The Electric Vehicle Transition

A Guidebook for Local Governments

A Report Issued by the Dynamic Sustainability Lab in partnership with the Alliance for Climate Transition

April 2025

The Critical Role of Local Governments in the EV Transition

Cities, counties and towns across the country are on the front lines of the clean transportation revolution. As climate change intensifies and transportation remains one of the largest sources of greenhouse gas emissions, local governments are being called upon to take action. The transition to electric vehicles (EVs) is no longer a distant goal—it is an immediate necessity. Yet, with shifting federal policies, new financing opportunities, and evolving utility regulations, navigating this transition can feel overwhelming for municipal leaders. This is why the Alliance for Climate Transition (ACT) and the Syracuse University Dynamic Sustainability Lab have partnered to create guidance and help communities reach their decarbonization goals.

This EV Guidebook is specifically designed to provide local government decision-makers with a clear roadmap to electrification. Whether in a small town with limited resources or a large city or county spearheading ambitious emissions goals, this guide offers practical tools to help you plan, finance, and implement EV infrastructure. It covers everything from vehicle options and charging infrastructure to utility partnerships, policy incentives, and financial planning—all tailored to the needs of local and regional governments.

This guidebook is needed now more than ever as the new federal administration is shifting the EV policy landscape. While some states remain committed to ambitious EV adoption and emissions reduction targets, the potential rollback of federal mandates, incentives, and fuel standards could slow progress nationwide. Utilities, once ramping up EV charging investments, may hesitate to expand programs if they anticipate reduced demand. As of March 2025, the Federal Highway Administration (FHA) suspended funding for some NEVI (National Electric Vehicle Infrastructure) projects. However, the NEVI program is still moving forward, with many states already using funds to build EV charging stations.

This means that state, local, and municipal governments will bear even greater responsibility in ensuring the success of the EV transition. Cities, counties and towns have the power to lead by:

- Electrifying government fleets, including school buses, emergency vehicles, and public transit.
- Ensuring charging infrastructure is built so all residents—including low-income and multi-unit housing communities—have access.
- Partnering with utilities to ensure that grid capacity keeps pace with growing EV demand.
- And, exploring sustainable funding models, as declining gas tax revenues will require new ways to support road maintenance and transportation projects.

A BLUEPRINT FOR ACTION

This guidebook provides a comprehensive overview of what municipalities and counties need to know about EV adoption, covering:

EV Types and Charging Options: Understanding different vehicle technologies and the charging solutions available.

Grid Impacts and Utility Coordination: Planning for the increased electricity demand and working with utilities to ensure grid stability.

The Policy Landscape: Navigating emissions targets, grants, incentives, and local regulations to maximize financial support.

Funding and Financing Strategies: Identifying sources of funding for road maintenance and government fleets while planning for future revenue shifts.

Best Practices for Fleet Transition: Step-by-step guidance on how to electrify municipal fleets efficiently and cost-effectively.

The Role of Local Governments in Driving Adoption: How cities can influence and accelerate EV adoption in their jurisdictions.

Cities and towns are not just reacting to change—they are driving it. Local innovation, from microgrids to community charging hubs, is unlocking resilience and affordability for residents. As technology advances and costs decline, EV adoption will continue to accelerate. However, this transition must be guided by smart policies, strategic planning, and community engagement.

Municipal leaders have a unique opportunity to shape the future of transportation in ways that benefit people, place, and planet. This guide serves as a practical resource for taking action, ensuring that local governments remain at the forefront of building a cleaner, more resilient, and more equitable transportation system.

ABOUT THE DYNAMIC SUSTAINABILITY LAB

Launched during the fall of 2021 by Dr. Jay Golden, The Dynamic Sustainability Lab at Syracuse University now has over 50 paid student research fellows plus faculty from a broad set of disciplines across the Syracuse University campus and faculty colleagues from the United States and internationally. The lab examines the opportunities as well as risks and unintended consequences resulting from the rapid transition to a new generation of sustainable technologies, strategies and policies associated with the net-zero carbon transition. Our focus is in providing interdisciplinary scientific approaches that support organizations in realizing sustainability transition opportunities by identifying the dynamic risks and developing strategies and tools to achieve success.

The lab focuses on the following transitions:

1. Energy & Technology Transitions
2. Agriculture & Biobased Transitions
3. Building & Infrastructure Transitions
4. Institutional Transitions

For more information visit **www.DynamicsLab.org**

ABOUT THE ALLANCE FOR CLIMATE TRANSITION

The Alliance for Climate Transition (ACT) leads the just, equitable, and rapid transition to a clean energy future and a diverse climate economy. ACT members span the broad spectrum of the clean energy industry, including clean transportation, energy efficiency, wind, solar, energy storage, microgrids, fuel cells, and advanced and "smart" technologies. ACT is dedicated to growing the climate economy across the region.

ACT includes The Alliance for Climate Transition, a nonprofit business member organization, and ACT Institute, a nonprofit focused on industry research, innovation, policy development, and strategic communications. ACT's innovation program includes Cleantech Open Northeast, the Northeast affiliate of the national cleantech accelerator Cleantech Open, and Cleantech Navigate, which provides cleantech startups with curated connections to mentors, test sites, customers, corporate partners, and investors. ACT brings together business leaders and key stakeholders to engage in influential policy discussions and business initiatives while building connections that propel the clean energy industry forward.

Visit www.joinact.org for more information.

EXECUTIVE SUMMARY

Across the country, cities operate about 4 million cars, trucks and buses which is many times more than the U.S. government's federal fleet. In New York City and San Jose, California, 25 percent of the municipal fleet is made up of clean vehicles. And, with the passage of the 2022 Bipartisan Infrastructure Bill, local and regional governments have access to billions of dollars to transition their fleets and provide the necessary infrastructure upgrades for their communities.

During 2023 through 2024 the **Dynamic Sustainability Lab (DSL) at Syracuse University partnered with the Alliance for Climate Transition (ACT)** examining the implications that the Electric Vehicle Transition in the United States will have on local and regional governments. This work built upon prior efforts by the DSL in partnership with the Pew Charitable Trusts to examine the impacts to State Budgets.

The work by the DSL and ACT included extensive research of policies, budgets, community interactions, energy systems, economics, finance as well as fleet management, planning, public safety and environmental justice. Additionally, in April of 2024 the DSL and ACT jointly hosted an EV Symposium for local governments throughout the Northeast at a venue in the greater Boston area.

Mr. Joe Curtatone, President of ACT at the joint DSL-ACT EV Transition Symposium in Boston, April 2024.

Our Guidebook is the culmination of our joint work and is intended to provide officials in local and regional governments an understanding of the complexities of the rapid EV Transition that impact almost every aspect of governance.

This document will be a **useful reference and operational planning guide supporting various departments and boards** to have a holistic understanding of the numerous issues and opportunities to meet the EV challenge. This includes:

1. City Councils, Mayors and County Supervisors
2. City and County Executives
3. Planning & Zoning Commissions and Boards
4. Public Works
5. Public Safety
6. Energy & Municipal Utility Departments
7. Fleet Management & Public Transportation Departments
8. Environmental and Sustainability Offices
9. Tax and Budget Offices
10. Community Liaison Offices

Moving forward, the DSL and ACT partnership will continue to monitor the most up-to-date policies, incentives, and case studies to provide government and industry leaders across the country with the most useful research and information to support policies and strategies specific to the EV transition.

ABOUT THIS REPORT

HOW TO CITE THIS REPORT

Otis, A., Golden, J.S. and A. Pim (2025). The Electric Vehicle Transition: A Guidebook for Local Governments. A Report Issued by the Dynamic Sustainability Lab at Syracuse University and the Alliance for Climate Transition. Accessed at www.DynamicsLab.org

ABOUT THE AUTHORS

Aaron Otis
aaotis@syr.edu

Aaron Otis is the Senior Project Manager at the Syracuse University Dynamic Sustainability Lab. Aaron oversees a research team of undergraduate and graduate research fellows engaged in numerous net-zero and sustainability advancing projects. With a strong background in research methods and technical reporting, he has authored and co-authored a number of reports on topics including the EV transition, state and regional renewable electricity transitions, GHG sensing technologies, and the U.S. Bioeconomy for the USDA. Aaron holds a Master's of Public Administration (MPA) from the Syracuse University Maxwell School and a Master's of Environmental Studies (MPS) from SUNY College of Environmental Science and Forestry (ESF).

Dr. Jay S. Golden
JGolde04@syr.edu

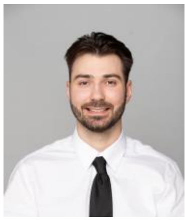
Dr. Jay Golden, is the Pontarelli Professor of Environmental Sustainability & Finance in the Maxwell School at Syracuse University. Dr. Golden is also the founder and director of the Dynamic Sustainability Lab. Golden holds a PhD in engineering from Cambridge University and a Master's in Environmental Engineering and Sustainable Development from a joint program of MIT and the University of Cambridge. He is the author of the recent book, Dynamic Sustainability: Implications for Policies, Markets and National Security. Golden recently completed two terms on the Board of Scientific Counselors for the US EPA including on its Executive Board. Golden serves in various advisory roles for global companies and consults for both public and private organizations on pressing sustainability, energy and climate related topics. Golden is the recipient of numerous awards including the Aspen Institute Faculty Pioneer Award for his sustainability work.

Alistair Pim
apim@joinact.org

Alistair Pim is Vice President of Innovation & Partnerships, for ACT-The Alliance for Climate Transition (formerly NECEC), a non-profit business association which stands at the forefront of driving innovation, economic growth, and sustainability. With a steadfast commitment to advancing the clean energy sector in the Northeast, ACT fosters collaboration among industry leaders, policymakers, and innovators, catalyzing a dynamic transition towards a low-carbon economy, creating jobs, spurring investment, and ensuring environmental stewardship. He and his team help startups accelerate to commercialization with a mix of programs, events and networks. Alistair runs ACT's Clean Transportation Working Group and their Strategic Partner Network. Prior to ACT, Alistair held various corporate strategy positions at Schneider-Electric including VP Global Strategic Alliances. Allistair also held the positions of General Manager for European Operations and VP of Worldwide Sales for SynQor Incorporated.

RESEARCH FELLOWS

The Dynamic Sustainability Lab and Alliance for Climate Transition would like to thank the contributions of the research fellows who assisted in developing this report.



Michael Garzone-White

Michael Garzone-White was a research fellow at the Dynamic Sustainability Lab. He holds a B.S. in Political Science and Government from SUNY Oneonta and a Master's of Public Administration (MPA) from the Syracuse University Maxwell School.

Michael currently works as a Senior Consultant at Booz Allen Hamilton.

Nadia Duplessis

Nadia Duplesss was a research fellow at the Dynamic Sustainability Lab. She holds a B.S. in Environmental Sustainability and Policy and B.S. in Political Science from Syracuse University.

Nadia currently works as a Legal Information Aide with the Onondaga County District Attorney's Office.

Gillian Ederle

Gillian Ederle served as a research fellow at the Dynamic Sustainability Lab and an intern at NECEC (now ACT). She is currently a Junior at Northeastern University where she is working to earn her B.S. in Environmental & Sustainability Sciences.

ACKNOWLEDGEMENTS

The Dynamic Sustainability Lab wishes to thank the generous support of Mr. Jim Ajello in supporting student research fellows in the DSL and advancing the research and outreach efforts specific to both the EV and Energy Transitions taking place around the globe. We especially appreciate his unwavering support of the student research fellows in the lab. We also wish to thank Ms. Allison Haynes, project coordinator at the DSL and Ms. Natasha Perez from ACT for their detailed reviews and copywriting support.

TABLE OF CONTENTS

Section 1: Electric Vehicle Transition: Drivers

Section 2: Charging Infrastructure

Section 3: Electricity Considerations

Section 4: Local Roads & Highway Considerations

Section 5: Funding & Revenue Models

Section 6: Electrifying the Government Fleet

Section 7: Zoning & Permitting

Section 8: Additional Resources

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

E.V: Electric Vehicle

PHEV: Plug-in Hybrid Electric Vehicles

FCEVs: Fuel Cell Electric Vehicles

NEVI: National Electric Vehicle Infrastructure Program

BIL: Bipartisan Infrastructure Bill (where NEVI was established in)

IRA: Inflation Reduction Act

EVSE: Electric Vehicle Supply Equipment

VMT: Vehicle Miles Traveled

DOE: US Department of Energy

EPA: Environmental Protection Agency

DOT: US Department of Transportation

GHG: Greenhouse Gases

LDVs: Light Duty Vehicles

MHDVs: Medium Heavy Duty Vehicles

DC: Direct Current

AC: Alternating Current

PPPs: Public-Private Partnerships

ICE: Internal Combustion Engines

Section 1:

The Electric Vehicle Transition: Drivers

Drivers

Across the globe, governments and corporations are increasingly recognizing and committing themselves to achieving a global Net Zero Carbon economy and slashing greenhouse gas (GHG) emissions.[1] The transition from fossil-fuel powered Internal Combustion Engines (ICE) to cleaner Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEVs) within developed global economies is a key component of this monumental effort.

Local and regional governments are powerful agents for change within their communities and states, and increasingly called upon to lead the efforts required to make this transition possible in their own cities, towns and counties.

This guidebook is intended as a jumpstart for local and regional government efforts to electrify government fleets while also supporting community and business members with their EV transition. This document is intended to highlight the critical issues and provide key resources and tools. Thorough planning is critical to help ensure continued economic growth, enhanced national security, and increased community climate resiliency.

1.1 Transportation Sector Emissions

In 2022, the transportation sector in the United States accounted for 28% of national greenhouse gas emissions, the largest of all sectors [1]. In 2018, light-duty vehicles (LDVs)- which include passenger cars, light trucks, vans, and SUVs- were responsible for 57% of the national transportation sector energy use, or approximately 16% of total national emissions [2]. Given these high numbers, the transportation sector is a clear and substantial intervention opportunity to reduce local government and national GHG emissions.

1.2 Federal Investment & Targets

The 2022 Inflation Reduction Act (IRA) and 2021 Bipartisan Infrastructure Law (BIL) marked an unprecedented federal funding opportunity for climate change prevention and resiliency, earmarking substantial funds for transportation improvements and EV.

In addition to federal funding opportunities, federal administrative initiatives are also setting ambitious national targets for electrification. The Biden-Haris Administrative targets aim to have 50% of all new vehicle sales in 2030 be from Electric Vehicles [3].

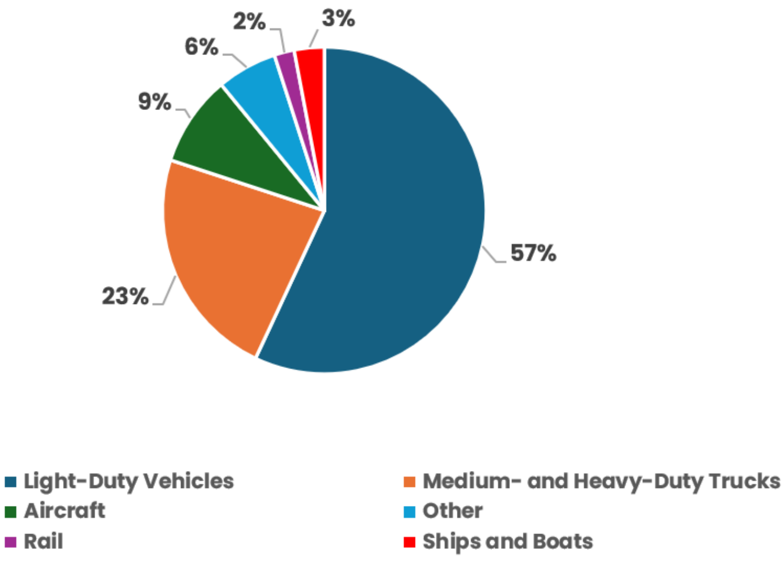
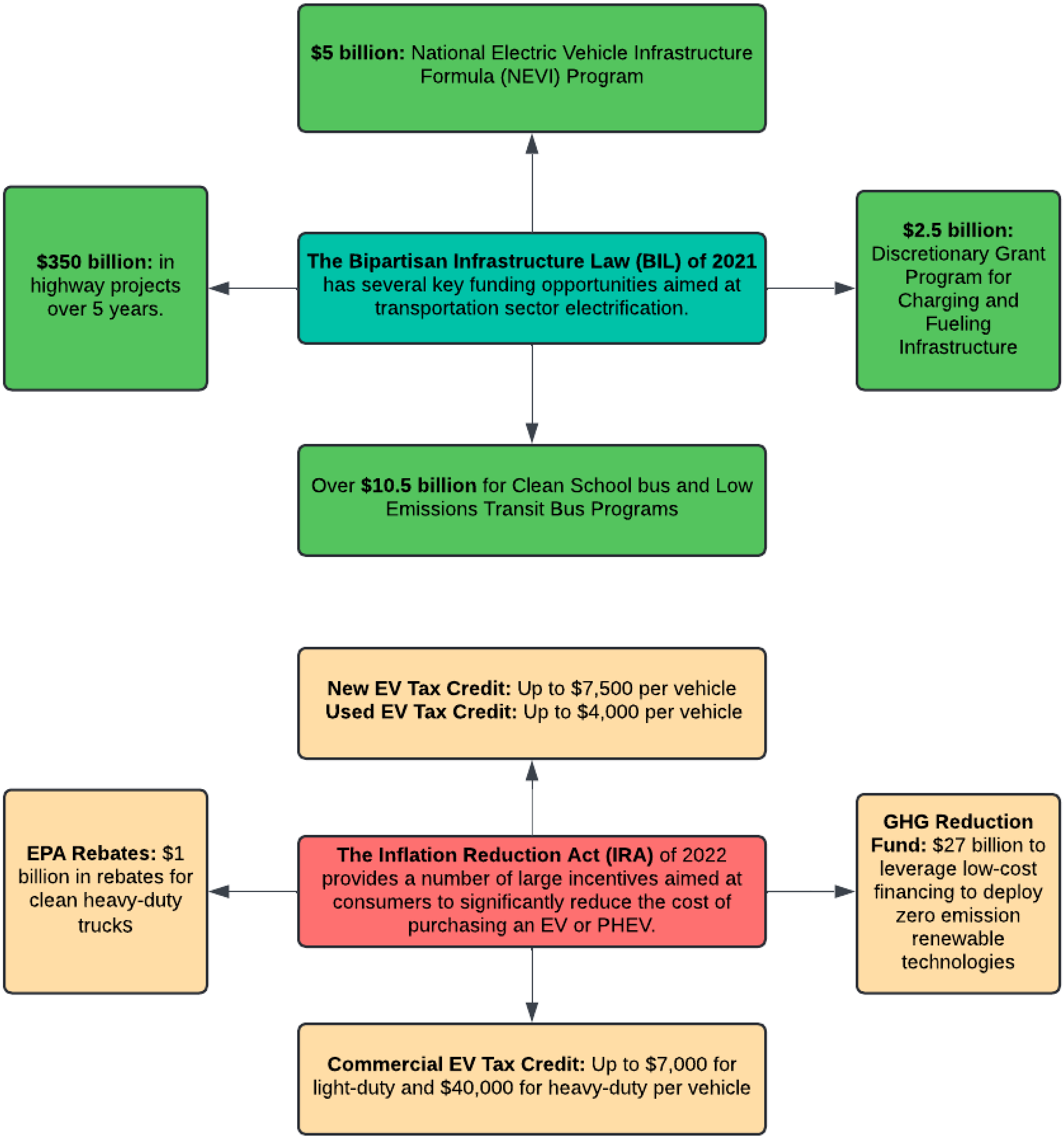


Figure 1.1 2022 U.S. Transportation Sector GHG Emissions by Source. Adapted from [4].

---

[1] Net-Zero Emissions refers to a full balancing of the amount of GHG emissions produced by an organization and the amount of GHG emissions removed or offset.



The Bipartisan Infrastructure Law (BIL) of 2021 has several key funding opportunities aimed at transportation sector electrification.

$5 billion: National Electric Vehicle Infrastructure Formula (NEVI) Program

$350 billion: in highway projects over 5 years.

$2.5 billion: Discretionary Grant Program for Charging and Fueling Infrastructure

Over **$10.5 billion** for Clean School bus and Low Emissions Transit Bus Programs

The Inflation Reduction Act (IRA) of 2022 provides a number of large incentives aimed at consumers to significantly reduce the cost of purchasing an EV or PHEV.

New EV Tax Credit: Up to $7,500 per vehicle
Used EV Tax Credit: Up to $4,000 per vehicle

EPA Rebates: $1 billion in rebates for clean heavy-duty trucks

GHG Reduction Fund: $27 billion to leverage low-cost financing to deploy zero emission renewable technologies

Commercial EV Tax Credit: Up to $7,000 for light-duty and $40,000 for heavy-duty per vehicle

Figure 1.2 Key Provisions and Funding of the Bipartisan Infrastructure Law (2021) and Inflation Reduction Act (2022). Adapted from [5].

1.3 State Mandates & Incentives

Many states across the U.S. are also rapidly accelerating their own transition to EVs through a complex web of legislative mandates and voluntary vehicle purchasing requirements, incentivization structures, and funding programs that encourage both the purchase of EVs and the integration of critical EV infrastructure. Many states are offering residents significant rebates and financial incentives to purchase an EV or PHEV.

As of publication of this document, 13 states and the District of Columbia (D.C.) have adopted ***California's Advanced Clean Cars II Rule****, establishing increasingly ambitious mandatory targets for EV and PHEV vehicle sales from 2026 to 2035 as seen in Figure 1.3*

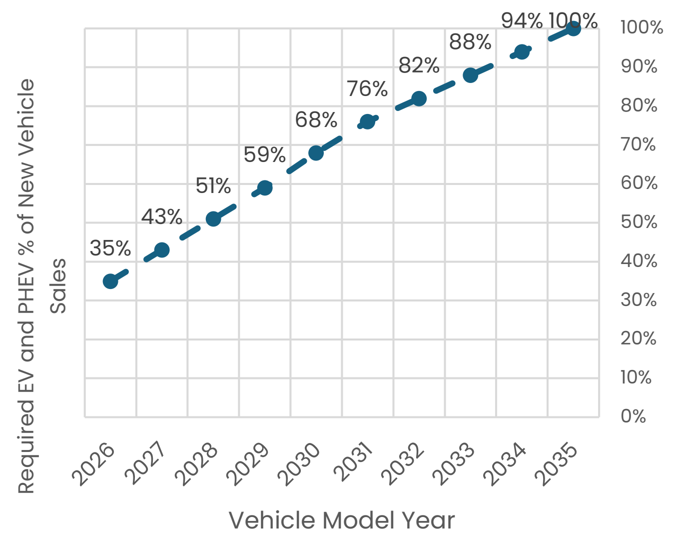


Figure 1.3 Timeline of Vehicle Sale Requirements under the Advanced Clean Cars II Rule. Source: [6].

While numbers vary by state, the following states currently top the nation in terms of rebate monetary value and accessibility:

- **Colorado**: offers up to $7,500 for the purchase of a new EV on qualifying vehicles costing less than $35,000 [7].
- **Maine**: offers up to $7,500 for qualifying low-income families for the purchase of a new EV., and lower rebates for higher income brackets [8].
- **Massachusetts:** offers up to $3,500 rebate for qualifying new or used EVs and $1000 for trading in a gas-powered vehicle for an EV [9].
- **Maryland:** offers up to $3,000 for EV purchase costing less than $50,000 [10].
- **Delaware:** offers up to $2,500 in rebates on eligible EV purchases. [11].

Many states are also offering significant rebates on home charging stations and other EV appliances, all of which incentivize EV adoption and utilization.

1.4 Net Zero: Scope 1 & 3 Emissions

Net zero refers to balancing the amount of GHG emissions produced with the amount removed from the atmosphere. Net-zero targets can be set by entities as small as a household or as large as a country. Net zero can be achieved through both emissions reductions such as reducing fossil fuel consumption and/or through emissions removals, like carbon capture and storage technologies. Achieving timely global net-zero emissions ensures global GHGs remain at a stable and ecologically safe level.

When discussing net zero and GHG emissions there are several key concepts known **as Scope 1, Scope 2, and Scope 3 emissions**. Each scope defines a specific set of criteria for evaluating GHG emission levels. Eliminating scope 1 and 3 are the areas of largest concern for organizations attempting to reduce their transportation based GHG emissions.

Scope 1 emissions: originate from sources and activities directly controlled by an organization. **Examples include:**

- Fuels burned by organizational vehicles
- Facility boilers
- Facility furnaces

In the context of local and regional governments, Scope 1 transportation emissions are those emitted by their vehicle fleets. This includes public transport, school buses, fire trucks, police vehicles, ambulances, Department of Transportation vehicles, and more.

Scope 3 emissions: are those that originate from indirectly adding to an organization's emissions throughout the value chain. **Examples include:**

- Transportation and shipping
- Product processing and manufacturing
- End-of-life product treatment
- Investments

While Scope 3 emissions are less directly linked to local and regional government emissions, they are key to understanding the drive for electrification we are seeing from many corporations aiming to reduce their GHG emissions profiles.

As seen in Figure 1.4 gasoline vehicles are high emitters compared to EVs and PHEVs. Annual driving of an EV generates approximately 79% less emissions per year compared to the average gasoline vehicle.

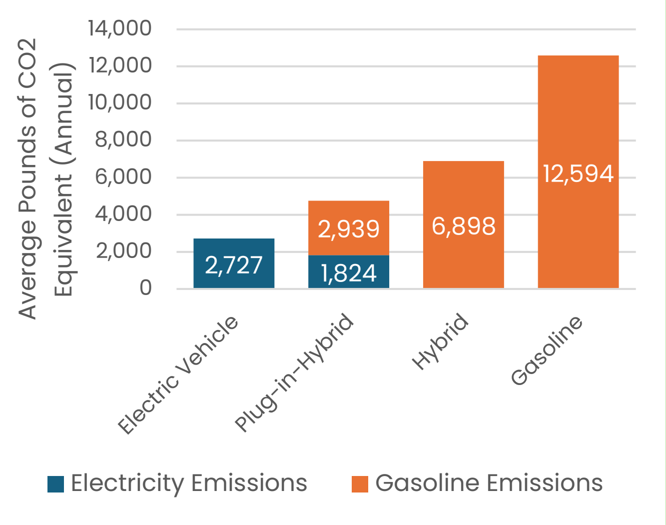


Figure 1.4 National Average Annual CO2 Equivalent Emissions per Year by Vehicle Type. Source [12].

1.5 Local & Regional Government: Transportation Sector Emissions

Transportation sector emissions can amount to significantly large portion of overall GHGs in many local and regional government entities.

City of Dallas, TX (population, 1.3 million): estimates its transportation sector, including “private and public vehicles, trains, and planes, contributes 34% of citywide GHG emissions, of which 98% is attributed to on-road transportation” [13].

New York City, NY (population, 19.68 million): in 2016, a government GHG audit found that 30% of total citywide emissions came from transportation, 96% attributed to “on-road vehicles”. [14]

Bozeman, MT (population, 56,100): in 2020, a city audit found that transportation emissions accounted for 32% of total emissions generated in the city. [15].

Tompkins County, NY (population, 104,800): in 2019, 28% of countywide emissions originated from the transportation sector, and 47% of County government emissions originated from the on-road county fleet. [16].

These examples highlight that transportation sector emissions are substantial regardless of location or population size.

1.6 Local & Regional Government: Net Zero & Emissions Reduction Goals

The recognition of large transportation emissions coincides with many local and regional governments at increasingly acknowledging the need to curb their GHG emissions to achieve net zero and emission-reductions plans. Examples of local and regional governments committing themselves to net zero include:

City of Dallas, TX: committed to achieving net-zero by 2050, and 43% below 2015 levels by 2030 [17].

City of Portland, OR: committed to achieving net-zero prior to 2050, and 50% below 1990 levels by 2030 [18].

Orange County, FL: committed to reducing county operational GHG emissions to 30% below 2015 levels by 2030 [19].

Hennepin County, MN: committed to achieving net-zero emissions by 2050, and 45% below 2010 levels by 2030 [20].

City of Durham, NC: committed to reducing city operational GHG emissions 50% by 2030, and 100% by 2040 [21].

For local governments, EV and PHEV fleets are key to overcoming transport-based Scope 1 emissions reductions in order to achieve net-zero goals.

1.7 Corporate Net-Zero Emissions Targets

In addition to the constituency demands and government fleet transitions, local and regional leadership will have to plan for increased electricity and infrastructure demands within their communities driven by corporations and businesses.

Roughly 45% of U.S. S&P 500 companies have committed themselves to achieving future organizational net-zero emissions [22]. With the transportation sector comprising a large share of corporate Scope 1 and Scope 3 emissions, we are already beginning to see the marked increases in large-scale, energy-intensive warehouse and distribution centers fully powering their electric corporate fleets to lower their environmental impacts.

1.8 Transparency & Accountability

Both mandatory and voluntary GHG emissions reporting are anticipated to drive the adoption of EVs. While many companies are voluntarily committing to net zero and adopting transparent emissions reports, many too have resisted. New state and federal emissions reporting regulations may soon radically alter the way companies and corporations operate.

At the State level, California's State Bill 253 (SB 253), the "Climate Corporate Data Accountability Act" mandates the disclosure of total emissions throughout the supply chain (scope 1, 2, and 3) for all corporations or businesses operating in the state whose total revenue exceeds $1 billion USD [23].

At the Federal level, the Securities and Exchange Commission (SEC) approved a climate disclosure rule in March 2024 that, once in effect, will require applicable public companies to report on their scope 1 and scope 2 GHG emissions as well as the risks those emissions place on their organization. The rule requires all substantial scope 1 and 2 emissions to be reported, starting fiscal year 2025, with reports to be filed in 2026 [24][25]. Despite limitations, developments of this ruling should be followed closely.

1.9 Auto Manufacturing

While traditional fossil fuel vehicles still dominate the car sales market, EV and PHEV sales in the U.S. and abroad are rising steadily. In 2023, 1.6 million EVs were sold in the U.S., up 60% from 2022. Simultaneously, 2022 saw global sales exceeding 10 million new electric cars.

Tesla, the historically dominant U.S. EV manufacturer with 56.3% of EV market share in January to October 2023, is facing increasing competition from domestic companies offering a slew of alternative vehicle selections [26].

Increased competition, supply chain cost reductions, and innovation are already driving down the average cost of EVs. In 2023, the average EV sticker price of $53,400 was only 10% higher than the average overall new car. Compare this to 42% higher than average in 2022 and it is clear that EVs are increasingly reaching market parity with conventional gas and diesel vehicles [27]

Notable Manufacturing Commitments and Investments

Ford: Investing $22 billion minimum in EVs by 2025 [28]

Chrysler: Committing to a 100% EV lineup by 2028 [29]

General Motors (GM): 100% EV sales by 2035 [30]

Honda: 40% EV global sales by 2030 [31]

Honda: Investing 60 $billion in electrification by 2030 [32]

Tesla: Goal of 20 million EV sales per year by 2030 [33]

Mitsubishi: 50% EVs by 2030, 100% by 2035 [34]

While automakers are taking different approaches to EV and PHEV development in terms of scope and execution, the broad consensus is continued development of the EV marketplace. Substantial investment into the electrification of both domestic and international vehicle markets is already dramatically lowering costs and increasing the viability of affordable, long range, fast charging EVs.

Section 2:
Charging Infrastructure

Charging Infrastructure

Electrification of both government and personal use vehicles requires large additions and modifications to our national infrastructure systems. Planning and implementing the infrastructure needs to allow for 100% electrification requires mass charger deployment, increased electricity distribution and grid modernization, enhanced renewable energy development, and many additional considerations.

The U.S. National Renewable Energy Lab (NREL) estimates that in a 2030 mid-adoption EV scenario, a national network of 28 million ports will be required to support approximately 33 million EVs. Of this required number, 26.8 million chargers are needed at residences and workplaces, 182,000 public fast chargers along highway corridors and throughout local communities, and 1 million publicly accessible charging ports in the vicinity of high-density neighborhoods, office buildings, retail outlets [35].

While roughly 80% of national charging will occur at the home, municipalities will still need to plan for this remaining 20% of public network charging needs and the infrastructure systems required to support overall electrification in their communities [36].

This chapter outlines some of the fundamental issues municipalities will need to navigate when planning and achieving their electrification infrastructure goals.

2.1 Charging Station (EVSE) Types & Terms

Electric vehicles charging stations, also more accurately known as "**Electric Vehicle Supply Equipment" (EVSEs)** are in essence systems that comprise the holistic electrical hardware, components, and computer software that deliver energy to EVs and PHEVs [37].

While EVSE technologies vary by brand and design, they generally fall into one of three primary categories: Level 1, Level 2, and Direct Current Fast Charging (DCFC).

Level 1 (L1) chargers are the most accessible, using a standard household outlet (120 volts in the United States) to deliver a slow charge, typically overnight, making them suitable for hybrid vehicles or as a last resort for all-electric vehicles.

Level 2 (L2) chargers require a higher-powered outlet (240 volts) offering a faster charge that can replenish an EV's battery in a few hours—these are the level most installed in homes, public parking spaces, and workplaces.

Direct Current Fast Chargers (DCFC), provides the quickest charge by using direct current (DC) rather than alternating current (AC) and can charge an EV's battery to 80% in as little as 20 to 30 minutes. These chargers are typically found along highways and in commercial charging stations to facilitate long-distance travel.

Common EVSE/Charger Metrics	Level 1	Level 2	DCFC (Level 3)
Cost Range per Unit and Installation	$200 to $1,000	$1,500 to $10,000	$20,000 to $200,000
Estimated EV Charge Time from Empty	40 to 50 hours	4 to 10 hours	20 minutes to 1 hour
Estimated Range per Hour of Charging	2 to 5 miles	10 to 20 miles	180 to 240 miles
Operating Voltage	120 Volt AC	240 Volt AC	3-phase 480 Volt AC
Typical Power Output	1 kW	7kW – 19kW	50 – 350 kW
Permitting Timeline	1-4 weeks	1-2 months	6 months to 1 year
Typical Placement	Home	Home, Work, Public	Public

Table 2.1 Common Metrics of EVSE Charger: Cost, Charge Times, Operating Voltage, Power Output, Permitting Timeline, Typical Placement. Adapted from [38], [39].

Each EVSE charging level represents a trade-off between:

☐ Utilization Rates
☐ Charging Duration
☐ Unit Cost
☐ Charging Speed
☐ Required Electrical Infrastructure
☐ Placement Opportunities

Station Location: a site with one or greater EVSE ports at the same location. This includes parking lots, garages, and any other physical site with an EVSE port [40].

EVSE Port: provides electricity to charge one vehicle at a time, though an EVSE port may have multiple connectors. The physical unit that houses EVSE ports is referred to as a charging post, which can have one or multiple EVSE port [41].

Connector: comprises the equipment plugged into a vehicle to charge it. Multiple connectors and connector types (e.g., Tesla, CCS, CHAdeMO) can be available on one EVSE port, but only one vehicle is charged per connector. Connectors are sometimes called plugs [42].

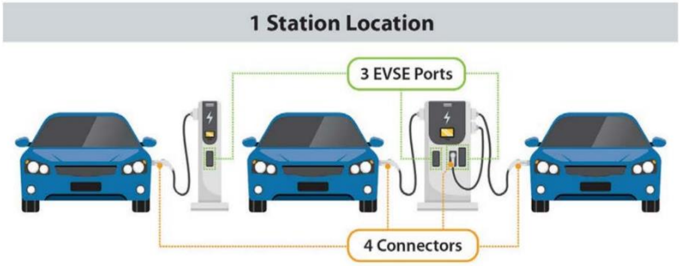


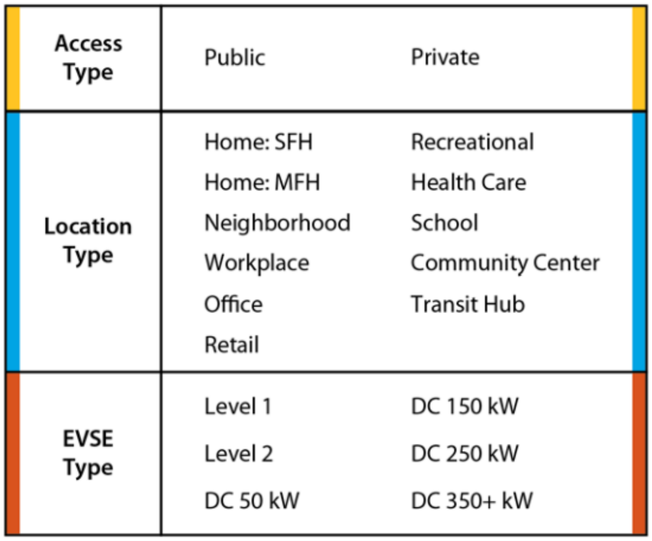
Figure 2.1 EV Charging Infrastructure Terminology. Source [43].

There are many additional terms and concepts related to electrification throughout this report, but understanding these core features can help municipal leaders navigate this critical transition effort.

Fleet managers should work with their vehicle and charging suppliers to ensure compatibility between equipment and to determine the advantages and disadvantages that exist between different charger brands and technologies.

2.2 EVSE Planning and Development Segments

Combining the concepts of charger type, public vs. private ownership, and location selection options and criteria can be overwhelming when building out and planning for new EV infrastructure. The National Renewable Energy Lab (NREL) has developed an EVSE Taxonomy that stratifies EVSEs by three primary categories: **Access Type**, **Location Type**, and **EVSE Type**.



Access Type	Public	Private
Location Type	Home: SFH	Recreational
	Home: MFH	Health Care
	Neighborhood	School
	Workplace	Community Center
	Office	Transit Hub
	Retail	
EVSE Type	Level 1	DC 150 kW
	Level 2	DC 250 kW
	DC 50 kW	DC 350+ kW

Table 2.2 EVSE Taxonomy for Planning and Development. Source [44].

It can be helpful for local government officials to utilize these categories as a framework and reference point to assess the varying needs of different constituencies to select the proper siting, EVSE type/level, and public versus private use opportunities.

Private Charging Areas

By 2030, approximately 92% of anticipated EVSE needs will be privately owned L1 and L2 chargers, the majority of which will be for residential and home use [45].

2.3 Home & Residential

Home and residential charging will comprise the bulk of EV charging demand across the nation in terms of both EVSE installation quantity and the demand for electricity. The bulk of charging, 80-93%, of national EV charging occurs overnight during the primary hours of disuse [46].

2.4 Retailers & Local Business

Increasing access to EVSEs at retailers and local businesses is a prime opportunity to increase charging opportunities while also supporting local businesses and municipal economic development. Properly planned, public private partnerships (PPP) between local governments and businesses can help reduce charger installation costs, while also furthering mutual goals to increase sustainability and climate-smart initiatives [47].

Figure 2.2 Walmart EV Charging Station, Source [48].

2.5 Warehouses & Distribution Centers

The large size of warehouses and distribution center fleets presents a logistical challenge for utilities and large demand on existing electrical systems. With the expansion of e-commerce, consumer preferences for quick deliveries, and technological improvements, warehouses and distribution centers are growing in the United States, up to 22,000 in 2023 from just 14,600 in 2007 [49].

With over 300 U.S. warehouses, Amazon now maintains a fleet of 15,000 electric Rivian delivery vans covering 1,800 U.S. cities, all of which require charging [50]. Currently the retail giant operates over 17,000 charging stations at 120 warehouses, the largest private EVSE network in the country [51].

Warehouses and distribution centers can present a large logistical challenge for local governments and utility grid management, as the need can arise rapidly anywhere at any time.

Figure 2.3 Amazon Warehouse Distribution Center Fleet Example. Source [52].

Public Charging Areas

2.6 Curbside, Streetlight, & Public Right-of-Way

Curbside, Streetlight, and public right-of-way EVSE placement all fall directly under the scope of municipal operations. Curbside charging refers specifically to EVSEs located on the side of roads or sidewalks. Streetlight charging comprises EVSEs attached to streetlights or poles. Public right-of-way EVSEs are located at any spot owned by a government entity, including highways, roads, sidewalks, etc [53].

2.7 Highway & Interstate

Highway and interstate charging are a critical component of the national demand for EV charging. Properly distanced and a sufficient quantity of national DCFC stations on highways and interstates are key national and state priorities to reduce EV driver "range anxiety" and provide timely charging opportunities.

2.8 Municipal Fleets

Electrifying municipal fleets is a direct opportunity for local governments to reduce their GHG emissions while setting a positive example and precedent for their communities. Beyond GHG emissions reductions, electrified municipal fleets can help reduce harmful effects of air pollution, which disproportionately fall on disadvantaged communities and also children who are more vulnerable to the effects of fossil-fuel emissions emitted by school buses and other modes of public transportation [54].

EVSE Siting, Selection, & Equity

Proper siting and selection of the optimal charger type for public facing EVSE placement is critical to ensuring equitable and widespread access, maximized use frequency, and ensuring cost-effective use of municipal budgets along with state and federal funding opportunities. This section focuses on the strategic siting and placement of EVSEs that fall under some jurisdiction of local governments.

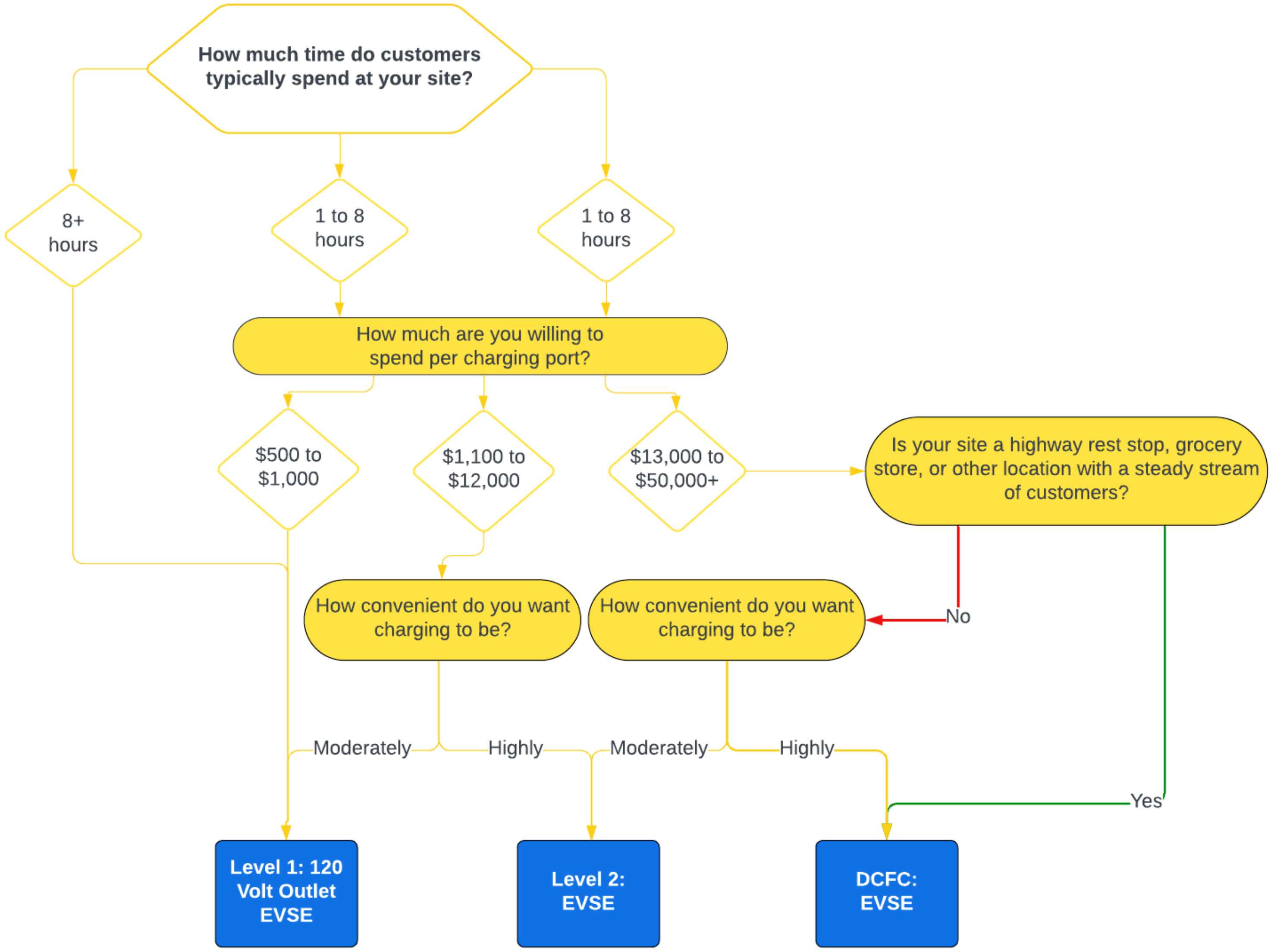


Figure 2.4 Charger Selection Decision Tree. Adapted from [55].

2.9 EVSE Selection & Requirements

The first step in any EVSE infrastructure deployment is to determine the current and anticipated charging needs of the primary users.

While most EVSE unit selection will be determined by the primary application, siting and design conditions may hinder the adoption of certain EVSE units for safety or practicality reasons. A comprehensive fleet and site evaluation alongside consultation with EVSE suppliers will help reveal these potential problem areas prior to their arising and ensure any charging gaps are addressed.

A comprehensive fleet assessment, as outlined in section 6, can be used to best determine the baseline municipal fleet EVSE charging needs.

2.10 EVSE Siting & Design

Once the type and quantity of EVSEs has been determined, the next step is selecting or creating proper siting for the charging units. As discussed, proper siting ensures peak EVSE performance, safety, and accessibility. Table 2.3 outlines the siting criteria developed by the New York State Energy Research and Development Authority (NYSERDA) and Transportation and Climate Initiative to help municipal leaders ensure optimal siting conditions and EVSE selection.

2.11 Accessibility & Equity Considerations

Equitable EVSE placement is critical to supporting disadvantaged communities, ensuring widespread access, and adhering to federal and state regulations.

Renter & Multi-Family Accessibility:

Multifamily households (apartments, condos, etc.) may not have access to the physical spaces required for at-home charging (private garages, driveways, etc.).

Municipal leaders need to ensure equitable operations and access to EVSEs for renters and non-homeowners. Incentives or mandates for landlords and property owners can help reduce resistance to install EVSEs on leased or rented properties. Some states, such as Connecticut, already mandate landlord approval of EV charger installation in their designated parking space [56].

Underserved Communities

Underserved communities may also face significant challenges in the transition to an electrified vehicle system. Lower-income households may struggle to afford the installation costs of personal at-home chargers. It may also be the case that lower-income individuals lack the smartphone technology required to hook up to EVSE charging network applications.

Installation	Accessibility	Operations
EVSE selection and site design, planning, and cost considerations	Accessibility to communication networks, buildings, and other user experience design elements.	Design elements of day-to-day use concerns and long-term goals of hosts and operators
☐ Charge Level	☐ Network Connection	☐ Host-Operator Agreements
☐ Proximity to Power	☐ Accessibility	☐ Visibility
☐ Mounting Approach	☐ Proximity to Traffic	☐ Location in Lot
☐ Number of Cord Sets	☐ Proximity to Building Entrance	☐ Metering
☐ Parking Space Dimensions	☐ Proximity to Elevator	☐ Length of Stay
☐ Environmental Conditions	☐ Lighting	☐ Future-Proofing
☐ Technology	☐ Signage and Wayfinding	
☐ Hazards	☐ Pedestrian Traffic	

Table 2.3 EVSE Siting Design Elements. Adapted from [57].

In a study conducted by HSU and Fingerman, black and Hispanic neighborhoods were shown to be 30% less likely to have access to public chargers compared to the average, no majority reference group [58].

Justice40 Initiatives

The Justice40 Initiative adopted by the Biden-Harris Administration requires a number of provisions to increase equitable access to EVSEs if states are to qualify for certain federal funding opportunities such as the National Electric Vehicle Infrastructure (NEVI) Formula Plan.

This initiative aims to direct 40% of certain federal investments to disadvantaged communities [59][60]. While local governments may not be required to develop all EVSEs under Justice40 guidelines, voluntary adherence to federal equity guidelines can help increase community access and reduce unequal charging burdens on constituents.

EVSE Installation & Costs

Determining the cost of building out EVSE networks is a key concern all governments seeking to electrify their communities and fleets face. While EVSE networks require annual upkeep and maintenance costs, the bulk impact on budgets will arise from the initial purchase and installation of an EVSE unit.

While typical installation costs vary widely by EVSE selection, regional access, utility coverage, and infrastructure requirements, there are several core items municipal leaders can examine to assess a baseline estimate of EVSE installation costs.

2.12 Material, Labor, Permits, & Taxes

Materials, labor, permits, and taxes reflect the primary costs associated with the initial installation and deployment of an EVSE. These costs can vary substantially depending on existing versus required infrastructure and local government zoning and regulatory requirements. Industry consensus is that the cost of EVSE units is decreasing and will continue to be more affordable [61].

2.13 Operational, Maintenance, & Warranty Costs

After installation, the primary costs associated with EVSEs are operational costs, yearly upkeep, and "network fees".

Maintenance includes checking that the unit and its hardware are functional, cleaning equipment, and storing charging cables properly. It also includes intermittent repairs and troubleshooting needs.

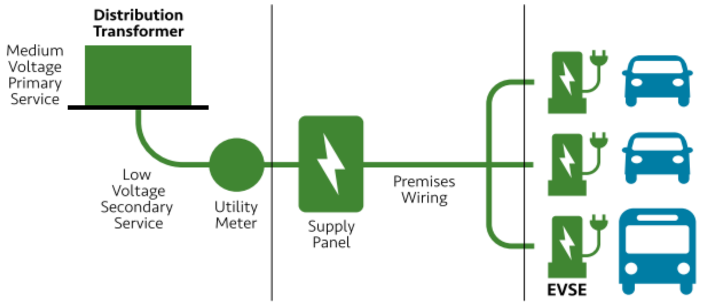
The average cost of maintenance should be allotted at approximately $400 a year per charger, with prices varied based on the charger level [62].

Warranties are another cost associated with EVSE operation. The California Energy Commission estimates "annual extended warranties for DC fast chargers can cost over $800 per charger per year". This figure is often less for Level 1 and Level 2 charger fixed-length warranties, but may leave EVSE owners responsible for EVSE maintenance and repairs after the warranty expires. [63].

2.14 EVSE Ownership Models & Arrangements

Determination of the ownership, operation, and responsibility of the EVSE and related electrical infrastructure is an important step in EVSE siting.

There are several ownership models that can be considered. Typically, the utility itself or the utility customer can own and operate EVSE charging stations and infrastructure [64]. Third-party ownership and operation is also an option, whereupon the site host does not receive direct revenue benefits from the charging station, but may benefit from secondary features such as the case of increased visitors to local businesses in the vicinity.



	UTILITY SERVICE	PREMISES WIRING	EVSE
1. Traditional	**Electric Company**	**Customer**	
2. Make Ready	**Electric Company**		**Customer**
3. EVSE Only	**Electric Company**	**Customer**	**Electric Company**
4. Full Ownership	**Electric Company**		

Figure 2.5 Various Approaches to Ownership Arrangements of EVSE and Related Site-Wiring. Source [65]

The Traditional Approach: involves the utility providing the wiring from public power lines to the facility, with the customer paying to install all remaining wiring and infrastructure required for the EVSE to operate. The customer owns and operates the EVSE. This model provides full ownership over the wiring and EVSE but also requires higher upfront costs [66].

Make-Ready Model: involves the utility providing and owning both the standard utility service wiring and the premises wiring up to the point of the EVSE installation. This model saves the site owner some money in the long run by allowing the wiring costs to be taken on and recuperated by the utility [67].

EVSE-Only Model: in this scenario, the installation and ownership of the EVSE falls to the utility, although the site ownership remains external. This can provide a low cost opportunity to develop an EVSE on-site, especially when most wiring and infrastructure is already present [68].

Full-Ownership Model: all components of the EVSE process, wiring, infrastructure, site, and the EVSE unit itself are owned and operated by the utility. The full ownership model is only recommended in locations where the market would not otherwise support an alternative business model, or where there are significant safety and operational risks. Such instances include supporting Low- and Moderate income communities and environmental justice communities. It also includes instances where EVSE installation and public safety is significantly more complex, such as with streetlight chargers.

This can be useful in situations such as DCFC installations where the high costs can be handled, and continued upkeep and public access is assured [69].

Working with your local utility and stakeholders involved in public charging scenarios can help to identify which ownership model and opportunities are best suited to the varying needs and capabilities of your local community, as well as developing a forward-looking understanding of future EVSE integration.

2.15 Chapter 2: Local & Regional Government Strategies

Strategy 1: Partner Early with Utilities and Relevant Stakeholders

Local governments, especially with larger constituencies, should collaborate with their utilities in the event they anticipate substantial grid limitations or upgrades.

Partnering with a utility can help:

- Address grid-level constraints from anticipated EVSE installations.

- Assist in site selection by assessing information regarding costs and limitations related to supplying electricity at a given site.
- Provide advice related to optimal ownership models, price structures, electricity rates, and technical installation support. Many utilities are offering Fleet Electrification Assessment Services.
- Identify opportunities to reduce financial burden through rebates and utility programs/ partnerships [70].

Some examples of governments partnering with utilities to expand their electrification efforts include:

Minneapolis & St. Paul, MN: the Twin Cities have partnered with Xcel Energy, Inc. to develop an EV charging network and car sharing program. This has helped expand EVSE networks while providing mobility options for community members with barriers to typical vehicle ownership [71].

Strategy 2: Upgrade Building & Zoning Regulations

Municipalities should update their building codes to ensure EVSE compatibility and optimization. This can substantially reduce future costs and the installation burden on municipal residents. See section 7 for more information on EV-Friendly building codes.

Strategy 3: Support Local Business and Retail Charging Installations

There are numerous reasons local governments should consider supporting and engaging with local businesses in their communities to further EV charging initiatives.

National EVSE Coverage Potential: With over 207,000 fast food restaurants alone in the U.S., big box, convenience, grocery, department, and discount stores have the potential to vastly increase EVSE access across the nation with even a small number of EVSE charging ports at each location [72]. This network of retail based EVSEs can help increase charger redundancy and reduce congestion at singular charger hubs.

Increased Business Visibility & Traffic: Access to chargers can help demonstrate a business commitment to sustainability, elevate brands, and increase the attractiveness of stopping at that location. Paired with smart planning, services and products can target the most likely visitors to EVSE stations.

A study examining the impacts of EVSE access on retailers found increase foot traffic for “brick-and-mortar retailers” by an average of 4%, and revenues by 5% [73].

EVSE Installation Cost Share: State and Federal government incentives are not limited to residential chargers. Many retail charger installations are also covered up to 30%, up to $100,000, under federal funding initiatives [74]. State and local governments may also help businesses realize significant cost savings when installing EVSEs through grants, rebates, and public-private partnerships.

In most instances, the costs incurred from large scale infrastructure development requested by large companies and industry are covered by the companies themselves. This avoids placing upgrade costs on the regular taxpayer, though in some instances typical utility upgrades are paid out of pocket by the utility [75].

Strategy 4: Examine all EVSE Supplier Options

Given the wide range of charging unit options and suppliers, governments should consider several key factors, including but not limited to:

Defining EVSE Needs: consider what the priorities are for your supplier selection. A robust technical support team is important to both small and large local governments to provide specific skills and expertise needed to execute EV transition operations [76].

Technical & Engineering Expertise: Suppliers with a strong engineering capability can help address local challenges and installation considerations [77].

Quality Control: Ensuring high-quality builds and product quality controls will reduce the down time of EVSE operations and potentially result in cost savings in the future [78].

Section 3:

Electricity Considerations

Electricity Considerations

The transition to EVs will increase electricity demand of government facilities and the community at large, often significantly. This increased demand will be primarily incurred from charging infrastructure through the electricity needed to power fleet operations and community at-home charging.

For municipalities with large government fleets and/or community at-home charging, the increased electricity demand can potentially strain current electrical systems. The development of modernized electricity infrastructure and increased transmission and distribution capacity may be required to satisfy municipal electricity demand.

3.1 U.S. Electricity Demand & Electric Vehicles

A large transition from ICEs to EVs entails a large corresponding increase in future electricity demand of the electric grid and infrastructure.

The U.S. Energy Information Agency (EIA) predicts an increase between 892% to 2,038% in national transportation section electricity demand from the year 2022 to 2050. These projections reflect a transportation sector electricity increase between 0.6 quads (Quadrillion BTU) and 1.3 quads by 2050, compared to a sector use of just 0.1 quads in 2022 [79].

A medium- to high-vehicle electrification scenario is predicted to **increase overall U.S. electricity consumption between 20% to 38% by 2050** according to the National Renewable Energy Lab (NREL) [80].

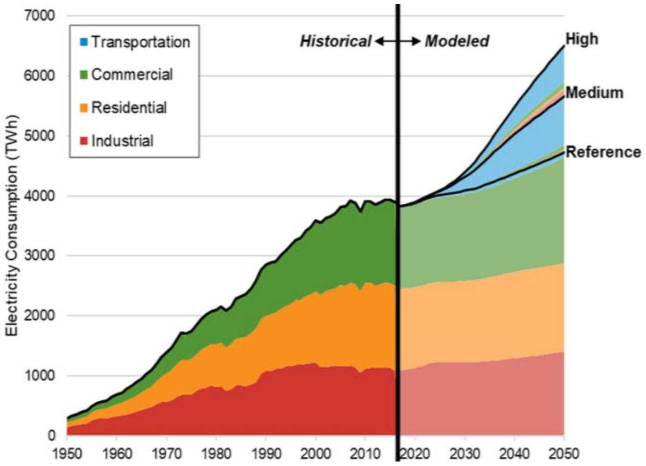


Figure 3.1 Historical and Modeled U.S. Electricity Demand by Energy Sector (1950 to 2050). Source [81]

3.2 Peak Demand & Load Profile Impacts

Peak demand, also known as peak load, is a period of time where consumer electricity demand is at its highest. Peak demand can be stratified along **both short-term** and **long-term timeframes**.

Many electricity systems nationwide see daily short-term peak demand in the evenings, when residents return home from their work. Long-term peak demand can also be seasonally affected. The need for cooling during the summer months often results in the highest seasonal peak electricity demand [82].

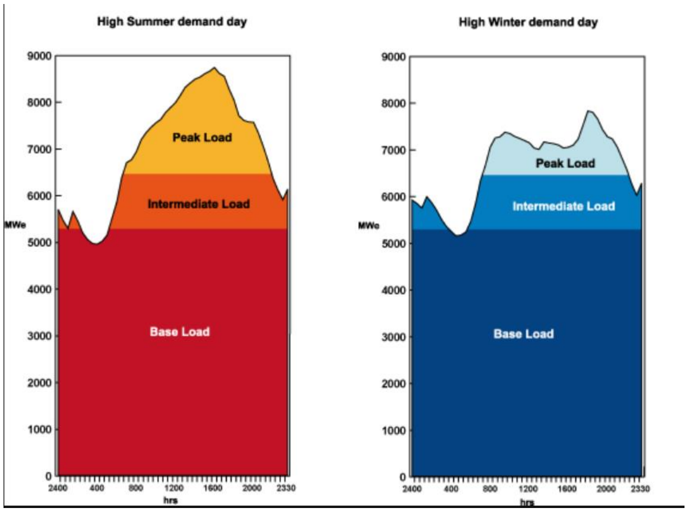


Figure 3.2 Load Curves for Typical Electricity Grid. Source [83].

The mass adoption of EVs and the growing reliance on renewable energy requires consideration of the impacts to peak demand and loads on electrical systems.

Managing impacts to local and grid-wide peak demand is important for a number of reasons [84]. Primarily, peak demand can significantly impact energy prices.

Localized Peak Demand Impacts

While overall national peak demand is only expected to increase by approximately 1% by 2030 and 5% by 2050 on average, research suggests EV adoption and peak demand impacts will vary significantly by region and locality.

Larger EV market-penetration and vehicle concentrations in cities and suburban areas may increase localized peak demand significantly [85]. For the general population, the gradual adoption of EVs and the average impact to peak demand will be tempered by continued use of ICE vehicles by many individuals. “For a typical residential feeder circuit of 150 homes at 25 percent local EV penetration, the analysis indicated that **the local peak load would increase by approximately 30%.**” [86]. This example does not use “smart charging” or any other centrally managed charging system which could dramatically reduce peak demands.

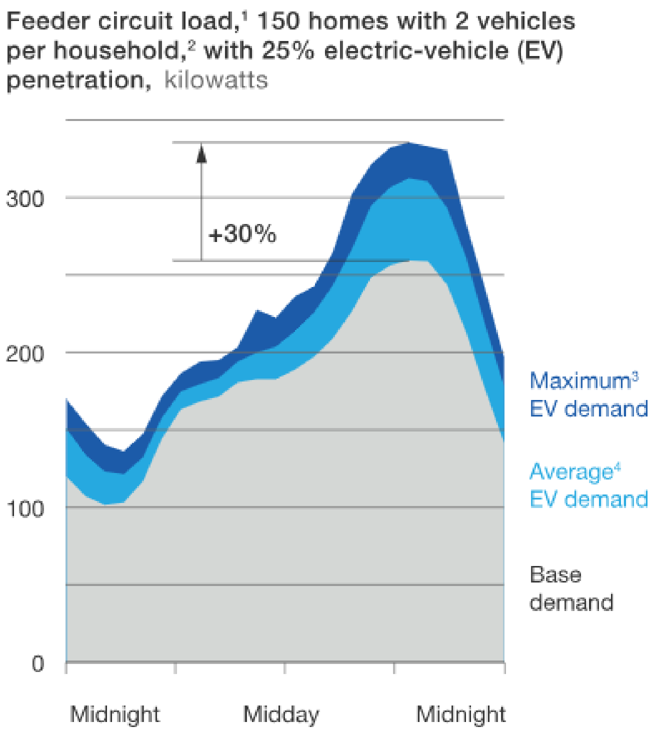


Figure 3.3 Theoretical Model of Feeder circuit load, 150 homes with 2 vehicles per household with 25% local EV penetration, kilowatts. Source [87].

3.3 Load Profile Fluctuations

Unlike peak demand, the electric “load profile” outlines the nominal electricity usage across a daily or seasonal basis. The load profile helps visualize and understand the variability of demand across a given time frame.

Perhaps even more challenging for grid operators than peak demand is maintaining system balance that experience the effects of “highly volatile and spiky load profiles of public fast-charging stations” [88]. As can be seen in figure 3.4, unlike a typical residential electric load profile which can fluctuate between 1 and 4 kW of electricity use over the course of the day, High-Power EV Charging Stations can jump from 0 draw to over 120 kW in a second’s notice.

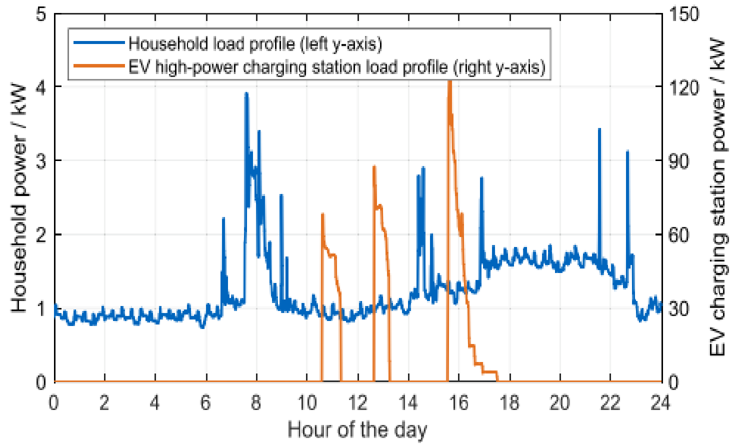


Figure 3.4 Household Load Profile versus EV High-Power Charging Station Load Profile. Source [89].

This extremely large electricity draw and rapid spike has the potential to strain localized electricity systems, particularly as EV and PHEV adoption becomes more widespread in the coming decades.

Generation, Transmission, & Distribution Systems

Generation, transmission, and distribution systems comprise the primary phases of moving electricity from the generation facility (via poles and wires) to the final user (home, business, charging hub, etc.).

3.4 Transmission Systems

Transmission, sometimes referred to as the “bulk grid” of electricity delivery, acts as the electrical “highway” of the electrical system, moving large amounts of high voltage electricity across long distances via substations. Transmission lines, substations, transformers and other high voltage equipment operates at 100kV (100,000 volts) or greater [90].

3.5 Distribution Systems

Distribution systems take over upon nearing the final use destination. High voltage power is reduced to lower voltages (“stepped down” via transformers) for compatibility with homes and businesses. From this stage, the distribution lines carry the proper voltage electricity directly to the final user. Distribution lines operate at around 13kV (13,000 volts), while standards homes run on 120 volts.

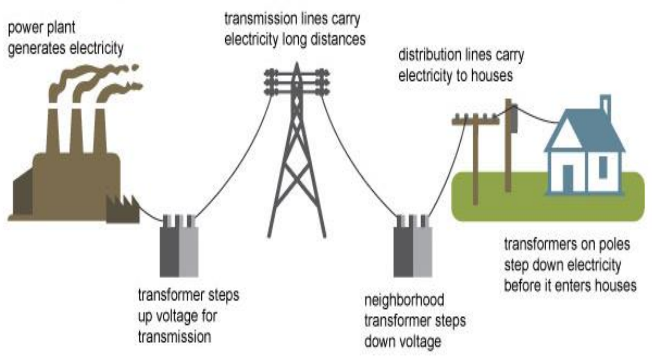


Figure 3.5 Electricity Generation, Transmission, and Distribution Overview. Source [91].

3.6 Substations and Feeders

EV charging largely takes place within the distribution phase of electricity transportation, and distribution is thus the area of larger risk when considering the impacts of EVs to municipal power and operations. Insufficient upgrades to electrical distribution may become the "primary bottleneck" of EV grid integration [92]

Within the distribution system, **substations** and **feeders** (circuits) are the primary areas of concern for infrastructure development and municipal operations.

Sub Stations: *"the connections that step down the high-voltage electricity from the transmission grid to lower voltages for local power distribution" [93]*

Feeders (Circuits): *"often refer to the conductors and transformers that deliver the stepped-down electricity to end-use consumers" [94]*

Forecasting the future impacts of EVs on distribution is highly challenging given the variable distribution and timing of charging loads across the nation.

Advanced modeling techniques, while imperfect, can help to capture some of the anticipated impacts of localized vehicle travel behaviors and upgrade needs.

3.7 Electric Utilities: Oversight & Structures

As governments consider impacts to their electrical infrastructure due to both EV charging requirements and increased renewable energy integration, understanding the basics of grid oversight and operations can help anticipate and plan for local effects. In the U.S. there are four primary types of utilities: Investor-Owned, Publicly Owned, Cooperatives, and Tribal Utility Authorities.

Investor-Owned Utilities (IOUs) provide service to nearly 75% of customers nationwide. There were 168 IOUs in the U.S. in 2017, servicing on average of 654,600 customers each. IOUs are privately-owned by shareholders, although they are subject to high regulation in regard to their operations and rate structures [95].

Public Owned Utilities (POUs) are utilities operated by Federal, State, or municipal entities. There were 1,958 POUs in the U.S. in 2017, servicing an average of only 12,000 customers each. POUs have greater flexibility in their ownership models and structures due to their unique ownership status. POUs may lack the financial and physical capital of IOUs given their smaller size [96].

Cooperative (Co-ops) are "not-for-profit member owned utilities" typically located in rural areas. There were 812 co-ops is in the U.S. in 2017, servicing on average 24,500 customers each. There are co-ops in 47 states, but they are more concentrated in the Midwest and Southeast. Co-ops are specialized into three primary types: generation, transmission, and distribution co-ops [97].

Tribal Utility Authorities (TUAs) are "entities formed by Tribal Governments" to regulate and control the delivery of electricity to customers within tribal lands. TUAs were formed to address inadequate utility provisions and to resolve challenges and poor relations with State and Federal entities over energy issues [98].

The primary responsibility for organizing and paying for these upgrades will come through the nexus of local utility providers.

Typically, grid improvements and modernizations are enacted by the utilities within a given jurisdiction.

Public Utility Commission (PUCs) are typically a single agency within a state who regulates utilities, including electricity. All 50 states have a PUC or several agencies sharing a PUC role. PUCs "typically regulate all investor-owned utilities (IOUs) within their state", including pricing rates and structures [99].

Approval of IOU rates charged to customers is done via a process known as a "**Rate Case**". Rate case is the formal process used to determine pricing and ensure fair consumer prices and avoid monopolistic pricing.

Key Concept: Utility "Rate Case"

"The rates encompass not just the cost of electricity but **also the cost of building and maintaining the power sources and grid infrastructure** to produce and deliver that electricity — and the spending on infrastructure, also known as capital expenses, is where the IOUs generate most of their earnings.

[IOUs] are allowed to make a guaranteed rate of return on investments in infrastructure, typically set in the 8 to 10 percent range, an arrangement intended to allow IOUs to attract shareholders to invest their money in the enterprise and minimize the utility's need to take on debt (and assume risk) for these projects." [100]

3.8 Medium-and-Heavy Duty Vehicle Charging & Distribution Centers

Distribution centers and other high vehicle concentration settings such as warehouses and municipal fleets are a unique challenge for localized electricity demand and utilization. A theoretical 100,000 square foot warehouse, that without EV fleets would consumes around 50 kilowatts of electricity, might require dozens of times as much power when 100 EVSEs are installed at said facility depending on vehicle type and quantity [101][102].

Megawatt (MW)-level charging is a critical factor for medium-and-heavy duty (MHDV) EVs such as class 8 long distance hauling trucks. Such vehicles require even more intensive electricity demand and pose a greater logistical challenge for fleet managers and utilities than light-duty fleets.

A long-haul truck 300-kWh battery can operate for approximately 150 miles before requiring a 1 hour, 1.6 Megawatt charge [103][104]. This is upwards of 30 times the daily 50 kW operating electricity required of a non-EV warehouse, for one class 8 charge. With these figures in mind, it is clear that large-scale heavy-duty charging is a huge logistical and technological challenge given the state of modern heavy-duty EV charging technology.

Despite present challenges, there are those taking the lead to set an example and pioneer MHDV charging opportunities. Some examples of building out large scale prototypes of MHDV charging facilities include:

Los Angeles, CA: Prologis, Inc. and Performance Team have developed the Denker charging depot, a 9 MW depot capable of charging 96 heavy-duty trucks at the same time, built in only 5 months [105].

Findlay, OH: One Energy operates the largest semitruck charging site in the country with a 30 MW capacity with an operational 138,000 voltage transmission line. The site is currently engaged in pilot programs while awaiting fleet operators to request specific charging ports to accommodate their heavy-duty fleets [106].

Newark, NJ: Axis Electrified is currently developing its own heavy-duty electric truck charging site with the capacity to charge 16 MDHVs alongside 60 level 2 chargers.

These charging hubs are the beginning of a wide network of MDHV charging that will be required nationally to support future EV fleet and trucking operations.

3.9 Distributed Energy Resources (DER) Opportunities

As communities and businesses seek to achieve net-zero carbon commitments, the transition to renewable energy sources is rapidly expanding. Distributed Energy Resources (DERs) are offering unique opportunities to power the EV transition. DERs include wind, solar, battery storage and other resources which can be coordinated into Virtual Power Plants (VPPs) for communities to tap into to meet EV charging needs.

3.10 Grid Reliability Backups

Widescale electrification of U.S. transportation has the potential to increase both grid resiliency but also vulnerabilities. There are numerous methods and technologies that can help to increase resiliency.

Managed Charging is a proactive charging tactic of EVs that controls the charging process to provide benefits to the consumer and the electrical grid. This process involves managing the charging time and/or the power consumption. There are two primary managed charging types [107].

- **Passive Management**- this involves influencing changes to charging behavior through examples such as incentives, charging education, or varying charging costs depending on timing [108]

- **Active Management**- relies on real time signals from the utility or other agency to influence the charging activity. Examples include demand response (DR) where the utility actively communicates the need to increase or decrease charging to reduce pressure on the grid or increase to utilize surplus supply [109].

"Bidirectional Charging" is a more novel technology in development that allows EVs to provide power from their batteries to other applications such as homes and even back into the shared electrical grid [110]. The primary bidirectional charging applications are:

- Vehicle to grid (V2G)
- Vehicle to home (V2H)
- Vehicle to load (V2L)
- Vehicle to vehicle (V2V)

Passive, active, and bidirectional charging all provide greater opportunities for increased grid resistance and adaptation.

3.11 Grid Electrical Vulnerabilities

Threats to grid stability also exist as EVs and PHEVs gain market share. Under contemporary grid scenarios, evening charging is often ideal due to reductions in peak demand. While this model is logical, there are significant considerations down the road, particularly concerning increased reliance on renewable energy.

While needed to achieve net-zero carbon emissions, renewable energy provides logistical challenges particularly in the areas of our grid's historical energy demand and supply profiles. Examples of challenges include:

New Peak Demand & Production Times- With solar projected as the largest source of renewable electricity in the coming decades, this may result in less electrical production in the evenings, when EVSE demands will be at their highest [111].

Increased Power Variation- Renewables are reliant on natural forces to ensure their operations. Meteorological fluctuations may pose both short-term and long-term challenges to ensuring adequate electricity in the times it is needed most such as in the case of wind and solar, where sunlight and wind can vary significantly on an hourly, daily, and even seasonal basis [112].

Utilities and local governments will need to develop new energy storage technologies, backup systems, and managed power models to ensure seamless transition to renewable energy and away from fossil fuel reliance while ensuring adequate power for EV operations.

3.12 Chapter 3: Local & Regional Government Strategies

Local governments in the U.S. have a varying degree of legal authority over utilities, depending on the specific circumstances and type of utility involved. While some have direct control over utilities through public ownership, many do not. For the majority of local governments with communities served by IOUs, there is limited legal authority at the local government level compared to POUs.

Despite these legal limitations, there are numerous ways that local governments can work together with their local utilities to mutually enhance grid improvements and preparation for EVs [113].

Strategy 1: Build Utility & Government Partnerships

Attempting to voluntarily align visions and goals with electrical utilities should be the first step of any local government approach. While this tactic may prove unproductive, many cities and towns have successfully engaged in partnerships with their utility providers to enhance EV charging networks and growth.

Austin, TX:

Austin, Texas has partnered with Public Works and Austin Energy to construct and install charging infrastructure for the local government EV fleet in a number of municipal buildings and parking lots. Austin Energy also offers an "EVs for Schools" program to help educate residents and students on ways to save energy and also educate students about emerging EV technologies [114][115].

Boston, MA:

The city of Boston has worked to expand its EV charging infrastructure through partnership with Eversource (IOU). Eversource's Electric Vehicle Charging Station program "provides make-ready installation costs and per-port rebates for non-residential customers to install approved Level 2 or direct current fast charging (DCFC) stations at businesses, multi-unit dwellings, workplaces, and fleet facilities". Environmental justice communities may receive increased rebates for installations [116].

Minneapolis, MN:

Minneapolis IOU Xcel Energy has established the goal of being a net-zero energy provider by 2050. Xcel Energy offers many rebates on EV purchases, installation costs for Level 2 EV chargers, and access to a charging subscription pilot program that offers unlimited charging at specified times for a flat monthly fee. Commercial EV charging rates are offered to businesses to help reduce infrastructure costs and encourage energy efficiency charging times [117]

Sumner, WA

To the south of Seattle, Sumner is a city of around 10,000 residents. The city and IOU Puget Sound Energy (PSE) partnered with PSE's "Up & Go Electric" program to introduce the first charging station in the county. The "Up & Go Electric for Public" program further offers incentives of up to 100% of the cost for installing public charging stations at businesses and organizations that seek to bring public charging options into their communities [118].

Strategy 2: Develop Pro-EV Zoning and Building Codes for Electrical Infrastructure

While local governments typically do not have direct control over utility providers, they can create and enforce zoning and building codes to mandate EV infrastructure installations on new buildings and structures.

San Francisco, CA:

The city of San Francisco Green Building Code 2022 ("SFGBC") requires compliance from newly built residential and commercial buildings along with existing buildings undergoing major alterations. The code builds on the CALGreen 2022 state requirements, establishing a minimum number of EV chargers per public parking lot and specified private parking lots.

The local government has partnered with IOU Pacific Gas & Electric Company (PG&E) to develop EV infrastructure, increase access to charging networks across the city, and test new clean energy technologies such as "Intelligent Backup Power", bidirectional charging of the Ford F-150 lightning, with capabilities to increase resiliency of residential homes [119].

Strategy 3: Optimize Power Consumption through Centralized "Smart" Grids and Other Methodologies

Adopting "Smart" Grids and other smart technologies specifically aimed at optimizing electricity consumption can help to reduce the impacts of electrifying the transportation sector.

Local government fleets are particularly well suited to techniques such as managed charging due to their constant operating cycles and predictable loads [120]. Working with utilities and EVSE suppliers can ensure that both local infrastructure and EVSE technologies are compatible to enable the desired Smart-Charging benefits.

In a study of utilities, 60% cited "Uncertainty Around EV Customer Participation" as the number one barrier to implementation of a managed EV charging program [121]. Local governments can assist in recruiting community participation and engagement. Greater detail is outlined in the "State of Managed Charging in 2021" report in Section 8.

Strategy 4: Leverage Bulk Purchasing in Deregulated Electricity Markets

In states with deregulated electricity markets, local governments can enact aggregation agreements for bulk purchase of electricity from third party suppliers [122].

Massena, NY

In 1974, Massena, NY residents voted to transfer their electric utility to publicly controlled, buying the local grid from Niagara Mohawk utility. After years of legal battles, the switch officially occurred in 1981 to Massena Electric Department and utility bills dropped by 24% immediately.

While not the largest utility type in the country, consideration of public utilities can help prioritize the purchase of clean energy for municipalities seeking to decarbonize their electricity portfolios.

Section 4:

Local Roads & Highway Considerations

Local Roads & Highways

Local governments play a critical role in maintaining our roads and highways, ensuring safe and convenient transportation, movement of economic goods and supplies, and rapid response capabilities of emergency and national security vehicles. The transition from fossil-fuel powered vehicles to electric vehicles has significant implications for the management, upkeep, and funding of roads and highways overseen by local governments.

4.1 Local Government Responsibility: Road Systems

In 2020, U.S. national road milage totaled approximately 4.1 million miles. These road miles can be broken down into four primary use categories or “**Functional Classifications**” per the Federal Highway Administration (FHWA):

- **Interstate System:** consists of all designated freeway routes meeting interstate standards. The highest classification of arterial roads and streets with the greatest mobility and highest speeds for long uninterrupted distances.

- **Other Arterials:** consist of limited access freeways, multi-lane, and other important highways that supplement the interstate system. They connect the nations urban areas, cities, and industrial centers and are important for national defense.

- **Collectors:** provide land access service and traffic movement within residential neighborhoods, commercial and industrial areas, and downtown city centers. They connect local roads and streets with arterials at a slower speed and shorter distance.

- **Locals:** local roads and streets that provide high levels of access to adjoining land with a limited mobility.

Responsibility for the upkeep and maintenance of roads depends on these FHWA functional classifications.

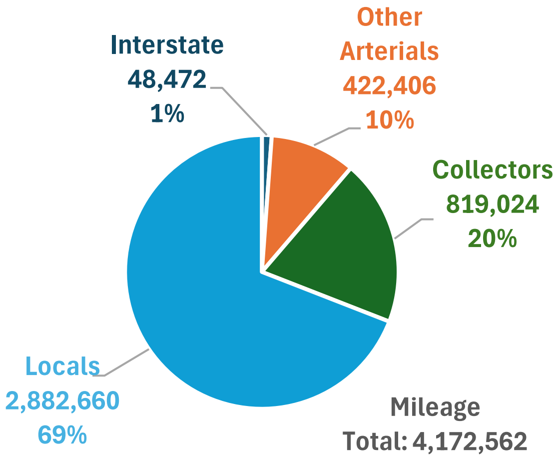


Figure 4.1 2020 U.S. National Road Miles by Function Adapted from FHWA Data, VM-202, HM-220 [123]

As can be seen in figure 4.1, **the majority of national local roadways, 77.4%, are under the ownership jurisdiction of their corresponding local governments** (towns, cities, and counties). States maintain primary jurisdiction over interstates and adjoining roads not included under federal and local oversight, approximately 19.6% in the early 2000s.

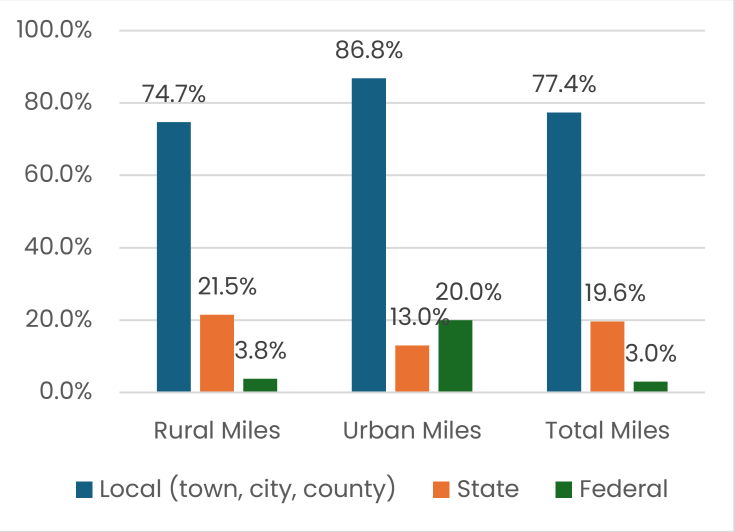


Figure 4.2 Road Miles Ownership by Local, State, and Federal Governments. Adapted from [124].

Overall, only around 3% of the nation’s roadways are under the direct ownership of the federal government, which include national parks and forests, military institutions, and on some Native American reservations.

This trend is generally the same regardless of communities differ along urban versus rural designation.

The implications of these figures are stark: Among all government levels, local governments will have to contend with the overwhelming majority of road maintenance, repairs, and upgrades impacted by the transition to EVs and the anticipated reductions in traditional fossil-fuel based funding streams.

4.2 EV Weight & Road Maintenance

Road maintenance costs are expected to increase substantially due to the EV transition. EVs weigh, on average, 30% more than gas-powered vehicles because of their lithium batteries [125].

The **"**Fourth Power Law**",** developed by the American Association of State Highway Officials (AASHO), holds that for every unit increase exerted by a vehicle's axle, the road *stress/damage to* is multiplied by 10^4 power.

Thus, a car axle load weighing 2 tons versus 1 ton, while only doubled in weight, causes **16 times more road stress per axle** (2^4). A 10-ton vehicle axle weight, while only 10 times more in weight than a 1 ton vehicle axle weight, causes a whopping **10,000 times more road stress per axle.**

From the real implications of this as seen in figure 4.3, it is clear to see why even a minor increase in average vehicle weight will wear down roads and bridges significantly more than gasoline powered vehicles, creating the need for more frequent road maintenance in communities.

Researchers have found that battery operated trucks and buses are responsible for between 20% to 40% greater road damage compared to ICEs.

This will mean a larger number of municipal funds will have to be allocated towards maintenance of roads and bridges.

4.3 Road Safety Upgrades

Safety upgrades are another significant area of potential expenditure municipalities will face. With substantially higher weights, researchers have suggested modern EVs could generate "**20 to 50% more impact energy**" compared to gas-powered vehicles crashes at the same rate of speed [126].

Modern guardrails and barriers developed for ICEs may thus be substantially unsuited for the safety demands of EVs, imposing a significant increase to municipal expenditure to fund the creation of new, modernized safety infrastructure [127].

In addition to on-road barriers and safety equipment, EVs and PHEVs may also present a risk to ICE drivers. Current safety standards for vehicle collisions may not be sufficient to protect lighter-weight vehicle passengers from their heavier battery powered counterparts.

Local governments will eventually need to consider assessing and updating their road infrastructure to meet these challenges.

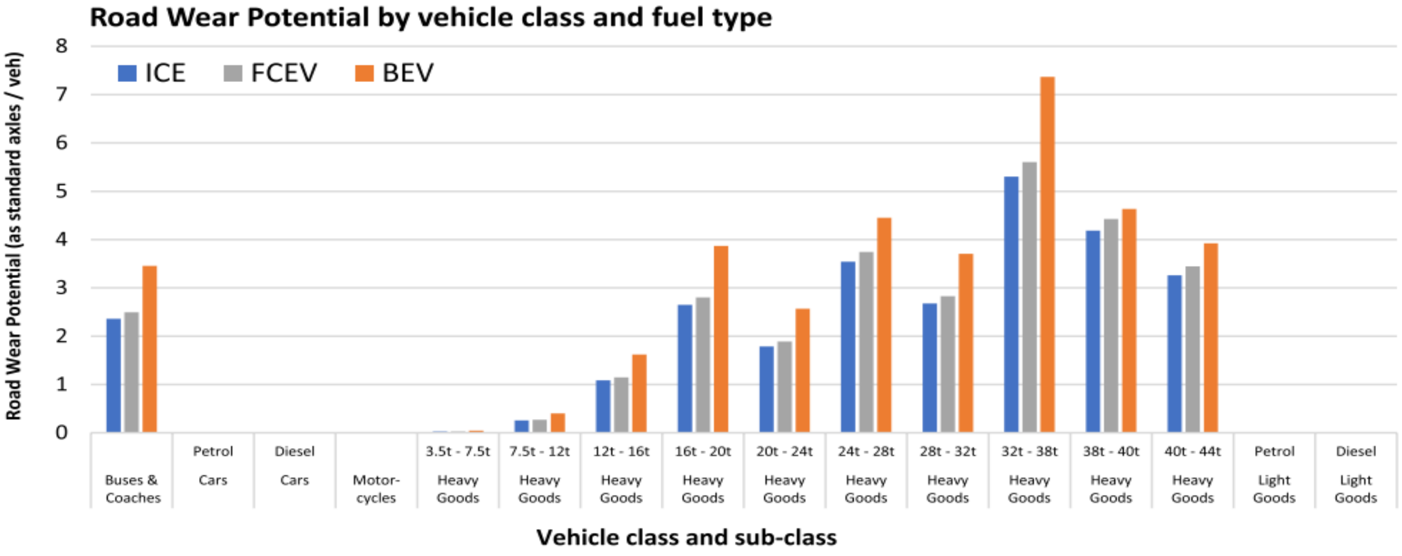


Figure 4.3 Road Wear Potential (RWP) per vehicle, sorted by vehicle sub-class, comparing ICE (Internal Combustion Engine), BEV (Battery Electric Vehicle) and HFCEV (Hydrogen Fuel Cell EV). RWP is the number of standard axles per axle, multiplied by the number of axles on the vehicle. Vehicles under 7.5t have negligible RWP in this context. Source [128].

updating their roadway speeds, organization, and infrastructure to better reflect and reduce the risks and challenges associated with greater EV use.

A study by the National Bureau of Economic Research found that "**a 1,000 pound difference between vehicles results in a 47% increase in the likelihood that crash turns deadly** [129]. The National Highway Traffic Safety Administration (NHTSA) is currently monitoring the issue of EV related crashes to help increase safety on the road.

4.4 Leaking Underground Storage Tanks (LUST)

Underground Storage Tanks (USTs) are commonly used to store fuel at fueling stations for multiple applications including cars, boats, other fueling needs. Leaking Underground Storage Tanks (LUST) sites are USTs designated by the U.S. EPA that leak fuel into the surrounding environment, a critical concern to clean drinking water, soil integrity, and public health [130].

Over the last two decades, the EPA has documented significant national progress towards reducing LUST sites, with over 515,000 LUST sites cleaned in 35 years as of 2023. From 2003 to 2023, the EPA and its partners have reduced LUST site backlog from 136,000 sites in 2003 to less than 58,000 in 2023 [131].

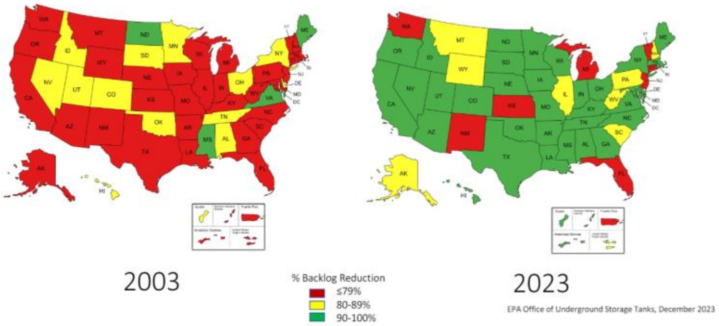


Figure 4.4 Percent Backlog Reduction Change in U.S. EPA Leaking Underground Storage Tank (LUST) sites: 2003 to 2023. Accessed from: [132]

4.5 Remediation of LUST Sites

The remarkable progress of the LUST reduction program has been powered by the **LUST Trust Fund.** Created in 1986 to address petroleum releases from federally regulated USTs, the LUST Trust Fund is financed by a 0.1 cent tax per gallon of motor fuel sold at the national level, amounting to $62 million in fiscal year 2024, and 90% direct distribution of funds to states, territories, and tribes for cleanup and prevention [133].

As the nation increasingly shifts from ICE to EVs, policy makers will need to consider the lifespan and cleanup efforts required to address a new spike in UST and LUST prevention, with **around 542,000 active USTs** nationwide storing petroleum or other hazardous substances [134]. Gas stations, with their uncertain futures, may experiences significantly reduced demand or closures leading to increased need for cleanup of abandoned tanks.

A substantial uptick in remediation could also strain the LUST Trust Fund revenue which is not tied to inflationary increases and at risk of motor fuel tax decreases from EVs and greater fuel economies. While the fund is federally controlled and local governments are not fully responsible for these projects, local governments may want to assess potential remediation requirements their communities may face in the coming years.

4.6 Chapter 4: Local & Regional Government Strategies

Strategy 1: Inventory Local Roads & Highways

While the transition to EVs is not a cause for immediate concern, the challenges of road upkeep and more critically road safety will continue to increase as greater levels of EV adoption are realized. Creating an inventory of local road and highway operating conditions to assess future safety requirements can help strategically target investments and improvements in the most needed areas.

Guardrails and crash attenuators are a priority area of focus local governments may wish to examine with the help of their local departments of transportation.

Strategy 2: Identify High-Use Corridors & EVSE Hubs

State and local governments are responsible for the nation's system of interstate highways. These areas are of considerable importance for both national transportation and development of a robust network of public DCFC charging stations for long-distance travelers.

Through collaboration with state governments, local businesses, and utilities, early planning can help maximize co-benefits to long-distance travelers and local jurisdictions and towns. This includes early awareness of any legal responsibilities for local governments to support EVESE hubs and development, strategic placement of EVSEs to maximize use and draw to local economic enterprises.

Strategy 3: Identify Environmental Risk Areas

LUST site remediation has been a large success story of the U.S. EPA with a 57.4% decrease from 2003 to 2023. Over time, increasing reliance on electric vehicles and services may cause many currently utilized USTs to be left in a state of disuse and potentially, hazardous in nature.

Local governments should consider identifying the high-risk businesses and properties within their jurisdiction that may be cause for concern as storage tanks are no longer needed and LUST remediation funding continues to decrease.

Early planning can help prepare for and mitigate the potential ecological and health threat to entire communities that arise if their contents are unmanaged and allowed to enter the environment and drinking water.

Section 5

Funding & Revenue Models

Revenues & Financing Background

Revenue impacts from the electrification of motor vehicles are a critical factor local governments must prepare and plan for to ensure adequate funding of their towns and cities well into the future.

Looking to the future, the electrification of the U.S. transportation sector poses two major monetary challenges for local governments**: 1) financing the widescale development and deployment of EVSE infrastructure and 2) anticipated revenue gaps due to the loss of conventional revenue sources.**

Across the U.S., municipalities are already struggling to maintain a positive budget, with 63 out of 75 of America's largest cities maintaining a taxpayer burden totaling a debt of nearly $330 billion in 2019 [135]. Financial insecurity extends to many small and medium sized communities as well.

The transition from traditional gasoline vehicles to electric threatens to compound preexisting funding challenges, as historic tax generating models relying on fossil fuel sales and utilization cease to function adequately.

This chapter outlines the current state of vehicle related tax revenues, the anticipated impacts of an increasingly electrified populace, and some of the alternative models leaders can integrate to ensure sufficient funding remains available to maintain our national and local transportation infrastructure and needs.

5.1 Financing EVSE Networks

The National Renewable Energy Lab estimates that by 2030, a total national capital investment of $53 to $127 billion in charging infrastructure will be required to support a mid-adoption scenario of 33 million EVs on national roads. This estimate excludes the cost of grid upgrades and distributed energy resources (DERs) [136].

EVSEs vary dramatically in cost depending on type. The National Renewable Energy Lab predicts that the required 182,000 Public Fast Charging ports needed by 2030 (less than 1% of EVSEs in terms of quantity) will require 39% of national financial investment [137].

Compared to the 26,700,000 (92% of EVSEs in terms of quantity) private charging ports which will cost around 52% of national financial investment.

It is clear to see just how wide the gap is between L1 and L2, and DC charging stations.

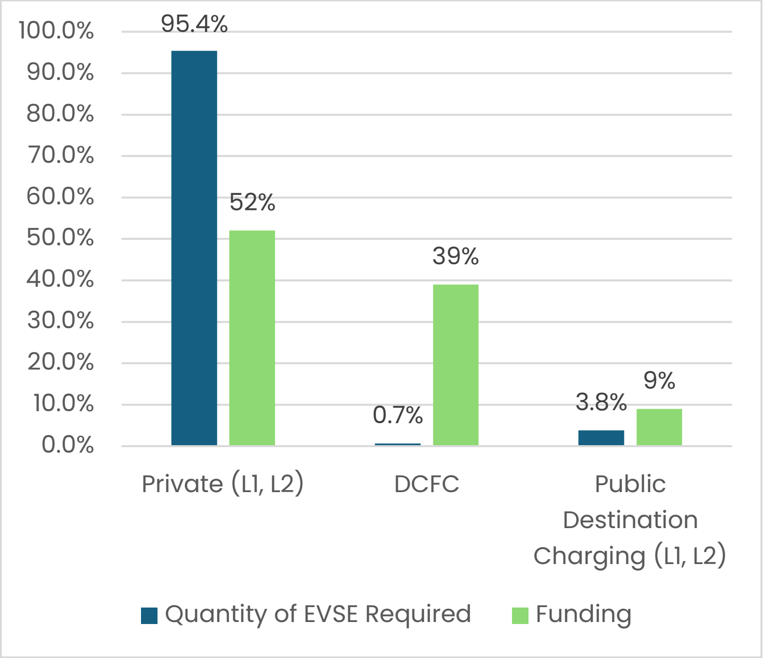


Figure 5.1 National Renewable Energy Lab (NREL) Assessment of Needed 2030 National EVSE Quantity by Charger Type, Versus Precent of Required National Financial Investment. Adapted from [138].

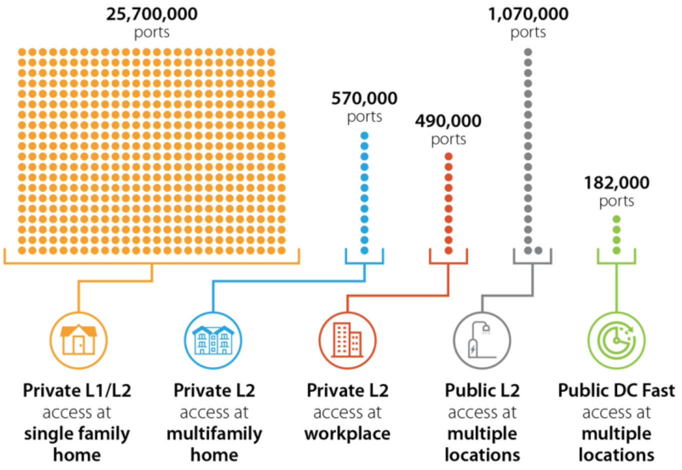


Figure 5.2 2030 National EV Charging Network Size, Dot Reflects 50,000 Charging Ports. Source [139].

5.2 Government Revenue Impacts

Without government intervention, the shift to EVs will result in significant funding shortfalls as the bulk of traditional government transportation funding models rely heavily on the fuel tax to generate federal, state, and local revenues.

Historically, transportation sector revenue has been generated using several different tactics and models:

Fuel Tax: places a per gallon tax on each unit purchased at the pump. Across the U.S, all consumers are subject to a flat federal gas and diesel tax, while state and local fuel taxes vary by jurisdiction.

Toll Road: A toll road can be either a public or private road for which users pay a fee to utilize a stretch of roadway. Many states are shifting to fully digitalized toll roads to reduce operating expenses.

Road User Fees: Also known as mileage-based user fees (MBUF), vehicle miles travelled (VMT) fees, or road usage charges (RUC) are fees charged to a driver based on how many miles they travel on a road system.

Vehicle License & Registration Fees: Fees for the registration of a new vehicle and procurement of a vehicular license.

Across the nation, states vary significantly in the methods and the share of state and local road spending that is covered by their state and local taxes, tolls, and user fees.

In Hawaii, taxes, tolls, and user fees covered 73.4% of 2016 state and local road spending, the highest in the nation. Conversely, Alaska only received 12.7% of state and local road spending from these revenue sources. Overall U.S. state average for funding from state taxes, tolls, and user fees was 50% in 2016 [140].

We examine vehicle electrification's potential impacts to both direct and indirect state revenue sources in the following sections as well as planning solutions.

5.3 Breakdown: Fuel/Gasoline Tax

Fuel taxes are one of the largest sources of revenue for many state and local governments' transportation budgets and the driving source of revenue for the federal Highway Trust Fund (HFT). The expected increase of EVs in the transportation sector suggests a large decrease in traditional at-the-pump fuel consumption in the coming years. This will mean a decrease in tax revenues that collected from these locations. Without this source of revenue, local and state governments may struggle to fund necessary transportation projects including replacements and upgrades to roads and bridges.

Fuel taxes overall provided an average of 41% of 2016 revenue that states directed to transportation funds which finance projects related to our roads and bridges. State fuel tax rates vary significantly by state as outlined in Figure 6 [141].

While predictions of the final fuel tax revenue impacts remain variable based on the speed of electric vehicle adoption, the possibility of a 10 to 20% reduction in fuel tax by 2030 has been predicted by some state agencies [142]. Further revenue reductions are expected through 2050.

Increased fuel efficiency standards also reduce the per unit demand of gasoline assuming consumer driving habits do not experience a significant "**rebound effect**" for PHEVs, whereby fuel savings lead to increased driving, in essence cancelling some of environmental gains of EV adoption.

5.4 Breakdown: Inflationary Impacts & Fuel Economy

Inflation has further compounded federal and state revenue concerns, resulting in declining purchasing power over time for taxes not tied to inflation. The last federal fuel tax increase was in 1993, when $1.00 dollar was worth $2.11, 2023 dollars adjusted for inflation using the Consumer Price Index (CPI) [143]. This reflects over a halving of purchasing power since the last federal tax establishment in the face of increasingly expensive transportation projects. Reductions in gas tax revenues have been further compounded by increases in the average fuel efficiency of vehicles on the road.

State and local governments are working to figure out where this money will come from in the future to maintain transportation infrastructure. Some are proposing new strategies for raising revenue dedicated to transportation projects.

5.5 Breakdown: Lottery Sales & Convenience Stores

In 2022, the Nation Advancing Convenience and Fueling Retailing (NACS) reported over 152,000 convenience stores in the U.S. Convenience stores are the primary point of sale for gasoline, distributing roughly 80% of national volume [144]. In addition to aforementioned fuel revenues, convenience stores also provide state and local revenue through the sales tax on in-store purchases and also serve as the primary distributor of lottery ticket sales in states that offer lottery.

Starting in the 1960s, U.S. lottery in its modern form made its debut in New Hampshire, with a rapid state expansion throughout the 1980s. In 2019 Mississippi became the 45th and latest state to authorize a state lottery [145]. As per the goal of New Hampshire in 1964, state lotteries have become an additional and relatively significant source of revenue for many state governments across the country.

With the transition to EVs and PHEVs, the typical use patterns of many convenience stores may be significantly altered as charging outside of long-distance trips will largely take place at the home or place of residence, reducing the draw to local stores for fueling purposes. This reduced traffic may potentially decrease the overall sales of consumer goods and lottery plays, decreasing both local sales tax revenues and lottery.

Individual states and municipalities should undertake examinations of their reliance on convenience store funding structures and identify early potential funding gaps through economic impact assessments. Additionally, they may consider working with convenience stores to plan sustainable and modernized business models for meeting the new demands of mass electrified vehicle adoption.

5.6 Breakdown: Property Taxes

Property tax is one of the largest municipal sources of revenue, generating 30% of local general revenues in 2021 [146]. With conventional fueling stations at risk of closure in the coming decades, decreases in local property tax may pose substantial municipal funding challenges depending on the scope and speed of convenience store closure.

The development of alternative economic enterprises in the place of closed facilities, and/or the adoption of alternative funding models as outlined in section 5 to cover funding gaps will enable municipalities to maintain positive revenue streams. This situation demonstrates the uncertainty of the electric vehicle transition and the unknown vulnerabilities of the shift.

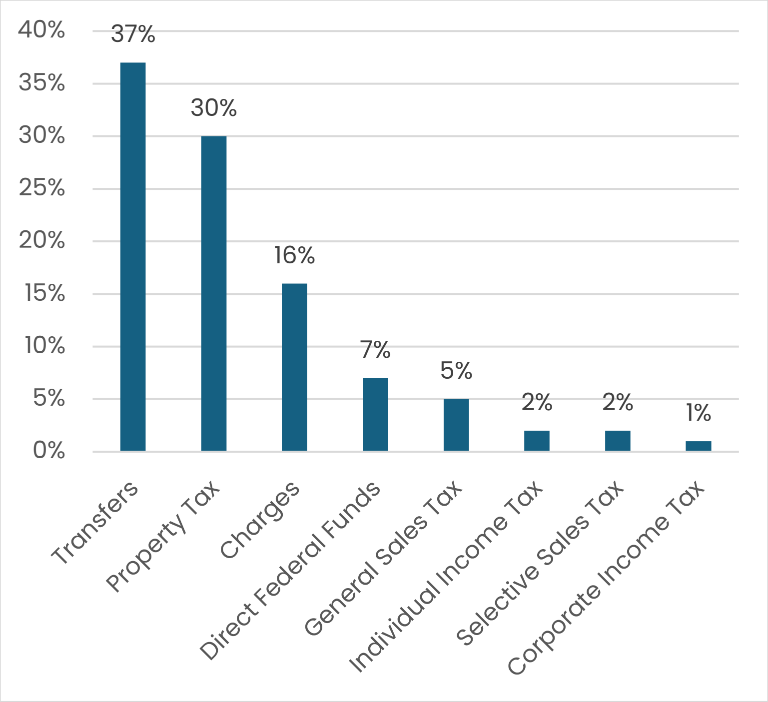


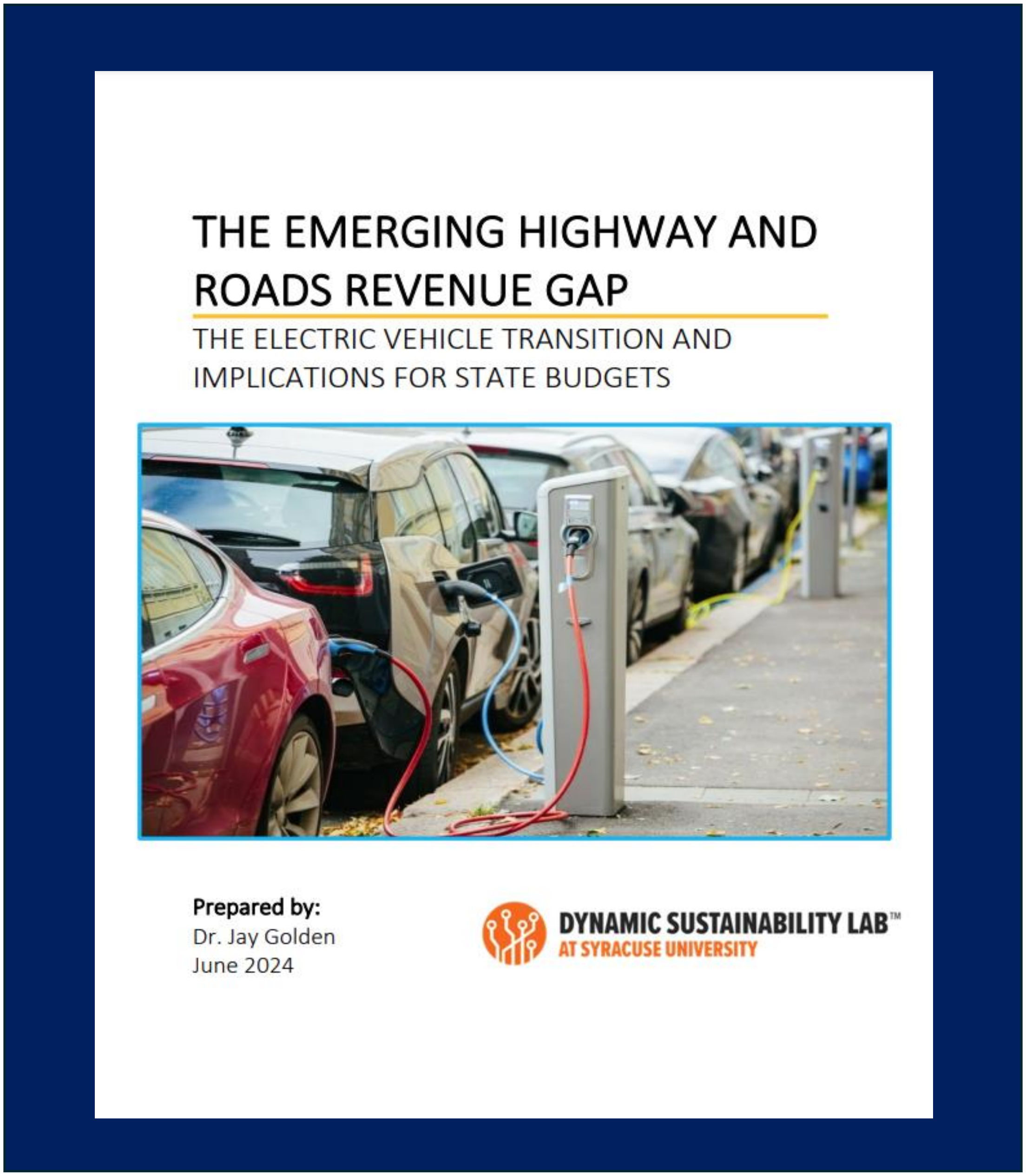
Figure 5.3 Sources of Local General Revenue: Share of Total Revenues, by Source, 2021. Adapted from [147].

5.7 Federal Revenue Concerns & Impacts to State & Local Governments

The Highway Trust Fund (HTF) is a federal transportation trust fund that serves as a major source of revenue for highway systems and other national transportation related projects. The HTF provides substantial federal funding to national infrastructure, public transportation, and mass transit projects among other areas. With primary HTF revenues generated by fuel tax revenues, the fund is expected to experience deepening revenue shortfalls in the coming years as EVs increase in market dominance and ICE vehicles increase in fuel efficiency.

Without federal action, there looms the real risk of large funding problem for mass transit, wherein large cost burdens may fall onto local governments. New sources of funding for these previously taken for granted funding sources will need to be considered as the country continues to electrify.

Accompanying this guidebook is a comprehensive co-report, "The Emerging Highway and Roads Revenue Gap.", which details the impacts of a depleted Highway Trust Fund as the country shifts to electric vehicles and the impacts to state budgets as a result of this transition. It also provides potential solutions to the budgetary issues and how states can make up some of the revenue that could be lost due to the EV transition. This is a report commissioned by the Pew Charitable Trust and was written by the Golden Advisory Group.



THE EMERGING HIGHWAY AND ROADS REVENUE GAP

THE ELECTRIC VEHICLE TRANSITION AND IMPLICATIONS FOR STATE BUDGETS

Prepared by:
Dr. Jay Golden
June 2024

DYNAMIC SUSTAINABILITY LAB™
AT SYRACUSE UNIVERSITY

Figure 5.4 The Emerging Highway and Roads Revenue Gap Report to be released accompanying this report.

To access the full report, visit the Dynamic Sustainability Lab website for download options at : https://www.dynamicslab.org/s-projects-basic

5.8 Alternative Revenue Models

As outlined, governments nationwide have been facing down transportation sector revenue shortages for several decades now. The expanding adoption of EVs and PHEVs alongside increased vehicle fuel-efficiency standards has accelerated the anticipated timeline of this shortage. Recognizing that traditional funding models for ICE vehicles will not work in an electric vehicle society, there exist a series of alternative revenue generating options for state and local governments.

5.9 Electric Vehicle (EV) Charging Tax

Implementing an **Electric Vehicle (EV) Charging Tax** is one viable option for transitioning away from ICE vehicle revenue streams.

EV Charging Tax Model

Advantages

❖ **Familiarity:** With most Americans already familiar with the premise of a gas tax, an electric vehicle charger tax is perhaps the most in line with traditional revenue models in our historically fossil fuel-based society.

❖ **Equitability**: A charging tax is relatively proportional to a user's utilization of transportation infrastructure. i.e: the more wear and tear on the roads from driving, the more of your share you pay.

❖ **Adjustability:** Tied to inflation, the EV charging tax can be set by governments to maintain a constant stream of revenue and baseline prices can be modified to meet social and governance needs.

Challenges

❖ **User & Political Opposition:** Taxes and fees are a largely unpopular enterprise and developing political and social consensus on taxing a relatively new industry may be challenging.

❖ **EV Marketing Impacts:** Although the per mile rate of electric vehicles driving miles is significantly less than internal combustion vehicles, leveraging a tax will make EVs and PHEVs somewhat less attractive financially than in their current position.

Figure 5.5 EV Charging Tax Model: Advantages and Challenges.

Under an EV charging tax system, governments levy a set tax rate per unit of electricity used to charge an EV or PHEV, typically per kilowatt-hour (kWh) at a private or public charging station. There are several distinct advantages and challenges municipalities should consider corresponding to the charging tax model.

5.10 Vehicle Miles Travelled (VMT) Tax

The Vehicle Miles Traveled (VMT) Tax model is a type of "mileage-based user fee" and another non-traditional revenue potential that may be adopted by state and municipal governments.

Vehicle Miles Traveled (VMT) Tax Model

Advantages

❖ **Uniform Applicability:** A VMT tax can be applied to all individuals nationwide, regardless of whether they drive an EV or an IC vehicle. A VMT can decouple revenue from variable tax systems and generate a uniform rate for all users of national transportation routes, regardless of vehicle type.

❖ **Resiliency to Devaluation:** A VMT would be insulated from the challenges of maintaining revenue streams in the face of increased fuel-efficiency gains. If tied to inflation, it would also keep pace with economic changes over time.

Challenges

❖ **Privacy Concerns:** Privacy concerns are perhaps the largest issue with VMT Taxes. The VMT model relies on tracking the miles users drive to properly tax them. This raises significant questions about the technologies and methods used to ensure the safety and privacy of this model.

❖ **Technology & Admin Costs:** The integration of VMT enabling technology within vehicles may cause increased costs to both the consumer via the final cost of purchase and governments would additionally have to create, manage and execute a federal, state, or local VMT tax management system.

❖ **Lower Sustainability Incentives:** A VMT, while potentially effective at revenue generation, does not inherently incentivize EV or PHEV adoption. The VMT does not distinguish between an energy efficient or inefficient vehicle, only the number of miles travelled.

Figure 5.6 Vehicle Miles Traveled (VMT) Tax Model: Advantages and Challenges.

Under a VMT model, users are charged a tax based on the number of miles a vehicle has travelled, offering several distinct advantages over an excise tax on fuel or electricity.

Despite the fact that vehicle miles travelled per capita in the U.S. has been significantly increasing over the last several decades, this uptick in driving has corresponded with continually decreased government revenue per vehicle mile travelled [148]. **The culprits: inflation** and **greater vehicle fuel-efficiency,** lowering fuel excise tax revenue.

Several states such as Oregon and Hawaii have begun dedicating research and legislative efforts into the VMT model. In Hawaii, all light vehicles will be required to participate in the state VMT program by 2033, and EVs by 2028. Oregon began looking into VMTs in 2015, the first state in the nation [149][150]. If policy makers can address public concerns related to privacy and technical costs, VMT taxes may be an attractive alternative to the presently dominant fuel tax model.

5.11 EV Ownership Fees

The EV Ownership Fee (EVOF) model has been adopted by a moderate number of states. This model charges users an additional annual fee specific to ownership of an electric vehicle in addition to the normal yearly or bi-yearly vehicle registration fee that all drivers pay. Current prices of EV Ownership Fees range from $50 to $225 dollars per year. There are several core considerations to adopting and managing an EV Ownership Fee [151][152].

Some states are proposing significant EV ownership fees. Illinois' proposal to levy a $1000 annual ownership fee has raised significant concern about excessively high ownership fees generating a poor public perception of electric vehicles. While ownership fees are a viable revenue generating model, other models may prove more advantageous and avoid potential pitfalls.

EV Ownership Fee Model

Advantages

❖ **Revenue Upkeep:** A purely ownership fee state revenue model would not lose revenue to increasing fuel economy, as rates are charged the same each year, although it would still lose revenue value due to inflation unless locked in.

Challenges

❖ **Duplicative Fees:** In many states EV owners are already subject to additional taxes on charging their vehicle. A substantive EV specific fee sticker tag can increase perceptions of EV cost, potentially disincentivizing ownership of an electric more than a single and appropriately price EV charging tax.

❖ **Unequitable Distribution:** An EV ownership fee is flat regardless of a user's wear and tear on roads or utilization of the transportation system and infrastructure. This can disproportionately benefit high-use drivers, while overcharging low-use drivers.

❖ **Inflexible Application:** Drivers under an ownership fee model cannot adjust their vehicle use to match their economic needs. Ex. With VMT tax, if the price of gas/electricity is high, or in periods of economic downturn, users could opt to drive less. An ownership fee model offers no flexibility in user cost.

Figure 5.7 EV Ownership Fee Model: Advantages and Challenges.

5.12 Increase Gas Tax & Other Fees

Another possible supplement to declining tax revenue is raising conventional gas taxes and other transportation user fees. As discussed, the federal government has not increased federal fuel taxes since 1993. While state governments have done better in terms of state fuel tax updates, sufficient gaps remain at both levels of government.

Significantly increasing the current federal and state gas tax is thus one way to decrease revenue shortages, with several primary benefits and challenges.

Increased Gas Tax/User Fees
Advantages
❖ **Familiarity and Scope:** The gas tax remains by far one of the largest sources of federal and state transportation revenues despite decreasing funding. A moderate increase to gas taxes has the power to generate a large windfall for state and federal transportation budgets. ❖ **Aligning Climate Incentives:** The negative consequences (externalities) of fossil-fuels are not currently reflected in the price of U.S. gasoline and diesel. While supporting transportation funds, increased revenue from higher gas tax can be used to offset excessive carbon emissions and also incentivize the purchase of EVs and PHEVs.
Challenges
❖ **Political Unpopularity:** Taxes are generally unpopular and an increase to gas taxes would undoubtedly prove politically challenging to implement and maintain. ❖ **Supply Chain Impacts:** Increases to gas taxes could potentially increase costs throughout the supply chain, as transportation costs increase nationally. ❖ **Waning Efficacy:** As electric vehicles increase in market share, drivers of fossil fuel powered vehicles will be reduced, subsequently reducing revenue unless further tax hikes are enacted to keep pace.

Figure 5.8 Increased Gas Tax/User Fees: Advantages and Challenges.

At a minimum, **indexing** federal and state gas taxes to inflation could help stave off further degradation of baseline revenue streams. While politically unpopular, a moderate increase to state and federal gas taxes could dramatically decrease national transportation deficits, while simultaneously encouraging a gradual transition to electric vehicles.

5.13 Additional Funding Opportunities

There are many ways to reimagine small interventions within government code and the structure of increasingly electrified towns and villages that can help supplement transportation revenue needs through marginal efforts.

Public Charging Station Time Limits: Imposing a penalty on users who occupy a charging station for too long can incentivize charging turn over while potentially raising revenues and ensuring EVSE availability.

Public Charging Station Advertisements: Similar to many gas station pumps, electric vehicle chargers could be built to offer advertisements for fees alongside other features to generate local revenues.

The Unknowns: With the blossoming market of EVs and PHEVs, there remain many unknowns. In this time of transition, leaders have the opportunity to simultaneously generate revenues and make their towns attractive options for tourism and travel by catering to EVs and PHEVs. Thinking of new and novel ideas outside of funding opportunities listed here may well serve the unique needs of many cities and communities.

5.14 Revenue Generation: Equity Considerations

While each funding model offers a potentially viable method for increasing municipal revenues, the transition to EVs and the adoption of new revenue streams can introduce equity considerations. Increases to the electricity cost at public charging stations and of the EV transition in general may **disproportionally fall on lower-income populations** who may not own their own home and may rely more on higher-costing public chargers. Substantial increases to the gas tax may impact already low-income households who are unable to afford an EV are also more likely to rely on used gasoline vehicles longer than their wealthier counterparts.

Detailed equity plans can help ensure accessibility and affordability for all as we transition away from our historical transportation methods. Data collection can assist local governments in developing informed policies. Cities and towns can track the utilization of charging stations and the revenue created through partnerships with charging station venders to create software and monitoring tools.

Companies like ChargePoint, a charging station provider, track how long a vehicle is plugged into a charging station and how long energy was being dispersed. Technology like this can also be used to penalize those who spend too long at charging stations while tracking the amount of energy dispersed and usage metrics. These data can then be used to make informed decisions on the pricing model that should be implemented based on the use of the charging station to ensure equitable distribution.

5.15 Pricing Structures

There are several primary pricing structures available to EVSE owners.

By Kilowatt (KwH) Pricing: under a per KwH fee system, the user is charged a set rate per unit of electricity used to charge their EV, similar in nature to the function of a traditional fuel tax [153].

By Session Pricing: a per-session fee system charges a flat rate to the user per use of the predetermined EVSE charging criteria. This can be an attractive option to reduce confusion about EVSE pricing variability compared to a "by-KwH" system where energy prices are subject to real-time fluctuations given the time of day and current grid demand [154].

Length of Time Pricing: timed pricing charges the user a rate based on the duration of the charge session itself [155].

Subscription Charging: primarily an option for residential charging, subscription-based charging is offered by some utilities where users can pay a fixed monthly fee to allow residential consumers to charge up to a set electricity quantity. [156].

5.16 Chapter 5: Local & Regional Government Strategies

Strategy 1: Create an Electrification Action Plan

Revenue & Expenditure Assessment

The first step in preparing for the budget implications of EV transitions it to take stock of the direct and indirect revenue impacts to your local community.

Revenues Assessment

- Local fuel tax revenues
- Local sales tax revenue (gas stations)
- Property values (gas stations)

Expenditures Assessment

- Public EVSE installation costs
- Government Fleet EVSE costs
- Infrastructure costs
- EVSE upkeep and maintenance costs

Establish Timelines

The EV transition, while moving forward steadily, will not occur immediately. Therefore, it is likely that many conventional fueling stations and convenience stores will shift their operations at a relative pace.

Governments should aim to estimate timelines for electrification impacts and needs as well as specific milestones/goals: Ex. 1 year, 2 year, 5 year, 10 year outlook.

Develop an Electrification Action Plan

Once impacts and timelines have been established, local governments should develop an electrification action plan. Action plans help establish goals & timelines, track their progress, and identify opportunities to address unique community needs and wants.

New York, NY: Electric Vehicle Vision Plan [157]

Portland, OR: City Electric Vehicle Strategy [158]

Strategy 2: Assess Local Revenue Vulnerabilities

At the local and regional government level, there are several key potential revenue vulnerabilities introduced by electric vehicles. The first is state and federal government transfers where traditional revenue streams are anticipated to decrease in the coming decades. This revenue stream is largely outside the control of local and regional governments.

More immediately, property (30%), general sales (5%), and selective sales taxes (2%) are the largest sources of local government revenue with greater management opportunities.

Within their localities, governments should consider modelling and assessment of their more vulnerable revenue sources such as potential impacts to property values and local sales taxes.

Early identification of these challenges may allow for timely adoption of alternative funding streams.

Oregon, Department of Energy

The Oregon Department of Energy has conducted several studies outlining the impacts and considerations for state revenues due to the rise in EVs and PHEVs [158].

Strategy 4: Consider Available Revenue Generating Models.

Local governments should work to identify alternative revenue sources to help offset local funding challenges as EVs begin to overtake fossil fuel vehicles. Some of the most readily available strategies at the local level include but are not limited to:

- Levying local taxes/fees on public EVSEs
- Limiting vehicle parking times at public EVSEs
- EVSE advertising & Public Private Partnerships

Local governments should carefully balance their revenue generating models to ensure that new revenue models do not overly harm disadvantaged communities and disincentivize the adoption of EVs.

Strategy 5: Leverage unprecedented state and federal funding opportunities.

Under the Biden-Harris Administration, unprecedented federal funding opportunities have substantially increased the availability of support for state and local governments. With much of this money administered via intra-governmental transfers to state agencies, local governments should begin working to identify potential state funding opportunities and incentives that align with their community profiles and electrification targets.

Numerous states also offer their own state funded cost-share programs that provide further incentives for expanding EVSE infrastructure.

Section 6

Electrifying the Government Fleet

Electrifying the Government Fleet

While the majority of electric vehicles will be purchased and operated by individual consumers, local governments have two unique responsibilities in the electrification process: 1) deploying public and municipal EV infrastructure and 2) converting their own government fleets to EVs and PHEVs, a significant challenge in its own right.

6.1 Fleet Electrification Opportunities

There are many different vehicle applications within the average local government fleet which are increasingly viable to electrify. While light-duty vehicle fleets remain the most readily available for electrification, new offerings for medium and heavy-duty vehicles (MHDV) such as buses, firetrucks, snowplows, and more are emerging in the market with increasingly efficient capabilities to match their current gasoline and diesel-powered counterparts. This section highlights some of the current and ongoing areas where governments can electrify their own fleets.

6.2 Emergency Response Vehicles

Emergency response vehicles are critical to ensuring the health and safety of communities across the country. In transitioning to electric fleets, policy makers and city planners will need to ensure that EVs can achieve at minimum the same level of efficacy and performance as their contemporary fossil fuel counter parts. Assessing and understanding the unique daily responsibilities and vehicle operations within each transitioning fleet is key to ensure sufficient coverage, performance, and functionality.

6.3 Law Enforcement

Law enforcement departments have a critical reliance on their patrol and department vehicles to meet the demands of their jobs. Law enforcement vehicles need to operate above the performance of regular passenger vehicles in terms of maneuverability, use extensive electricity for lights and sirens, radios and computer systems, and have traditionally been used around the clock, shift to shift.

Case Study: New York Police Department (NYPD)

Figure 6.1 Example of NYPD Electric Police Patrol Vehicle. Source: [159]

☐ **Fleet Goals**

NYC aims to fully electrify its municipal fleet by 2035. The NYPD is the nation's largest municipal police department in the U.S. with around 36,000 officers [160]. With approximately 9,500 law enforcement vehicles, this comprises 40% of the total municipal fleet.

☐ **Current Deployment**

With over 1,000 EVs now in its fleet, the NYPD recently added 184 Ford Mustang Mach-E GTs to its fleet in 2022 under a $420 million investment into municipal fleet electrification and is looking to adopt a number of additional EV trucks, vans, and other models in 2024.

☐ **Charging Infrastructure**

Over 50 DCFC for the NYPD have been installed to date and the city is looking to adopt 125 and 150KW advanced charging stations to replace the current 50KW fast chargers. The city is also working to figure out how to address the challenge of power outages and continued fleet operations [161].

South Pasadena, CA: Smaller police departments across the nation are almost complete in the full transition of their municipal police stations [162]. Savings are often substantial. South Pasadena's conventional fuel budget of $120,000 dwarfs yearly charging costs of only around $25,000, substantial savings for the department [163].

New York City, NY: Large fleets such as the New York Police Department (NYPD) have greater challenges ahead, though law enforcement fleet transitions, with their heavy reliance on light and mid-duty vehicles, are among the most favorable of all government sectors.

Law enforcement fleets should be considered one of the first areas of fleet electrification for many municipalities.

6.4 Firetrucks

Heavy-duty vehicles such as firetrucks are expected to become an increasingly affordable and viable option. While there are often range challenges with electrifying heavy-duty vehicles such as semi-trucks and snowplows, firetrucks are typically responsible for very localized areas of oversight, reducing the issue of distance.

Case Study: Los Angeles Fire Department (LAFD)

Figure 6.2 Los Angeles Fire Department (LAPD) first All-Electric Fire Engine in North America. Source: [164]

☐ **Brand:** The Rosenbauer Group

☐ **Range:** 62 miles pure electric, 300 miles with gas-powered range extender [165].

☐ **Cost:** $1.7 mill USD in 2022, compared to $1 mill USD for contemporary gas competitor, costs anticipated to fall alongside savings in fuel [166]

To address the challenges of long duration fires where engines require large power availability for pumps, ladders, floodlights, and other response needs, manufacturers have installed small fossil-fuel generators to make up the difference and provide redundancy in the event it is needed [167].

Similar to all emergency vehicles, assessing the drive and duty cycle of firetruck use will be key to ensuring proper coverage when charging is required.

6.5 Electric School Buses (ESB)

Besides light-duty government vehicles, public mass transit and electric school buses (ESB) a growing segment of electrified fleets across the country.

Seven states including as New York, California, Maine, and Washington have statutorily enacted the phasing out of diesel and gas school bus fleets. These states' school bus fleets alone comprise over 19% (100,000) of the total U.S. fleet and 26% (6 million) of all U.S. school bus riders [168].

ESB's and public transit buses offer a number of immediate advantages over their fossil fuel counterparts, the first of which is zero tailpipe emissions. In addition to reducing GHGs to the atmosphere, ESBs and electric public transit buses do not emit the significant quantities of air pollutants including particulate matter (PM), carbon monoxide (CO), and nitrogen oxide (NOx). These emissions are a health risk to all passengers on traditional buses, particularly so to children and riders with underlying respiratory illnesses [169].

6.6 Electric Passenger Buses

Although electrification of school buses has been the larger priority for many states and municipalities, the electrification of public transit buses is increasing through both mandatory and voluntary municipal action.

The "Multi-State Medium- and Heavy Duty Zero Emission Vehicle Memorandum of Understanding" is a coalition of 15 states and the District of Columbia (D.C.). The signatory states agree to aim for 100% sales of new zero-emissions medium and heavy-duty vehicles (MHDV) by 2050, and at least 30% by 2030. Under the agreement, states will track and report their progress towards meeting these targets [170].

Some states have gone even further to solidify their MHDV electrification. In California, the "Zero-Emission

Transit Bus Requirement" requires 50% of all new bus purchases to be zero-emissions by 2026 and 100% by 2029.

Many cities around the nation have began converting their fleets to electric buses as well. Leading cities include:

- **Los Angeles, CA**: Metro Board adopted plan for 100% zero emissions bus fleet by 2035 [171]
- **Seattle, WA**: Seattle's King County Metro is aiming for 100% zero-emission fleet by 2035 [172]
- **Chicago, IL**: The Chicago Transit Authority (CTA) aims for a fully electrified bus fleet by 2040 [173]
- **Austin, TX**: Capital Metro is partially electrifying its fleet, with plans to operate 100 electric buses by the end of 2024 [174]

Case Study: Seattle WA, King County Metro

Figure 6.3 Seattle WA, King County Metro Electric Bus Example. Source [175].

☐ **Fleet Goal:** Full electrification of 1,400 buses by 2035. Currently operating 50 fully electric buses [176]

☐ **Charging:** Planned creation of 8 distinct charging stations, developing 544, 000 square-foot base for maintenance facilities and charging infrastructure [177]

☐ **Community Benefits:** Reduced heat island effects, enhanced community air quality, economic growth [178]

Overall, electrified public transit fleets are increasingly gaining traction among municipalities. The American Public Transportation Association (APTA) projects that North American transit agencies will require over 60,000 fully electric buses by the year 2035, a large task ahead for both governments and suppliers nationwide [179].

6.7 Ancillary Fleet Electrification Opportunities

In addition to emergency vehicles and buses, the development of more specialized MHDVs are also a potential opportunity in the future. New advances in battery technologies are likely to make possible a future with electrified garbage trucks, snowplows, street sweepers, ambulances, and other municipal applications.

6.8 Benefits & Challenges of Fleet Electrification

Overall, electrifying municipal fleets offers a series of benefits to local communities. Electric vehicles, while higher in cost up front, can save municipalities significant quantities in annual fuel costs. Electric fleets are cleaner than their contemporary fossil fuel counter parts, increasing not only the health and safety of riders and citizens, but also enhancing the appeal of tourism and walkability to shoppers who avoid caustic gas and diesel fumes.

In the long run, electrified fleets can reduce remediation costs of underground storage tanks (USTs), while accessible charging ports can increase local through traffic. Indeed, the benefits are many.

For all the benefits of fleet electrification, there are certainly challenges as well. Charge times add a new element of complexity to fleet operations to account for vehicle down time. The effective range of EVs may warrant remapping vehicle routes to maximize coverage and efficiency. Lastly, upfront costs of fleet electrification can be undeniably steep for many communities.

With these items in mind, the following checklists will help fleet managers to maximize these benefits and reduce the potential challenges associated with expanding and unlocking their electric fleet potential.

6.9 Fleet Electrification Checklists

The following checklists are intended to provide a quick reference tool for government officials and fleet managers looking to electrify their government fleets and their communities.

Fleet Electrification Checklist	Description of Checklist Item
1. Take Inventory of Current Fleet	
☐ Vehicle Quantity ☐ Vehicle Age ☐ Vehicle Make and Models ☐ Vehicle Type (Emergency, Admin, Etc.)	Assessing your current fleet along its vehicle composition is the first stop in the fleet checklist. This process will help fleet managers determine their fleet status, estimate the timeline of naturally phased out vehicles, and determine overall electrification priorities.
2. Assess Current Fleet Facilities	
☐ Storage & Parking Lots ☐ Repair & Maintenance ☐ Facility Services & Amenities	Large local governments with multiple fleet parking areas and storage facilities should evaluate the optimal near and long-term development of charging facilities for their fleets based on factors such as proximity to electricity services, physical space, utility provider, etc..
3. Determine Duty Cycle & Drive Cycle Requirements	
☐ Duty Cycle ☐ Hours of Use per Day ☐ Shifts per Day ☐ Total Mileage per Cycle ☐ Average Load Cycle ☐ Drive Cycle ☐ Maximum Speed ☐ Average Speed ☐ Idle Time ☐ Engine/Vehicle Time Off ☐ Total Engine/Battery Hours per Cycle	Duty cycles and drive cycle are two of the most important variables to consider when electrifying your fleet. Evaluating both the duty cycle and drive cycle of electric vehicles is critical to ensuring they can meet the usage demands of the jobs they are tasked with, determining the number of vehicles needed to keep up with charging cycle limitations, and assessing the extent and type of charging infrastructure and facilities needed to meet the charging speed and capacity requirements. **Duty cycle:** comprises the frequency and duration of typical operations or in other words, how much and when a vehicle is used. **Drive cycle:** comprises the critical vehicle operating statistics during the time the vehicle is in use.
4. Forecast Fleet Growth & Timelines	
☐ Determine specific fleet purchase timelines ☐ Forecast fleet electrification rates (Short, Medium, Long-term)	Fleet electrification for most governments will take place incrementally. Forecasting the speed and timeline of EV adoption by vehicle type and sector ensures that fleet operations can scale infrastructure and capacity accordingly as needed, reduce costs, and prevent future fleet challenges.

5. Determine EVSE Requirements & Configurations	
☐ Based on steps 1-4 ☐ Quantity of EVSEs ☐ Breakdown by charging Level	Fleet managers should work with their partners and suppliers to determine the ideal EVSE charging configurations based on checklist steps 1-4. The lineup and rollout of EVSEs should match the quantity and speed needed to accommodate the fleets forecasted growth and expansion timeline.
6. Establish Siting and Optimal EVSE Configurations	
☐ Optimize placement for long-term fleet development ☐ Determine ideal EVSE configuration for fleet needs ☐ Shop for ideal supplier services	Once the quantity and speed of EVSEs has been determined, selection of the proper site is required. Considerations for long-term fleet development should be incorporated into the siting selection.
7. Calculate Electricity Demand & Electrical Upgrade Requirements	
☐ Predict Increased Electricity Demand (Near and Long Term) ☐ Determine electrical system upgrade requirements ☐ Utilize EV-Friendly Building Codes	Developing a robust EV fleet can mean a large increase in electricity requirements, particularly in the case of large government fleets and with increased medium and heavy-duty vehicle options. Fleet managers should work with their electrical utilities to determine the anticipated electricity demands and any electrical system upgrades required to facilitate EVSE integration at each phase of fleet expansion.
8. Leverage Funding Opportunities	
☐ Federal (grants and incentives) ☐ State (grants and incentives) ☐ Local/Other (grants and incentives)	There is a large number of federal, state, and local incentives to support developing EV fleets and operations. Local governments should identify all potential qualifying funding opportunities to decrease investment cost and maximize benefits.
9. Evaluate & Negotiate Utility Provisions	
☐ Connect with multiple utility providers ☐ Negotiate favorable electricity rates and structures ☐ Optimize utility purchasing based on cost variability ☐ Time of Use(TOU), daily, seasonal, peak power rates, etc.	In addition to funding opportunities, negotiating with multiple with utilities where possible can help to establish favorable electricity rate structures and agreements. These considerations include Time of Use (TOU), daily, and season peak power rates.
10. Engage Experts & Support Networks	
☐ Consult with experts at each stage of fleet development ☐ Engineering, siting, EVSE selection, building & permitting, etc. ☐ Local NGOs and support networks focusing on EV deployment	Many local and regional governments may require the insights of subject matter experts throughout the stages of electrifying their fleets. In this capacity, building trusting and high-quality partnership with experts and specialists along the development process may be critical for any governments lacking internal specialists.

11. Develop Long-Term Internal Support Systems & Fleet Vison	
☐ Retooling of maintenance workforce ☐ Establish fleet management protocols ☐ Develop long-term fleet vision	The processes of developing and maintaining a full electrified government fleet requires a rethinking of traditional maintenance and support models along with technical and policy support systems. Developing a long-term vision and electrification strategy will help identify the areas of key importance to establishing long term success.

Table 6.1 Government Fleet Electrification Quick Checklist. Adapted from [180].

COMMUNITY ELECTRIFICATION CHECKLIST

Community Electrification Checklist	Description of Checklist Item
1. Assess the Charging Needs of your Community	
☐ Current and predicted quantity of EV users ☐ Identify charging needs in each community sectors ☐ Residential, Workplace, Public ☐ Consider future demand projections	Local and regional governments should evaluate the optimal near and long-term development of charging infrastructure and policies for their communities based on factors such as: Home ownership versus renters, needs of underserved communities, creation of co-benefits to local and regional businesses, supporting thru traffic, etc.
2. Assess Current EV Policies and Conditions	
☐ State and local government EV policies/incentives ☐ Building codes ☐ Infrastructure ☐ Charging station distribution requirements ☐ Ex. Justice40 & NEVI Formula Program	Local and regional governments should take inventory of the current regulations and polices that impact the development of charging stations and EV infrastructure within their communities and jurisdictions. Early assessment of overarching policies ensures legal compliance, can reduce development time, and help maximize community benefits.
3. Foster Community Engagement	
☐ Create opportunities for community dialogue ☐ Public hearings ☐ Public comment opportunities ☐ Community leaders ☐ Develop educational and promotional materials	Community engagement is key to ensuring public support, equitable access, and a space for addressing community concerns prior to the execution of your electrification plan. Providing opportunities for public input can help build trust and transparency into the development process and identify challenge areas.

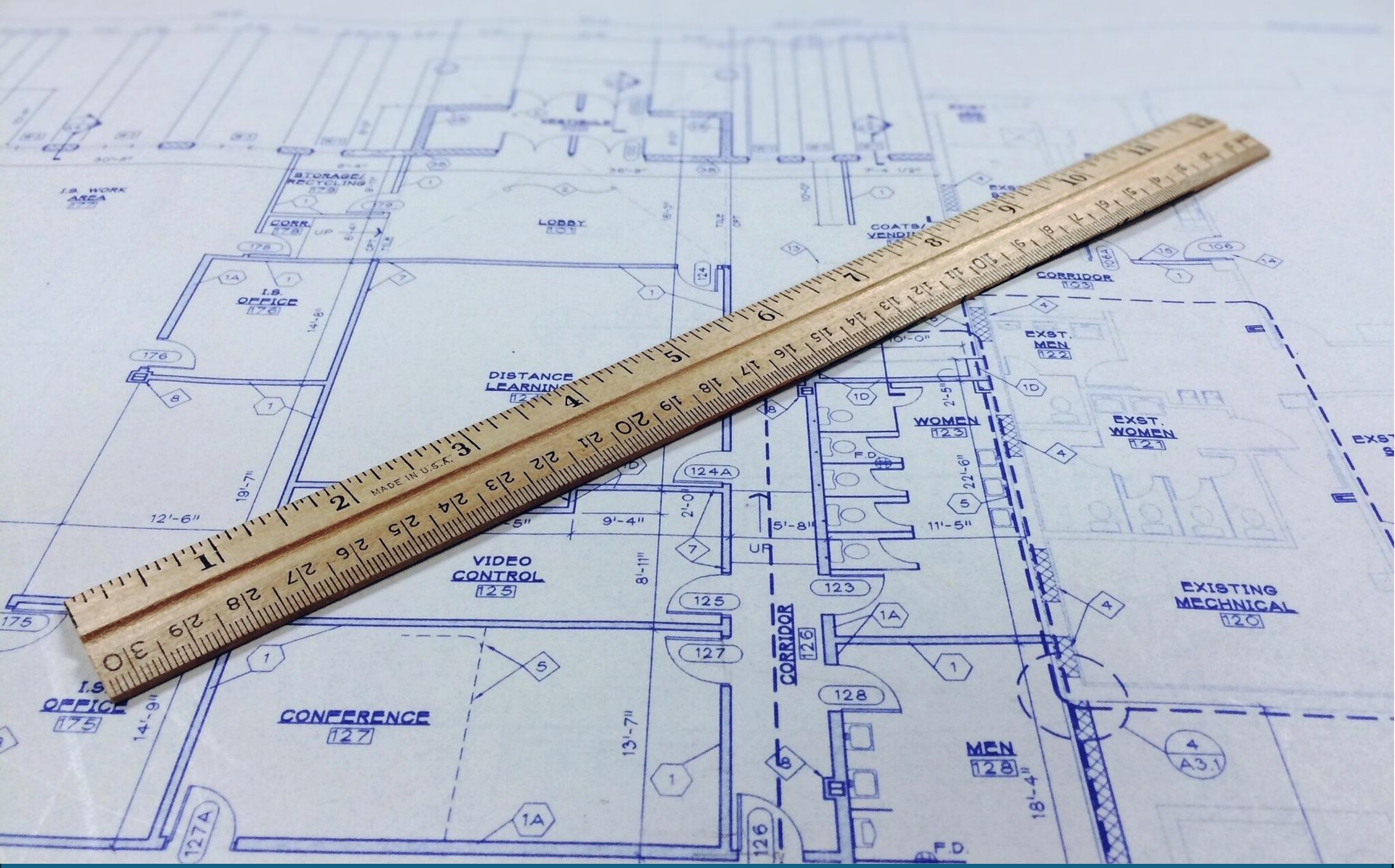
4. Coordinate with Relevant Stakeholders	
☐ Identify and engage with relevant stakeholders: ☐ Utilities ☐ Government departments ☐ Developers, engineers, site planners ☐ EVSE suppliers ☐ Neighboring communities	In addition to engaging with the community, governments should also gather insights and participation from key stakeholders involved in the electrification process. Working with utilities can help plan for infrastructure considerations. Coordinating with suppliers can help ensure the selected EVSEs are compatible with the needs and goals of their users. Incorporating the input of neighboring communities can help co-create opportunities within shared regions.
4. Develop an Electrification Roadmap	
☐ Determine government and community EVSE goals ☐ Establish timelines and milestones ☐ Forecast short, medium, and long-term needs (Short, Medium, Long-term) ☐ Select priority areas ☐ Ex. School buses, public transportation, multi-family residences, businesses, high traffic areas, etc.	Creating an electrification roadmap for you community can help to establish goals and timelines, outline unique community barriers and opportunities, and provide a collective space for multi-stakeholder inputs.
5. Implement EV-Friendly Policies	
☐ Zoning & Permitting ☐ Building Codes ☐ Ex. Multi-family housing EVSE requirements ☐ Consider EV drive share/micromobility options	EV friendly zoning and permitting policies can benefit both local governments and their constituents. Requiring buildings to adhere to "EV Make-Ready" Programs and other EV readiness standards can significantly reduce the long-term costs of installing EV chargers for constituents as well as help local governments achieve their electrification goals and targets.
6. Identify Revenue Opportunities and Vulnerabilities	
☐ Determine if charging will be free, paid, or both ☐ Identify revenue goals/considerations ☐ Consider alternative revenue streams ☐ Advertisements, charging time limits, etc. ☐ Determine pricing structure and costs	While state governments are expected to feel the largest revenue impacts as we transition to EVs, local governments may also suffer some revenue impacts. Areas include reduced gas taxes, sales taxes at convenience stores, and long-term impacts to property taxes. Strategic placement of EVSEs to foster economic opportunity and establishing a paid charging system can help to alleviate many revenue concerns.

7. Calculate Electricity Demand & Electrical Upgrade Requirements	
☐ Predict Increased Electricity Demand (Near and Long Term) ☐ Determine electrical system upgrade requirements ☐ Utilize EV-Friendly Building Codes	Developing a robust EVSE network can mean a large increase in electricity requirements. Local governments should work with their electrical utilities to determine the anticipated electricity demands of their communities and any electrical system upgrades required to facilitate EVSE integration at each phase of EVSE expansion.
8. Leverage Funding Opportunities	
☐ Federal (grants and incentives) ☐ State (grants and incentives) ☐ Local/Other (grants and incentives)	There is a large number of federal, state, and local incentives to support developing EV fleets and operations. Local governments should identify all potential qualifying funding opportunities to decrease installation cost and maximize EVSE benefits.
9. Evaluate & Negotiate Utility Provisions	
☐ Connect with multiple utility providers ☐ Negotiate favorable electricity rates and structures ☐ Optimize utility purchasing based on cost variability ☐ Time of Use(TOU), daily, seasonal, peak power rates, etc.	In addition to funding opportunities, negotiating with utilities can help to establish favorable electricity rate structures and agreements. These considerations include Time of Use (TOU), daily, and season peak power rates. Utilities are a critical stakeholder in community electrification process and should be approached earlier rather than later.
10. Engage Experts & Support Networks	
☐ Consult with experts at each stage of fleet development ☐ Engineering, siting, EVSE selection, building & permitting, etc. ☐ Local NGOs and support networks focusing on EV deployment	There are many national, regional, and local support systems and networks that offer low cost or free resources and assistance to local governments. In this capacity, building trusting and high-quality partnership with experts and specialists along the development process may be critical for any governments lacking internal specialists.
11. Develop Long-Term Internal Support Systems & Community Vison	
☐ Retooling of maintenance workforce ☐ Establish community EVSE management protocols ☐ Develop long-term community charging vision	The processes of developing and maintaining a full electrified community requires a rethinking of traditional maintenance and support models, along with technical and policy support systems. Developing a long term vision and electrification strategy will help identify the areas of key importance to establishing long term success.

Table 6.2 Government Community Electrification Quick Checklist. Adapted from [181].

Section 7

Zoning & Permitting



Pro-EV Building Codes

Building codes are a powerful tool in the municipal toolkit to incentivize and develop community EV adoption and infrastructure. Local government codes can be used to incorporate EVSE and EV needs into newly constructed residential, commercial, and government facilities [182]. Many states and local governments have already begun mandating builders and property owners adhere to EV-friendly policies and practices.

Pro-EV building codes and zoning can significantly reduce construction lead times, EVSE installation costs, and ensure equitable EVSE within local communities

According to the U.S. Department of Energy (DOE), "A study by the Southwest Energy Efficiency Project demonstrates that the installation of EV electrical equipment into new buildings can **decrease installation costs** of charging stations **by up to 75%** compared to retroactive installation during a building retrofit." [183].

Similarly, while building homes ready for EVs and heat pumps can increase the building cost by several hundred dollars, retroactive refits of non-compliant homes can cost owners anywhere from $1,000 to $5,000 dollars to accommodate such devices [184].

7.1 Building Code Opportunities

Some common options for municipalities to become more EV-Friendly through their building codes on construction and major renovations include but are not limited to:

☐ Requiring a minimum number of EV chargers per set amount of parking spots.

☐ Ensuring parking spaces can readily accommodate future charger installations

☐ Establish a minimum number of accessible EV charging parking spaces.

The following concepts commonly used in EV development literature can help fleet managers and city leaders ensure new parking spaces, buildings, and facilities meet the minimum requirements for current EVSE regulations and are primed for future development.

EV Make-Ready Programs

Includes the installation of service panels, junction boxes, conduit, wiring, and other essential components necessary for future EVSE installation [185].

EV-Capable

Installed electrical panel capacity with a dedicated branch circuit and continuous raceway from the panel to the future EV parking spot [186]

EVSE- Ready Outlet

EV Capable requirements are met, with the addition of wiring and junction box or 240 outlet (like for a clothes dryer) [187]

EVSE-Installed

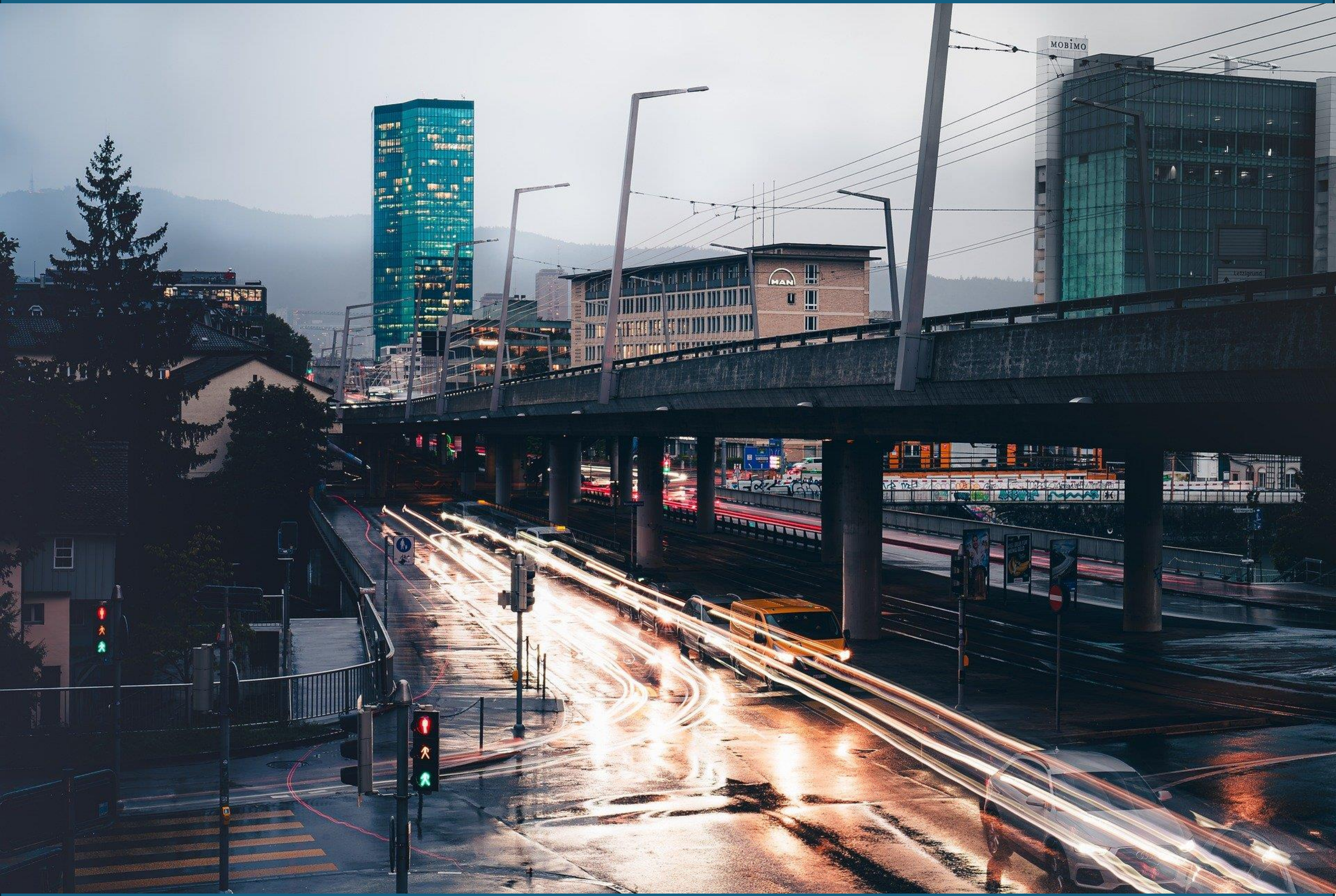
All of above, plus installation of a physical EVSE charging station [188]

Figure 7.1 EVSE Make-Ready and Building Code Concepts. Source [189]

.

Section 8

Additional Resources



LOCAL & REGIONAL GOVERNMENT ADDITIONAL RESOURCES

The following materials represent numerous additional tools and resources that local and regional governments can utilize to further navigate the electrification process within their communities.

General EV Policy/Planning Resources

U.S. Department of Transportation- Charging Forward: Toolkit for Planning and Funding Urban EV Infrastructure

U.S. Department of Transportation- Charging Forward: Toolkit for Planning and Funding Rural EV Infrastructure

U.S. Department of Energy, Alternative Fuels Data Center- Electric Vehicle Readiness Guides

Metropolitan Washington Council of Governments- Local Jurisdiction EV Ready Checklist

Electric Vehicle Council- Best Practice Guide for EVSE Regulations

Utilities & Fleet Assessment Tools

U.S. Department of Energy- Utility Finder Tool

American Public Power Association- national representative of POUs

Argonne National Laboratory- Energy Zones Mapping Tool

Edison Electric Institute- national representative of IOUs

National Rural Electric Cooperative Association- national representative of Co-ops.

Smart Electric Power Alliance- The State of Managed Charging in 2021

Electric Bus Programs

World Resources Institute- State Electric School Bus Policy Playbook

World Resources Institute- U.S. Electric School Bus Data Dashboard.

Zoning & Building Codes

U.S. DOE Alternative Fuels Data Center- Building Codes, Parking Ordinances, and Zoning Ordinances for EV Charging Infrastructure

Sustainable Energy Action Committee- Planning and Zoning for Electric Vehicle Charger Deployment

Great Plains Institute- Summary of Best Practices in Electric Vehicle Ordinances

EV Charging for All Coalition- Electric Vehicle Building Codes Toolkit: Guide for Equitable US Codes

Southwest Energy Efficiency Project- SWEEP Guide to EV Infrastructure Building Codes

Financial & Funding Resources

U.S. Department of Energy- 30C Eligibility Tax Tracker Tool

U.S. Department of Energy- Rural EV Infrastructure Funding

Equity & Environmental Justice Resources

Argonne National Laboratory- Electric Vehicle (EV) Charging Justice40 Map Tool

References

1. U.S. EPA. (2024). Sources of Greenhouse Gas Emissions. Accessed from: Sources of Greenhouse Gas Emissions | US EPA
2. Davis, S. C., & Boundy, R. G. (2021). Transportation Energy Data Book, Edition 39. *Oak Ridge National Laboratory.* Accessed from: Transportation Energy Data Book: Edition 39 (ornl.gov)
3. The White House (2023). FACT SHEET: Biden-Harris Administration Announces New Private and Public Sector Investments for Affordable Electric Vehicles. Accessed from: FACT SHEET: Biden-Harris Administration Announces New Private and Public Sector Investments for Affordable Electric Vehicles | The White House
4. U.S. EPA (2024). Fast Facts on Transportation Greenhouse Gas Emissions. Accessed from: Fast Facts on Transportation Greenhouse Gas Emissions | US EPA
5. Electrification Coalition (2022). Local Government Playbook: How Counties, Cities, and Towns can Support EV Infrastructure and Leverage Federal Investments. Accessed from: Local-Government-Playbook_Reader-file.pdf (electrificationcoalition.org)
6. California Air Resources Board (2024). Advanced Clean Cars II. Accessed from: Advanced Clean Cars II | California Air Resources Board
7. De Socio, M. These 7 States Are Giving You Money to Buy an EV. *CNET.* Accessed from: These 7 States Are Giving You Money to Buy an EV - CNET
8. Efficiency Maine. Electric Vehicle Incentives for Low- and Moderate-Income Mainers. Accessed from: Electric Vehicle Incentives for Low- and Moderate-Income Mainers - Efficiency Maine
9. De Socio, M. These 7 States Are Giving You Money to Buy an EV. *CNET.* Accessed from: These 7 States Are Giving You Money to Buy an EV - CNET
10. De Socio, M. These 7 States Are Giving You Money to Buy an EV. *CNET.* Accessed from: These 7 States Are Giving You Money to Buy an EV - CNET
11. De Socio, M. These 7 States Are Giving You Money to Buy an EV. *CNET.* Accessed from: These 7 States Are Giving You Money to Buy an EV - CNET
12. U.S. Department of Energy, Alternative Fuels Data Center: Emissions from Electric Vehicles. Accessed from: Alternative Fuels Data Center: Emissions from Electric Vehicles (energy.gov)
13. Dallas Climate Action. Goal 3: Dallas' Communities Have Access to Sustainable, Affordable, Transportation Options. Accessed from: Transportation | Dallas Climate (dallasclimateaction.com)
14. The City of New York. (2016). Inventory of New York City Greenhouse Gas Emissions in 2016. Accessed from: https://climate.cityofnewyork.us/wp-content/uploads/2022/10/NYC_GHG_Inventory_2016.pdf
15. City of Bozeman. (2020). City of Bozeman 2020 Community Greenhouse Gas Emissions Inventory Report. Accessed from: https://www.bozeman.net/home/showpublisheddocument/13144/638245776514370000
16. Tompkins County Department of Planning and Sustainability. (2021). 2019 Tompkins County Community Greenhouse Gas Emissions and Energy Use Inventory. Accessed from: https://tompkinscountyny.gov/files2/planning/Energy-greenhouse/2019_Community_GHG_Inventory_Report_FINAL.pdf
17. City of Dallas. (2020). Dallas Comprehensive Environmental and Climate Action Plan. Accessed from: 349b65_e4f9a262cebf41258fd4343d9af0504f.pdf (filesusr.com)
18. City of Portland. (2021). Portland General Electric's proposed modifications to Rate Schedule 300- Line Extension Allowance. Accessed from: https://edocs.puc.state.or.us/efdocs/HAC/adv1149hac152020.pdf
19. Orange County Government Florida. (2020). Orange County Sustainable Operations & Resilience Action Plan. Accessed from: 2030 ORANGE COUNTY SUSTAINABLE OPERATIONS & RESILIENCE ACTION PLAN (orangecountyfl.net)
20. Hennepin County Minnesota. Environmental Programs and Initiatives. Accessed from: Environmental programs and initiatives | Hennepin County

21. City of Durham. (2024). Sustainability and Energy Management: News. Accessed from: Sustainability and Energy Management | Durham, NC (durhamnc.gov)
22. MacFarland, M., Trapletti, P., & Fryer, D. (2024). Net-zero Commitments are Still the Exception for top US Companies, Not the Rule. *S&P Global.* Accessed from: Net-zero commitments are still the exception for top US companies, not the rule | S&P Global (spglobal.com)
23. Persenfoni. (2024). California SB 253 and SB 261: What Businesses Need to Know. Accessed from: California SB 253 and SB 261: What Businesses Need to Know - Persefoni
24. Naishadham Suman. (2024). SEC Approves Rule Requiring some Companies to Report Greenhouse Gas Emissions Legal Challenges Loom. *Associated Press.* Accessed from: SEC approves weakened climate disclosure rule after pushback | AP News
25. U.S. Securities and Exchange Commission. Fact Sheet: The Enhancement and Standardization of Climate-Related Disclosures: Final Rules. Accessed from: https://www.sec.gov/files/33-11275-fact-sheet.pdf
26. Straughan, D., & Mitchner, R. (2024). Electric Vehicle Statistics 2024. *MarketWatch Guides.* Accessed from: EV Statistics 2024 (marketwatch.com)
27. Fischer, J. (2024). The Average Price of an Electric Car Keeps Dropping (2024 Update). *CarEdge.* Accessed from: The Average Price of an Electric Car Is Dropping Fast - CarEdge
28. Ford. (2021). Ford Commits to Manufacturing Batteries, to Form New Joint Venture with SK Innovation to Scale North America Battery Deliveries. Accessed from: Ford Commits to Manufacturing Batteries
29. Capparella, J. (2022). Chrysler Airflow Concept Fully Revealed, Claims 400 Miles of Range. *Car and Driver.* Accessed from: Chrysler Airflow Concept Fully Revealed, Claims 400 Miles of Range (caranddriver.com)
30. Ferris, D. (2024). GM's 'all-in' Electric Future Now Includes Gasoline. *E&E News by Politico.* Accessed from: GM's 'all-in' electric future now includes gasoline - E&E News by POLITICO (eenews.net)
31. Narioka, K. (2024). Honda Motor Plans to Invest Over $60 Billion on EV Strategy. *The Wall Street Journal.* Accessed from: Honda Motor Plans to Invest Over $60 Billion on EV Strategy - WSJ
32. Narioka, K. (2024). Honda Motor Plans to Invest Over $60 Billion on EV Strategy. *The Wall Street Journal.* Accessed from: Honda Motor Plans to Invest Over $60 Billion on EV Strategy - WSJ
33. Tesla. (2021). Impact Report 2021. Accessed from: Tesla 2021 Impact Report
34. Straughan, D., & Mitchner, R. (2024). Electric Vehicle Statistics 2024. *MarketWatch Guides.* Accessed from: EV Statistics 2024 (marketwatch.com)
35. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure. *National Renewable Energy Lab.* Accessed from: The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure (nrel.gov)
36. John, J. (2022). 5 Charts that Shed New Light on How People Charge EVs at Home. *Canary Media.* Accessed from: 5 charts that shed new light on how people charge EVs… | Canary Media
37. EV Connect. What is Electric Vehicle Supply Equipment?. Accessed from: What Is EVSE? | EV Connect — EV Connect
38. U.S. Department of Transportation. Charger Types and Speeds. Accessed from: Charger Types and Speeds | US Department of Transportation
39. SparkCharge. EV Charging Station Infrastructure Costs and Breakdown. Accessed from: EV Charging Station Infrastructure Costs and Breakdown — SparkCharge
40. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure. *National Renewable Energy Lab.* Accessed from: The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure (nrel.gov)
41. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure. *National Renewable Energy Lab.*

Accessed from: The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure (nrel.gov)

42. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure. *National Renewable Energy Lab.* Accessed from: The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure (nrel.gov)
43. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure. *National Renewable Energy Lab.* Accessed from: The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure (nrel.gov)
44. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure. *National Renewable Energy Lab.* Accessed from: The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure (nrel.gov)
45. U.S. Office of Energy Efficiency & Renewable Energy. (2024). FOTW #1334, March 18, 2024: By 2030, the US Will Need 28 Million EV Charging Ports to Support 33 Million EVs. Accessed from: FOTW #1334, March 18, 2024: By 2030, the US Will Need 28 million EV Charging Ports to Support 33 million EVs | Department of Energy
46. Choi, C. Q. (2022). Nighttime Charging of EVs May Overburden the Grid: As EVs Proliferate, Charging Habits Might have to Change.
47. Chargepoint. ChargePoint, National Grid, and NYSERDA Launch Electric Vehicle Charging Station Project in Upstate New York. Accessed from: ChargePoint, National Grid, and NYSERDA Launch Electric Vehicle Charging Station Project in Upstate New York | ChargePoint
48. Cuthrell, S. (2024). Walmart's Ambitious Plan for Nationwide EV Fast-Charging Network. *EE Power.* Accessed from: Walmart's Ambitious Plans for Nationwide EV Fast-Charging Network - News (eepower.com)
49. Schneider, W. (2024). Exploring the Number of Warehouses in the US from 2007-2023. *Warehouse and Fulfillment.* Accessed from: Exploring the Number of Warehouses in the US From 2007-2023 (warehousingandfulfillment.com)
50. King, H. (2023). Amazon Reaches 10,000 Rivian Electric Delivery Vans in the U.S. *Axios.* Accessed from: Amazon reaches 10,000 Rivian electric delivery vans in U.S. (axios.com)
51. Day, M. (2024). Amazon Becomes the Largest US Private EV Charging Operator. *Transport Topics.* Accessed from: Amazon Becomes the Largest US Private EV Charging Operator | Transport Topics (ttnews.com)
52. Green, H. (2020). Germany to Receive Massive Charging Park Built by Amazon. *TheNextAvenue.* Accessed from: Germany to Receive Massive Charging Park Built by Amazon - The Next Avenue
53. U.S. Department of Energy. Project Lessons: Curbside EV Charging. Accessed from: Clean Cities and Communities: Project Lessons: Curbside EV Charging (energy.gov)
54. Union of Concerned Scientists. (2008). Cars, Trucks, Buses and Air Pollution. Accessed from: Cars, Trucks, Buses and Air Pollution | Union of Concerned Scientists (ucsusa.org)
55. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
56. U.S. Department of Energy. Electric Vehicle (EV) Charger Policies for Rental Properties. Accessed from: Alternative Fuels Data Center: Electric Vehicle (EV) Charger Policies for Rental Properties (energy.gov)
57. New York State Energy Research and Development Authority (NYSERDA) & Transportation and Climate Initiative. (2012). Siting and Design Guidelines for Electric Vehicle Supply Equipment. Accessed from: https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/ChargeNY/Siting-and-Design-Guidelines-for-EVSE.pdf

58. Hsu, C-W., & Fingerman, K. (2021). Public Electric Vehicle Charger Access Disparities Across Race and Income in California. *Transport Policy.* Accessed from: Public electric vehicle charger access disparities across race and income in California (sciencedirectassets.com)
59. U.S. Department of Transportation. Justice40 Initiative. Accessed from: Justice40 Initiative | US Department of Transportation
60. Federal Register. (2023). National Electric Vehicle Infrastructure Standards and Requirements. Accessed from: Federal Register :: National Electric Vehicle Infrastructure Standards and Requirements
61. U.S. Department of Energy. (2015). Costs Associated with Non-Residential Electric Vehicle Supply Equipment: Factors to Consider in the Implementation of Electric Vehicle Charging Stations. Accessed from: Costs Associated With Non-Residential Electric Vehicle Supply Equipment (energy.gov)
62. U.S. Department of Energy, Alternative Fuels Data Center. Operation and Maintenance for Electric Vehicle Charging Infrastructure. Accessed from: Alternative Fuels Data Center: Operation and Maintenance for Electric Vehicle Charging Infrastructure (energy.gov)
63. U.S. Department of Energy, Alternative Fuels Data Center. Operation and Maintenance for Electric Vehicle Charging Infrastructure. Accessed from: Alternative Fuels Data Center: Operation and Maintenance for Electric Vehicle Charging Infrastructure (energy.gov)
64. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
65. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
66. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
67. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
68. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
69. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
70. U.S. Department of Transportation. (2023). Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure. Accessed from: Charging Forward: A Toolkit for Planning and Funding Rural Electric Mobility Infrastructure (transportation.gov)
71. Blynn, K. (2021). Cities Rev Up Transition to EVs with Car Sharing Programs. *National Resource Defense Council.* Accessed from: Cities Rev Up Transition to EVs with Car Sharing Programs (nrdc.org)
72. IBIS World. Fast Food Restaurants in the US- Number of Businesses. Accessed from: Fast Food Restaurants in the US - Number of Businesses | IBISWorld
73. Lewis M. (2024). Who's Hot and Who's Not Among US Retailers for EV Charging. *Electrek.* Accessed from: Who's hot and who's not among US retailers for EV charging | Electrek
74. Lewis M. (2024). Who's Hot and Who's Not Among US Retailers for EV Charging. *Electrek.* Accessed from: Who's hot and who's not among US retailers for EV charging | Electrek
75. Day, M. (2024). Amazon Becomes the Largest US Private EV Charging Operator. *Transport Topics.* Accessed from: Amazon Becomes the Largest US Private EV Charging Operator | Transport Topics (ttnews.com)

76. CISION PRWeb. (2024). EV Parts Sourcing Simplified: 5 Tips for Finding a Reliable Supplier. Accessed from: EV Parts Sourcing Simplified: 5 Tips for Finding a Reliable Supplier (prweb.com)
77. CISION PRWeb. (2024). EV Parts Sourcing Simplified: 5 Tips for Finding a Reliable Supplier. Accessed from: EV Parts Sourcing Simplified: 5 Tips for Finding a Reliable Supplier (prweb.com)
78. CISION PRWeb. (2024). EV Parts Sourcing Simplified: 5 Tips for Finding a Reliable Supplier. Accessed from: EV Parts Sourcing Simplified: 5 Tips for Finding a Reliable Supplier (prweb.com)
79. U.S. Energy Information Administration. (2023). Annual Energy Outlook, AOE2023. Accessed from: Annual Energy Outlook 2023: Narrative (eia.gov)
80. Mai, T., Jadun, P., Logan, J., McMillan, C., Muratori, M., Steinberg, D., Vimmerstedt, L., Jones, R., Haley, B., & Nelson, B. (2018). Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States. *National Renewable Energy Labratory. NREL/TP-6A20-71500.* Accessed from: Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States (nrel.gov)
81. National Renewable Energy Laboratory. (2018). NREL Analysis Explores Demand-Side Impacts of a Highly Electrified Future. Accessed from: NREL Analysis Explores Demand-Side Impacts of a Highly Electrified Future | News | NREL
82. Reuters. (2024). New York's Electric Grid Prepped for Summer Demand, Flags Reliability Concerns. Accessed from: New York's electric grid prepped for summer demand, flags reliability concerns | Reuters
83. Aznar, A. (2015). Phrase of the Day: Peak Load. *National Renewable energy Laboratory.* Accessed from: Phrase of the Day: Peak Load | State, Local, and Tribal Governments | NREL
84. Unitil. (2023). What is Peak Demand, and How Does it Affect Me?. Accessed from: What Is Peak Demand, and How Does It Affect Me? | Unitil
85. Engel, H., Hensley, R., Knupfer, S., & Sahdev, S. (2018). The Potential Impact of Electric Vehicles on Global Energy Systems. *McKinsey & Company.* Accessed from: How electric vehicles could change the load curve | McKinsey
86. Engel, H., Hensley, R., Knupfer, S., & Sahdev, S. (2018). The Potential Impact of Electric Vehicles on Global Energy Systems. *McKinsey & Company.* Accessed from: How electric vehicles could change the load curve | McKinsey
87. Engel, H., Hensley, R., Knupfer, S., & Sahdev, S. (2018). The Potential Impact of Electric Vehicles on Global Energy Systems. *McKinsey & Company.* Accessed from: How electric vehicles could change the load curve | McKinsey
88. Engel, H., Hensley, R., Knupfer, S., & Sahdev, S. (2018). The Potential Impact of Electric Vehicles on Global Energy Systems. *McKinsey & Company.* Accessed from: How electric vehicles could change the load curve | McKinsey
89. Tepe, B., Haberschusz, D., Figgener, J., Hesse, H., Sauer, D. U., & Jossen, A. (2023). Feature-conserving gradual anonymization of load profiles and the impact on battery storage systems. *Applied Energy.* Accessed from: https://www.researchgate.net/publication/370773207_Feature-conserving_gradual_anonymization_of_load_profiles_and_the_impact_on_battery_storage_systems/link/6462bb6df43b8a29ba5276d1/download?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19
90. PJM Learning Center. Electricity Basics: Transmission & Distribution. Accessed from: https://learn.pjm.com/electricity-basics/transmission-distribution#:~:text=Transmission%20and%20distribution%20refers%20to%20the%20different,been%20generated%2C%20a%20system%20of%20electrical%20wires
91. U.S. Energy Information Administration. (2024). Electricity Explained: How Electricity is Delivered to Customers. Accessed from: https://www.eia.gov/energyexplained/electricity/delivery-to-consumers.php
92. Li, Y., & Jenn, A. (2024). Impact of Electric Vehicle Charging Demand on Power Distribution Grid Congestion. *PNAS, 121(18), 1-10.* Accessed from: https://www.pnas.org/doi/epub/10.1073/pnas.2317599121
93. Li, Y., & Jenn, A. (2024). Impact of Electric Vehicle Charging Demand on Power Distribution Grid Congestion. *PNAS, 121(18), 1-10.* Accessed from: https://www.pnas.org/doi/epub/10.1073/pnas.2317599121
94. Li, Y., & Jenn, A. (2024). Impact of Electric Vehicle Charging Demand on Power Distribution Grid Congestion. *PNAS, 121(18), 1-10.* Accessed from: https://www.pnas.org/doi/epub/10.1073/pnas.2317599121

95. U.S. Department of Transportation. (2023). Rural EV Toolkit:Utilities. Accessed from: https://www.transportation.gov/rural/ev/toolkit/ev-partnership-opportunities/electric-utilities#:~:text=Investor%2Downed%20utilities%20(IOUs),operate%20in%20almost%20every%20State.

96. U.S. Department of Transportation. (2023). Rural EV Toolkit:Utilities. Accessed from: https://www.transportation.gov/rural/ev/toolkit/ev-partnership-opportunities/electric-utilities#:~:text=Investor%2Downed%20utilities%20(IOUs),operate%20in%20almost%20every%20State.

97. U.S. Department of Transportation. (2023). Rural EV Toolkit:Utilities. Accessed from: https://www.transportation.gov/rural/ev/toolkit/ev-partnership-opportunities/electric-utilities#:~:text=Investor%2Downed%20utilities%20(IOUs),operate%20in%20almost%20every%20State.

98. U.S. Department of Transportation. (2023). Rural EV Toolkit:Utilities. Accessed from: https://www.transportation.gov/rural/ev/toolkit/ev-partnership-opportunities/electric-utilities#:~:text=Investor%2Downed%20utilities%20(IOUs),operate%20in%20almost%20every%20State.

99. State Climate and Energy Program. (2010). An Overview of PUCs for State Environmental and Energy Officials. Accessed from: https://www.epa.gov/sites/default/files/2016-03/documents/background_paper.pdf

100. Takemura, A. F., (2022). Electric Utilities 101: A Breakdown of the Basics on US Power Providers. *Canary Media.* Accessed from: https://www.canarymedia.com/articles/guides-and-how-tos/power-by-people-glossary-bundle#:~:text=But%20in%20many%20states%20today,Florida%20Power%20&%20Light

101. Day, M. (2024). Amazon Becomes the Largest US Private EV Charging Operator. *Transport Topics.* Accessed from: https://www.ttnews.com/articles/amazon-ev-charging-largest

102. Argonne National Laboratory. (2023). Charging for Heavy-Duty Electric Trucks: Frequently Asked Questions about the Megawatt Charging System and SAW J3271. Accessed from: https://www.anl.gov/sites/www/files/2023-03/MCS_FAQs_Final_3-13-23.pdf

103. Argonne National Laboratory. (2023). Charging for Heavy-Duty Electric Trucks: Frequently Asked Questions about the Megawatt Charging System and SAW J3271. Accessed from: https://www.anl.gov/sites/www/files/2023-03/MCS_FAQs_Final_3-13-23.pdf

104. Sierzchula, W. (2022). Electrifying US Long Haul Trucks Will Require 504 TWh a Year. But that Won't be the Hardest Part. *Utility Dive.* Accessed from: https://www.utilitydive.com/news/electrifying-us-long-haul-trucks-will-require-504-twh-a-year-but-that-won/636684/#:~:text=The%20Gladstein%20Neandross%20&%20Associates%20state,predominant%20fuel%20for%20semi%20tractors.

105. Prologis. (2024). Performance Team- A Maersk company & Prologis Launch New EV Truck Charging Depot, Powered by Nation's Largest EV Truck Microgrid. Accessed from: https://www.prologis.com/about/news-press-releases/performance-team-maersk-company-prologis-launch-new-ev-truck-charging

106. Karidis, A. (2024). One Energy Launches Largest US. Truck Charging Site. *Waste 360.* Accessed from: https://www.waste360.com/fleet-technology/one-energy-launches-largest-u-s-truck-charging-site

107. Electric School Bus Initiative. (2022). All About Managed Charging and "Vehicle-to-Everything" or V2X. Accessed from: https://electricschoolbusinitiative.org/all-about-managed-charging-and-vehicle-everything-or-v2x#:~:text=What%20is%20Managed%20Charging?,energy%20often%20from%20renewable%20generation.

108. Electric School Bus Initiative. (2022). All About Managed Charging and "Vehicle-to-Everything" or V2X. Accessed from: https://electricschoolbusinitiative.org/all-about-managed-charging-and-vehicle-everything-or-v2x#:~:text=What%20is%20Managed%20Charging?,energy%20often%20from%20renewable%20generation.

109. Electric School Bus Initiative. (2022). All About Managed Charging and "Vehicle-to-Everything" or V2X. Accessed from: https://electricschoolbusinitiative.org/all-about-managed-charging-and-vehicle-everything-or-v2x#:~:text=What%20is%20Managed%20Charging?,energy%20often%20from%20renewable%20generation.

110. EV Connect. What is Bidirectional Charging? Understanding the Benefits for Both Drivers and Businesses. Accessed from: https://www.evconnect.com/blog/what-is-bidirectional-charging

111. Choi, C. Q. (2022). Nighttime Charging of EVs May Overburden the Grid. *IEEE Spectrum.* Accessed from: https://spectrum.ieee.org/electric-vehicles
112. Wan, Y. (2012). Long-Term Wind Power Variability. *National Renewable Energy Lab.* Accessed from: https://www.nrel.gov/docs/fy12osti/53637.pdf
113. American Council for Energy Efficient Economy (ACEEE). (2015). Overview: Local Government-Utility Partnerships. Accessed from: https://www.aceee.org/toolkit/2015/01/overview-local-government-utility-partnerships
114. Austin Energy. School Outreach: Free Science and Learning Opportunities for Students. Accessed from: https://austinenergy.com/about/community-outreach/school-outreach#:~:text=Electric%20Vehicles%20(EV)%20for%20Schools%20Available%20for%20Grades%206%2D12&text=This%20is%20one%20of%20the,in%2Dperson%20or%20virtual%20presentations.
115. Austin Texas Gov. (2022). Leading the Charge: City of Austin Accelerates Commitment to Electric Vehicle Adoption. Accessed from: https://www.austintexas.gov/article/leading-charge-city-austin-accelerates-commitment-electric-vehicle-adoption#:~:text=To%20support%20the%20electric%20transportation,municipal%20buildings%20and%20parking%20garages.
116. U.S. Department of Energy. Alternative Fuels Data Center: Electric Vehicle (EV) Charging Station Installation Incentive- Eversource. Accessed from: https://afdc.energy.gov/laws/12161#:~:text=Eversource's%20Electric%20Vehicle%20Charging%20Station,%2C%20workplaces%2C%20and%20fleet%20facilities.
117. Xcel Energy. Driving the Future of Clean, Affordable Transportation. Accessed from: https://www.xcelenergy.com/staticfiles/xe-responsive/Marketing/EV%20Vision%20brochure.pdf
118. Puget Sound Energy. (2024). Puget Sound Energy Opens new Sumner Electric Vehicle Charging Station.
119. BusinessWire. (2022). PG&E and Ford Collaborate on Bidirectional Electric Vehicle Charging Technology in Customers' Homes. Accessed from: https://www.businesswire.com/news/home/20220311005458/en/
120. Blair, B., Fitzgerald, G., & Doughert, C. (2021). The State of Managed Charging in 2024. *Smart Electric Power Alliance.* Accessed from: https://sepapower.org/resource/state-of-managed-charging-in-2024/
121. Blair, B., Fitzgerald, G., & Doughert, C. (2021). The State of Managed Charging in 2024. *Smart Electric Power Alliance.* Accessed from: https://sepapower.org/resource/state-of-managed-charging-in-2024/
122. American Council for Energy Efficient Economy (ACEEE). (2015). Overview: Local Government-Utility Partnerships. Accessed from: https://www.aceee.org/toolkit/2015/01/overview-local-government-utility-partnerships
123. U.S. Department of Transportation. (2020). Policy and Governmental Affairs Office of Highway Policy Information: Highway Statistics 2020. Accessed from: https://www.fhwa.dot.gov/policyinformation/statistics/2020/
124. U.S. Department of Transportation. (2022). The Highway System. Accessed from: https://www.fhwa.dot.gov/ohim/onh00/onh2p5.htm#:~:text=Ownership%20of%20U.S.%20Roads%20and,town%2C%20city%2C%20county).
125. Kertscher, T. (2023). Carry that Weight? Electric Vehicles Outweigh Gas Cars but Aren't Main Culprit of Road Wear. *Politifact.* Accessed from: https://www.politifact.com/article/2023/jun/21/carry-that-weight-electric-vehicles-outweigh-gas-c/#:~:text=Civil%20and%20environmental%20engineering%20professor,hundreds%20of%20pounds%20or%20more.
126. Nebraska Today. (2024). Nebraska Experts Weigh Highway Safety and Electric Vehicles. *University of Nebraska-Lincoln.* Accessed from: https://news.unl.edu/article/nebraska-experts-weigh-highway-safety-and-electric-vehicles
127. Nebraska Today. (2024). Nebraska Experts Weigh Highway Safety and Electric Vehicles. *University of Nebraska-Lincoln.* Accessed from: https://news.unl.edu/article/nebraska-experts-weigh-highway-safety-and-electric-vehicles

128. Low, J. M., Haszeldine, R. S., & Harrison, G. P. (2022). The Hidden Cost of Road Maintenance due to the Increased Weight of Battery and Hydrogen Trucks and Buses- a Perspective. *Clean Technologies and Environmental Policy, 25.* P. 757-770. Accessed from: https://link.springer.com/article/10.1007/s10098-022-02433-8
129. Cleave, K. V. (2023). As Electric Vehicles Become More Common, Experts Worry they Could Pose a Safety Risk for Other Drivers. *CBS News.* Accessed from: https://www.cbsnews.com/news/electric-vehicle-safety-heavy-battery/
130. NEIWPCC. Underground Storage Tanks. Accessed from: https://neiwpcc.org/our-programs/underground-storage-tanks/#:~:text=USTs%20are%20commonly%20used%20for,storage%20tanks%20(LUST)%20sites.
131. U.S. Environmental Protection Agency Office of Underground Storage Tanks. (2023). 20 Years of Progress Closing LUST Sites: Percentage of LUST Sites Closed (Cumulative) By State. Accessed from: https://www.epa.gov/system/files/documents/2024-01/backlog-reduction-2003-2023-dec2023.pdf
132. U.S. Environmental Protection Agency Office of Underground Storage Tanks. (2023). 20 Years of Progress Closing LUST Sites: Percentage of LUST Sites Closed (Cumulative) By State. Accessed from: https://www.epa.gov/system/files/documents/2024-01/backlog-reduction-2003-2023-dec2023.pdf
133. U.S. Environmental Protection Agency. (2024). Underground Storage Tanks (USTs): Leaking Underground Storage Trank Trust Fund. Accessed from: https://www.epa.gov/ust/leaking-underground-storage-tank-trust-fund
134. U.S. Environmental Protection Agency. (2024). Underground Storage Tanks (USTs). Accessed from: https://www.epa.gov/ust#:~:text=Approximately%20542%2C000%20underground%20storage%20tanks,store%20petroleum%20or%20hazardous%20substances.
135. Valladares, M. R. (2019). America's Largest Cities are Practically Broke. *Forbes.* Accessed from: https://www.forbes.com/sites/mayrarodriguezvalladares/2019/01/29/americas-largest-cities-are-practically-broke/
136. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu, Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure.
137. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu, Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure.
138. Wood, E., Borlaug, B., Moniot, M., Lee, D-Y., Ge, Y., Yang, F., & Liu, Z. (2023). The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure.
139. U.S. Office of Energy Efficiency & Renewable Energy. (2024). FOTW #1334, March 18, 2024: By 2030, the US Will Need 28 Million EV Charging Ports to Support 33 Million EVs. *Vehicle Technology Office.* Accessed from: https://www.energy.gov/eere/vehicles/articles/fotw-1334-march-18-2024-2030-us-will-need-28-million-ev-charging-ports#:~:text=Of%20the%2028%20million%20charging,stores%2C%20restaurants%2C%20and%20hotels.
140. Fritts, J. (2019). How Are Your State's Roads Funded?. *Tax Foundation.* Accessed from: https://taxfoundation.org/data/all/state/states-road-funding-2019/
141. Goodman, J. (2022). As Electric Vehicle Growth Squeezes Gas Tax Revenues, Data Helps States Prepare. *Pew.* Accesses from: https://www.pewtrusts.org/en/research-and-analysis/articles/2022/10/03/as-electric-vehicle-growth-squeezes-gas-tax-revenues-data-helps-states-prepare
142. Goodman, J. (2022). As Electric Vehicle Growth Squeezes Gas Tax Revenues, Data Helps States Prepare. *Pew.* Accesses from: https://www.pewtrusts.org/en/research-and-analysis/articles/2022/10/03/as-electric-vehicle-growth-squeezes-gas-tax-revenues-data-helps-states-prepare
143. Federal Reserve of Minneapolis. Inflation Calculator. Accessed from: https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator
144. National Association of Convenience Stores. (2024). U.S. Convenience Store Count. Accessed from: https://www.convenience.org/Research/Convenience-Store-Fast-Facts-and-Stats/FactSheets/IndustryStoreCount
145. Neuman, S. (2023). The Settler Brought the Lottery to America. It's had a Long, Uneven History. *NPR.* Accessed from: https://www.npr.org/2023/08/09/1192893936/mega-millions-powerball-lottery-history-in-america
146. Tax Policy Center. (2024). What are the sources of revenue for state and local governments?. Accessed from: https://taxpolicycenter.org/briefing-book/what-are-sources-revenue-state-and-local-

governments#:~:text=What%20are%20the%20sources%20of%20revenue%20for%20local%20governments%3F,30%20percent%20from%20property%20taxes

147. Tax Policy Center. (2024). What are the sources of revenue for state and local governments?. Accessed from: https://taxpolicycenter.org/briefing-book/what-are-sources-revenue-state-and-local-governments#:~:text=What%20are%20the%20sources%20of%20revenue%20for%20local%20governments%3F,30%20percent%20from%20property%20taxes
148. Macumber-Rosin, J., & Hoffer, A. (2024). Vehicle Miles Traveled Taxes Rollout across States. *Tax Foundation.* Accessed from: https://taxfoundation.org/blog/state-vmt-vehicle-miles-traveled-taxes/
149. Macumber-Rosin, J., & Hoffer, A. (2024). Vehicle Miles Traveled Taxes Rollout across States. *Tax Foundation.* Accessed from: https://taxfoundation.org/blog/state-vmt-vehicle-miles-traveled-taxes/
150. Oregon Department of Transportation. What is the Road User Fee Task Force?. Accessed from: https://www.oregon.gov/odot/Programs/Pages/Road-User-Fee-Task-Force.aspx
151. Gorzelany, J. States that Charge Extra Fees to Own an Electric Vehicle. Accessed from: https://www.myev.com/research/interesting-finds/states-that-charge-extra-fees-to-own-an-electric-vehicle
152. Khatib, M. (2024). EV Drivers in 36 States Pay a Surplus of Fees Each Year. *EV Hub.* Accessed from: https://www.atlasevhub.com/data_story/ev-drivers-in-36-states-pay-a-surplus-of-fees-each-year/
153. U.S. Department of Energy. Operation and Maintenance for Electric Vehicle Charging Infrastructure. Accessed from: https://afdc.energy.gov/fuels/electricity-infrastructure-maintenance-and-operation
154. U.S. Department of Energy. Operation and Maintenance for Electric Vehicle Charging Infrastructure. Accessed from: https://afdc.energy.gov/fuels/electricity-infrastructure-maintenance-and-operation
155. U.S. Department of Energy. Operation and Maintenance for Electric Vehicle Charging Infrastructure. Accessed from: https://afdc.energy.gov/fuels/electricity-infrastructure-maintenance-and-operation
156. Walton, R. (2023). Duke Energy Unveils EV Charging Subscription Service, Partnering with BMW, Ford and GM. *Utility Dive.* Accessed from: https://www.utilitydive.com/news/duke-energy-bmw-ford-gm-ev-charging-subscription-service/692281/
157. New York City Department of Transportation. (2021). Electrifying New York: An Electric Vehicle Vision Plan for New York City, September 2021, Letter from the Commissioner, NYC Department of Transportation. Accessed from: https://www.nyc.gov/html/dot/downloads/pdf/electrifying-new-york-report-text-only.pdf
158. Oregon Department of Energy. (2023). 2023 Biennial Zero Emission Vehicle Report. Accessed from: https://www.oregon.gov/energy/Data-and-Reports/Documents/2023-Biennial-Zero-Emission-Vehicle-Report.pdf
159. Celona, L., & Fitz-Gibbon, J. (2023). NYPD Rolls Out Fleet of Fully Electric and Speedy Patrol Cars for the First Time. *New York Post.* Accessed from: https://nypost.com/2023/04/24/nypd-rolling-out-sleek-and-speedy-electric-patrol-cars-for-the-first-time/
160. New York City Police Department. About NYPD. Accessed from: https://www.nyc.gov/site/nypd/about/about-nypd/about-nypd-landing.page
161. Grimes, C. (2023). A Closer Look at NYC's Alt-Fuel Law Enforcement Fleets. *Government Fleet.* Accessed from: https://www.government-fleet.com/10199205/a-closer-look-at-the-nypds-alt-fuel-fleet
162. Descant, S. (2024). South Pasadena, Calif., Police Take Entire Fleet Electric. *Government Technology.* Accessed from: https://www.govtech.com/transportation/south-pasadena-calif-police-take-entire-fleet-electric
163. Descant, S. (2024). South Pasadena, Calif., Police Take Entire Fleet Electric. *Government Technology.* Accessed from: https://www.govtech.com/transportation/south-pasadena-calif-police-take-entire-fleet-electric
164. Los Angeles Fire Department. (2022). Fire Chief Crowley Debuts Arrival of LAFD's First Electric Fire Engine. *Youtube.* Accessed from: https://youtube.com/watch?v=vSDnDjdc-YY
165. DeMuro, R. (2022). Step Inside the Nation's Fire Electric Fire Truck. Accessed from: https://ktla.com/news/technology/ride-inside-nations-first-electric-fire-truck-los-angeles-hollywood-rosenbauer/

166. DeMuro, R. (2022). Step Inside the Nation's Fire Electric Fire Truck. Accessed from: https://ktla.com/news/technology/ride-inside-nations-first-electric-fire-truck-los-angeles-hollywood-rosenbauer/
167. Anderson, B. (2021). First Electric Fire Truck (With a Lil' Help from Diesel Generator) Shows Off its Tech in Arizona. *CarScoops.* Accessed from: https://www.carscoops.com/2021/03/first-electric-fire-truck-with-a-lil-help-from-diesel-generator-shows-off-its-tech-in-arizona/
168. Freehafer, L., Lazer, L., & Zepka, B. (2024). The State of Electric School Bus Adoption in the US. *World Resource Institute.* Accessed from: https://www.wri.org/insights/where-electric-school-buses-us#:~:text=State%20legislatures%20are%20also%20bolstering,and%20the%20state%20of%20Washington.
169. New York State Energy and Research Development Authority. (2023). Electric School Bus Guidebook, Guide 1: Benefits. Accessed from: file:///C:/Users/aaotis/Downloads/Benefits%20of%20School%20Bus%20Electrification%20(1).pdf
170. Multi-state Medium and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding. Accessed from: https://www.nescaum.org/documents/mhdv-zev-mou-20220329.pdf
171. Scauzillo, S. (2024). Getting to 100 Zero Emission Buses for LA Metro will take Five Years Longer. *Los Angeles Daily News.* Accessed from: https://www.nescaum.org/documents/mhdv-zev-mou-20220329.pdf
172. King County Metro. Zero Emissions by 2035. Accessed from: https://kingcounty.gov/en/dept/metro/programs-and-projects/zero-emissions
173. Chicago Transit Authority. Electric Buses: We're Electrifying our Entire Bus Fleet. Accessed from: https://www.transitchicago.com/electricbus/
174. Bernier, N. (2024). Cap Metro Stops Shift to all-electric Bus Fleet. *Austin Monitor.* Accessed from: https://www.austinmonitor.com/stories/2024/07/cap-metro-stops-shift-to-all-electric-bus-fleet/
175. King County Metro. Zero Emissions by 2035. Accessed from: https://kingcounty.gov/en/dept/metro/programs-and-projects/zero-emissions
176. Deshais, N. (2024). Auditor Raises Red Flags in Metro's Push to Electrify Bus Fleet by 2035. *Seattle Times.* Accessed from: https://www.seattletimes.com/seattle-news/climate-lab/auditor-raises-red-flags-in-metros-push-to-electrify-bus-fleet-by-2035/
177. Metro Magazine. (2024). Seattle's King County Breaks Ground on New Electric Bus Facility. Accessed from: https://www.metro-magazine.com/10217149/seattles-king-county-breaks-ground-on-new-electric-bus-facility
178. Metro Magazine. (2024). Seattle's King County Breaks Ground on New Electric Bus Facility. Accessed from: https://www.metro-magazine.com/10217149/seattles-king-county-breaks-ground-on-new-electric-bus-facility
179. Deshais, N. (2024). Auditor Raises Red Flags in Metro's Push to Electrify Bus Fleet by 2035. *Seattle Times.* Accessed from: https://www.seattletimes.com/seattle-news/climate-lab/auditor-raises-red-flags-in-metros-push-to-electrify-bus-fleet-by-2035/
180. Hamblin, J. (2023). 14 Essential Considerations for EV Fleet Owners and Operators to Evaluate their Charging Infrastructure. *Electrada*. Accessed from: https://electrada.com/14-essential-considerations-for-ev-fleet-owners-and-operators-to-evaluate-their-charging-infrastructure/#:~:text=Assessing%20the%20entire%20fleet%20turnover%20plan%20and,such%20as%20take%2Dhome%2C%20public%2C%20and%20depot%20charging
181. Hamblin, J. (2023). 14 Essential Considerations for EV Fleet Owners and Operators to Evaluate their Charging Infrastructure. *Electrada*. Accessed from: https://electrada.com/14-essential-considerations-for-ev-fleet-owners-and-operators-to-evaluate-their-charging-infrastructure/#:~:text=Assessing%20the%20entire%20fleet%20turnover%20plan%20and,such%20as%20take%2Dhome%2C%20public%2C%20and%20depot%20charging
182. Friedman, J., Lewis, G., Pforzheimer, A., Folger, M., & Casale, M. (2021). An Electric Vehicle Toolkit for Local Governments. *Frontier Group, Environment America Research & Policy Center, U.S. PIRG Education Fund.* Accessed from: https://publicinterestnetwork.org/wp-content/uploads/2021/11/AME-EV-Toolkit-Oct21-web-2.pdf

183. U.S. Department of Energy. Alternative Fuels Data Center: Building Codes, Parking Ordinances, and Zoning Ordinances for Electric Vehicle Charging Infrastructure. Accessed from: https://afdc.energy.gov/fuels/electricity-codes-and-ordinances
184. St. John, J. (2024). Homes Need to Electrify. New Building Codes will Make that Harder. *Canary Media*. https://www.canarymedia.com/articles/carbon-free-buildings/homes-need-to-electrify-new-building-codes-will-make-that-harder
185. New Jersey Department of Environmental Protection. Definitions & Terminology. Accessed from: https://dep.nj.gov/wp-content/uploads/drivegreen/pdf/mud-toolkit/ev-terminology.pdf
186. Oreizi, D. (2020). What is the Difference Between EV Capable, EV Read, and EV Installed. *ChargedFuture.* Accessed from: https://www.chargedfuture.com/ev-capable-ev-ready-and-ev-installed/
187. Larsen, D. (2021). EV Readiness- Why We Need it Now. *Southern Alliance for Clean Energy.* Accessed from: https://www.cleanenergy.org/blog/ev-readiness-and-why-we-need-it-now/
188. Larsen, D. (2021). EV Readiness- Why We Need it Now. *Southern Alliance for Clean Energy.* Accessed from: https://www.cleanenergy.org/blog/ev-readiness-and-why-we-need-it-now/
189. Blink. (2024). What Construction and Electrical Contractors Need to Know About EV Charging. Accessed from: https://blinkcharging.com/blog/what-construction-electrical-contractors-need-to-know-about-ev-charging

ABOUT THE DYNAMIC SUSTAINABILITY LAB

Launched during the fall of 2021, The Dynamic Sustainability Lab examines the opportunities as well as risks and unintended consequences resulting from the rapid transition to a new generation of sustainable technologies, strategies, and policies for the Net-Zero Carbon Economy. Our focus is in providing interdisciplinary scientific approaches that support organizations in realizing sustainability transition opportunities by identifying the dynamic risks and developing policies, strategies, and tools to achieve success.

Follow the Lab at: www.DynamicsLab.org

ABOUT THE ALLIANCE FOR CLIMATE TRANSITION

The Alliance for Climate Transition (ACT) leads the just, equitable, and rapid transition to a clean energy future and a diverse climate economy. ACT members span the broad spectrum of the clean energy industry, including clean transportation, energy efficiency, wind, solar, energy storage, microgrids, fuel cells, and advanced and "smart" technologies. ACT is dedicated to growing the climate economy across the region.

ACT includes The Alliance for Climate Transition, a nonprofit business member organization, and ACT Institute, a nonprofit focused on industry research, innovation, policy development, and strategic communications. ACT's innovation program includes Cleantech Open Northeast, the Northeast affiliate of the national cleantech accelerator Cleantech Open, and Cleantech Navigate, which provides cleantech startups with curated connections to mentors, test sites, customers, corporate partners, and investors. ACT brings together business leaders and key stakeholders to engage in influential policy discussions and business initiatives while building connections that propel the clean energy industry forward.

Visit www.joinact.org for more information.

DYNAMIC SUSTAINABILITY LAB™
AT SYRACUSE UNIVERSITY

ACT The Alliance for Climate Transition