI 53209, United States	80.9k	Parks Department	$48,934.57	Black: 46.1% White: 35.1% Hispanic: 10.3% Other: 3.4% Asian: 5.0%	1.35

Vel R. Phillips Youth and Family Justice Center	10201 W Watertown Plank Rd, Milwaukee, WI 53226, United States	72k	Administrative Services and Fiscal Affairs	$54,418.90	Black: 27.2% White: 50.0% Hispanic: 15.7% Other: 3.4% Asian: 3.7%	1.45
Rainbow Park	700 S 119th St, Milwaukee, WI 53214, United States	58.7k	Parks Department	$51,922.79	Black: 19.1% White: 51.8% Hispanic: 21.0% Other: 3.3% Asian: 4.7%	1.49
Washington Park	1859 N 40th St, Milwaukee, WI 53208, United States	56.9k	Parks Department	$40,742.75	Black: 52.5% White: 30.8% Hispanic: 8.8% Other: 3.3% Asian: 4.6%	1.24
Kulwicki Park	108th & Coldspring Rd, Milwaukee, WI 53228, United States	54.4k	Parks Department	$59,614.65	Black: 8.6% White: 67.7% Hispanic: 16.2% Other: 3.4% Asian: 4.1%	1.59
Warnimont Park	5400 S Lake Dr, Cudahy, WI 53110, United States	53.3k	Parks Department	$58,063.20	Black: 5.1% White: 58.1% Hispanic: 31.5% Other: 3.0% Asian: 2.3%	1.64
Dretzka Park	12020 W Bradley Rd, Milwaukee, WI 53224, United States	51.1k	Parks Department	$55,009.96	Black: 34.4% White: 50.0% Hispanic: 7.4% Other: 3.2% Asian: 5.0%	1.41
Currie Park	3535 N Mayfair Rd, Milwaukee, WI 53222, United States	46k	Parks Department	$64,841.01	Black: 19.5% White: 65.1% Hispanic: 8.0% Other: 3.7% Asian: 3.7%	1.44
Carver Park	311 W Brown St, Milwaukee, WI 53212, United States	44.3k	Parks Department	$36,243.87	Black: 71.2% White: 15.8% Hispanic: 5.3% Other: 3.5% Asian: 4.1%	1.22

Gordon Park	1321 E Locust St, Milwaukee, WI 53212, United States	41.2k	Parks Department	$42,420.18	Black: 52.3% White: 31.2% Hispanic: 9.1% Other: 3.7% Asian: 3.8%	1.23
Sheridan Park	4800 S Lake Dr, Cudahy, WI 53110, United States	40.7k	Parks Department	$52,556.11	Black: 8.2% White: 49.4% Hispanic: 36.8% Other: 2.9% Asian: 2.7%	1.57
King Community Center	1531 W Vliet St, Milwaukee, WI 53205, United States	33.8k	Parks Department	$34,789.25	Black: 60.8% White: 16.8% Hispanic: 14.2% Other: 3.2% Asian: 5.0%	1.17
Training Academy	9225 S 68th St, Franklin, WI 53132, United States	33.5k	Sheriff's Department	$52,723.45	Black: 23.1% White: 50.5% Hispanic: 19.1% Other: 3.2% Asian: 4.0%	1.48
Noyes Park	8235 W Good Hope Rd, Milwaukee, WI 53223, United States	31.9k	Parks Department	$42,449.20	Black: 59.6% White: 25.3% Hispanic: 5.8% Other: 3.5% Asian: 5.8%	1.31
Medical Examiner	1004 N 10th St, Milwaukee, WI 53233, United States	664.5k	Administrative Services and Fiscal Affairs	$50,464.18	Black: 33.8% White: 42.4% Hispanic: 16.5% Other: 3.5% Asian: 3.8%	1.39
Courthouse	901 N 10th St, Milwaukee, WI 53233, United States	514.3k	Administrative Services and Fiscal Affairs	$50,636.64	Black: 31.2% White: 45.1% Hispanic: 16.5% Other: 3.4% Asian: 3.7%	1.4
Safety Building	821 West State Street, Milwaukee, WI 53233, United States	427.8k	Administrative Services and Fiscal Affairs	$49,698.83	Black: 33.1% White: 42.7% Hispanic: 16.9% Other: 3.5% Asian: 3.8%	1.38

Milwaukee County Transit System	612 W Atkinson Ave, Milwaukee, WI 53212, United States	787.3k	Department of Transportation	$38,122.85	Black: 58.9% White: 23.3% Hispanic: 10.3% Other: 3.4% Asian: 4.1%	1.18
KK Transit Complex	1710 S Kinnickinnic Ave, Milwaukee, WI 53204, United States	348.6k	Department of Transportation	$48,367.02	Black: 25.2% White: 45.6% Hispanic: 22.7% Other: 3.3% Asian: 3.2%	1.35
Humboldt Park	3000 S Howell Ave, Milwaukee, WI 53207, United States	226.8k	Parks Department	$52,360.11	Black: 11.9% White: 50.3% Hispanic: 31.3% Other: 3.2% Asian: 3.2%	1.44
McCarty Park	2567 S 79th St, Milwaukee, WI 53219, United States	126.1k	Parks Department	$51,233.08	Black: 17.9% White: 48.7% Hispanic: 26.3% Other: 3.5% Asian: 3.6%	1.5
Fiebrantz Complex	1900 W Fiebrantz Ave, Milwaukee, WI 53209, United States	35.7k	Department of Transportation	$35,277.91	Black: 74.1% White: 11.4% Hispanic: 7.4% Other: 3.4% Asian: 3.7%	1.19

* Annual visits, Median household income, Ethnicity, and Average vehicles per household are based on Placer.ai data encompassing 70% of Potential Market.
* Cells highlighted in yellow indicate case study locations expanded upon on pages 29-35 of this guidebook.