NEW HAMPSHIRE MUNICIPAL EV TOOLKIT

Driving EV Adoption

Drive Electric NH

https://www.driveelectricnh.org/

August 2022

DRIVE ELECTRIC NH

Source: Clay Banks, Unsplash

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Acknowledgements

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Goal and Scope

This document aims to serve NH municipalities electrifying their fleets and developing public charging infrastructure. As electrification of the transportation sector accelerates in the United States, municipalities will have to revisit their local procedures, purchasing policies, and capital development plans to capture the benefits to public health, local economy, and sustainability that EVs bring. Best practices, actionable strategies, and informative tools will be provided so that planners, fleet managers, and other interested parties can promote electrification while avoiding common pitfalls. This toolkit will also guide the process for demonstrating the value of and estimating the need for public EV charging infrastructure in local communities.

The inclusion of specific products or partners within this toolkit does not mean they are endorsed solutions by the sponsors of this toolkit.

Executive Summary

Transportation accounts for 47% of NH's Greenhouse Gas (GHG) emissions.[1] Clean transportation and electric vehicles (EVs) are an important part of the federal push to create a more sustainable nation. Consumer demand for EVs has been growing, increasing from 120k EVs sold globally in 2012 to 6.6 million in 2022.[2] In the first six months of 2022, EVs represented 5% of all new autos sold in the US, an increase from 0.4 percent in 2012.[3]

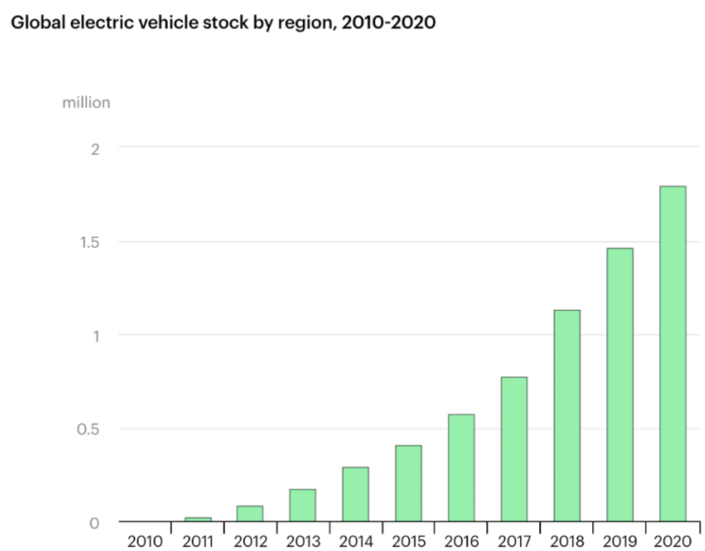

Figure 1: Electric vehicle stock growth in the US between 2010 – 2020 (Source: IEA 2021 EV Outlook)

Local communities will need to prepare for this ongoing transformation to remain competitive in the New England tourist economy. While EVs were once a small portion of the vehicle market, they are projected to represent a massive consumer base. Driver behaviors, including where they decide to shop, eat, or vacation, are going to be heavily influenced by the availability of Electric Vehicle Supply Equipment (EVSE).

In certain instances, total cost of ownership—which includes the upfront and operating costs of a vehicle—is already substantially lower for EVs, though this is less true in New

[1] NH DES. (2017). *Greenhouse Gas Emissions Inventory*. Retrieved August 2022, from https://www.des.nh.gov/climate-and-sustainability/climate-change/greenhouse-gas
[2] IEA (2022), *Global EV Outlook 2022*, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2022
[3] BNEF (2022). *US Crosses the Electric-Car Tipping Point for Mass Adoption. July 9, 2022.* https://www.bloomberg.com/news/articles/2022-07-09/us-electric-car-sales-reach-key-milestone

England due to our high electricity rates.[4] Municipal fleets and other heavily used vehicles represent a better economic case, since the higher upfront cost can be offset by greater fuel savings. Such investment can realize an immediate benefit for local communities, where reduced costs can translate to more funds for local infrastructure improvement projects. Furthermore, the price of EVs continues to decrease, and projections show purchase price parity of EVs with internal combustion engine vehicles (ICEVs) can be achieved in the United States around 2026, once battery pack prices drop to $80 per kilowatt hour (kWh).[5]

The benefits of converting to EVs are not solely economic, as it has been estimated that transportation electrification would create $3.9 billion in public health benefits due to better air quality in the state of NH alone, as well as less tangible benefits such as decreased noise pollution in urban cores and along major traffic corridors.[6]

To make the most of this transformation, municipalities can implement several strategies across local policy, procurement, outreach, siting, and financial analysis to make the most of this transformation. The decision-making process for EVs and EVSE is complex though, and local stakeholders will need to understand the impact each decision has on equity, grid stability, and local economy.

The case for electrification is growing. Accounting for EVs locally will require careful planning, but equipped with an understanding of common concerns, experiences, and opportunities, municipal decision makers will be more successful in town meetings, and more successful in building a sustainable future for their communities.

Key Findings

EV planning strategies should be evaluated based on local context. However, many valuable strategies to start with are low cost; parking code changes, permitting standardization, and promotional events can all accelerate EV and EVSE adoption. To ensure sufficient short and long-term charging projects are developed communities should calculate their local need for charging based on the number of expected EV drivers. These projects can leverage significant amounts of federal funding and can be

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[4] Orvis, Robbie (2022). *Most Electric Vehicles are Cheaper to Own Off the Lot than Gas Cars.* Energy Innovation. Retrieved from https://energyinnovation.org/wp-content/uploads/2022/05/Most-Electric-Vehicles-Are-Cheaper-Off-The-Lot-Than-Gas-Cars.pdf
[5] McKerracher, C. (2021). Hyperdrive daily: The EV price gap narrows. *Bloomberg Newsletter,* Retrieved from https://www.bloomberg.com/news/newsletters/2021-05-25/hyperdrive-daily-the-ev-price-gap-narrows
[6] American Lung Association 2022 Road to Clean Air Report. https://www.lung.org/getmedia/13248145-06f0-4e35-b79b-6dfacfd29a71/zeroing-in-on-healthy-air-report-2022.pdf

integrated with existing development plans. Installation costs of charging equipment are significantly reduced when repaving efforts are already underway, so pairing EVSE with local development plans enables communities to maximize the benefits of public charging; future proofing locations by adding in additional capacity during short-term projects reduces the costs of long-term plans. As charging is developed fee structures can drive consumer behavior, and siting of charging near destinations like grocery stores, recreational areas, and entertainment will lead to high usage and local spending. Training emergency responders on EV safety will ensure EV adoption is providing not just financial security, but physical safety as well.

Table 1: Cost, Effort, and Impact of Several Key EV planning strategies

Strategy	Cost	Effort	Impact
Local Policy			
Update parking ordinances to require EV-ready spaces	Low	Low	High
Create a separate EVSE permit and make guidelines clear	Low	Med.	Low
Integrate EVSE into existing development plans	Med.	High	High
Municipal Fleets			
Update purchasing policies	Low	Low	Med.
Future proof lots with conduit, or added electrical capacity	Med.	High	Med.
Equity & Outreach			
Identify underserved communities and hold needs surveys	Low	Med.	Med.
Hold events like Ride and Drives and info campaigns	Low	Med.	High
Siting & Design			
Identify sites in high traffic and commerce areas	Low	Med.	High
Install bollards, and cord retraction systems	Med.	Med.	High
Review accessibility, signage & wayfinding guides	Low	Med.	Med.
Financial Analysis			
Apply to relevant grants	Low	High	High
Review secondary revenue & fee structures	Low	Med.	High
Calculate local need	Low	Med.	Med.
Other considerations			
Provide safety information to first responders	Low	Med.	High
Join a stakeholder group for technical assistance	Low	Low	High

Table 1 Key:

Low ○	Medium ◒	High ●

The State of EVs

Projections

Between 2019 and 2021, 150 different EV models were released.[7] Many mainstream automobile manufacturers have committed to selling millions of EVs by the end of the decade, and some anticipate electrifying their entire range of vehicle models.[8]

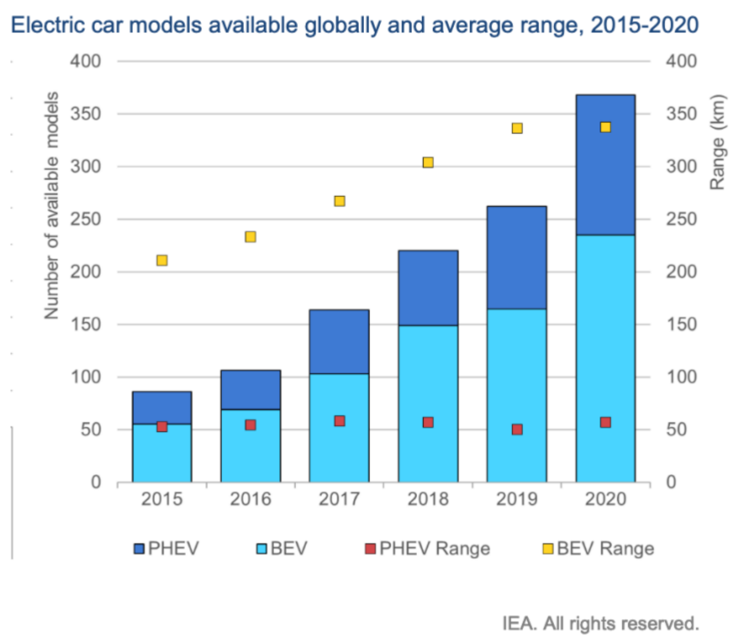

Figure 2: Number of Electric Vehicle models from 2015-2020 (Source: IEA 2021 EV Outlook)

In step with manufacturers, President Biden signed an executive order in August of 2021 which set a goal of 50% EV sales share in 2030.[9] To achieve that, funding is being invested through in the Bipartisan Infrastructure Law (BIL), enacted as the Investment and Jobs Act (IIJA), and other federal programs. In particular, the National Electric Vehicle Infrastructure (NEVI) Program will provide up to $7.5 billion in funding to help support the installation of EVSE and the procurement of EVs.[10]

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[7] IEA (2022), *Global EV Outlook 2022*, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2022
[8] IEA (2021), *Global EV Outlook 2021*, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2021
[9] President Joe Biden. (2021). *Executive order on strengthening american leadership in clean cars and trucks.*https://www.whitehouse.gov/briefing-room/presidential-actions/2021/08/05/executive-order-on-strengthening-american-leadership-in-clean-cars-and-trucks/#:~:text=America%20must%20lead%20the%20world,or%20fuel%20cell%20electric%20vehicles.
[10] The National Electric Vehicle Infrastructure (NEVI) Formula Program Guidance, (2022).

Consumer demand for EVs is growing rapidly. Between 2022 and 2028, the EV market size is projected to grow to $980 billion, at a compound annual growth rate of 24.5%.[11] In March of 2022, customer interest in used EVs spiked 69% as gas prices rose.[12] While the price increase may not last, consumers are increasingly considering fuel costs and EVs.

EV Basics

EV drivers will notice positive differences with their new vehicle. EVs boast higher acceleration and torque compared to ICEVs. All-electric vehicles have smaller engines which increases storage space. Coupled with onboard outlets like those in the Ford Lightning F150, which can power a house for 10 days, EVs can also help drivers bring their tools on the road.[13]

Not all EVs use electricity in the same way. Vehicles that are always powered by electricity are referred to as All-electric vehicles or Battery Electric Vehicles (BEV), as opposed to hybrid vehicles, which can still use liquid fuels like gas. Hybrid EVs (HEV) have both an ICE and battery. Plug-in Hybrid EVs (PHEV) can be plugged into an electric power source to charge their batteries, which often operate until they are out of electricity, at which point the ICE takes over. Hybrids that cannot plug in to external electric power sources have their battery charged by regenerative braking.

Charging a BEV/PHEV is different than fueling an ICEV. The EV battery can accept varying amounts of electricity based on the electricity sources they are connected to and the capacities of their batteries. Similarly, different vehicle models require different connectors to plug in to the vehicle's charging port. In the United States EVs use the standard J1772 connector for Level 1 and Level 2 charging. Fast charging has three different connector types. Currently only the Nissan Leaf uses the CHAdeMO, with other non-Tesla EVs using the CCS connector. Here are the standard speeds and connectors used for EV charging:

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[11] Global Newswire. (2022). At 24.5% CAGR, global electric vehicle market size & share to surpass US$ 980 bn by 2028 | EV industry trends, growth & forecast report by facts & factors. Retrieved from https://www.globenewswire.com/en/news-release/2022/03/15/2403398/0/en/At-24-5-CAGR-Global-Electric-Vehicle-Market-Size-Share-to-Surpass-US-980-Bn-by-2028-EV-Industry-Trends-Growth-Forecast-Report-by-Facts-Factors.html

[12] Cox Automotive. (2022). Interest in EVs and hybrids spike as fuel prices rapidly increase. Retrieved from https://www.coxautoinc.com/market-insights/interest-in-evs-and-hybrids-spike-as-fuel-prices-rapidly-increase/

[13] McCandless, J. (2022). How can the electric ford F-150 lightning power a house for 10 days? Retrieved from https://www.newsweek.com/how-can-ford-f-150-lightning-power-house-10-days-1704444

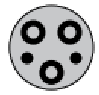
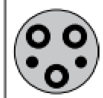
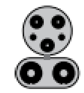
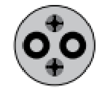
	Level 1	Level 2	DC Fast Charging
Connector Type[2]	J1772 connector 	J1772 connector 	CCS connector  CHAdeMO connector  Tesla connector 
Typical Power Output	1 kW	7 kW - 19 kW	50 - 350 kW
Estimated PHEV Charge Time from Empty[3]	5 - 6 hours	1 - 2 hours	N/A
Estimated BEV Charge Time from Empty[4]	40 - 50 hours	4 - 10 hours	20 minutes - 1 hour[5]
Estimated Electric Range per Hour of Charging	2 - 5 miles	10 - 20 miles	180 - 240 miles
Typical Locations	Home	Home, Workplace, and Public	Public

Figure 3: Overview of EV connectors, power outputs and standard locations (Source: US DOT)

It's important to understand the best cases for each level of charging. Unlike refueling an ICEV at a gas station, 80% of EV charging occurs at home.[14] The vast majority of EV charging will be residential Level 1 (L1) or Level 2 (L2) charging. Since average daily travel is around 40 miles, EV owners with L2 charging at home can recoup that range with an overnight charge.[15]

However, there are two important caveats to the utility of residential charging. First, this does not account for long-distance travel. When traveling on the highway, it is unrealistic to expect an EV owner to stop for 8 hours and wait for their vehicle to charge. In these cases, Direct Current Fast Charging (DCFC) is recommended.

Second, not all EV owners will have access to charging at home. EV owners in cities where parking is at a premium, or in multi-unit dwellings (MUDs) where it's difficult to retrofit and install a charger, will have limited access to charging at home. For these users, who are a growing segment of the EV market, accessible public charging is crucial, and municipalities may consider requiring installation of charging equipment in new MUDs.

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[14] US Dept of Energy. National Plug-in Electric Vehicle Infrastructure Analysis. Sept 2017. https://www.nrel.gov/docs/fy17osti/69031.pdf
[15] veic. (2022). *Northern new england rural EV adoption toolkit*

NH EVSE

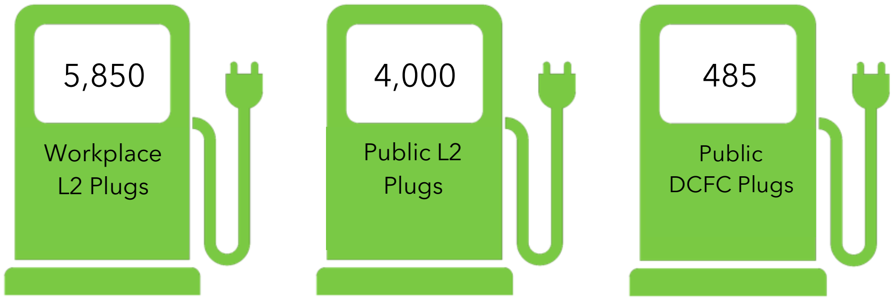

Figure 4: Number of Charging Plugs Needed in NH by 2030

By 2030 it is projected that there will be 30,000 to 145,000 Battery EVs and 62,000 Plug-in Hybrid EVs in NH.[16] To support those EVs 5,850 workplace charging plugs, 4,000 public L2 plugs, and 485 public DCFC plugs are needed.[17] That means quadrupling the number of existing DCFC charging plugs and adding 3,750 public L2 plugs.

Chargers are important to support tourism, and NH's economy. Accessible charging across the state supports a growing segment of the tourist population. Currently VT receives nearly twice as many overnight visitors from Canada as NH does.[18] While VT and Quebec have extensive charging networks, there's a lack of DCFC stations in northern NH.

NH has several sustainable transportation laws and regulations in place, and guidance from the [Electric Vehicle Charging Stations Infrastructure Commission](). Several key considerations are how utilities must consider creating Time of Use (TOU) rates for charging, school districts are responsible for establishing policies to reduce emissions from their buses and fleets, and diesel drivers must reduce idling. The state hopes to make sustainability progress itself, as the state fleet must reduce its emissions by 30% compared to a 2010 baseline.[19]

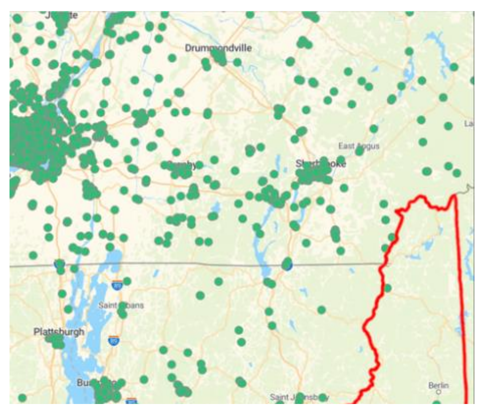

Figure 5: DCFC locations in North Country (Source: AFDC)

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[16] National Renewable Energy Laboratory. "Personally Owned Light Duty Vehicle Stock," *State and Local Planning for Energy*, accessed 7/19/2022, https://maps.nrel.gov/slope.

[17] US Department of Energy. (2022c). *Electric vehicle infrastructure projection tool (EVI-pro) lite.*https://afdc.energy.gov/evi-pro-lite (85,000 EVs, Full-support, and 90% access to home charging)

[18] Brand, B., & Elander, M. (2020). *Expanding EV charging in the north country: Insights from north of the notch*

[19] Alternative Fuels Data Center: New Hampshire Laws & Incentives https://afdc.energy.gov/laws/all?state=NH#Laws%20and%20Regulations

Figure 6: Existing and Pending AFCs in NH (Source: NH DOT)

Over the next five years the state, supported by the NH Department of Transportation and NH Department of Environmental Services primarily, will be developing EVSE across major highways, leveraging the $17 million it received in funding from the IIJA. The funds will be allocated through RFPs, focusing first on interstate routes, and then on state highways. Interested municipalities should review the Alternative Fuel Corridors nominated by NH DOT, as they represent potential areas where projects will be accepted (generally within 1 mile of the highway).

For information on the plan, visit NH DOT's charging infrastructure website. The NH DOT website and social media will also communicate updates, and if you're interested in sending feedback the following email address can be used: ev-infrastracture@dot.nh.gov

The Case for EVs

Local Economic Benefits

Charging infrastructure, and its fee structures, can drive behavior. As EV owners plan their days, they will look to charging infrastructure to determine where to get groceries, shop, or eat dinner. EV owners are likely to spend more time and more money at retail locations with chargers than their ICEV counterparts.[20] In addition to the increased time and money, EVSE creates customer loyalty, encouraging them to return time and again. Deploying EVSE downtown will draw EV owners to the amenities located near public charging infrastructure.

Additionally, fossil fuels are more volatile in price, so EVs represent a more consistent bill for residents. Electric payments stay local too; for each dollar spent on an electric bill, 62 cents will stay local, compared to 25 cents or lower for fossil fuels.[21]

Public Health Improvements

Emissions from ICEVs impact local health. Tailpipe emissions that form "smog" negatively affect pulmonary health, particularly for residents near highways or busy roads.

While municipalities can make their communities more attractive to visitors driving EVs, they can also encourage EVs in their communities and in their fleets. Air quality benefits from large scale transportation electrification can lead to significant benefits in NH.

Table 2: Benefits of zero-emission transportation and generation (Source: American Lung Association)[22]

State	Cumulative Health Benefits, 2020 - 2050			
	Health Benefits (Billions)	Premature Deaths Avoided	Asthma Attacks Avoided	Lost Work Days Avoided
New Hampshire	$3.9	356	5,860	32,800

[20] Satterfield, C., & Nigro, N. (2020). *Public EV charging business models for retail site hosts*
[21] Vermont Agency of Commerce and Community Development, 2021
[22] American Lung Association 2022 Road to Clean Air Report. https://www.lung.org/getmedia/13248145-06f0-4e35-b79b-6dfacfd29a71/zeroing-in-on-healthy-air-report-2022.pdf

DRIVE ELECTRIC NH

Local Grid Stability

EVs represent a new class of resources on the grid. More electricity will be drawn than in the past. This increased demand will lead to an opportunity to improve the electricity grid.

As climate change worsens and the effects of extreme weather amplify, the likelihood of blackouts and disruptions to electricity may increase. Energy storage can increase local resiliency. Different battery technology capabilities are highlighted by the DOE. [23][24][25] Mobile energy storage devices, like EV batteries, can be deployed on-site at emergency locations, serving as an uninterruptable power supply, and microgrid.

Sustainability

Municipalities with GHG reduction goals can make significant progress with EVs. EVs emit 57-68% fewer GHG emissions than ICEVs during their lifecycle.[26] Emissions are even lower if you are only evaluating vehicle operation, and not accounting for manufacturing. Likewise, if the EV is charged by renewable sources the emissions from operation shrink considerably. The DOE's alternative fuel tools can calculate fleet emissions.

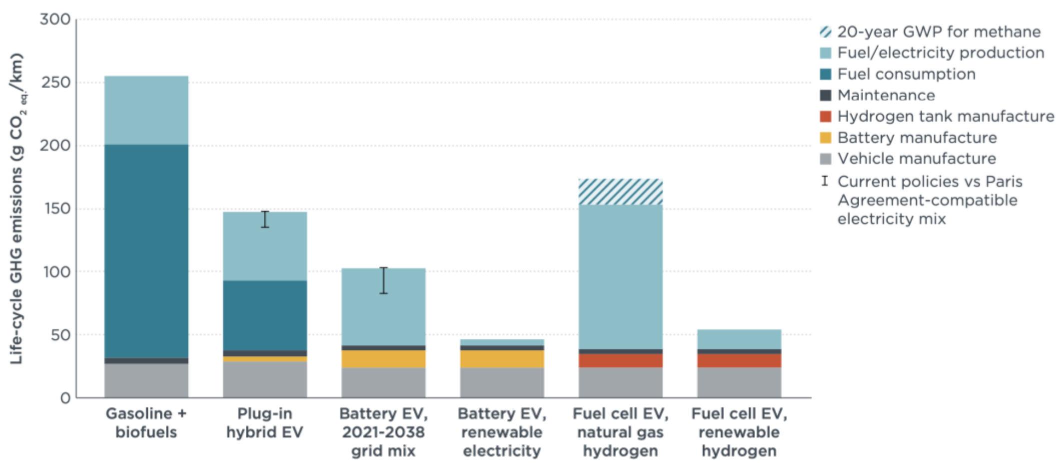

Figure 7: Lifecycle Emissions from US ICEV & BEVs (Source: Bieker)[27]

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[23] U.S. Department of Energy, "Grid Energy Storage," December 2013. https://www.energy.gov/sites/prod/files/2014/09/f18/Grid%20Energy%20Storage%20December%202013.pdf

[24] PJM Interconnection, "PJM's Evolving Resource Mix and System Reliability," March 30, 2017. https://www.pjm.com/~/media/library/reports-notices/special-reports/20170330-pjms-evolving-resource-mix-and-system-reliability.ashx

[25] Milligan Grid Solutions, "Sources of Grid Reliability Services," 2018. http://milligangridsolutions.com/Sources%20of%20Essential%20Reliability%20Grid%20Services%20Fact%20Sheet.pdf

[26] Bieker, G. (2021). A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars. *The International Council on Clean Transportation*

[27] Ibid.

Financial Analysis

Calculating Local Need

Municipalities will have unique charging needs based on the number of EV drivers and the amount of existing supply equipment. 2020 DMV data on the existing amount of EVs in your town or county can provide a baseline for the number of drivers in your local area. Projecting your future EV base will be critical in ensuring long term plans meet local needs.

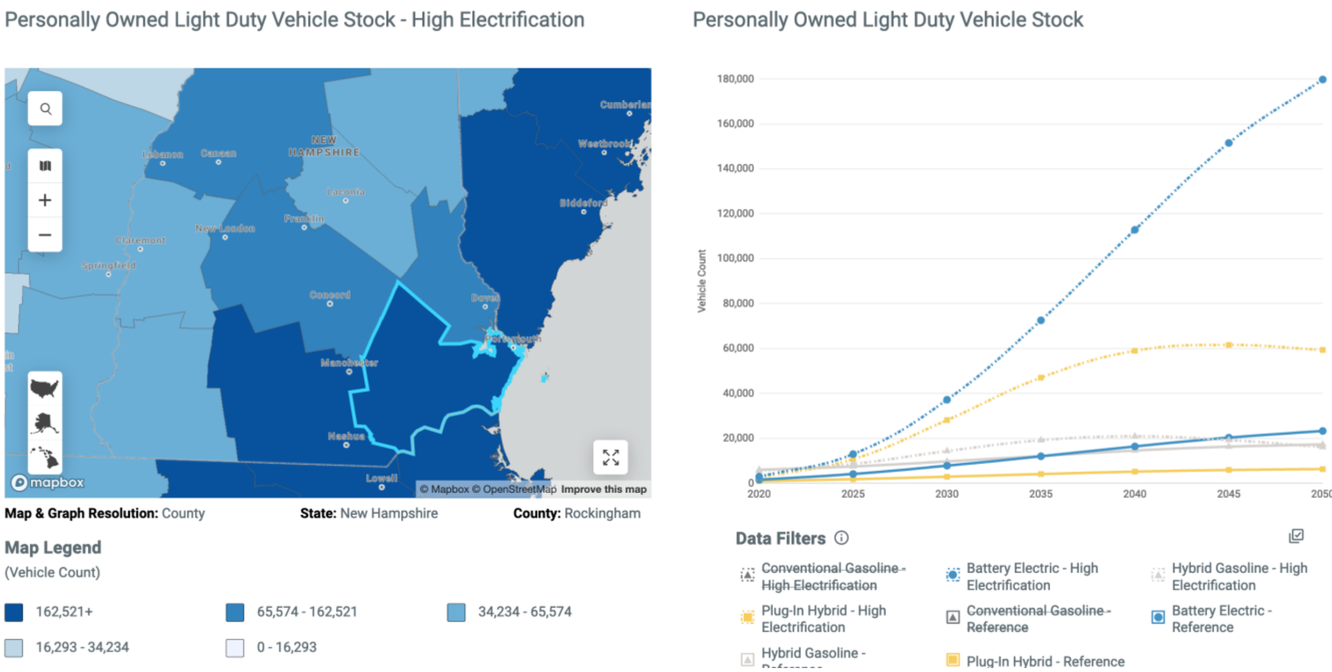

Figure 8: Map of Electric Vehicles in NH Counties (Source: NREL Data Viewer)[28]

The National Renewable Energy Laboratory provides county level data on the current numbers of EVs and ICEVs, and projects future vehicle stocks based on a reference scenario, and a high electrification scenario (which represents a scenario where many vehicles are electrified). Understanding the size of your municipality within the county, you can approximate the number of EVs to expect in the coming years.

After approximating the number of future EVs in your community, it's time to determine how much charging is needed to support those drivers. Using the Department of Energy's EVI-Pro Lite tool, you can understand the necessary amount of workplace, Level 2, and

[28] National Renewable Energy Laboratory. "Personally Owned Light Duty Vehicle Stock," *State and Local Planning for Energy*, accessed 7/19/2022, https://maps.nrel.gov/slope.

DCFC chargers. Currently the tool focuses on urban areas, but rural needs can be approximated if you know the number of vehicles to support.

Electric Rates

The cost of EVSE is heavily tied to electric rates. Most non-residential electric bills include base charges, delivery charges, transmission charges, electricity consumption charges, and demand charges. The two fees most directly influenced by EV charging behavior are the electricity consumption charges, which is your total electricity consumption over the month times a cost per unit, and demand charges.

New Charges	Units		Cost Per Unit	Charge
Basic Charge (fixed fee)				$23.00
Electricity Consumption	23,245	kWh	$0.16253	$3,778.01
Demand Charge - 15 min kW			*Total Demand Charges:*	$4,306
On-peak	500	kW	$7.13	$3,565
Off-peak	150	kW	$4.94	$741
Delivery Charge	23,245	kWh	$0.00619	$143.89
Transmission Charge	23,245	kWh	$0.00266	$61.83
Total Due				**$8,312.73**

Figure 9: Demand Charge Bill (Source: Renewable Energy World)[29]

Demand for electricity rises throughout the day, generally peaking around the 4PM to 8PM time frames. Utilities need to maintain enough capacity for generation and distribution of electricity at all times, including peak hours. A large amount of expensive equipment, and backup power production facilities, need to be kept on standby for peak demand periods.

To help spread out the consumption of electricity throughout the day, and ideally reduce the amount of costly standby equipment, utilities will charge non-residential costumers demand charges. The cost of demand charges will depend on the utility, but the critical components are peak demand and the demand charge rate. Peak demand is often the highest amount of power used during the highest use 15-minute period in a month. This peak demand is then multiplied by the rate set by the utility to determine the demand charge for the month.

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[29] Brown, G. (2017). *Making sense of demand charges: What are they and how do they work?*https://www.renewableenergyworld.com/wind-power/making-sense-of-demand-charges-what-are-they-and-how-do-they-work/#gref

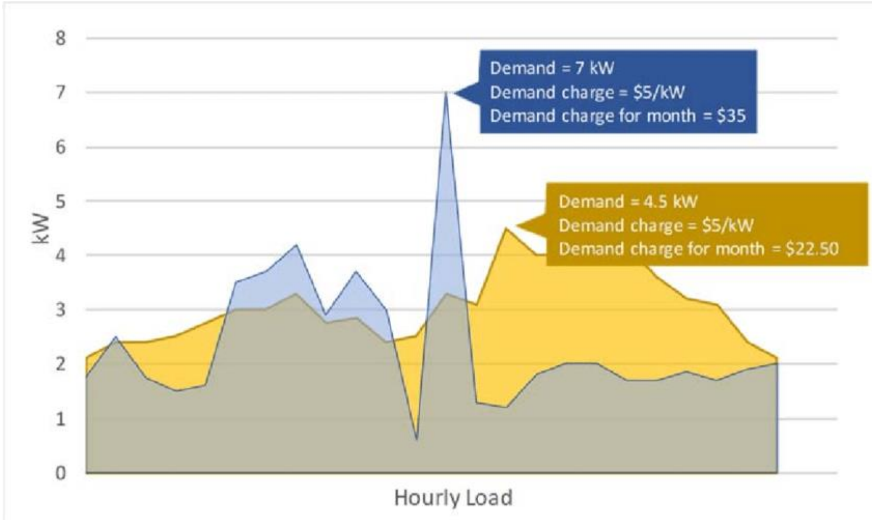

Figure 10: Graph of Demand Charges for two different customers (Source: Whited et al.)[30]

Demand charges can make the financials of owning DCFC or even Level 2 EVSE challenging. The NEVI formula program, for example, requires charging locations to have four 150kW charging stations. Peak demand for these chargers can reach 600kW, if all EVSE is used at once. One way to make revenue on publicly owned stations is to charge for the electricity consumed. However, if peak demand is high and the usage of the stations is low then demand charges will be very costly and the revenue from sold electricity will be low, and likely not enough to recoup losses from demand charges.

A way to reduce demand charges is to create a 'power-shared' or load-managed system of EVSE.[31] When one charging station is in use the full power will be supplied. When multiple charging stations are used the electricity will be split between the stations. For charging locations that anticipate low usage in the beginning this approach can be a valuable way to prevent costly demand charges while offering full charging most of the time. Similarly, adding EVSE to meters with already high demands can be a lower cost option. Partnering with NHSaves, and performing an energy assessment and reviewing Energy Efficiency standards may identify areas to reduce existing load as well.

Electricity consumption fees can be reduced when you pair charging stations with on-site electricity generation or storage. Solar panels can power the charging stations when receiving sunlight as EVSE are in use, and batteries can discharge electricity to EVSE when

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[30] Whited, Melissa & Kallay, Jennifer & Bhandari, Divita & Havumaki, Ben. (2018). Driving Transportation Electrification Forward in Pennsylvania: Considerations for Effective Transportation Electrification Ratemaking. 10.13140/RG.2.2.19734.78403.
[31] ChargePoint. (2022). *Power management FAQ*
.https://www.chargepoint.com/products/power-management-faq

the batteries are full. These technologies are not as reliable in decreasing demand charge fees though since timing the demand peak with renewable electricity generation is inconsistent.

Utility Incentives

Some NH utilities provide incentives for electric vehicles and charging equipment:

Incentive	Description
NHEC – Charging Station Rebates (Commercial) (Residential)	NHEC provides a rebate on municipal and commercial and residential charging stations. Residential • $300 per charger • Maximum $600 per property Commercial • 75% of the install cost, up to $2,500 Maximum $5,000 per property
NHEC – EV Rebates	New Hampshire Electric Co-op provides a rebate on Electric Vehicle purchases, depending on the type of vehicle. $1,000 for Battery Electric Vehicles $600 for Plug-in Hybrid Vehicles $300 for Electric Motorcycles
NH Utilities – Time of Use (TOU) Rate	Liberty Utilities, Unitil, Eversource, and NHEC all offer different forms of TOU rates where customers pay lower rates during off-peak hours

In the future more incentives may be available through utilities or at the state level. Looking to incentivize innovative technologies, NHEC is currently piloting a Transactive Energy Rate (TER) with Plymouth State University (PSU). Although most EVs draw electricity from the grid, they can also supply electricity to the grid with the appropriate charging equipment. In doing so, they can help utilities balance the electric load by providing electricity when demand is highest and drawing electricity when it is lowest. Currently PSU is leasing two Nissan Leafs and estimates they will be able to pay their vehicle leases with the credits gained from their TER.[32] Increased use of this vehicle-to-grid technology can stabilize the energy grid and provide an additional source of revenue for EV owners.

[32] Plymouth State University. (2021). New electric cars to power energy savings. Retrieved from https://www.plymouth.edu/news/new-electric-cars-to-power-energy-savings/

Charger Selection & Fee Structures

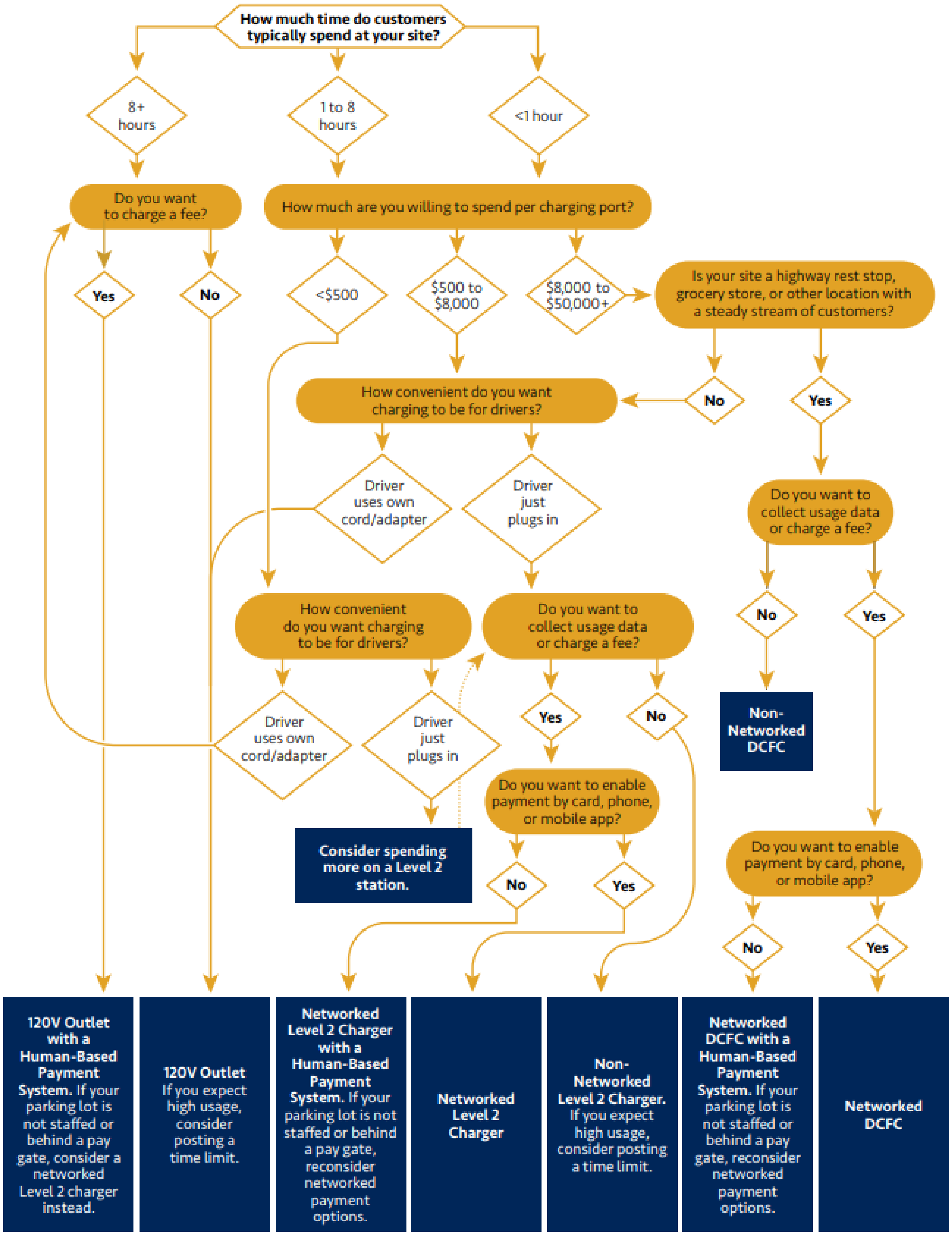

Figure 11: Charger Selection Decision Tree (Source: USDOE)

When considering what type of charger to use, it's important to think about fee structures early on. Based on your community goals, charging may be free, or it may be a service and an additional source of revenue.

EV charging stations have different capabilities depending on their network capability and the provider. The cities of Pittsburgh and Vancouver provide information on the creation of their rate structures. Altering the fees and availability of EV charging can drive the behavior of EV owners who stop to use the stations. Consider the behavior that is most beneficial to the goal of promoting EVSE in your community, and then work with EV charging equipment providers to ensure their products can meet your needs:

- Costs
  - **Free charging** can increase usage, but can require a mechanism to prevent the EV from monopolizing the charger after charging is complete
  - **Flat fees** are simple to understand, but don't drive specific behaviors
  - **TOU rates** adjust based on "peak" hours, incentivizing utilization when rates are lower
  - **Per Hour rates** integrate easily into existing parking fees
  - **Per kWh rates** are good for locations with longer dwell times, and fair for drivers with vehicles that charge at lower speeds
  - **Driver group prices** can be offered so employees pay less than the public
  - **Length-of-stay price** is a method to charge a certain amount for an initial time period and then a second amount for subsequent periods
  - **Combination approaches**, such as charging a flat rate for the first hour, then an increased time-based per-hour rate for longer sessions is a custom pricing strategy to encourage people to move their EV once charging is complete
  - **Minimum / Maximum price per session**
  - **Idle / parking fees:** Collected to incentivize customer turnover and prevent EVs from monopolizing the charger after charging is complete. These fees can be collected after a certain amount of time, e.g., 10 cents per minute after 30 minutes. 25–50-minute retail stays provide the most value[33]
  - **User fee:** These are flat fees paid to gain access to the charging network. They can reduce the chance of unprofitability[34]
- Time Restrictions
  - No time restrictions on charging will increase accessibility for overnight parkers who do not have charging capabilities at home

[33] Satterfield, C., & Nigro, N. (2020). *Public EV charging business models for retail site hosts*
[34] Ibid.

Secondary revenue, especially advertising, can be valuable for increasing profitability of EVSE. Certain charging stations can display advertisements on their screens, like gas stations. The use of advertising on downtown lots can be a valuable way to promote the local restaurants and shops that stand to benefit from the increased traffic.

Incentives & Grants

Receiving grants for EVSE can offset project costs. Several funding opportunities can provide a large portion of the upfront capital needed to procure EVs or EVSE.

The Department of Transportation provides a list of funding opportunities rural EV toolkit available, including many of the following most important programs, and more:[35]

- NH Community Development Finance Authority
- NEVI Formula
- USDA Community facilities direct loan
- USDA Rural business development grants
- Congestion Mitigation and Air Quality (CMAQ) Improvement Program
- EPA Diesel Emission Reduction Act
- NH Clean Diesel Grant Program
- FTA Low or no emission vehicle program
- EPA Clean School Bus Program
- Qualified Plug-in Electric Drive Motor Vehicles (IRC 30D)
- Federal Lands Access Program (FLAP)
- FTA Grants for Buses and Bus Facilities
- Title XVII Renewable Energy and Efficient Energy Projects
- Rebuilding American Infrastructure with Sustainability and Equity (RAISE)

The Database of State Incentives for Renewables & Efficiency is one source of information on incentives. Additionally, the US DOE Alternative Fuels Data Center maintains a database of Federal and State Laws and Incentives.

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[35] Department of Transportation. (2022). *Rural EV infrastructure funding matrix* .https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-funding-and-financing/funding-matrix

Cost Saving Opportunities

Charging infrastructure components can be expensive and have a wide range of costs. When evaluating the appropriate infrastructure review Table 3, which provides a general idea of what may be feasible based on your budget.

Table 3: Average Cost ranges for charging infrastructure components[36]

COST ELEMENT	LOWEST COST	HIGHEST COST
Level 2 residential charger	$380 (2.9 kW)	$689 (7.7 kW)
Level 2 commercial charger	$2,500 (7.7 kW)	$4,900 (16.8 kW); outlier: $7,210 (14.4 kW)
DCFC (50 kW)	$20,000	$35,800
DCFC (150 kW)	$75,600	$100,000
DCFC (350 kW)	$128,000	$150,000
Transformer (150–300 kVA)	$35,000	$53,000
Transformer (500–750 kVA)	$44,000	$69,600
Transformer (1,000+ kVA)	$66,000	$173,000
Data contracts	$84/year/charger	$240/year/charger
Network contracts	$200/year/charger	$250/year/charger
Credit card reader	$325	$1,000
Cable cost	$1,500	$3,500

Procuring multiple charging stations at one time has been shown to reduce average installation per port. This benefit is more noticeable at remote sites far from electrical capacity, as the cost to meet charger needs can be significantly reduced when spread across several chargers. [37] Retrofitting locations is also much more expensive than installing EVSE during new construction where repaving efforts are already occurring. [38]

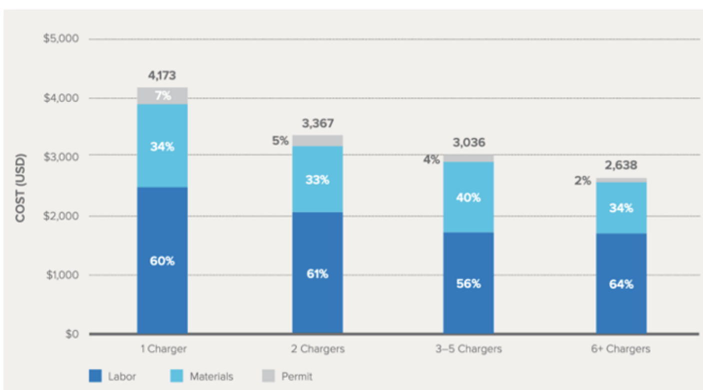

Figure 12: Install costs per # of chargers (Source: RMI)

Network data fees are projected to come down in price in the future, so shorter plans for data could be beneficial, instead of being locked into longer, higher price rates. A data plan may cost $20 a month, which could over a year equal the price of purchasing a L2 charging station.

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[36] Nelder, C., & Rogers, E. *Reducing ev charging infrastructure costs*
[37] Ibid.
[38] Hutchins-Knowles, L. (2022). *EV charging in new multi-family household*

Siting

Providing "destination charging" where EV owners charge while engaging in other activities has been proven to increase usage. Municipal parking lots are a common place to start, but locations like recreational areas, community centers, beaches, or privately owned locations like laundromats, restaurants, hotels, retail sites, and cinemas can promote high usage. Properly siting EVSE to maximize usage is vital to ensure EVSE does not become a financial burden on the communities that host them. MJ Bradley & Associates provide an infrastructure planning tool that evaluates main roads and highway exits for potential sites based on traffic levels and the amount of commercial activity nearby.[39]

Existing Infrastructure

Most EV drivers will have an application to find the charging stations most convenient to them. Some commonly used applications are Plugshare, Chargemap, EVgo, EVmatch, and ChargePoint. Start the siting process by understanding where existing EVSE is located. Consider the most common roads for traffic, and if drivers have access to EVSE when taking roads in or out of town.

After a location has been selected, it's important to involve your local utility. Your utility can provide you with information on the electrical capacity of any site, and the feasibility / cost of potentially upgrading it. Upgrades to electrical capacity can be costly, and dramatically increase the upfront capital needed for a project. Locations with existing conduit, are on three-phase power, and have sufficient electrical capacity to support the addition of EVSE are ideal candidates. If the capacity needs to be upgraded, consider adding more than is needed so the location can have more charging stations added at a lower cost in the future. Repave efforts, trenching, and boring are all expensive, and future-proofing locations reduces the cost of adding more EVSE later. Meeting with your Regional Planning Commission (RPC) to discuss their plan for a local, integrated EV charging map will help ensure continuity across your region.

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[39] "All rights reserved. Neither the Infrastructure Location Identification Tool nor the Visualization Map, nor any part of either, may be reproduced, stored in a retrieval system, reverse-engineered, or transmitted in any form or by any means, electronic, mechanical, or otherwise, without the written permission of M.J. Bradley & https://www.mjbradley.com/news-events/mjba-releases-version-30-electric-vehicle-infrastructure-tool

Design Guidelines

Consider placing EV parking spaces in desirable locations close to building entrances, under canopies, or in well-lit areas. It is likely cheaper to mount charging stations on walls to keep wires inside, or near grassy areas where pavement disturbances are limited, so evaluate both to determine the appropriate balance of costs and convenience.

The US Access board has basic guidelines for how to make EVSE parking spaces accessible. Spacing requirements are detailed within their guide and other design guidelines.[40] [41]

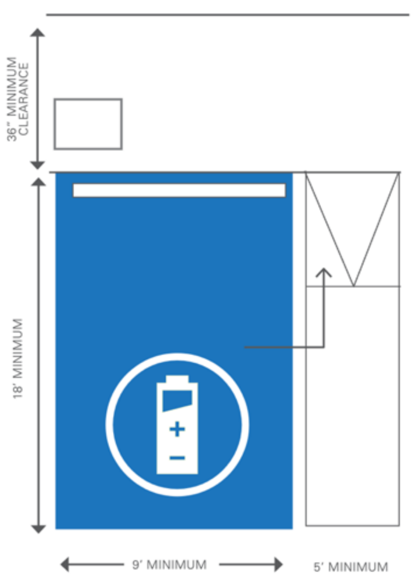

Figure 13: Accessibility considerations for parking (Source: WXY Architecture + Design)

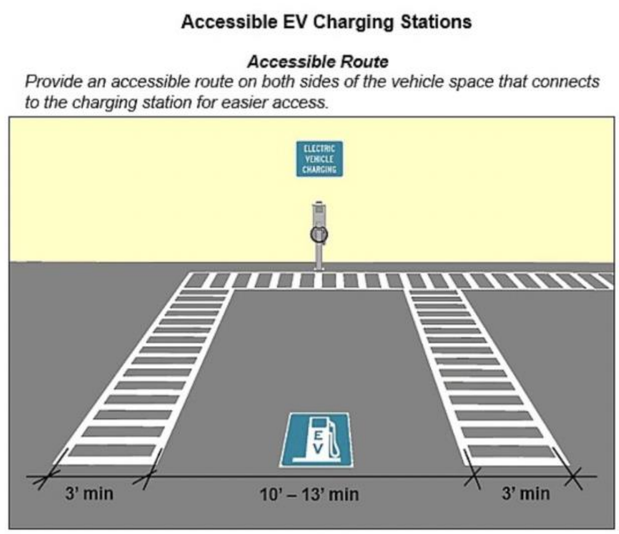

Figure 14: Guidance on Accessible EV Parking (Source: ADA)

[40] *ADA standards: Chapter 5: Parking spaces.* (2022). https://www.access-board.gov/ada/guides/chapter-5-parking/#electric-vehicle-charging-stations

[41] WXY Architecture + Urban Design. (2012). *Siting and design guidelines for electric vehicle supply equipment*
https://www.transportationandclimate.org/sites/default/files/EV_Siting_and_Design_Guidelines.pdf

NH's climate adds an additional factor to account for in design: snow, ice, and plowing. Cords can become stuck in the snow, and damaged by plows. Installing a cord retraction system can help alleviate this.[42] In general, plowing practices should be considered so charging stations are accessible. Additionally, protecting charging stations with bollards and tire stops prevents most damage charging stations could face from vehicles.

Figure 16: Tire stops used for EVSE protection (Source: Energetics)

Figure 15: Cord cut from plows (Source: Energetics)

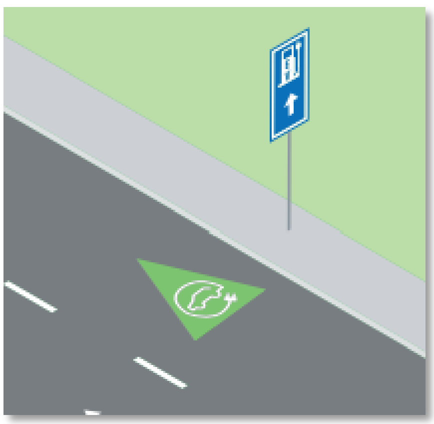

Figure 17: Wayfinding and signage (Source: WXY Architecture + Design)

Another important guideline is signage and wayfinding, which can assist EV drivers in finding EV charging sites. Typical additions are EV specific painted figures on the lot. Any time restrictions should be noted by signage posted at the parking space. Similarly, if these spaces are reserved for EVs, the consequences of parking in them with ICEVs (whether a fine or being towed) should be easily understood and clearly visible.

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[42] Energetics Incorporated. (2017). *Charging station EVSE installation analysis* *https://tompkinscountyny.gov/files2/itctc/projects/EV/Tompkins%20EVSE%20Installation%20Analysis%20FINAL.pdf*

Local Policy

At the municipal level some of the easiest solutions to implement will be the cheapest ones. Local policy, while it may require effort to win over residents, can create a significant impact on EV adoption.

Summary of key city policies

Benefits & impact key: High, Medium, Potential Negative
Dificulty & cost key: Low, Medium, High

		Benefits & impact					Difficulty to pass	Current cost to implement
		Direct GHG reduction	Health	Equity benefits	Jobs	Market impact		
Charging infrastructure	1. Infrastructure deployment	Medium	High	High	High	High	Medium	High
	2. EV-ready buildings & businesses	Medium	Medium	High	High	Medium	Medium	Low
	3. Equitable charging	Medium	Medium	High	High	Medium	Medium	Medium
	4. Streamlined charging approval (permits)	Medium	Medium	Medium	Medium	Medium	Low	Medium
Multi-sector	5. Zero emission (ZE) areas, diesel bans, or similar	High	High	High	High	High	High	Medium
	6. Road tolls and CO_2-focused congestion pricing	High	High	Potential Negative	Medium	Medium	Medium	Medium
	7. Funding for electric vehicles and charging	High	High	High	Medium	High	Medium	High
Freight	8. Zero emission freight/delivery zones/curb access	High	High	High	High	High	Medium	Medium
	9. Zero emission ports and inland hubs/ warehouse districts	High	High	High	High	High	High	High
Fleets (buses, light-duty)	10. Zero emission bus requirements & rollout	High	High	High	Medium	High	Medium	High
	11. Fleet EV funding and business models	Medium	Medium	Medium	Medium	High	Low	High
	12. Light-duty city fleet requirements	High	Medium	Medium	High	High	Low	Medium
	13. EV procurement and use policies (all classes)	High	Medium	Medium	Medium	Medium	Low	Medium
Consumer	14. ZE mobility service provider/taxi deployment	Medium	Medium	High	Medium	High	Medium	Medium
	15. City programs for faster uptake (bulk purchase agreements & dealer & education campaigns) (action)	Medium	Medium	High	Medium	Medium	Medium	Medium

Figure 18: Key Policy summary by Climate Mayors

Master Plans

Infrastructure costs from EVSE can be significant. The lowest cost projects are ones where electrical infrastructure is already in an "EV-ready" state, or where repaving is done in tandem with other efforts. Including EVSE in municipal plans for future development can significantly lower the cost of implementation. Identifying projects that require repaving, such as those within a capital improvement plan, can provide opportunities to introduce EVSE while meeting other local goals. New EVSE installation projects should be included in capital improvement plans to detail the timeline and budget with respect to other ongoing works.[43]

[43] Proposed Capital Budget, Fiscal Year 2021: Palo Alto (pg: 92) https://www.cityofpaloalto.org/files/assets/public/administrative-services/city-budgets/fy-2021-city-budget/fy-2021-proposed-city-of-of-palo-alto-capital-budget-for-web.pdf

Tax Incremental Financing (TIF) can be used with local development. TIF, designed to promote public areas, were successfully used in Peterborough, NH to install EVSE near their Depot square, with the intention for it to draw visitors to the town and spend locally.[44]

Ordinances & Code

Types of EV Parking Spaces

Parking spaces have different terms in the context of EV charging:

An EV capable parking space is one where the conduit is run, but there are no wires, and nothing to plug into.

An EV ready parking space has the conduit and wires run. There's normally an outlet or receptacle that can be plugged into.

An EV charging station has all the electrical work done, and a charging station available for EV owners to use.

Parking Space Ordinances

The infrastructure costs of implementing EVSE can be significantly reduced when paired with other construction efforts. A common tool for local ordinances is to require or encourage several parking spaces to be "EV-ready" when parking lots are constructed or significantly reworked.

Example ordinance language from Dover can be seen below:

> Site Plan Review ➢
> [1] Multi-family residential projects: 5% of the total number of new parking spaces.
> [2] Non-residential projects: 2% of the total number of new parking spaces.
> [3] The number would be rounded up in all cases with a minimum of one space of electric vehicle charging readiness per project requiring Site Plan Review
>
> If the percentage of parking spaces providing EVSE is greater than that of section (a), the applicant shall be eligible for a fifty-percent reduction in the paved area application fee.

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[44] Stinneford, J. (2022, April 4th,). Peterborough unveils charging stations for electric vehicles. *Monadnock Ledger Transcript,* Retrieved from https://www.ledgertranscript.com/Peterborough-Puts-in-Electric-Vehicle-Charging-Stations-45767103?utm_source=HeadlineAlerts&utm_medium=DailyNewsletter&utm_campaign=HeadlineAlerts

Conditional Use Permit ➢
[a] For uses that typically result in at least two hours or longer of parking the applicant shall provide one Level II commercial electric vehicle charging station for every 10 spaces requested over the parking maximum.
[b] For uses that do not typically result in at least two hours or longer of activity, the applicant shall provide two additional parking spaces that meet electric vehicle readiness requirements for every 10 parking spaces requested over the parking maximum.[45]

Reductions in paved area, permit application, or other fees may also entice parking lot owners to consider designating EV spaces. ACEEE provides a policy toolkit on vehicle efficiency strategies like parking maximums, congestion fees, and complete street designs.

Streamlining Permitting

Electric Vehicle Charging (EVC) Station Uniform Permit Application

Date Stamp

Application Date: __________
Municipal Permit #: __________
Property Owner's Name: __________
Property Owner's Address: __________
Telephone: (____) __________ Fax: __________
Cell Phone: (____) __________
Email Address: __________
Applicant's Name: __________
Contractor's Business Name: __________
Contractor's License #: __________
Address: __________
Telephone: (____) __________ Fax: __________
Cell Phone: (____) __________
Email Address: __________

Occupancy Type: Check One
RESIDENTIAL: □ One Family □ Two Family □ Three Family □ Multi Family
COMMERCIAL: Please describe: (i.e. Retail, Business, Parking Garage)

Manufacturer of Charging Station: __________

Location of Charging Station (i.e. Garage, Front or back of building) __________

Type of Charging Station: Wall mounted □ Pedestal type □

□ Level I (120 volts) □ Level II (208/240 volts) □ Level III (480 volts)

EXISTING SERVICE:
Size of Main Breaker: ___ Amps Size of EV Branch Circuit ___ Amps

SERVICE UPGRADE: □ 60 Amps to 100 Amps
□ 100 Amps to 200 Amps
□ 200 Amps to 400 Amps
Please describe if other:

Size of Main Breaker: ___ Amps Size of EV Branch Circuit ___ Amps

NEW SERVICE:
Size of Main Breaker: ___ Amps Size of EV Branch Circuit ___ Amps

Figure 19: Standardized EVCS Permit (Source: Westport, CT)

As EVSE deployments are a growing field and many new owners are emerging, it is important to make the permitting process straightforward and efficient. Several techniques exist for streamlining the permitting and inspection processes and reducing some of the soft costs of installation.

Include as many details as possible about EVSE permit requirements online. This should include relevant fees, documentation needs, timelines associated with the process, and a contact person that can be reached for specific questions. If there are separate requirements based on the level of charging being installed, be sure to include those as well.

Providing a separate permit for EVSE installations makes the process clear for applicants.[46] Listing EVSE as a line item in standard electrical permits is valuable as well, opposed to an 'Other' option. Though this may not be possible for

[45] City of Dover, NH / Division 2 Planning Board Regulations / Site Review Regulations: Site Development Design Criteria, (2022). https://ecode360.com/33400293
[46] Town of Westport, C T. (2022). *Electric vehicle charging permit* .https://www.westportct.gov/Home/ShowDocument?id=15910

every municipality, receiving applications online and online signatures can speed up the process.

Municipalities have had success with using standardized checklists for both the permit application, permit review, and electrical inspection process. A review checklist should be provided to the relevant local authority, and any electrical inspection checklists provided to contractors should be available online.

City of Keene, NH
Electric Vehicle Charging Station (EVCS) Residential Permit Application Checklist

This permit application checklist is for residential (1 & 2 family) electric vehicle charging station installations. A complete building permit application is required for plan review. Applications will be processed in the order of receipt. Complete applications typically take 2-3 business days to review; however, they may take up to 10 business days. If you have any questions, please call the Community Development Department at (603) 352-5440 or email PermitTech@ci.keene.nh.us.

- Building permit application. Electronic submissions are encouraged.
  - Link to online permit application: https://talktomycity.com/create
  - Link to paper application: https://ci.keene.nh.us/sites/default/files/2018-07/Permit_application.pdf
  - Permit Type: Electrical
  - Building Use: One Family OR Multi-Family (specify two units)
  - Work Type: Renovation
  - Application must be signed by a licensed electrician. If you are the owner of a single-family home and you are not working with a licensed electrician, a signed homeowner affidavit is required.
- Application fee (see online fee schedule).
  - Note: For single family owner-occupied homes, there is a 10% discount for using a licensed electrician.
  - Application fee is not accepted until after the application is reviewed and approved.

INSPECTION CHECKLIST (non-inclusive), EVSE Inspection Activity Details

	Item	Inspection Activity	Code Reference	Comments
	1.	Verify permit is posted and all plans, calculations and installation instructions are available as required. May require use of examples in NEC Chapter 9. A calculation may be required to determine adequate capacity.	Local Regulations and NEC 90.8, 220.12, 220.14, 220.16, 220.82	
	2.	Verify that the EVSE is listed by an NTRL and installation instructions are provided	NEC 90.7, 625.5, 110.3(B)	
	3.	Verify the EVSE location and that it is securely fastened to the structure and guarded from physical damage as required.	NEC 110.13, 110.27(B), 625.40	
	4.	Determine if EVSE is directly wired to the branch circuit or is cord-and-plug connected. Must be listed for cord-and-plug connection. Individual receptacle reqd.	NEC 110.3(B), 625.10, 625.15, 625.16, 625.17, 625.18	
	5.	Verify an individual branch circuit is installed for the EVSE. Applies to Level 1	NEC Article 100 continuous load, 210.19(A)(1), 215.2(A), 625.40	

Figure 20: Application checklist (Source: Keene NH)[47] *Figure 21: Inspection Checklist (Source: San Luis Obispo County)*[48]

If you are searching for more guidance on incentives and local laws beyond those listed here, the Southern Maine Planning and Development Commission created zoning and ordinance guidance that may be practicable for your community, and the Alternative Data Fuels Center has examples from local incentives and laws gathered from across the nation.[49][50]

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[47] Keene, N. H. (2022). *Electric vehicle charging station (EVCS) residential permit application checklist.* https://keenenh.gov/sites/default/files/Community%20Development/Applications/Residential%20EVCS%20permit%20checklist.pdf

[48] County of San Luis Obispo. (2019). *Electric vehicle supply equipment (EVSE) inspection checklist.* https://www.slocounty.ca.gov/Departments/Planning-Building/Forms-Documents/Building-(Construction)-Forms-and-Documents/Renewable-Energy-Permits/BLD-2041-11082019-Electric-Vehicle-Supply-Equipmen.pdf

[49] Southern Maine Planning & Development Commission & Maine Clean Communities Coalition. (2021b). *Municipal EV readiness toolkit: Permitting guide*

[50] US Department of Energy: Energy Efficiency & Renewable Energy. (2022b). *Examples of local laws and incentives.* Retrieved June, 2022, from https://afdc.energy.gov/laws/local_examples

Municipal Fleets

Procuring EVs can demonstrate EV leadership in your community. The DOE provides guidance on rightsizing your fleet; minimally, a spreadsheet of costs, age, usage, mileage, maintenance, and condition should be maintained. If this information can be automatically gathered, work with your IT departments to ensure you have a data management plan.

Procurement

Updating Purchasing Policies

The procurement process can take years for some vehicles, so it's important to plan appropriately. Procurement policies can be used to institutionalize EVs and fuel efficiency in day-to-day local government decision making. Specifically, they may set anti-idling requirements, ensure fuel efficiency within vehicle classes, or require alternative fuel or hybrid options when creating procurement plans. ACEEE ranks cities across the US on their energy efficiency and provides a database of high-ranked cities which includes information on local transportation planning policies in addition to their procurement policy database.

Leasing EVs can decrease the costs of ownership. If local procurement policies restrict leasing, work to update them, and pursue leasing in addition to traditional procurement practices. Local fleets have mostly implemented these lease types: Fair Market Value, Terminal Rental Adjustment Clause, and Tax-exempt Lease Purchases.[51] Flexible procurement policies allow fleets to use ownership structures that fit best. Open-end leases provide the ability to upgrade vehicles when necessary, and leasing companies can use their knowledge of maintenance costs, and degradation to potentially reduce EV costs.

Example Procurement Documents

To facilitate smooth procurement processes, local governments can use the NH Department of Administrative Services. Municipalities can purchase form the State Contract (also known as the Vehicle Index) to assist with purchasing electric vehicles.[52]

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[51] Nigro, N., & Walsh, A. (2017). *Approaches to overcoming adoption barriers of plug-in electric vehicles in public fleets*
[52] NH Department of Administrative Services. (2022). *Statewide contracts* .https://apps.das.nh.gov/bidscontracts/contracts.aspx

Another method to increase the speed of procurement is to use cooperative purchasing through a partner like Sourcewell. As a government agency they can obtain contracts for vehicle purchasing on behalf of other government entities.[53] These contracts with manufacturers can help speed up the Request for Proposal (RFP) process.

Table 4: List of EV and EVSE RFIs/RFPs

Description	Equipment (EV or EVSE)	Contract Type	Group-purchase
City of Sacramento: ZEV Program		RFI	N
Montgomery County, MD: Neighborhood Charging		RFI	Y
Montgomery County, MD: EV Group Buy		RFI	Y
Hanover, NH Lebanon, NH Hartford, VT: Public EVSE Community Purchase		RFI	Y
Peterborough, NH: Riverwalk Parking Lot EV Charging Stations		RFP	N
City of New Rochelle: Electric Vehicle Charging Infrastructure		RFP	N
City of Sacramento: Curbside EV Charging Pilot		RFP	N
Xavier U of Louisiana: Charging Station Solutions		RFP	N
North Carolina Level 2 Charging Station Access Program		RFP	N/A
Evaluation of Colorado EV Group Purchase Programs		-	Y
Department of Energy RFP Guidance		RFP	N

Key 1: EVSE

Key 2: EV

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[53] Climate Mayors. (2022). *Procurement process | drive EV fleets.* https://driveevfleets.org/procurement-process/

Future Proofing Lots

EVSE projects may require additional circuits and electrical capacity at municipal sites. When planning for EVSE projects, consider building in enough capacity for short-term and long-term goals for EVSE accessibility. Modifications to capacity later will be more costly than building it all at once. Similarly, consider what is already connected to the electrical meter EVSE will be connecting to, and the impact any future electrical additions will mean to demand. Energy audits can help reduce electricity load and find savings opportunities.

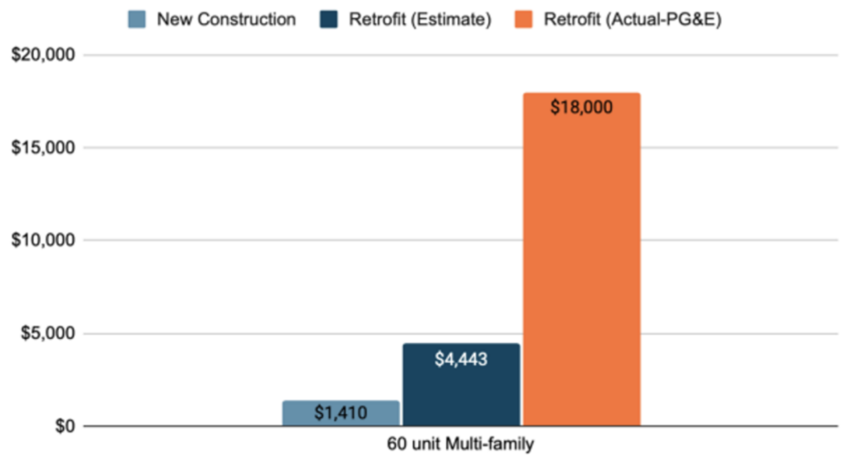

Figure 22: Retrofit costs vs new construction costs (Source: EV Charging for All Coalition)

Buses

EVs require different fueling behavior than ICEVs. Standard, consistent bus routes are great candidates for planned charging.

An area of focus has been electric school buses. School buses running on diesel have negative impacts on children. Emissions within the cabin run 4 to 5 times higher levels than outside the bus, and children are more likely to develop respiratory issues from emissions, sitting in the cabin of diesel buses for hours a day.[54]

School buses can also be used for significant vehicle to grid (V2G) efforts, which serve as a secondary revenue source, if set up correctly. School districts can take advantage of programs like NHEC's TER, which incentivizes providing energy from the bust battery back to the grid. School buses can also be used as mobile energy storage, providing backup during emergencies.

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[54] Vermont Department of Environmental Conservation. (2016). *School bus emissions & retrofits*

Fortunately, electric buses are becoming more popular, and cheaper. More than 1500 electric buses are on order or deployed at over 130 transit agencies, including cold weather climates like Denver and Chicago.[55] While the cost of electric school buses can be high at onset, federal grant money is available through the EPA's Clean School Bus program and FTA's Low or No Emissions programs.[56] The Alternative Fuel Data Center's VICE, and AFLEET tools can be leveraged to gauge the lifecycle cost of a bus, helping to determine what amount of grant assistance is needed.[57][58]

Figure 23: Battery Electric Bus (Source: Proterra Website)

Another consideration for battery electric buses (BEB) is temperature. While BEBs are being used successfully in parts of Alaska that face temperatures below -40 degrees Fahrenheit, ensuring the internal temperatures are high enough may require some consideration.[59] Some transit authorities are equipping BEBs with diesel or propane powered generators to heat the cabins during their coldest days.[60] When contacting manufacturers consider discussing cold-weather strategies implemented by other municipalities or transit authorities.

Police Vehicles

Police cruisers can spend much of their day idling and burning through gas. In recent years several police fleets have taken advantage of EVs.

The main case for EVs is cost reduction. Due to the lower cost of fuel and maintenance EVs can cost much less than ICEVs for police units. Bargersville, Indiana operated their Tesla

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[55] Popel, E. (2018). *Breathing easy: A survey of zero emissions buses across america*

[56] https://www.epa.gov/system/files/documents/2022-05/2022-csb-rebates-prioritized-school-districts-2022-05.pdf

[57] US Department of Energy. (2022). *Vehicle and infrastructure cash-flow evaluation model.*https://afdc.energy.gov/vice_model/

[58] Argonne National Laboratory. (2022). *Alternative fuel life-cycle environmental and economic transportation (AFLEET) tool.*, 2022, from https://greet.es.anl.gov/afleet

[59] Jordan, R. (2022, January 21). Alaskan electric school bus operates in extremely cold temperature. *Nature World News*,

[60] Blewett, T. (2021, November 26th,). City rolling out electric buses early next year, though you can't quite call them 'zero-emission'. *Ottawa Citizen,* Retrieved from https://ottawacitizen.com/news/local-news/city-rolling-out-electric-buses-early-next-year-though-zero-emission-isnt-entirely-accurate

Model 3 for 13 months and saved $6,755 in fuel. One Tesla Model S in Fremont, CA will save them $30,000 during its life.[61]

Performance and safety are other beneficial areas for EV inclusion in police fleets. EVs have increased acceleration and handling due to their electric drivetrain and low center of gravity. Tesla models, which have primarily been the police vehicle maker of choice, can accelerate to 60 mph in around 2.8 seconds.[62] The Tesla Model 3 and Model Y also received a 5-star rating in every category and subcategory from The National Highway Traffic Safety Administration.[63] In addition to the cameras that are fitted on the vehicle for surveillance in all directions, the Model 3 was rated as having the lowest probability of injury of all vehicles rated to date by the National Highway Traffic Safety Administration.

Developing charging at Police Stations is a must. However, blackouts can occur, and preparing with battery storage, maintaining high charge levels, and diversifying the fleet, and charging and fueling sources ensures fleet resiliency.

A unique aspect of police vehicles is the electrical equipment that is used within the cabin. Electric accessory usage can impact range. Where possible, reduce non-essential electronic devices. Certain retrofits may be required with electric vehicles too. The Monadnock Sustainability Hub has produced a report outlining the case for EV Police Cars and example modifications to original equipment manufacturer setup.[64]

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[61] Monadnock Sustainability Hub. (2021). *Making the case for EV police cars*
[62] Kane, M. (2019, All-electric car acceleration 0 to 60 MPH compared. *Inside EVs,* Retrieved from https://insideevs.com/reviews/348111/electric-car-acceleration-compared-may-2019/
[63] NHTSA. (2020). *2020 tesla model 3 safety ratings* .https://www.nhtsa.gov/vehicle/2020/TESLA/MODEL%2525203/4%252520DR/RWD#safety-ratings-frontal
[64] Monadnock Sustainability Hub. (2021). *Making the case for EV police cars*

Equity & Outreach

Rural Consumers

Much of NH is rural. To date most EV adoption has been urban. This is largely due to the focus on early infrastructure and promotional efforts in major cities. However, rural drivers can maximize the benefits of EV ownership, since they average 44% more miles daily than urban drivers.[65]

Rural consumers are more likely to have charging at their homes but will benefit the most from DCFC stations located near highways, as there may be fewer charging locations in their region. The NH NEVI plan, coordinated by the NH Department of Transportation includes information on the strategy of developing DCFC throughout the state. RFPs will be used for site nomination, similar to the process used for VW Environmental Mitigation Trust fund allocation. Partnering with private entities to propose site locations near highways will ensure rural consumers feel secure buying an EV.

Required electrical upgrades for EVSE in rural areas can stall implementations. Rural communities should pursue partnerships with RPCs, utilities, and tourist destinations. Detailed information on rural partners, and the benefits and challenges to electrifying rural transportation can be found in the US Department of Transportation's rural EV planning toolkit.[66]

Low-Income Residents

Although the price of EVs is decreasing and the total cost of ownership may be similar or less than an ICEV, low-income residents likely will not have the upfront capital needed to purchase an EV. This is unfortunate because low-income Americans spend more of their budget on fuel (measured as a % of income) than anyone else:

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[65] 2 US Dept of Transportation 2017 National Household Travel Survey New England Census Division Data https://nhts.ornl.gov/

[66] US Department of Transportation. (2022). *Charging forward: A toolkit for planning and funding rural electric mobility infrastructure*

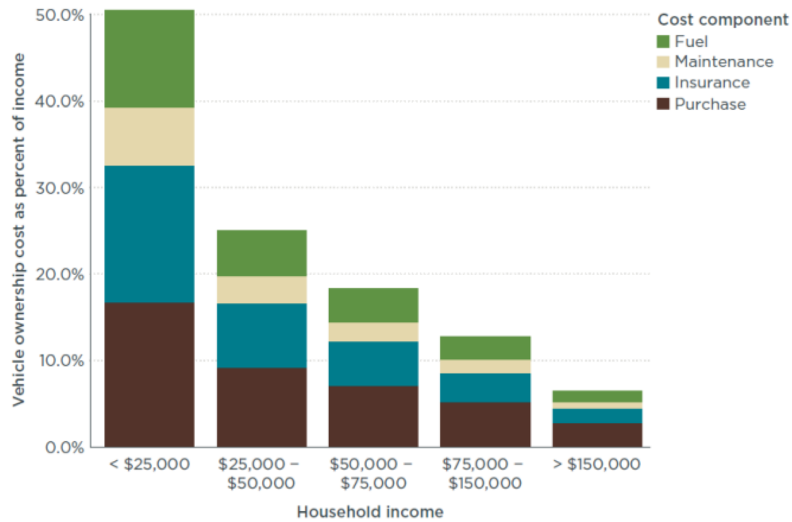

Figure 24: Cost of gasoline-powered vehicle ownership as % of income (Source: ICCT)[67]

Providing incentives for EV purchases to low-income residents is the best possible way to assist. While it may be easier to provide purchase rebates based on the price of the vehicle, this is less likely to benefit low-income residents since anyone can purchase a low-cost EV regardless of their income.

Micromobility

Micromobility will be critical for expanding access to affordable, clean transportation options. Electric micromobility (e.g., electric bikes, and scooters) provides fun and practical options for short trips in urban areas, or recreation in more rural areas. They also drive critical delivery services in urban areas.

Electric bikeshare stations can increase the access to e-bikes for those who can't afford them. Most e-bikes can be plugged into a typical 120V outlet, but designated bikeshare services (BSS) and charging stations can be implemented. Like with EVSE, the location of charging significantly impacts adoption. Consider proximity to recreational attractions, retail destinations, and walking safety when placing BSS. Creating protected bike lanes, car-free streateries, or bike freeways that allow for commuting without streetlights or vehicle congestion, can all increase micromobility adoption and safety as well.[68]

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[67] International Council on Clean Transportation. 2021. When might lower-income drivers benefit form electric vehicles? https://theicct.org/sites/default/files/publications/EV-equity-feb2021.pdf
[68] The Zebra. (2022). *The future of micromobility: How short, shared rides are disrupting car travel.*https://www.thezebra.com/resources/driving/micromobility/#how-infrastructure-can-enhance-micromobility

Multi-Unit Dwelling Residents

Residents of multi-unit dwellings (MUD) may not have access to charging at home, which can be challenging for EV adoption. Generally, if parking is available to MUD residents, they may not have the authority or ability to retrofit parking spaces with EVSE. Encouraging MUD owners to include EV-ready spaces in the parking lot can promote private partnerships and the development of future EV charging. To further incentivize MUD owners, fee reductions or rebates can be provided to MUD owners who make their charging available to the public. The public availability of charging would help MUD owners increase the usage of their chargers and potentially attract new visitors to the community if they stop to charge instead of passing through. New visitors can be a boost to the local economy when they stop, charge, and shop.

A study conducted in Maryland recommends providing a L2 charger for every 14 residents.[69] To accommodate overnight charging, a "Low-power" L2 (LPL2) charging setup can be used. Charging at 3.8kW for 10 hours overnight would provide 130+ miles, which should be more than enough for the typical commute.[70] [71] Guidance, like Lebanon's EV Subcommittee Presentation to their planning board, on load-management and LPL2 can assist MUD owners in designing EVSE setups that work for their residents. However, the need for MUD residents can sometimes be hard to determine before installing EVSE. In the case of a property in NH, 1 resident pushed for the installation of the EVSE, but once it was installed 7 residents signed up to use it.[72]

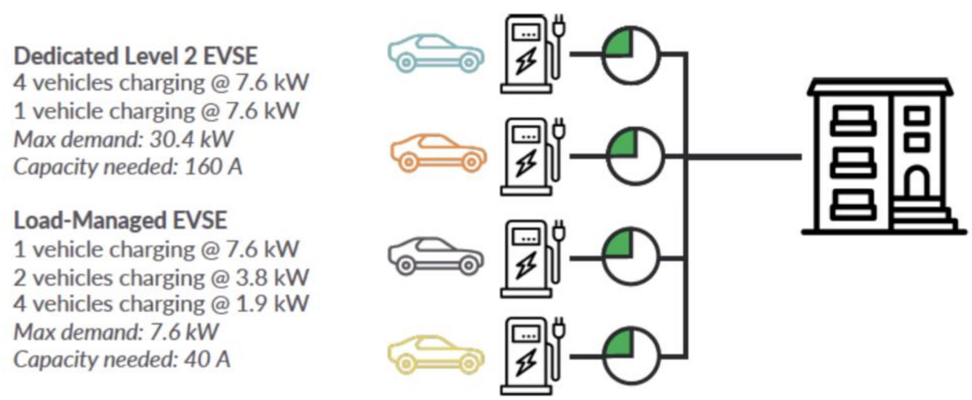

Figure 25: Example residential load managed EVSE diagram (Source: "Controlling Costs with EV Load Management", Ryan Bird, Clean Transportation Energy Solutions)

[69] GreenACES. (2022). *Greenbelt advisory committee on environmental sustainability report to city council*
[70] Peninsula Clean Energy. (2021). *Riding the EV wave: An introduction to EV charging & building codes in apartments and condos*
[71] Ibid.
[72] Boschert, S. (2022), Chair of Lebanon EV Subcommittee and Co-founder of Plug In America. *NH municipal EV toolkit: Stakeholder engagement meeting*

Working with Communities

In addition to rural or low-income consumers, underserved and overburdened communities should be brought in as partners when considering locations for implementing public EV Charging. As part of the Justice 40 Initiative, and the federal funding that is available for clean energy and clean transportation, the federal government is requiring 40% of the overall benefits of the investments flow to underserved and overburdened communities.[73] These communities are most frequently affected by the negative impacts from emissions near highways. Investing in these communities would help revert the damages caused by traditional transportation.

The Department of Transportation and US Department of Energy have worked together to identify tracts of populations that fall in the category of underserved and overburdened by traditional transportation. Criteria to be included in these tracts span from income to energy burden, to reliance on fossil fuels.

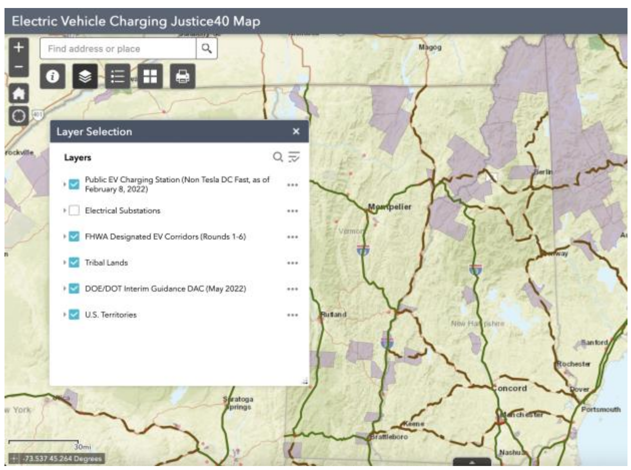

Figure 26:Map of Designated Underserved or Overburdened communities in NH (Source: EV Charging Justice40 Map)[74]

However, simply implementing projects in these tracts does not ensure they benefit the local community though. Before acting on behalf of any community it's important to meet with them and understand their needs. Typical methods of holding mobility needs assessments can be surveys, listening sessions, or interviews with the community and their

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[73] President Joe Biden. (2021). *Executive order on strengthening american leadership in clean cars and trucks.*https://www.whitehouse.gov/briefing-room/presidential-actions/2021/08/05/executive-order-on-strengthening-american-leadership-in-clean-cars-and-trucks/#:~:text=America%20must%20lead%20the%20world,or%20fuel%20cell%20electric%20vehicles.

[74] Department of Energy, & Department of Transportation. (2022). *Electric vehicle Justice40 map.*https://anl.maps.arcgis.com/apps/webappviewer/index.html?id=33f3e1fc30bf476099923224a1c1b3ee

community organizations. More strategies can be found in Greenlining's EV Equity Toolkit.[75]

Promotional Events

A major factor that can impact EV adoption is local promotional events. Consumers have questions about EV ownership. A common way to address those is to host EV Showcases and Ride & Drive events where residents can ride in or drive EVs. These EVs are often supplied by residents who can answer questions about ownership, or dealers who can provide information on purchasing an EV. Combining these Ride & Drive events with other local events is a great way to draw the most participants possible. After holding their first EV Car Show and seeing the local interest, Dover decided to hold another during their 2022 Apple Harvest Day.

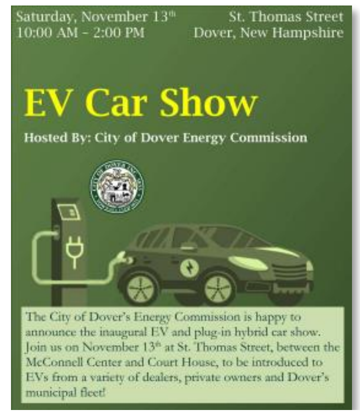

Figure 27: Promotional Material for Dover's first EV Car Show (Source: Dover Energy Commission)

Working with NGOs to create marketing materials, advocate on policy, or engage with local supporters can aid the transition to more sustainable transportation systems. Campaigns through social media, community email lists, or reaching out to local news outlets can be effective in spreading the word about local EV events.

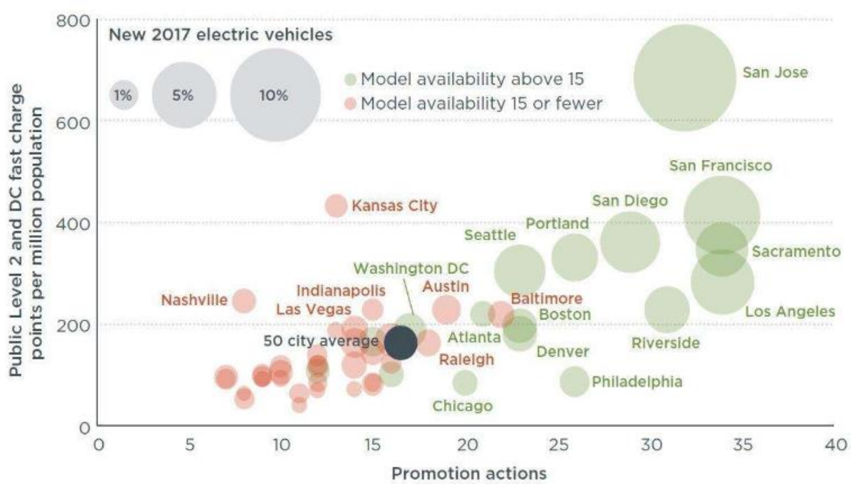

Figure 28: Electric vehicle adoption levels (Source: Slowik and Lutsey)[76]

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[75] Greenlining Institute. (2022). *Electric vehicles for all: An equity toolkit* .https://greenlining.org/resources/electric-vehicles-for-all/

[76] Slowik, P., and N. Lutsey. 2018. The continued transition to electric vehicles in U.S. cities. International Council on Clean Transportation. Online at https://www.theicct.org/publications/continued-EV-transition-us-cities-2018.

Further Considerations

Safety

EVs have been subject to many news stories surrounding concerns about their safety. Although many EVs have exemplary safety ratings, such as the Tesla Model 3, EV fires are different than those from ICEVs and require separate protocols. [77] The National Fire Protection Agency provides training to emergency responders on handling EV fires. Encouraging emergency responders to enroll will help ensure your municipality is prepared under even the direst of circumstances. Educating your residents on the training taken by emergency responders to handle EV safety issues will also engender trust in the technology and local leadership.

Technical Assistance

Beyond this toolkit, hands-on guidance might be needed. One local source for technical assistance is to contact the Granite State Clean Cities Coalition (GSCCC).[78] This Coalition, which is hosted by the NH Department of Environmental Services and sponsored by the US Department of Energy, is a source for information and consultation. While not necessary to receive support, municipalities are encouraged to become stakeholders of GSCCC by filling out a partner agreement.

In addition to your local Clean Cities Coalition, you can request support from technical assistance teams at the National Renewable Energy Laboratory and Joint Office of Energy and Transportation. These experts can provide a range of guidance from general to technical, such as determining technologies, answering technical codes and standards questions, and evaluating project potential.

Maintenance of EVs is often straightforward. Tires and brakes will still wear out, although perhaps less frequently due to regenerative braking. That said, manufacturers can provide training to Department of Public Works staff that are interested in handling minor maintenance and non-warranty repairs in house. Major repairs should be coordinated with the manufacturer. EVSE should be installed and maintained by technicians certified by the

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[77] National Fire Protection Association. (2022). *Alternative fuel vehicle (AFV) safety training.* Retrieved June, 2022, from https://www.nfpa.org/EV

[78] Clean Cities Coalition. (2022). *Clean cities coalition network: Technical assistance.* https://cleancities.energy.gov/technical-assistance/

EVITP or electricians who graduated a Registered Apprentice Program that includes EVSE specific training. Reach out to colleagues or EVITP for finding a contractor.

Advocacy

While much can be done in planning and implementation, the tools dictated in this guide are largely determined by the landscape of energy policy in NH. Energy is one of the most highly regulated sectors in the country, and EVs are impacted by those policies. If you are interested in advocating for changes to electric rates, charging infrastructure setup, or incentives for the deployment of EVs, reach out to Drive Electric NH and the New Hampshire Municipal Association. Support from local communities is important to accelerate the adoption of EVs, and development of policies that are needed to ensure support from the energy sector.

Cold Weather Conditions

Batteries need to be at appropriate temperatures to operate correctly and require warming after being left idle in the cold. Similarly, vehicle cabins need to be warmed, and the power to heat an EV cabin comes directly from the battery. In the cold battery range decreases by 12% at 20 degrees, when the heater is off. When the heater runs the range decreases 41%.[79] Range reductions can be expected with warmer temperatures and the use of air conditioning, but not to the same degree (4% and 17% respectively).[80] Planning for half range trips during the winter and reviewing EVSE locations before trips is recommended to ensure EV drivers are not stranded.

Turning on the EV while connected to EVSE will pre-heat the battery and reduce the amount of power used to initially warm the battery. This can also be used as a time to increase the temperature in the vehicle cabin. Dressing warmer and using seat or steering wheel heaters while driving can also reduce the power spent on maintaining cabin temperature.

Many EVs are equipped to handle the snow, ice, and moderate off-road conditions in New Hampshire. A wide array of existing EVs have all-wheel drive, and more SUV and Truck models are being released soon:

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[79] Krisher, T. (2019, February 7th,). AAA: Cold weather can cut electric car range over 40 percent. Retrieved from https://apnews.com/article/04029bd1e0a94cd59ff9540a398c12d1

[80] Krisher, T. (2019, February 7th,). AAA: Cold weather can cut electric car range over 40 percent. Retrieved from https://apnews.com/article/04029bd1e0a94cd59ff9540a398c12d1

Table 5: Existing EV Models with All-wheel Drive (Source: VEIC)

Make / Model	EV Type	Vehicle Type	Electric Range (miles)	PHEV Total Range (miles)	Base Price (MSRP)
Hyundai Tucson PHEV	PHEV	Crossover/SUV	33	420	$34,900
Subaru Crosstrek Hybrid	PHEV	Crossover/SUV	17	480	$35,845
Mitsubishi Outlander PHEV	PHEV	Crossover/SUV	24	320	$36,995
Hyundai Santa Fe PHEV	PHEV	Crossover/SUV	30	440	$39,500
Hyundai Ioniq 5	BEV	Crossover/SUV	220-303		$39,700
Toyota RAV4 Prime	PHEV	Crossover/SUV	42	600	$39,800
Kia EV6	BEV	Crossover/SUV	232-310		$40,900
Volkswagen ID.4	BEV	Crossover/SUV	280		$41,230
Ford Mustang Mach-E	BEV	Crossover/SUV	224-303		$43,895
Audi Q4 e-tron	BEV	Crossover/SUV	241		$43,900
Kia Sorento PHEV	PHEV	Crossover/SUV	32	460	$44,990
Polestar 2	BEV	Crossover/SUV	249-270		$45,900
Lincoln Corsair Grand Tour	PHEV	Crossover/SUV	28	430	$50,390
Volvo XC40 Recharge	BEV	Crossover/SUV	223		$51,700
Jeep Wrangler 4xe	PHEV	Crossover/SUV	22	370	$53,795
Volvo XC60 T8 PHEV	PHEV	Crossover/SUV	19	500	$54,250
Audi Q5 E PHEV	PHEV	Crossover/SUV	19	400	$55,400
Jeep Grand Cherokee 4xe	PHEV	Crossover/SUV	26	470	$58,095
Volvo C40 Recharge	BEV	Crossover/SUV	226		$58,750
BMW X5 xDrive45e	PHEV	Crossover/SUV	31	400	$63,700
Volvo XC90 T8 PHEV	PHEV	Crossover/SUV	18	520	$64,800
Tesla Model Y	BEV	Crossover/SUV	318		$64,990
Audi e-tron	BEV	Crossover/SUV	238		$65,900
Rivian R1T	BEV	Pickup Truck	314		$67,500
Lincoln Aviator Grand Tour	PHEV	Crossover/SUV	21	460	$68,680
Jaguar I-Pace	BEV	Crossover/SUV	234		$69,200
BMW iX	BEV	Crossover/SUV	305-324		$83,200
GMC Hummer EV	BEV	Pickup Truck	300-350		$110,295
Tesla Model X	BEV	Crossover/SUV	332		$114,990

Conclusion

EV technology is rapidly evolving in tandem with the growth of the EV market share. Strategies to plan for EV adoption will evolve as the price of EVs reduces and the market matures further. State and Federal EV guidance and energy regulations will advance as well. Recently the Inflation Reduction Act (IRA) has been signed. During 2023 we anticipate more details on the qualifications for and potential impacts of funding from the IRA. This toolkit is intended to be updated to continually reflect the changing landscape of EVs in NH. Integrating EVs in your municipal strategies will lead to the lowest costs for and highest return on electrified transportation. Transportation connects us, and we believe in connecting with your regional partners to share experiences with, unique strategies used, and takeaways from EV planning. As your community begins to institutionalize the benefits of EVs we hope this toolkit serves as your nexus of planning, and the beginning of harmonizing EV coordination across all regions of NH.

Appendix

Tools

Argonne National Laboratory. (2022a). Alternative fuel life-cycle environmental and economic transportation (AFLEET) tool., 2022, from https://greet.es.anl.gov/afleet

Argonne National Laboratory. (2022b). JOBS models.https://www.anl.gov/es/jobs-models

Atlas Public Policy. (2019). EV charging financial analysis tool. Retrieved June, 2022, from https://atlaspolicy.com/ev-charging-financial-analysis-tool/

Plugshare. (2022). EV charging station map.https://www.plugshare.com/

The Sustainability Institute by, ERM. (2022). Regional EV charging infrastructure location identification toolkit.https://www.sustainability.com/thinking/regional-ev-charging-infrastructure-location-identification/

US Department of Energy. (2022a). Alternative fuel and advanced vehicle search.https://afdc.energy.gov/vehicles/search/

US Department of Energy. (2022b). Alternative fueling station locator.https://afdc.energy.gov/stations#/find/nearest

US Department of Energy: Energy Efficiency & Renewable Energy. (2022a). Alternative fuels data center: Tools. Retrieved June, 2022, from https://afdc.energy.gov/tools

US Department of Energy. (2022c). Electric vehicle infrastructure projection tool (EVI-pro) lite.https://afdc.energy.gov/evi-pro-lite

US Department of Energy. (2022d). Vehicle and infrastructure cash-flow evaluation model.https://afdc.energy.gov/vice_model/

US Department of Energy. (2022e). Vehicle cost calculator.https://afdc.energy.gov/calc/