Electric Vehicle Roadmap for Connecticut

Connecticut's Policy Framework
for Accelerating Electric Vehicle Adoption

DRAFT

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1 Roadmap Overview

Connecticut's transportation sector is the largest source of statewide greenhouse gas (GHG) emissions, responsible for 38 percent in 2016, the most recent year for which data is available.[1] The transportation sector was also responsible for 66 percent of the emissions of nitrogen oxides (NOx) in 2017, a key component of ground-level ozone (smog).[2] Reducing GHG emissions from the transportation sector is required to achieve economy-wide targets of at least 45 percent below 2001 levels by 2030,[3] and 80 percent below 2001 levels by 2050, [4] as required by the 2008 Global Warming Solutions Act (GWSA) and the 2018 Act Concerning Climate Change Planning and Resiliency. These emissions reductions also help to reduce other harmful air pollutants to achieve attainment of the 2008 and 2015 National Ambient Air Quality Standard (NAAQS) for ground-level zone.[5]

There are several strategies that the state must employ to achieve these statutory GHG and air quality standards, however wide-scale electric vehicle (EV) deployment has been identified as the primary solution for reducing harmful pollution, including ozone and GHG emissions. This strategy includes replacing light-duty vehicles (i.e., passenger cars and light-trucks) and medium- and heavy-duty vehicles, such as freight trucks and school buses that utilize internal combustion engines (ICE), with vehicles that are powered by low-to-zero carbon electricity.

Pursuant to the recommendations of the *Comprehensive Energy Strategy*,[6] the Connecticut Department of Energy and Environmental Protection (DEEP) has developed this *Electric Vehicle Roadmap for Connecticut* (*EV Roadmap*). The purpose of this roadmap is to evaluate the current state of EV deployment in Connecticut, identify the necessary deployment levels needed to meet the state's climate and air quality goals, discuss the potential benefits and impacts of increased EV deployment, recommend strategies for equitable access for underserved and low- and moderate-income (LMI) communities, and identify proposed strategies to further accelerate EV deployment in the state.

This *EV Roadmap* begins with an overview of the Connecticut laws, regulations, and policy directives that drive vehicle electrification and an analysis of potential costs, benefits, and barriers that hinder widespread adoption. Next, it evaluates EV charging infrastructure and electric utility rate design, identifying potential policies and regulatory tools for the Public Utilities Regulatory Authority (PURA) to consider in forthcoming dockets. Lastly, the roadmap discusses the role of marketing and outreach to improve customer awareness, provides policy recommendations for strategic deployment of funds from the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) Program and VW Mitigation funds, and proposes an engagement process for equity, diversity, inclusion, and environmental justice planning for the electrification of transportation.

Underserved communities, communities disproportionately impacted by vehicle emissions, and LMI residents must be provided equitable access to the benefits of electrification as the state pursues vehicle electrification as a key strategy for meeting the state's GHG reduction targets and air quality standards. As such, equitable access

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[1] 2016 Connecticut Greenhouse Gas Emissions Inventory. Connecticut Department of Energy and Environmental Protection. Retrieved July 30, 2019 from https://www.ct.gov/deep/lib/deep/climatechange/publications/ct_2016_ghg_inventory.pdf.

[2] EPA Emissions Inventories, https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data

[3] Section 7 of Public Act 18-82, An Act Concerning Climate Change Planning and Resiliency, codified at Conn. Gen. Stat. § 22a-200a.

[4] Section 2 of Public Act 08-98, An Act Concerning Global Warming Solutions, codified at Conn. Gen. Stat. § 22a-200a.

[5] 40 C.F.R. parts 50-52 and 58; *see also* 42 U.S.C. §§ 108-109.

[6] Comprehensive Energy Strategy. Connecticut Department of Energy and Environmental Protection. February 8, 2018. Retrieved August 28, 2019 from https://www.ct.gov/deep/lib/deep/energy/ces/2018_comprehensive_energy_strategy.pdf.

recommendations are integrated throughout the *EV Roadmap* in order to signal the importance of integrated sustainable solutions versus stand-alone fixes.

Because some of the issues discussed in this roadmap are primarily relevant to electric utility regulatory frameworks over which the PURA has jurisdiction, DEEP will address these components in comments and briefs in PURA's planned reopener of its grid modernization docket, Docket 17-12-03RE04, *PURA Investigation into Distribution System Planning of the Electric Distribution Companies – Zero Emission Vehicles* ("ZEV Docket"), which will be focused specifically on EV deployment. Engaging these topics in PURA proceedings will ensure that DEEP's views are informed by, and in dialogue with, the positions of other docket participants in the PURA process that can lead to the regulatory decisions necessary for implementation.

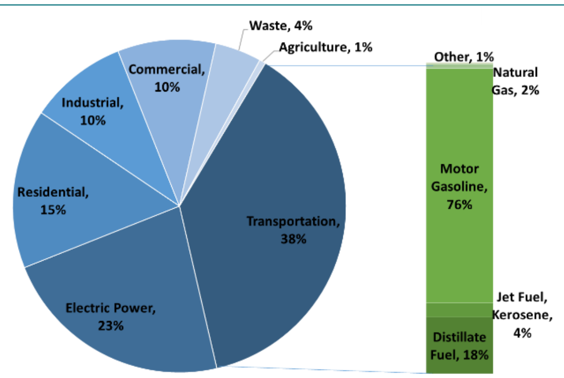
It is important to underscore that vehicle electrification is an essential, but not exclusive, strategy for reducing GHG emissions and other harmful pollutants from the transportation sector. Other key strategies include reducing vehicle miles traveled (VMT) through increased use of public transit services and alternatives modes of transportation (such as walking and biking), advancing transit-oriented development (TOD), and promoting the efficient movement of goods and services. Electric vehicle deployment strategies covered in this *EV Roadmap* complement investments in transit and transportation infrastructure. All of these strategies will be necessary to accelerate Connecticut's transition toward a modern, clean transportation system.

2 Statutes and Regulations Requiring the Acceleration of EV Deployment in Connecticut

Enacted in 2008, Connecticut's GWSA, codified at Conn. Gen. Stat. § 22a-200a, requires the state to achieve economy-wide GHG emission reductions of at least 10 percent below 1990 levels by 2020, and 80 percent below 2001 levels by 2050. In 2018, the GWSA was updated in Section 7 of Public Act 18-82, *An Act Concerning Climate Change Planning and Resiliency*, to include a mid-term GHG reduction target of 45 percent below 2001 levels by 2030.

Transportation sector emissions continue to be the largest source of GHG emissions (38%), primarily from the combustion of fossil fuels in more than 2.4 million light-duty vehicle passenger-cars and light-duty trucks registered in Connecticut as of July 1, 2019 (Figure 1). A 2018 report of the Governor's Council on Climate Change (GC3), *Building a Low Carbon Future for Connecticut: Achieving a 45% Reduction by 2030,* determined that Connecticut must reduce transportation sector emissions 29 percent below 2014 levels by 2030 in order to meet its 45 percent GHG emissions reduction target.[7]

Figure 1: 2016 Connecticut GHG emissions by sector



2016 Connecticut Greenhouse Gas Emissions Inventory. Connecticut Department of Energy and Environmental Protection. Retrieved July 30, 2019 from https://www.ct.gov/deep/lib/deep/climatechange/publications/ct_2016_ghg_inventory.pdf.

[7] Building a Low Carbon Future for Connecticut, Achieving a 45% GHG Reduction by 2030. Connecticut Department of Energy and Environmental Protection. December 2018. Retrieved July 30, 2019 from https://www.ct.gov/deep/lib/deep/climatechange/publications/building_a_low_carbon_future_for_ct_gc3_recommendations.pdf.

Generally, this transition will require facilitating access to low- and zero-emitting light-duty vehicles, cleaner public transit options, alternative modes of travel, and the efficient movement of goods and services. With regard to light-duty vehicles, the GC3 analysis projected that 20 percent of the statewide fleet, or 500,000 vehicles, must be converted to EVs by 2030.

In addition to achieving statutorily mandated GHG reductions, EV deployment is also a necessary strategy for Connecticut to attain compliance with federal health-based air quality standards—namely the 2008 and 2015 NAAQS for ground-level ozone. (*See* 40 C.F.R. parts 50-52 and 58; *see also* 42 U.S.C. §§ 108-109.) Connecticut air quality monitors record some of the highest ozone levels in the eastern United States, especially along heavily-trafficked transportation corridors where criteria air pollutants are most densely concentrated. Nonattainment with the 2008 and 2015 ozone NAAQS is one of the most critical air quality and public health challenges we face. Poor air quality and ozone exposure can exacerbate acute and chronic respiratory problems such as asthma, Chronic Obstructive Pulmonary Disease, and other lung diseases. A recent national report, *Asthma Capitals 2019*, ranked New Haven (#11) and Hartford (#13) among the 100 largest U.S. cities where it is most challenging to live with asthma.[8] Reduction of emissions from mobile sources—particularly light-duty vehicles and medium- and heavy-duty trucks—which account for approximately 67 percent of all ozone precursor emissions in the state, is necessary for Connecticut to attain the ozone NAAQS.

To date, Connecticut has adopted several regulatory programs designed to reduce GHG emissions and harmful air pollutants from mobile sources. While states are generally pre-empted from establishing new motor vehicle tailpipe standards, the state of California has a special exemption under Section 209 of the Clean Air Act (CAA), codified at 42 U.S.C. § 7543. Section 177 of CAA, codified at 42 U.S.C. § 7507, authorizes any state to adopt the state of California's new motor vehicle emissions standards in lieu of less stringent federal requirements. Pursuant to a 2004 state statute, An Act Concerning Clean Cars, codified at Conn. Gen. Stat. § 22a-174g, Connecticut committed to implement by regulation California's new motor vehicle emissions standards, including the Greenhouse Gas Tailpipe Standards and the Zero Emission Vehicle (ZEV) Program, and to amend its regulations in accordance with changes in those standards. See Conn. Agencies Regs. § 22a-174-36b and 22a-147-36c.

The ZEV Program requires auto manufacturers to deliver ZEV credit eligible vehicles as a percentage of their fleet. ZEV credit eligible vehicles include transitional EVs such as plug-in hybrid electric vehicles (PHEVs), and single fuel EVs such as battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). The auto manufacturers must deliver vehicles to dealerships for sale or lease in the state. Table 1, below, sets forth ZEV delivery requirements for all participating states under the program through the 2025 vehicle model year (MY). The ZEV Program delivery requirements in this table do not reflect the actual number of ZEVs that may be in operation on the road in the corresponding years due to the credit earning, banking, and pooling provisions of the ZEV regulation. The percentage requirements establish a compliance threshold which must be met in any given year; however some vehicles will earn more than one credit and credits from past years may be used for compliance.

[8] Asthma Capitals 2019. Asthma and Allergy Foundation of America. Retrieved August 5, 2019 from https://www.aafa.org/media/2426/aafa-2019-asthma-capitals-report.pdf.

Table 1: ZEV program delivery requirements

Model Year	ZEV Requirement (Percentage of Deliveries)
2018	4.5%
2019	7%
2020	9.5%
2021	12%
2022	14.5%
2023	17%
2024	19.5%
2025 and later, until new requirements are established	22%

In October 2013, Connecticut and seven other states entered into the Zero Emissions Vehicle Memorandum of Understanding (ZEV MOU).[9] The ZEV MOU, now endorsed by nine states and under consideration by several more, commits its signatories to deploying 3.3 million ZEVs on the road by 2025. Pursuant to the ZEV MOU, Connecticut has committed to deploying the equivalent of 125,000-150,000 ZEVs by 2025.

In support of these efforts, the Multi-State ZEV Task Force was formed to coordinate and achieve successful implementation of state ZEV programs responsible for delivering increasing quantities of ZEVs to member states now through 2025. Most recently, the Multi-State ZEV Task Force released its 2018-2021 Action Plan to propel rapid adoption of light-duty ZEVs over the next several years.[10]

The federal Corporate Average Fuel Economy (CAFE) and GHG emission standards are another important driver for reducing emissions from passenger and light-duty vehicles. However, in 2018, the U.S. Environmental Protection Agency (EPA) and the National Highway Traffic and Safety Administration (NHTSA) announced they would abandon the 2016 mid-term review final determination[11] of current CAFE and GHG emission standards, which concluded that the MY 2025 targets were attainable given advances in automotive manufacturing technologies.[12] In their place, the U.S. EPA and NHTSA proposed the Safer Affordable Fuel-Efficient Vehicles Rule for MYs 2021-2026 Passenger Cars and Light Trucks (SAFE Vehicles Rule), which would freeze the CAFE standards at the MY 2021 level. This proposed new rule would not only significantly weaken the CAFE and GHG emission standards, but may also revoke the CAA waiver[13] that allows California to set tailpipe emissions stricter than federal law. If finalized, the proposed new standards could result in $37 billion in annual public health and environmental costs due to increased CO_2 pollution, with drivers paying an additional $193 billion to $236 billion in oil and gas expenses through 2035.[14] Connecticut has thus joined 23 states and the District of Columbia in opposition to the proposed rule.

[9] State Zero-Emission Vehicle Programs—Memorandum of Understanding. Northeast States for Coordinated Air Use Management. Signed October 24, 2013.

[10] Multi-State ZEV Action Plan 2018-2021, Accelerating the Adoption of Zero Emission Vehicles. Multi-State ZEV Task Force. June 20, 2018. Retrieved August 28, 2019 from https://www.zevstates.us/wp-content/uploads/2018/07/2018-zev-action-plan.pdf.

[11] Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light Duty Vehicles, 83 Fed. Reg. 16077 (April 13, 2018)

[12] Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emissions Standards for Model Years 2022-2025. U.S. Environmental Protection Agency. November 30, 2016. Retrieved August 5, 2019 from https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3DO.pdf.

[13] Section 209 of the federal Clean Air Act permits California to seek a waiver of the preemption which prohibits states from enacting emission standards for new motor vehicles due the state's existing emission standards that preceded the federal CAA. Under the Act, California may submit a waiver to set emissions standards more stringent than the federal government.

[14] Akpan, Nsikan. "What Trump's plan to roll back fuel-economy standards means for your wallet and the environment." PBS News Hour. August 2, 2018. Retrieved from July 30, 2019 from https://www.pbs.org/newshour/nation/what-trumps-plan-to-roll-back-fuel-economy-standards-means-for-your-wallet-andthe-environment.

On September 19, 2019, NHTSA issued final regulations referred to as the SAFE Vehicles Rule Part One: One National Program purporting to preempt California's ZEV emission standards.[15] Connecticut is part of the twenty-four state coalition that filed a complaint on September 20, 2019, against NHTSA challenging the Trump Administration's final rule designed to preempt California's authority to regulate motor vehicle GHG emissions and issue ZEV standards. Given the states that have adopted California GHG and ZEV standards comprise almost 35 percent of the domestic light-duty vehicle market. In light of the uncertainty created by the SAFE rule proposal, four auto manufacturers, who were in support of the California rules established in 2013, have agreed in principle to comply with voluntary standards that would meet the previously established GHG standards for 2025 one year later.[16]

In addition to legislation mandating GHG reductions, the Connecticut Legislature has passed more specific statutes regarding electric vehicle deployment and infrastructure. Section 93 of Public Act 19-117, An Act Concerning the *State Budget for the Biennium Ending June 30, 2021, and Making Appropriations Therefore, and Provisions Related to Revenue and Other Items to Implement the State Budget,* to be codified at Conn. Gen. Stat. § 4a-67d, provides that on and after January 1, 2030, at least 50 percent of all cars and light-duty trucks and 30 percent of all buses purchased or leased by the state shall be zero-emission buses. Under Sections 5 and 6 of Public Act 16-135, *An Act Concerning Electric and Fuel Cell Electric Vehicles*, the Connecticut's electric distribution companies (EDCs) are required to integrate EV charging load projections into their distribution planning, based on the number of EVs registered in Connecticut and any projected EV sales trends, and to publish on their websites annual reports explaining how EV charging load projections factor into their distribution system planning. In addition, Public Act 16-136 requires DEEP, in the Integrated Resources Plan, to "analyze the potential for electric vehicles . . . to provide energy storage and other services to the electric grid and identify strategies to ensure that the grid is prepared to support increased electric vehicle charging, based on projections of sales of electric vehicles."

3 Equitable Access to Clean Transportation: Engagement Process

Throughout the *EV Roadmap*, DEEP makes recommendations and highlights issues regarding vehicle incentives and access to charging for LMI residents and underserved communities. However, DEEP recognizes that it must engage directly with affected communities to develop approaches that are responsive to communities' needs. DEEP looks to partner with the Connecticut Department of Transportation (CT DOT), to deploy a communications strategy and convene public listening sessions to gather input on how best to meaningfully meet the mobility needs of low-income households and underserved communities through strategic electrification. These sessions should be hosted in coordination with other relevant state agencies, municipal transit districts, local community groups, non-profits, EDCs, financing organizations, and auto dealerships, and take place within underserved communities outside of traditional work hours. Public listening sessions should include planning exercises for mapping solutions such as prioritizing deployment of electric buses with routes running through underserved communities and opportunities for lowering costs to EV ownership. Local community input, when integrated with technical expertise from state agencies, will result in a more holistic and equitable approach to transportation planning.

[15] The State of California was joined by 24 state attorneys general in filing a complaint against the NHTSA challenging the legality of the Trump Administration's final rule. The complaint can be found at this link.

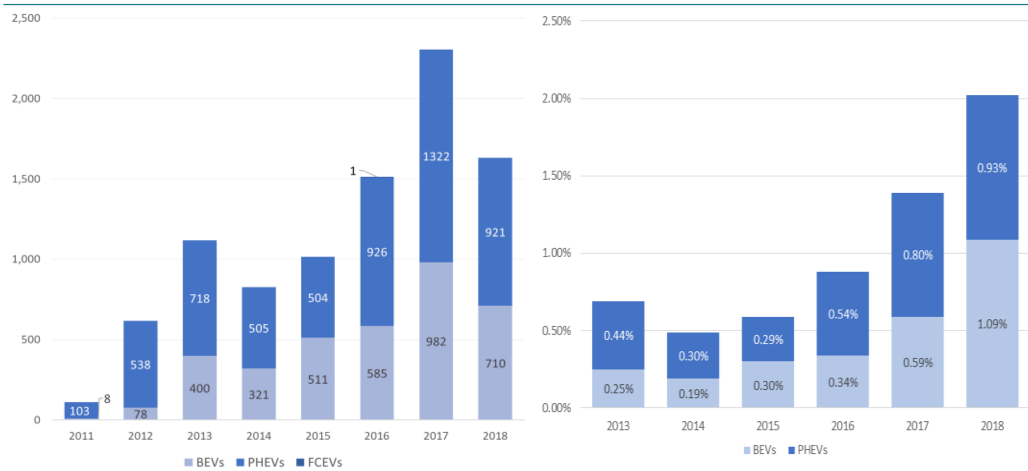
[16] California and major automakers reach groundbreaking framework agreement on clean emission standards. California Air Resources Board. July 25, 2019. Retrieved September 4, 2019 from https://ww2.arb.ca.gov/news/california-and-major-automakers-reach-groundbreaking-framework-agreement-clean-emission.

4 EV Market Trends and Projected Deployment Needs

Connecticut currently ranks 19th nationwide in total advanced technology vehicle[17] sales as of December 2018.[18] While the market share of light-duty EV sales has increased 45 percent from 2017 to 2018, EVs only accounted for 2 percent of all light-duty vehicles sold in-state in 2018 (Figure 2).[19] Comparing projections of the business as usual market (BAU) share of EV sales to the market share of EV sales needed to achieve key statutory and regulatory targets demonstrates that under forecast conditions, EV sales will be within striking distance of the sales volume needed to reach the ZEV MOU (125,000-150,000)[20] target in 2025. However, significant intervention will be needed to close the gap between expected EV sales in the BAU case and the 500,000-vehicle target needed to meet Connecticut's 2030 GHG reduction target (Figure 3). Moreover, the ZEV regulatory program requirements create competition among states for a limited number of available EVs due to the availability of credit pooling[21] such that state incentives/consumer demand will be critical to ensuring sufficient EV inventory is delivered to Connecticut. Factors such as vehicle costs, model availability, vehicle range, customer education, and the phase-out of federal EV tax credits[22] are expected to influence the pace at which consumers select and purchase EVs over ICE vehicles. Battery prices continue to decline, reducing the overall cost of EVs while increasing vehicle range, and several manufacturers have announced their intent to produce a wider variety of models to address the needs and preferences of a broader range of customers.

To maintain the rate of sales needed out to 2030, it is essential that Connecticut implement policies and programs to support this rapidly evolving market. This includes, but is not limited to, providing targeted vehicle rebates, increasing consumer education and outreach, electric rate design that provides incentives for off-peak charging, and increased charging infrastructure.

Figure 2: *Annual sales of light-duty EVs in Connecticut, 2011-2018 (left) and market share of EVs in Connecticut, 2013-2018 (right)*



Source: Alliance of Automobile Manufacturers (2019). Advanced Technology Vehicle Sales Dashboard. Data compiled by the Alliance of Automobile Manufactures using information provided by IHA Markit. Data last updated on 3/12/2019. Retrieved August 10, 2019 from https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

[17] Advanced Technology Vehicles include FCEVs, BEVs, and PHEVs.

[18] Alliance of Automobile Manufacturers (2019). Advanced Technology Vehicle Sales Dashboard. Data compiled by the Alliance of Automobile Manufacturers using information provided by IHS Markit. Data last updated March 12, 2019. Retrieved July 31, 2019 from https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

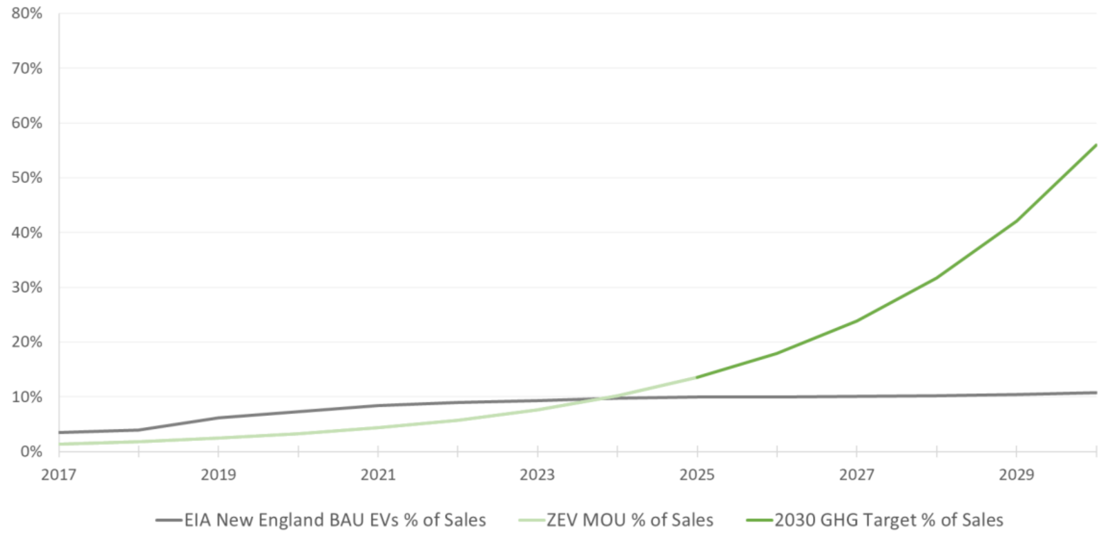
[19] EV Market Share by State. EVAdoption.com. Retrieved July 31, 2019. https://evadoption.com/ev-market-share/ev-market-share-state/.

[20] This value in an equivalency, and given compliance flexibilities in the ZEV rule, actual vehicle deliveries could be substantially lower and still meet the terms of the MOU.

[21] Per California Code of Regulations section 1962.2, manufacturers are allowed to meet the yearly credit obligation for one state by transferring excess credits earned from the delivery of vehicles in another state. The regulation creates two "pools" where this is possible, an eastern pool and a western pool. Connecticut is in the eastern pool, along with Vermont, Maine, Massachusetts, New York, Rhode Island, New Jersey and Maryland.

[22] Federal tax credits, currently valued at up to $7,500 per vehicle depending on battery capacity, will be phased phase-out once a manufacturer achieves 200,000 cumulative EV sales.

Figure 3: Projected business-as-usual market share of light-duty EV sales compared to market share of light-duty EV sales needed to achieve the 2030 GHG reduction target



Source: Market projections from the Energy Information Administration (EIA) data for the New England region were utilized to serve as a representative proxy for future EV sales rates in Connecticut. Connecticut 2030 EV projections are based on (1) achieving Connecticut's share of the ZEV MOU commitment of approximately 125,000 -150,000 ZEVs on the road by 2025 and (2) achieving EV deployment levels of 500,000 or 54% of sales by 2030 as determined by the GC3 analysis. A compound annual growth rate was used to estimate level of sales between the three anchor dates of 2017, 2025, and 2030.

After vehicle purchase price and concerns over vehicle range, consumers rank a lack of access to charging infrastructure as the third most significant barrier to EV adoption.[23] EV charging infrastructure is also a crucial component of demonstrating proof of concept and alleviating fears of range anxiety. There are currently three forms of charging infrastructure, defined by voltage and power level: Level 1, Level 2, and Direct Current Fast Chargers (DCFC).

- Level 1 charging (1 kilowatt (kW)), which does not require an electrical upgrade and is included with the purchase of an EV, plugs into a standard 120-volt electrical outlet and charges at an approximate rate of 5 miles of range per hour.[24]
- Level 2 charging (3 kW to 19.2 kW), which requires the purchase of a charger and potentially electrical upgrades, plugs into a 220- or 240-volt outlet and charges at a rate of approximately 25 miles of range per hour. Level 2 charging equipment costs between $379 and $999 depending on technical specifications,[25] and installation costs can range from $1,200 to $2,000 depending on the level of electrical upgrades needed.[26] Level 2 charging is most commonly found in public and workplace settings, as well as in private residences of citizens that opt for faster charging capability.
- DCFC, sometimes referred to as Level 3 charging (20 kW and up), utilizes a 480-volt alternating current (AC) circuit that converts the electricity to direct current (DC) and charges at a rate of approximately 250

[23] Electrifying insights: How automakers can drive electrified vehicle sales and profitability. McKinsey & Company. January 2017. Retrieved August 5, 2019 from https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/Electrifying%20insights%20How%20automakers%20can%20drive%20electrified%20vehicle%20sales%20and%20profitability/Electrifying%20insights%20-%20How%20automakers%20can%20drive%20electrified%20vehicle%20sales%20and%20profitability_vF.ashx.
[24] EV Charging 101. Plug In America. Retrieved August 13, 2019 from https://s3-us-west-1.amazonaws.com/zappyassets/img/custom/plugstar/PIA_EV_Charging_101_Final.pdf.
[25] Level 2 Home Chargers. PlugStar. Retrieved August 14, 2019 from https://plugstar.com/chargers.
[26] How Much Does An Electric Car Charging Station Installation Cost? HomeAdvisor. Updated June 2019. Retrieved August 14, 2019 from https://www.homeadvisor.com/cost/garages/install-an-electric-vehicle-charging-station/#level2.

miles of range per hour.[27] DCFC equipment costs roughly $25,000 and electrical service upgrades range from $75,000 to $100,000 per station.[28] DCFCs are more frequently placed along highways and heavily trafficked interstate transit corridors.

While at-home Level 1 or Level 2 charging can meet the travel needs of most EV users, the presence of public DCFCs, in addition to Level 2 chargers, contributes to decreasing range anxiety and augments regional connectivity along interstate travel corridors such as I-95.[29] However, DCFC deployment is inhibited by high costs associated with equipment and installation, especially since few, if any, cost-effective business models currently exist.[30] These costs are dependent on proposed site location, existing electric distribution system capacity at the proposed site, and the cost of labor. Although the cost of DCFC equipment is anticipated to decline as the EV industry matures, installation costs will continue to vary depending on the complexities of each proposed DCFC location. For example, if long distance trenching is required to lay electrical supply conduit or the electrical capacity to the site needs to be upgraded, the cost of installation will rise significantly. In building out its DCFC network, the state must weigh the costs to investment against the benefits it will provide, such as connecting Connecticut's cities to major regional networks in Massachusetts and New York.

In order to sufficiently accelerate EV adoption to meet the trajectory shown in Figure 3, EV charging infrastructure, both public and private, will have to match this pace. Connecticut's EDCs have partnered with public agencies to build out regional EV charging infrastructure. DEEP, through the EVConnecticut program, partnered with Eversource Energy to develop and award grants to fund the installation of EV charging infrastructure across the state, beginning in 2013. Altogether, 277 EV charging stations were installed under this program. There are currently 344 publicly accessible EV charging stations with a total of 823 charging outlets in the state.[31] This number includes 34 DCFC locations with 126 charging ports. Further investments in charging infrastructure, including fast charging, will be critical.

Significant levels of vehicle electrification will reduce total energy consumption (for all fuels) from the transportation sector, due to the fact that EVs use energy more efficiently than ICE vehicles.[32] According to Bloomberg New Energy Finance's (BNEF) 2019 Electric Vehicle Outlook, by 2040 EVs could displace 13.7 million barrels of oil per day, but only use the energy equivalent of 3.6 million barrels of oil per day.[33]

4.1 Current and projected EV vehicle model availability

Availability of a large range of vehicle models and types will be essential to increase EV adoption rates. As of May 2019, there were 22 BEV models, 24 PHEV models, and 3 FCEV models available for purchase in the U.S.[34] Not all models are available for purchase in Connecticut.[35] As noted above, actual deliveries of EV models in Connecticut will be influenced in part by manufacturers' strategies for meeting ZEV MOU mandates in the participating states. Manufacturers are expected to deploy EV models to those states with the most robust

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[27] 2019 Guide on How to Charge Your Electric Car With Charging Stations. ChargeHub. Retrieved August 14, 2019 from https://chargehub.com/en/electric-car-charging-guide.html.

[28] Charge NY: Installing a Charging Station. New York State Energy Research and Development Authority. Retrieved August 14, 2019 from https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY/Charge-Electric/Charging-Station-Programs/Charge-Ready-NY/Installing-a-Charging-Station.

[29] A U.S. Consumer's Guide to Electric Vehicle Charging. Electric Power Research Institute. October 2016. Retrieved September 9, 2019 from https://www.firstenergycorp.com/content/dam/customer/get-help/files/PEV/guide-to-ev-charging.pdf.

[30] Walton, Robert. 'Nearly all' high voltage EV charging stations lose money: Report. Utility Dive. August 22, 2019. Retrieved August 30, 2019 from https://www.utilitydive.com/news/nearly-all-high-voltage-ev-charging-stations-lose-money-report/561026/?utm_source=Sailthru&utm_medium=email&utm_campaign=Issue:%202019-08-28%20Utility%20Dive%20Load%20Management%20%5Bissue:22709%5D&utm_term=Utility%20Dive:%20Load%20Management.

[31] Alternative Fuels Data Center. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. Retrieved September 6, 2019 from https://afdc.energy.gov/stations/#/analyze?region=US-CT&country=US&fuel=ELEC&lpg_secondary=true&hy_nonretail=true&ev_levels=all.

[32] Office of Energy Efficiency & Renewable Energy. U.S. Department of Energy, Retrieved September 5, 2019 from https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs.

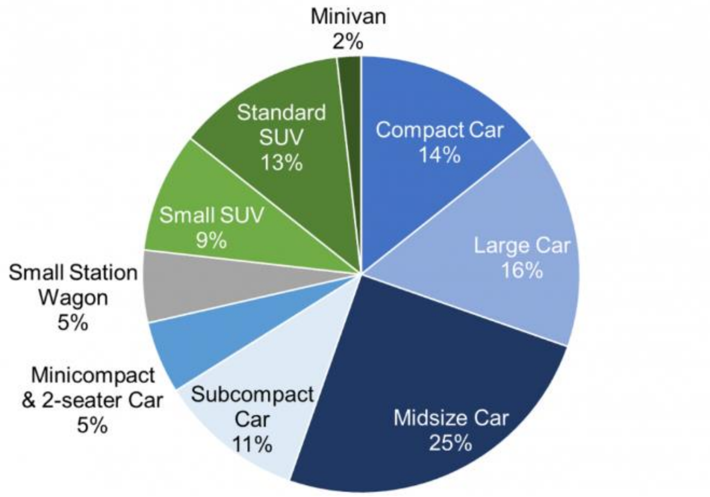
[33] Electric Vehicle Outlook 2019. Bloomberg New Energy Finance. June 2019. Retrieved August 5, 2019 from https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport.

[34] EV Models Currently Available in the US. EVAdoption. Data last updated 3/30/2019. Retrieved July 31, 2019 from https://evadoption.com/ev-models/.

[35] Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 37*, ORNL/TM-2018/987, January 2019. Retrieved August 5, 2019 from FuelEconomy.Gov website.

rebates and other EV-friendly policies, anticipating quicker sales and faster ZEV MOU compliance. This will put states like Connecticut in competition with surrounding states to provide attractive incentives and policies.

Figure 4: Electric-drive vehicle models available by size class, model year 2018



Source: FOTW #1093, For Model Year 2018, Electric-Drive Vehicle Models Were Available in Nine Different Size Classes. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. Retrieved August 5, 2019 from https://www.energy.gov/eere/vehicles/articles/fotw-1093-august-5-2019-model-year-2018-electric-drive-vehicle-models-were.

As the market for vehicles expands to meet consumer demand, so will the availability of vehicles to meet different consumer needs, mileage ranges and price ranges. While 10 years ago the selection of EV options was very limited, today's vehicle selection has expanded and includes sedans and sport utility vehicles (SUVs), compacts, and sport and luxury vehicles with some ranges exceeding 500 miles.

Table 2: Example of vehicle types and available models

Vehicle Type	BEV sample models	PHEV sample models
Compact and subcompact cars	Volkswagen e-Golf *(MSRP: $31,895 - $38,895; Range 125 miles)* Fiat 500e *(MSRP: $33,210; Range 84 miles)*	Chevrolet Volt *(MSRP: $33,520 - $38,120; Range 53 electric miles, 420 total range)* BMW i3 with Range Extender *(MSRP: $48,300; Range 126 electric miles, 200 total range)*
Mid-size and large cars	Hyundai Ioniq (*MSRP: $29,500; Range 124 miles)* Chevrolet Bolt *(MSRP: $37,500; Range 238 miles)* Nissan Leaf 40 kWh *(MSRP: $29,990; Range 150 miles)* Nissan Leaf 62 kWh *(MSRP: $36,550; Range 226 miles)* Tesla Model 3 standard range *(MSRP: $39,000; Range 220 miles)*	Toyota Prius Prime *(MSRP: $27,350 - $33,350; Range 25 electric miles, 640 total range)* Ford Fusion Energi *(MSRP: $36,595; Range 26 electric miles, 610 total range)* Honda Clarity *(MSRP: $33,400; Range 48 electric miles, 340 total range)* Hyundai Sonata *(MSRP: $33,400 - $39,000; Range 28 electric miles, 600 total range)*
SUVs and pickups	Hyundai Kona Electric BEV, *(MSRP: $36,950; Range 258 miles)* Hyundai Nexo FCEV, *(MSRP: $58,300; Range 380 miles)* Kia Niro BEV, *(MSRP: $38,500; Range 239 miles)* Rivian R1T Pickup Truck BEV (Not available until 2020, *(MSRP: $69,000; Range 400 miles - estimated)* Audi e-Tron BEV, *(MSRP: $74,800; Range 204 miles)* Jaguar i-Pace BEV, *(MSRP: $69,850; Range 234 miles)* Tesla Model X BEV, *(MSRP: $81,000; Range 325 miles)*	Volvo XC60 AWD *(MSRP: $52,900 - $60,250; Range 17 electric miles, 500 total range)* Mitsubishi Outlander *(MSRP: $34,595; Range 22 electric miles, 310 total range)*

Vehicle Type	BEV sample models	PHEV sample models
Minivans	None currently available	Chrysler Pacifica *(MSRP: $39,995 - $45,545; Range 32 electric miles, 520 total range)*

Source: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. Find Electric Vehicle Models https://www.energy.gov/eere/electricvehicles/find-electric-vehicle-models.

In recent years, several auto manufacturers have made commitments to integrate more EV models into their light-duty vehicle lineups over the next decade. Volkswagen, for example, has committed to a lineup of 70 fully electric vehicle models by 2028,[36] with other auto manufacturers announcing similar goals and timelines. Continental AG, the world's fourth largest manufacturer of auto parts, announced that the company will begin eliminating its investment in ICE technologies due to increasingly strict emissions regulations, limited foreseeable growth in ICE part innovation, and faster than anticipated demand for EVs.[37] The scale of these commitments, shown in Table 3 below, highlights the auto industry's sharp pivot toward an electrified future. By 2022, the number of light-duty EV models available in the U.S will increase to 81, including electrified SUVs, cross-overs, and pick-up trucks.[38] Expanded vehicle variety will open up the market to consumers who were previously deterred by the limited selection of EVs and promote a competitive and more widely appealing marketplace for EVs in the future.

Table 3: Manufacturer commitments to expand EV offerings

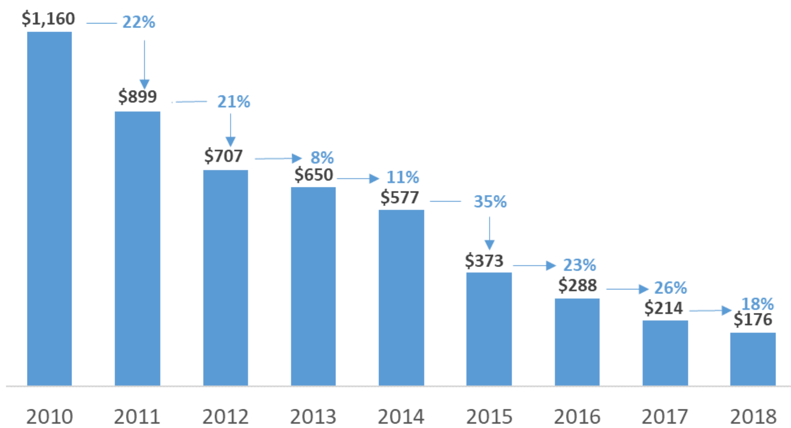
Auto Manufacturer	Commitment
Ford	$11 billion in investments and 40 BEVs and PHEVs by 2022.[39]
General Motors	20 new all-electric models by 2023.[40]
Honda	Introduce a new dedicated EV platform by 2025 and electrify 2/3 of its global vehicle lineup by 2030.[41]
Hyundai	Under *FCEV Vision 2030* – commit to producing 700,000 fuel cell systems/year by 2030, including 500,000 units for FCEVs[42]
Nissan	12 new ZEVs by 2022.[43]
Toyota	6 new EVs between 2020 and 2025, and half of all global sales by 2025.[44]
Volkswagen	70 new EV models by 2028 and 22 million EVs produced over the next 10 years.[45]

[36] Volkswagen plans 22 million electric vehicles in ten years. VolkswagenAG. March 12, 2019. Retrieved August 8, 2019 from https://www.volkswagenag.com/en/news/2019/03/VW_Group_JPK_19.html#.
[37] Boston, William. Auto Supplier Continental Slams Brakes on Engine Parts Amid Shift to Electric. The Wall Street Journal. August 7, 2019. Retrieved August 8, 2019 from https://www.wsj.com/articles/auto-parts-giant-continental-slams-brakes-on-engine-parts-amid-shift-to-electric-11565165087.
[38] Electric Vehicle Market Status. M.J. Bradley & Associates. May 2019. Retrieved August 5, 2019 from https://www.mjbradley.com/sites/default/files/ElectricVehicleMarketStatus05072019.pdf.
[39] Cary, Nick and White, Joseph. Ford plans $11 billion investment, 40 electrified vehicles by 2022. Reuters. January 14, 2018. Retrieved August 8, 2019 from https://www.reuters.com/article/us-autoshow-detroit-ford-motor/ford-plans-11-billion-investment-40-electrified-vehicles-by-2022-idUSKBN1F30YZ.
[40] 'We Believe the Future is All-Electric.' GM Corporate Newsroom. October 10, 2017. Retrieved August 8, 2019 from https://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2017/oct/1002-mark-reuss-ev.html.
[41] Greimel, Hans and Okamura, Naoto. Honda hatches a modular EV plan for the U.S. Automotive News. July 15, 2019. Retrieved August 8, 2019 from https://www.autonews.com/future-product/honda-hatches-modular-ev-plan-us.
[42] Hyundai Motor Group reveals 'FCEV Vision 2030.' Hyundai Motor Group. December 11, 2018. Retrieved September 4, 2019 from https://www.hyundai.news/eu/brand/hyundai-motor-group-reveals-fcev-vision-2030/.
[43] Lambert, Fred. Renault, Nissan & Mitsubishi alliance will launch 12 new all-electric vehicles within the next 5 years. Electrek. September 15, 2017. Retrieved August 8, 2019 from https://electrek.co/2017/09/15/renault-nissan-mitsubishi-alliance-12-new-all-electric-vehicles/.
[44] Lambert, Fred. Toyota unveils images of upcoming all-electric cars, accelerates EV plans by 5 years. Electrek. June 7, 2019. Retrieved August 8, 2019 from https://electrek.co/2019/06/07/toyota-electric-car-images-accelerate-plan/.
[45] Volkswagen plans 22 million electric vehicles in ten years. VolkswagenAG. March 12, 2019. Retrieved August 8, 2019 from https://www.volkswagenag.com/en/news/2019/03/VW_Group_JPK_19.html#.

4.2 Expected battery technology improvements

Over the past decade, advances in battery technology, improvements in electric powertrain component scaling, and reduced costs for research and development have rapidly reduced the cost of EV batteries while increasing capacity and vehicle range. Although battery packs remain the single highest-cost component in EVs, battery prices dropped from $650/kWh in 2013 to $176/kWh in 2018.[46] Furthermore, the proportion of the cost of the vehicle attributed to the cost of the battery for a midsize EV has declined from 57 percent in 2015 to 33 percent in 2019.[47] Experts are predicting that the battery share of EV costs will decline to 20 percent of the total vehicle cost by 2025. The International Energy Administration predicts that battery prices will drop to between $80-$120/kWh by 2030,[48] while BNEF more optimistically forecasts battery prices to fall to $62/kWh by 2030.[49] These developments have led BNEF to predict that EVs will reach price parity with ICE vehicles in 2022, two years earlier than its previous forecast. The International Council on Clean Transportation predicts that 150-mile, 200-mile, and 250-mile range BEVs will reach cost parity with the average U.S. ICE vehicle by 2024, 2025, and 2027, respectively.[50]

Figure 5: Declining electric vehicle battery costs, 2010-2018



Source: Goldie-Scot, Logan. A Behind the Scenes Take on Lithium-ion Battery Prices. Bloomberg New Energy Finance. March 5, 2019. Retrieved August 12, 2019 from https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/.

4.3 Secondary EV market

The Connecticut Automotive Retailers Association (CARA) estimates that nearly twice as many new EVs are leased over purchased because EV technology is rapidly evolving. As these vehicles come off of their leases it is likely that they will be offered on the secondary vehicle market. The pre-owned vehicle market represents a large percentage of annual vehicle sales and attracts buyers who cannot or choose not to purchase or lease a new vehicle.[51] As Connecticut's EV market matures, efforts must be made to develop the secondary EV market for those drivers who cannot buy new EVs. Experts at the University of California Davis are (UC Davis) undertaking a used EV market study revealed initial results that, in California, most pre-owned EVs entered the market after only two to three years of usage by the original owner, still under warranty, and with 23,400 miles

[46] Electric Vehicle Outlook 2019. Bloomberg New Energy Finance. June 2019. Retrieved August 5, 2019 from https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport.

[47] Bullard, Nathaniel. Electric Car Price Tag Shrinks Along With Battery Cost. Bloomberg. April 12, 2019. Retrieved August 8, 2019 from https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost.

[48] Global EV Outlook 2019. International Energy Agency. Retrieved August 12, 2019 from www.iea.org/publications/reports/globalevoutlook2019/.

[49] Electric Vehicle Outlook 2019. Bloomberg New Energy Finance. June 2019. Retrieved August 5, 2019 from https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport.

[50] Lutsey, Nic and Nicholas, Michael. Update on electric vehicle costs in the United States through 2030. The International Council on Clean Transportation. June 2019. Retrieved August 8, 2019 from https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf.

[51] Davies, Alex. Now on Used Car Lots: Great Electric Vehicles for Cheap. Wired. August 5, 2019. Retrieved August 6, 2019 from https://www.wired.com/story/now-used-car-lot-great-electric-vehicles-cheap/?verso=true.

logged on average.[52] Moving forward, Connecticut must consider strategies to develop the secondary EV market and retain off-lease vehicles in the state in order to reach mandatory GHG reduction targets and ZEV goals. There are positive indicators to support the development of a robust secondary EV market underway in Connecticut.

Generally, consumers can purchase three-year old used BEVs and PHEVs with advanced safety features for roughly one third of the original MSRP.[53] And because EVs have far fewer moving parts, consumers do not need to be concerned with wear and tear of engine and powertrain parts. Used EV buyers' biggest concern will be vehicle battery health and capacity. Shift, an online used vehicle reseller in California, reported that used EVs accounted for 4 percent of vehicle sales in the first half of 2019, tripling their share of such sales from 2018 and doubling the overall EV share of new vehicle sales in the U.S.[54] As longer range models, including but not limited to the Chevy Bolt, Hyundai Kona, Kia Niro, Nissan Leaf Plus, and Tesla Model 3 enter the secondary market over the next few years, range anxiety will become less of an issue because currently available EVs can already meet 87 percent of all commuter trips.[55]

4.4 Geographic distribution of EVs in Connecticut

Geographic distribution of EVs registered in Connecticut demonstrates that a greater share of registration is seen in Fairfield County, with Hartford and New Haven counties following (see Figure 6). While EVs are registered in more rural parts of the state, the adoption rate is lower in those areas. Higher EV penetration rates in Connecticut's urban and suburban areas are consistent with national adoption rates in those areas. According to the Union of Concerned Scientists, people living in urban and suburban areas are three times more likely to own an EV compared to those in rural areas.[56] Some of the barriers for rural drivers may include range anxiety, inadequate charging infrastructure, and availability of EV models to meet their performance needs, such as driving in snow or unpaved roads.

The benefits of EV adoption in rural areas are significant. On a daily basis, rural drivers drive further distances to work, to stores, and for other daily errands which results in a larger portion of their monthly income spent on gasoline, more frequent vehicle repairs, and increased emissions. The potential cost savings for rural residents who make a switch from an ICE vehicle to an EV can be substantial. According to a recent study conducted by the Union of Concerned Scientists, "the average [rural] driver will save $870 per year and cut carbon dioxide emissions by more than 3 metric tons per year by choosing an electric vehicle over a conventional sedan. That is almost twice the average emissions reduction from an EV in our most urban counties."[57] Programs and policies that target drivers in rural areas of the state will be necessary to maximize these benefits and reach our emissions reduction goals.

[52] Plug-in Hybrid & Electric Vehicle Research Center, UC Davis. Retrieved September 4, 2019 from https://phev.ucdavis.edu/research/.

[53] Plungis, Jeff. It's a Great Time to Buy a Used Electric Vehicle. Consumer Reports. August 31, 2018. Retrieved August 8, 2019 from https://www.consumerreports.org/hybrids-evs/great-time-to-buy-a-used-electric-vehicle/.

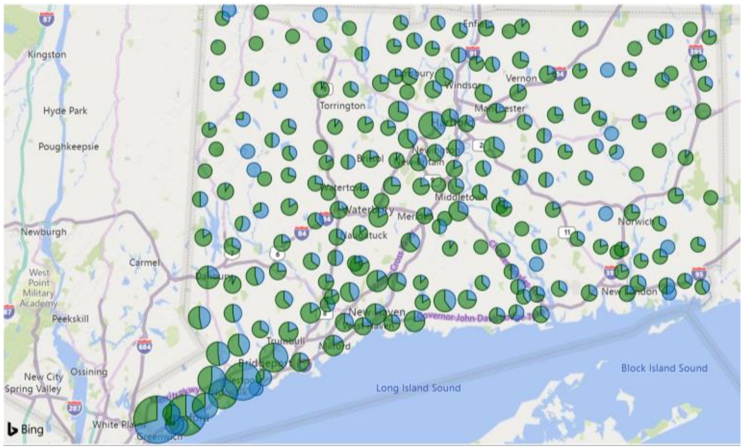
[54] Davies, Alex. Now on Used Car Lots: Great Electric Vehicles for Cheap. Wired. August 5, 2019. Retrieved August 6, 2019 from https://www.wired.com/story/now-used-car-lot-great-electric-vehicles-cheap/?verso=true.

[55] Caruso, Catherine. Why Range Anxiety for Electric Cars is Overblown. MIT Technology Review. August 15, 2016. Retrieved August 8, 2019 from https://www.technologyreview.com/s/602174/why-range-anxiety-for-electric-cars-is-overblown/.

[56] Gatti, Daniel. Rural Drivers have the Most to Gain from Clean Vehicles. Union of Concerned Scientists. February 15, 2019. Retrieved August 12, 2019 from https://www.dailyyonder.com/union-concerned-scientists-rural-drivers-can-save-clean-vehicles/2019/02/18/30455/.

[57] Gatti, Daniel. Rural Drivers have the Most to Gain from Clean Vehicles. Union of Concerned Scientists. February 15, 2019. Retrieved August 12, 2019 from https://www.dailyyonder.com/union-concerned-scientists-rural-drivers-can-save-clean-vehicles/2019/02/18/30455/.

Figure 6: EVs registered in Connecticut by location



Blue – BEV,
Green – PHEV/EREV
(extended range electric vehicle)

Source: EvaluateCT Data Dashboard. CT Transportation Electrification Toolkit, Atlas Public Policy. https://atlaspolicy.com/rand/transportation-electrification-toolkit-for-connecticut/.

4.5 Public and private fleets

The Energy Information Administration's 2019 Annual Energy Outlook found that 20 percent of all passenger cars and 17 percent of all light trucks sold in the U.S. in 2018 were for use in fleets, including rental business, commercial and utility, government, and ride hailing or taxi fleets.[58] Fleet vehicles' high annual mileage, operational costs, and public exposure make them viable and attractive candidates for electrification. Whether on the road or parked in public settings, EV fleet vehicles send a clear and positive message to the broader public about the viability of the technology. Deploying EVs in fleets also increases employee exposure and increases the likelihood that employees will consider purchasing an EV for personal use.

Fleet managers will see the greatest savings over the operable lifetime of EVs when accounting for maintenance, fuel, and other ancillary costs compared to their ICE counterparts. Moreover, fleet procurement, which typically involves the acquisition of larger quantities of vehicles, often qualifies for group purchase discounts from certain auto manufacturers, further strengthening the overall economic case for fleet electrification.

The following recommendations regarding setting EV fleet procurement targets, deploying telematics systems to capture fleet benchmark data, and aligning useful vehicle life with EV battery warranties are intended to serve as a blueprint for replication in both public and private fleet electrification. The focus on Connecticut's public fleet stems from Executive Order No. 1 signed by Governor Ned Lamont on April 24, 2019. Executive Order No. 1 directs state agencies to "Lead by Example" by setting targets and policies to achieve near-term and 2030 emissions reductions from the state vehicle fleet.[59]

Connecticut's public fleet, which is overseen by the Department of Administrative Services (DAS), is comprised of more than 3,500 vehicles that support the day-to-day business operations of more than 85 state agencies and log approximately 40 million miles per year.[60] Many of these fleet vehicles depart from and return to the same location every day, and their recorded trips are often local and daily in nature. The large fleet size and high utilization rates, along with DEEP's experience installing EV charging infrastructure at a number of state-owned facilities, place Connecticut in a unique position to lead by example in fleet electrification.

As noted above, Section 93 of Public Act 19-117 requires that on and after January 1, 2030, at least 50 percent of all cars and light-duty trucks purchased or leased by the state shall be EVs. To put Connecticut on a pathway

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[58] Assumptions to the Annual Energy Outlook 2019: Transportation Demand Module. Energy Information Administration. February 2019. Retrieved August 5, 2019 from https://www.eia.gov/outlooks/aeo/assumptions/pdf/transportation.pdf.

[59] Executive Order No. 1. The Office of Governor Ned Lamont. Effective April 24, 2019. Retrieved August 7, 2019 from https://portal.ct.gov/-/media/Office-of-the-Governor/Executive-Orders/Lamont-Executive-Orders/Executive-Order-No-1.pdf.

[60] Over, DAS Basic Fleet Information and Services. Connecticut Department of Administrative Services. Retrieved August 7, 2019 from https://portal.ct.gov/DAS/Fleet-Operations/DAS-Basic-Fleet-Information-and-Services.

to achieve this goal, the state could establish interim annual vehicle procurement goals, beginning with a recommended 5 percent of procured vehicles in 2020. To optimize the achievement of an annual procurement target, the state is deploying telematics systems to benchmark data on day-to-day fleet vehicle operations for right-sizing of fleets and to inform future fleet investments. Telematics systems utilize onboard GPS and vehicle diagnostic software to collect and transmit data on where a vehicle is traveling and how its mechanical and electrical systems behave under varying conditions.

It is anticipated that both public and private fleet managers will require, or at minimum prefer, day-to-day benchmarking data pertaining to the operational costs and vehicle performance of existing fleets and EVs prior to investing in a new vehicle technology. In particular, useful benchmarking data includes but are not limited to daily mileage/usage, fuel economy, time spent idling, operational and maintenance costs, vehicle age and remaining useful life estimates, and emissions. Additional data that accounts for Connecticut-specific variables such as weather and traffic patterns, driving habits, and fueling practices will help fleet managers identify, with confidence, what roles are and are not best suited for EVs. Ultimately, the use of telematics will identify, by ranking, fleet vehicles suitable for electrification.

Telematics is also useful in electric vehicle supply equipment (EVSE) infrastructure planning and to optimize deployment of infrastructure that fits fleet managers' specific needs. Analysis of such data could lead to prioritizing charging locations based on the ability to centrally locate multiple charging ports with minimal infrastructure investment.

When evaluating the cost of an ICE vehicle compared to an electric vehicle, fleet managers should utilize a total cost of ownership approach when procuring new vehicles. While EVs typically have higher upfront MSRPs than ICE vehicles, decreased fuel and maintenance costs can make them a more cost-effective long-term purchase. It is recommended that fleet managers align the useful life cycle of EVs with manufacturer battery/mileage warranties, which average 8 years/100,000 miles, when making procurement decisions. Shifting to total cost of ownership considerations will enable fleet managers to assess savings accrued over the lifetime of EVs. In March 2019, New York City's Department of Citywide Administrative Services (NYCDCAS) completed a fuel and maintenance costs analysis for 1,893 out of 9,196 light-duty fleet vehicles operated in 2018. The analysis found that fuel and maintenance costs for all BEVs was less than for gas, hybrid, and PHEVs. The results demonstrate that over a nine-year period, including EVSE costs, the Nissan Leaf will realize $8,748 (21%) in savings compared to the gas-powered Ford Fusion, the traditional option for NYCDCAS' passenger car fleet.

To maximize the benefits of any telematics systems and electric fleet vehicle procurements conducted by DAS, DEEP will work with DAS to publish procedural data, pilot program results, and best practices as a case study to inform future public and private fleet electrification. This information could be shared as part of the public reporting related to Executive Order No. 1. The City of Columbus, Ohio, as part of its Smart Columbus initiative, published the Smart Columbus Playbook detailing the jurisdiction's step-by-step process to deploy 300 EVs in its public fleet. The Playbook contains a variety of best practices, case studies, progress reports, webinars, and communications materials that other cities can draw from in support of their own fleet electrification.[61] In addition to this case study, DEEP will develop a web-based resource center dedicated to fleet electrification with helpful resources for fleet managers. Examples of fleet resources include the Greenhouse gases, Regulation Emissions, and Energy use in Transportation Model (GREET) tool and the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool developed by the Argonne National Laboratory. The GREET tool is used to simulate the full life cycle energy and environmental impacts of various vehicle technologies,[62] and the AFLEET tool is designed to help fleet managers forecast petroleum consumption, GHG and air pollutant emissions, and vehicle cost of ownership.[63]

[61] Playbook, Smart Columbus. Retrieved August 9, 2019 from https://smart.columbus.gov/playbook.
[62] Energy Systems, GREET Model. Argonne National Laboratory. https://greet.es.anl.gov/.
[63] AFLEET Tool. Argonne National Laboratory. https://afleet-web.es.anl.gov/home/.

Fleet electrification, which contributes to Connecticut's overall efforts to meet GHG reduction targets, requires organizations to allocate time and resources to fuel switching.[64] Organizations will likely need to conduct benchmarking exercises, revise procurement cost-benefit analysis, fund and install EV charging infrastructure, and train employees in EV operations. As such, Connecticut should establish an awards program to recognize municipalities, businesses, and organizations leading in fleet electrification across the state. Separate awards categories should be created to highlight fleet electrification leadership in the government and commercial sectors. The state could follow the model set forth by 100 Best Fleets' Green Fleets Award.[65] 100 Best Fleets is sponsored by transportation mobility leaders Dannar, GoSolar, Greenlots, Invers, and the NC Clean Energy Technology Center. In order to be considered for the Green Fleets Award, governments and commercial organizations must submit an application to be evaluated in the areas of fleet composition, fuel and emissions, policy and planning, fleet utilization, education, executive and employee involvement, and supporting programs. A potential Connecticut fleet recognition program can evaluate applicants based on similar criteria to be developed by DEEP with awards to be presented by the Office of the Governor.

Policy Recommendations: Public and private fleets

1. The state should consider setting targets for annual EV procurement for the state fleet, beginning with the goal of 5 percent of state vehicles in the first year.
2. Fleet managers should utilize vehicle telematics systems, as DAS is currently doing, to establish fleet benchmark data on the day-to-day operations of both EVs and comparable ICE vehicles, in order to inform future vehicle purchasing and infrastructure deployment decisions.
3. Fleet managers should align the useful life cycle of EVs with manufacturer battery/mileage warranties and consider total cost of vehicle ownership when making procurement decisions.
4. DEEP will create a web-based resource center dedicated to fleet electrification with helpful resources for fleet managers, including case studies, best practices, and vehicle benchmarking tools.
5. An awards program should be established to recognize Connecticut municipalities and commercial organizations leading in fleet electrification.

4.6 EVs beyond light-duty vehicles

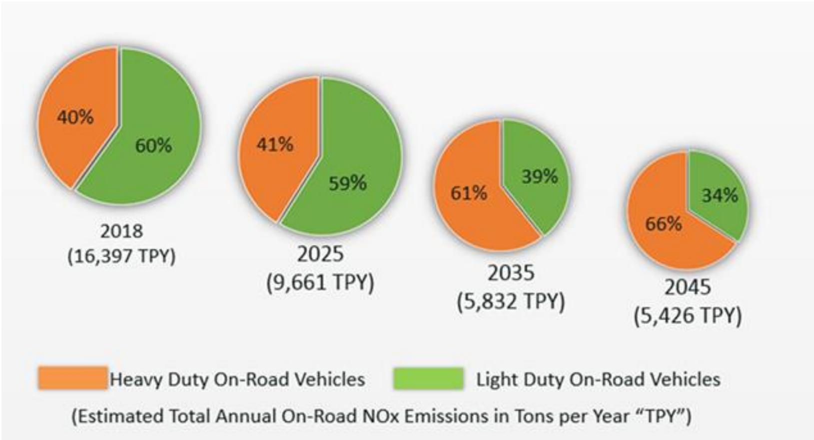
While electrification of light-duty vehicles has been a focus to date, there is on-going analysis of emerging applications for medium- and heavy-duty vehicles in order to identify strategies that target transportation electrification opportunities in those sectors. It is anticipated that by 2035, heavy-duty vehicles will contribute 61 percent more NOx emissions than light-duty vehicles (See Figure 7) due to decreasing light-duty vehicle emissions as a result of stronger new vehicle emission standards.

Continued movement by regulators and industry toward medium- and heavy-duty fleet electrification will be driven by California's Advanced Clean Truck regulations, which will likely be proposed in late 2020. The proposed regulation would require manufacturers to sell zero-emission trucks as an increasing percentage of their annual sales for 2024 through 2030 model years similar to the existing ZEV regulation. The anticipated regulation would also include a reporting component to provide information on fleet operations that would help to identify future strategies to ensure fleets purchase available zero-emission trucks and place them in service in applications to which they are suited.

[64] Terreri, Michael. Electric Vehicles Require New Tactics for Tracking Fleet Utilization. Center for Sustainable Energy. August 1, 2017. Retrieved August 9, 2019 from https://energycenter.org/thought-leadership/blog/electric-vehicles-require-new-tactics-tracking-fleet-utilization.

[65] The Green Fleet Awards. 100 Best Fleets. Retrieved August 9, 2019 from http://www.the100bestfleets.com/gf_about.htm.

Figure 7: *NOx contribution by vehicle sector based on MOVES2014 data*



Source: Source: CT Department of Transportation Ozone and PM2.5 Air Quality Conformity Determination of the 2019-2045 Metropolitan Transportation Plans and the 2018-2021 Transportation Improvement Programs. February 2019, revised April 2019.

If Connecticut intends to secure the environmental benefits afforded by electrification of significant numbers of medium- and heavy-duty vehicles, then the state will need to put promulgate regulations to adopt California's standards as authorized by Section 177 of the federal CAA. Decreasing emissions through the electrification of truck fleets will be important to meet air quality goals and improve air quality in environmental justice or other impacted communities which abut interstate limited access highways highly traveled by medium- and heavy-duty trucks. These communities are often in urban areas where many freight distribution routes end.

Further electrification of freight trucks will come through the development of EV applications for freight hauling semi-trucks. The electrification of semi-trucks faces additional challenges, such as providing these vehicles with reliable areas to recharge while on-road, and ensuring the electric distribution grid is prepared to integrate significant, mobile charging loads. Ten companies have announced future EV truck models to be available as early as 2019. These companies include new startups as well as traditional semi-truck makers. The electrification of semi-truck fleets will greatly reduce emissions from these vehicles.

The options currently available to reduce emissions from medium- and heavy-duty truck classes through EV technology are limited; however, several prototype or pilot vehicles that utilize electric and hydrogen fuel cells have been built and tested across the United States. Chicago, for example, replaced 20 diesel garbage trucks with electric models, resulting in a reduction of 68 tons of GHGs per year, per truck.[66]

Recognizing this value, the CT DOT applied for, and received, $4.9 million in funding in 2018 under the VW Settlement grant program, in part to offset the cost of deploying 12 electric transit buses[67] in Hamden, Connecticut (Hamden Bus Pilot). The remaining funds for the $15 million project will come from Federal Transit Administration Funding for bus replacements and capital facility improvement projects along with CT DOT Bureau of Public Transportation capital funds. On September 4, 2019, CT DOT released a request for proposals (RFP) to procure 35' and 40' low floor, heavy-duty battery electric powered transit buses. CT DOT plans to deploy 10 battery electric buses alongside 10, 120 kW electric bus chargers and software that enables the agency to charge the buses in two successive waves, which will minimize demand charges.

DEEP is currently conducting a proceeding to examine distributed and grid-side technologies and services that could help to more cost-effectively integrate electric charging for transit buses through the Hamden Bus Pilot.[68]

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[67] Section 93 of Public Act 19-117, An Act Concerning the State Budget for the Biennium Ending June 30, 2021, and Making Appropriations, Retrieved Oct. 1, 2019 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=602744&deepNav_GID=1619.
[68] Energy Filings: Public Act 15-5 – Section 103 – Grid-Side System Enhancements Demonstration Projects. Connecticut Department of Energy and Environmental Protection. Retrieved October 10, 2019 from http://www.dpuc.state.ct.us/DEEPEnergy.nsf/$EnergyView?OpenForm&Start=30&Count=30&Expand=42.6&Seq=4.

Insights gained may be relevant for consideration of rate design modifications that could promote electrification of transit buses and other vehicle fleets. The Hamden Bus Pilot will provide an opportunity to assess the costs and benefits of various technologies and services, including distributed generation, storage, demand response, managed charging, and other technologies, that may be utilized to minimize the distribution system costs of the project.

Section 93 of Public Act 19-117 requires that 30 percent of all buses purchased or leased by the state be zero-emission buses by 2030. The Hamden Bus Pilot and lessons learned from other state pilot programs should provide guidance on best practices for bus electrification, although each community's needs should be considered on an individual basis.

School buses represent another class of heavy-duty vehicles well suited for electrification. Electric school buses, which cost between $120,000[69] and $250,000[70] more than diesel school buses, are eligible for up to $20,000, per bus, in Diesel Emissions Reduction Act (DERA) funding under the U.S. EPA'sDERA School Bus Rebate Program.[71] On a per-vehicle basis, electric school buses will realize approximately $170,000 in lifetime operation and maintenance savings compared to their diesel counterparts.[72] Generally, school buses are taken out of service at the conclusion of each academic year and remain parked during summer months. This usage cycle makes electric school buses attractive candidates for providing vehicle-to-grid (V2G) services, such as storing energy and discharging it back to the grid during peak demand periods or demand response events. V2G is still in its infancy but has the potential to generate additional revenue for electric school bus fleets and is currently being piloted in California, New York, and Virginia.

Policy Recommendations: EVs beyond light-duty vehicles

1. DEEP recommends that PURA consider requiring the utilities to include medium- and heavy-duty fleet conversion as part of utility distribution system planning, and target underutilized electric distribution circuits for fleet charging depots.
2. DEEP will continue the Hamden Bus Pilot program under Public Act 15-5 to identify options to integrate managed charging, demand response, and distributed generation and storage to minimize costs of medium- and heavy-duty fleet charging on the distribution system and improve demand charge costs for fleet owners.
3. PURA and DEEP should assess pilot programs in Connecticut and other states to identify the types of grid modernization investments that will be necessary for visualization, control, and dispatch of vehicle-to-grid charging capabilities in school buses or other medium- and heavy- duty fleet vehicles.
4. Connecticut should evaluate the California Advance Clean Trucks rule, which will be proposed in 2021.

5 Expanding EV Charging Infrastructure

Strategic deployment of charging infrastructure is essential to meet the anticipated charging demand needs of Connecticut EV adoption targets. In an analysis utilizing the National Renewable Energy Lab's Pro-Lite tool, an estimated deployment of 5,858 workplace Level 2 charging plugs, 3,848 public Level 2 charging plugs, and 282 public DCFC plugs is necessary to meet targets.[73] This projection is indicative of the widespread deployment of EVSE necessary to meet future charging demand. The challenge for Connecticut is building the proper regulatory

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[69] Paying for Electric Buses, Financing Tools for Cities and Agencies to Ditch Diesel. U.S. PIRG Education Fund. 2018. Retrieved September 6, 2019 from https://uspirg.org/sites/pirg/files/reports/National%20-%20Paying%20for%20Electric%20Buses.pdf.

[70] Parscale, Jordan. Dominion Energy Will Buy Virginia Electric School Buses…If They Can Use the Batteries. WAMU. August 29, 2019. Retrieved September 6, 2019 from https://wamu.org/story/19/08/29/dominion-energy-will-buy-virginia-electric-school-buses-if-they-can-use-the-batteries/.

[71] Clean Diesel Rebates. U.S. Environmental Protection Agency. Retrieved September 6, 2019 from https://www.epa.gov/cleandiesel/clean-diesel-rebates#replacement.

[72] Paying for Electric Buses, Financing Tools for Cities and Agencies to Ditch Diesel. U.S. PIRG Education Fund. 2018. Retrieved September 6, 2019 from https://uspirg.org/sites/pirg/files/reports/National%20-%20Paying%20for%20Electric%20Buses.pdf.

[73] This projection uses a compound annual growth rate for all EV types (assuming an electric vehicle mix in 2025 of: 20% PHEVs – 20 mile range, 27% PHEVs – 50 mile range, 12% EVs – 100 mile range, and 41% EVs – 250 mile range) and the Electric Vehicle Infrastructure Project Tool (EVI-Pro) Lite tool developed by the National Renewable Energy Laboratory (NREL) and the California Energy Commission. This projection assumes that most PHEV drivers would not need to use gasoline on a typical day.

framework and identifying cost-effective strategies to enable a robust charging infrastructure network that supports and accelerates EV adoption and limits negative impacts on the electric grid such as increased demand during peak times.

Managed charging of EVs has the potential to provide a variety of benefits to EV owners while also flattening peak demand, improving the reliability of the grid, and maximizing utilization of clean energy sources. Managed charging allows a utility or a third-party the ability to remotely control vehicle charging by increasing or decreasing electric demand in concert with the needs of the grid, similar to traditional demand response programs. Managed charging programs in other states are most often administered by EDCs via a networked charging station, on-board vehicle software, or behavioral load control through a mobile phone app and Wi-Fi connected toggle device.[74] Depending on the platform used to administer the program, EV owners may schedule their charging sessions in response to price signals or their EDC may automatically manage their charging during demand response events. In order to amplify the benefits and limit the costs of EV deployment, it is critical to investigate managed charging solutions for any utility regulatory framework under consideration.

5.1 EV siting, building codes and permits, and data collection

Unlike ICE vehicles that are refueled at a gas station in between destinations, 80 percent of EV charging takes place at home[75] and any remaining charging mostly takes place at a charging station at or nearby the driver's destination. Given this paradigm shift, careful consideration must be afforded to the design of public charging stations and the manner in which they interface with their users.

Consistency in positive consumer experience is fundamental to the successful adoption of EVs. Public charging equipment should be interoperable with any EV make and model. Signage at public charging stations should provide visible and transparent pricing information that communicates the level of refueling to expect and the quantity of electricity to be drawn per charging session. These stations should offer easy-to-access charging and allow for multiple payment options. Furthermore, a communications ecosystem, via signage or in real-time via mobile phone apps or on-board technology installed in some EVs, can help maximize user access to EV charging stations, and provide status alerts on the availability of open chargers and spaces, as well as notifications of any inoperable charging equipment or scheduled maintenance plans.

Electric distribution system planning processes that provide greater transparency around locational characteristics of the Connecticut EDCs' distribution system—specifically, circuits that may have underutilized capacity—would help to identify any locations along transportation corridors that may have lower installation costs for DCFC. PURA may wish to require EDCs to identify locations with such characteristics as part of its ZEV Docket.

5.1.1 Siting public charging stations

Connecticut's EV deployment policy must prioritize policies that encourage off-peak, at-home EV charging. At the same time, the state's policy must provide for more deliberately planned expansion of the public charging network to meet consumers' on-the-go charging needs and expand consumer confidence in EV technologies.[76] Behind purchase price and vehicle range concerns, consumers rank access to efficient charging stations third in the list of most significant barriers to EV adoption according to a 2016 McKinsey and Company survey. Progressing the availability of public EV charging has the strongest effect at reducing the range anxiety that

[74] A Comprehensive Guide to Electric Vehicle Managed Charging. Smart Electric Power Alliance. May 2019.

[75] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. Retrieved August 13, 2019 https://www.energy.gov/eere/electricvehicles/charging-home

[76] Wood, E., Rames, C., Muratori, M., Raghavan, S., Melaina, M. Plug-In Electric Vehicle Infrastructure Analysis. National Renewable Energy Laboratory. September 2017. Retrieved September 9, 2010 from https://www.nrel.gov/docs/fy17osti/69031.pdf.

hinders EV adoption. Moreover, higher visibility of the public charging network has been shown to correlate with higher rates of EV adoption.[77]

As the deployment of EVs ramps up, public charging availability will be essential to both local EV drivers and out-of-state drivers without access to residential charging infrastructure. If EV sales match forecasts for the next decade, a lack of available charging infrastructure to meet refueling demand may become an impediment to EV adoption.[78] With the rapid growth of ride-hailing and car sharing services such as Uber, Lyft, and ZipCar, the placement of EV chargers at more frequented destinations would help enable a shift to greater EV use in those service fleets.

The Clean Vehicles and Fuels workgroup of the Transportation Climate Initiative (TCI), of which Connecticut is a member, brings together Northeast and Mid-Atlantic jurisdictions to coordinate charging infrastructure planning and deployment throughout the Northeast and Mid-Atlantic regions. TCI tools and resources include reports and analyses of current EVSE infrastructure, best practices for siting and design, and signage.[79] In particular, the EV Corridor Analysis Tool can be used to assess potential locations for EV charging infrastructure development, including site assessment of current distribution system infrastructure and planning needs to accommodate Level 2 and/or DCFC charging equipment. The GIS- and Microsoft Excel-based EV Corridor Analysis Tool evaluates site locations in the TCI region based on existing EV charging stations, population, vehicle travel data, and commercial activity.[80] Northeast States for Coordinated Air Use Management's (NESCAUM) Northeast Corridor Regional Strategy for Electric Vehicle Charging Infrastructure 2018-2021 provides recommendations and best practices for expanding DCFC charging networks and leveraging public-private partnerships to optimize charging infrastructure buildout in the region. Together, these combined tools can help private and public entities prioritize EVSE deployment in locations that extend the geographic range of EVs along travel corridors and require minimal infrastructure investment.

To support the expansion of its public charging network, Connecticut should continue to identify key destination locations for EVSE installation. Travel and tourism statistics could be analyzed to identify key locations for destination charging. Potential locations should include interstate highways, parking lots and garages, airports, transit centers, retail sites, state facilities and properties, historical sites, multi-use entertainment venues, and lodging and accommodations. This information could be made publicly available to encourage EVSE investment in these areas. Where possible, the state should embrace public-private partnerships to increase the number of public chargers, and increase data collection and analysis to adopt models that can help inform EVSE charger placement.

5.1.2 Building codes and permitting requirements

To better enable rapid and widespread deployment of EVs in Connecticut, state and local government building codes must advance requirements for EVSE installation and streamline the permitting process. For all building types, it is significantly cheaper to pre-wire for EVSE when compared to retrofitting for EVSE due to costly retrenching, rewiring, or electric panel upgrades. The DAS, State Codes and Standards Committee, and the Office of the State Building Inspector should continue to align the State Building Code with the most recent International Energy Conservation Code (IECC) standards for EVSE installation to keep pace with these rapidly evolving technologies. Connecticut’s 2018 State Building Code conforms to 2015 International Code Council (ICC) standards, and requires all newly constructed residential garages possess the level of circuitry necessary to

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[77] Hall, Dale and Lutsey, Nic. Emerging Best Practices for Electric Vehicle Charging Infrastructure. The International Council on Clean Transportation. October 2017. Retrieved August 12, 2019 from https://theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf.

[78] Charging ahead: Electric-vehicle infrastructure demand. McKinsey & Company. August 2018. Retrieved August 15, 2019 from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/charging-ahead-electric-vehicle-infrastructure-demand.

[79] Northeast Electric Vehicle Network Documents. Transportation and Climate Initiative. Retrieved August 14, 2019 from https://www.transportationandclimate.org/northeast-electric-vehicle-network-documents.

[80] Accelerating Development of Northeast EV Corridors. Georgetown Climate Center. Retrieved July 8, 2019 from https://www.georgetownclimate.org/transportation/development-ev-corridors.html.

accommodate EV charging.[81] In February 2019, the State Building Inspector, State Fire Marshal, and the Codes and Standards Committee announced their intent to adopt the 2020 State Building and Fire Safety Codes based on the 2018 editions of the ICC standards, which incorporate the latest IECC standards.[82]

In Connecticut's current State Building Code cycle, the State Codes and Standards Committee and the Office of the State Building Inspector are considering a proposal related to EV pre-wiring. DEEP recommends the adoption of standards that require all new multi-unit dwellings (MUDs) and commercial developments be pre-wired for Level 2 EV charging during initial construction and reserve parking spaces for EV charging in new parking facilities. As a baseline, based on DEEP environmental reviews of DAS projects, DEEP recommends that the State Building Code require at least 10 percent of all parking spaces in new construction be pre-wired to accommodate the future installation of a Level 2 (220- or 240-volt) EV charger and be outfitted with a 120-volt outlet to accommodate Level 1 charging. Recommended pre-wiring requirements based on parking space quantity are set forth in Table 4 below.

Table 4: Pre-wiring EV parking space requirements for new construction

Total Number of Parking Spaces	Number of Required Level 2 EV-Ready Charging Spaces
0-9	1
10-25	2
26-50	4
51-75	6
76-100	9
101-150	12
151-200	17
201 and over	10 percent of total*

* The number of spaces has been rounded up to the nearest whole number.

Following the California Green Building Standards Code (CALGreen) model, which sets forth multiple-tiered, voluntary EV parking space pre-wiring requirements[83] for municipalities seeking to exceed the CALGreen baseline, DEEP recommends that the State Codes and Standards Committee consider introducing its own voluntary pre-wiring requirements to exceed the Connecticut State Building Code baseline.

Currently, DEEP, DAS Construction Services, and the Office of the State Building Inspector are drafting regulations that reflect High Performance Building Standards requirements to install Level 2 EVSE at newly constructed state buildings and public schools. A 2018 California Air Resources Board (CARB) report found, at minimum, 10 percent of all parking spaces must include EV charger installation to meet Level 2 charging demand between 2025 and 2030 and help California achieve its GHG reduction goals.[84] Connecticut, with its own GHG reduction and EV deployment targets, should consider incorporating CARB's recommendation and require 10 percent of parking spaces at new state buildings and public schools include Level 2 EV charging installation to meet future demand.

The design and installation of EV charging stations must comply with the Americans with Disabilities Act (ADA) and be easily accessible to all consumers. In accordance with the ADA, specific design considerations include

[81] Sec. 29-252. Chapter 541: BUILDING, FIRE AND DEMOLITION CODES. FIRE MARSHALS AND FIRE HAZARDS. SAFETY OF PUBLIC AND OTHER STRUCTURES. https://www.cga.ct.gov/current/pub/chap_541.htm.

[82] Building and Fire Code Adoption Process. Connecticut Department of Administrative Services. Retrieved September 9, 2019 from https://portal.ct.gov/DAS/Office-of-State-Building-Inspector/Building-and-Fire-Code-Adoption-Process.

[83] CALGreen (2016) Title 24, Part 11, Appendices A4 &A5. https://www.ladbs.org/docs/default-source/publications/code-amendments/2016-calgreen_complete.pdf?sfvrsn=6.

[84] Electric Vehicle (EV) Charging Infrastructure: Multifamily Building Standards. California Air Resources Board. April 13, 2018. Retrieved July 30, 2019 from https://arb.ca.gov/cc/greenbuildings/pdf/tcac2018.pdf.

accessibility, ease of use, and safety for disabled drivers; however,[85] federal ADA standards for EV charging stations do not currently exist. In the next code cycle, the State Codes and Standards Committee should consider adopting amendments to the State Building Code that establish ADA-compliant requirements for EV charging stations. In 2016, California became the first state in the nation to codify ADA requirements for EVSE in its state building code.[86] The California building code revisions could serve as a blueprint for revising the Connecticut State Building Code.

Municipalities around the country are beginning to recognize that state building codes, as the foundation for EV-ready buildings, do not go far enough to deploy the charging infrastructure necessary to spur EV adoption rates that will drive emissions reductions from the transportation sector.[87] Municipalities in the Western United States have begun adopting more stringent EV-ready building codes that meet EV market needs and "future proof" new construction to support higher EV adoption rates. In order to expedite the county and municipal code adoption process in Connecticut, the State Codes and Standards Committee should prepare EV-ready residential and commercial building code templates modeled after those released by the Southwest Energy Efficiency Project, which are designed to meet EV market needs.[88,89] Furthermore, municipalities can expand EVSE infrastructure installation through parking and zoning ordinances that govern the use of property by land use and occupancy type.

For example, in 2017 the City of Atlanta, Georgia passed its EV Ready Ordinance (17-0-1654) to require 20 percent of parking spaces in all new commercial buildings and multi-family dwellings to be outfitted with electrical infrastructure, including conduit, wiring, and electrical capacity necessary to support the installation of EV charging stations.[90]

In addition to adopting the most recent ICC standards in the State Building Code, the State Codes and Standards Committee and the Office of the State Building Inspector should consider consolidating and streamlining the permitting and inspection process for Level 2 EVSE and DCFC installations. In particular, DCFC deployment is in its nascent stages and most jurisdictions have not permitted for such chargers.[91] Creation of a single, streamlined process will help eliminate unnecessary obstacles for deploying EVSE needed to meet EV demand and alleviate range anxiety concerns. It is recommended that the Codes and Standards Committee and the Office of the State Building Inspector adopt best practices for DCFC permitting and deployment as highlighted in NESCAUM's May 2019 white paper, *Preparing Our Communities for Electric Vehicles: Facilitating Deployment of DC Fast Chargers*. In Oregon, the Building Codes Division set forth a single streamlined permit for the installation of EVSE and periodically updates its regulations to reflect current technology standards. The Oregon EVSE permitting process involves connecting EV customers with EVSE providers, assessing a customer's site for EVSE for electric panel adequacy, obtaining a permit for applicable electrical installations (if necessary), EVSE

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[85] ADA Requirements for Workplace Charging Installation: Guidance in Complying with Americans with Disabilities Act Requirements. Workplace Charging Challenge, U.S. Department of Energy. November 2014. Retrieved August 14, 2019 from https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf.

[86] The following resources contain best practices for establishing ADA-compliant requirements for EV charging stations: The Colorado Electric Vehicle and Infrastructure Readiness Plan accessed at http://lungwalk.org/CleanCitiesWebsite/wordpress/wp-content/uploads/2015/05/Colorado-PEV-Readiness-Plan.pdf, U.S. Department of Energy's Guidance in Complying with Americans with Disabilities Act Requirements accessed at https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf, and Clean Fuels Ohio's EV Charging for Persons with Disabilities. Retrieved August 15, 2019 from https://docs.wixstatic.com/ugd/cf3da3_5062021a94df41de8bee125f995c030e.pdf.

[87] Cracking the Code on EV-Ready Building Codes. Southwest Energy Efficiency Project. October 23, 2018. Retrieved July 30, 2019 from http://www.swenergy.org/cracking-the-code-on-ev-ready-building-codes.

[88] Sample EV-Ready Building Code: Residential. Southwest Energy Efficiency Partnership. October 23, 2018. Retrieved July 30, 2019 from http://www.swenergy.org/data/sites/1/media/documents/publications/documents/Sample%20IRC_EV%20Building%20Code%20Proposal.pdf.

[89] Sample EV-Ready Building Code: Commercial. Southwest Energy Efficiency Partnership. October 23, 2018. Retrieved July 30, 2019 from http://www.swenergy.org/data/sites/1/media/documents/publications/documents/Sample%20IBC_EV%20Building%20Code%20Proposal.pdf.

[90] City of Atlanta Passes "EV Ready" Ordinance into Law. City of Atlanta, GA. November 17, 2017. Retrieved July 30, 2019 from https://www.atlantaga.gov/Home/Components/News/News/10258/1338?backlist=/.

[91] O'Grady, Elaine and Way, Jesse. Preparing our Communities for Electric Vehicles: Facilitating Deployment of DC Fast Chargers. May 2019. Northeast States for Coordinated Air Use Management.

installation by an electrician, inspection of the EVSE, and interconnecting the equipment with the grid.[92] This simplified permitting process provides for jurisdictions within Oregon to concurrently conduct building, electric, and other reviews, saving time and resources.

In 2014, DEEP published its *Guidelines for the Installation of EVSE at State-Owned Facilities.* The document addressed equipment procurement through approved vendors, equipment specifications, site design considerations including parking space dimensions and charging access, signage, permitting and inspection, operation and maintenance, and payment.[93] Given the rapid advancement in EV and EVSE technologies, and the focus on electrification of state fleets as part of Executive Order No. 1, DEEP should update, add best practices, and publish new guidelines for the installation of EVSE that extend beyond state-owned facilities to both public and private charging stations.

5.1.3 Data collection to inform grid impact planning for increased EV charging loads

In New England, an EV penetration rate of 5 percent could result in an increase in peak demand of approximately 3.5 percent.[94] If vehicle penetration rates in the region reach 25 percent by 2030, peak demand could increase by nearly 20 percent if charging if not managed, which could require significant investment in generation, transmission, and distribution capacity.[95] EV penetration rates and subsequent utilization rates of public charging infrastructure are projected to rapidly increase as states meet their EV deployment targets in the mid-2020s.[96] Given these potential grid impacts, Connecticut EDCs should continue to regularly assess short- and long-term distribution system reliability and capacity to meet projected and actual charging demand associated with rising levels of EV adoption.

Under Section 2 of Public Act 16-135, the Connecticut Department of Motor Vehicles (DMV) is required to update on its website every six months the total number of EVs registered in Connecticut, including the total number registered in the state each year.[97] As of July 1, 2019, there are 10,339 EVs registered in Connecticut;[98] however, registration data do not include any geographic indicators such as street address, zip code, municipality, or county where they are registered.

Identifying where EVs are registered is important for EDCs to improve load forecasting and overall distribution system planning while safely and reliably serving new EV-related loads in their service territories. To help plan for longer-term statewide EV penetration, EDCs need to understand EV charging impacts on local distribution system assets in communities with high concentrations of EVs. Connecticut EDCs prepare hosting capacity maps to estimate the amount of generation that can be accommodated without adversely affecting power quality or reliability, and without requiring infrastructure upgrades. Such maps are typically useful for evaluating solar installations, but have not previously included EV charging loads. Under Sections 5 and 6 of Public Act 16-135, the EDCs are required to integrate EV charging load projections into their distribution planning, based on the number of EVs registered in Connecticut and any projected EV sales trends.[99] In addition, these statutes require that the EDCs publish on their websites annual reports explaining how EV charging load projections factor into their distribution system planning. Moving forward, DEEP recommends that PURA enforce these statutory

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[92] Oregon Leads the Charge for Plug-In Electric Vehicles and Infrastructure. Alternative Fuels Data Center. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. October 10, 2014. Retrieved July 30, 2019 from https://afdc.energy.gov/case/1000.

[93] Guidelines for the Installation of Electric Vehicle Charging Stations at State-Owned Facilities. Connecticut Department of Energy and Environmental Protection. Revised September 2014. Retrieved August 12, 2019 from http://www.ct.gov/deep/lib/deep/air/electric_vehicle/guidelines_for_the_installation_of_electric_vehicle_charging_stations_at_state_facilities.pdf.

[94] Nelder, Chris, Newcomb, James and Fitzgerald, Garrett. Electric Vehicles as Distributed Energy Resources. Rocky Mountain Institute. 2016. Retrieved October 10, 2019 from http://www.rmi.org/pdf_evs_as_DERs.

[95] Ibid.

[96] Lutsey, Nic and Nicholas, Michael. Update on electric vehicle costs in the United States through 2030. The International Council on Clean Transportation. April 2, 2019. Retrieved August 15, 2019 from https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf.

[97] Public Act 16-135: AN ACT CONCERNING ELECTRIC AND FUEL CELL ELECTRIC VEHICLES. https://www.cga.ct.gov/2016/ACT/pa/pdf/2016PA-00135-R00HB-05510-PA.pdf.

[98] Number of Electric Vehicles Registered in Connecticut. Connecticut Department of Motor Vehicles. Retrieved September 10, 2019 from https://www.ct.gov/dmv/cwp/view.asp?a=807&q=600850.

[99] Public Act 16-135: AN ACT CONCERNING ELECTRIC AND FUEL CELL ELECTRIC VEHICLES. https://www.cga.ct.gov/2016/ACT/pa/pdf/2016PA-00135-R00HB-05510-PA.pdf.

requirements to help the EDCs plan for increased levels of EV adoption. DEEP also recommends that the PURA provide guidance and vision about specific compliance steps to meet the statutory requirement in its ZEV Docket.

Access to EV registration data by street address would also help EDCs target new products and services, such as EV-specific time-of-use (TOU) rates or EVSE incentives, to their customers that own or lease EVs. Access to DMV EV registration data and other sources will be necessary to accurately plan for changes in electricity demand on the system and to enable the EDCs to target new products and services.

The development of more detailed hosting capacity maps will enable the EDCs, in coordination with EV charging station developers, to identify preferable locations that optimize existing distribution system assets and minimize infrastructure investments. These updated hosting capacity maps will become a valuable asset for EDCs and fleet managers when siting EVSE to support medium- and heavy-duty EVs such as electric transit bus fleets. In addition, EDCs should make hosting capacity maps publicly available by website with high-level estimates for local distribution system hosting capacity.

In conjunction with hosting capacity maps, DEEP recommends that the EDCs use TCI's EV Corridor Analysis Tool to assess and prioritize suitable locations for EV charging infrastructure development that require minimal infrastructure investment to support new demand for EV charging loads. This tool evaluates site locations in the TCI region[100] based on existing EV charging stations, population, vehicle travel data, and commercial activity to extend the geographic range of EVs along travel corridors.[101]

Lastly, the EDCs should develop a program to collect and aggregate pertinent data including the dates, times, durations, and electricity usage (kWh) per charging session as well as monthly total electric load (kWh) from EV charging.[102] The EDCs should recruit EV owners and lessees with Level 2 charging equipment and provide the opportunity for them to voluntarily opt into data collection efforts. To protect confidentiality, EDCs should minimize the collection of personally identifiable data and ensure that data remain encrypted using secure industry standard techniques. Pertinent data should be incorporated into hosting capacity maps to help EDCs optimize existing grid assets to serve EV-related loads and inform the development of demand response pilot programs (e.g. EV-specific TOU rates, managed charging, etc.) that would shift loads and alleviate grid impacts during peak demand periods.

5.2 Infrastructure development for fuel cell electric vehicles

Connecticut recognizes that the successful penetration of EVs is dependent on insuring that a robust mix of EVs is available to consumers. Many advances have been made in the deployment of an EV charging network across the state. Similar efforts are needed for the deployment of an economically viable hydrogen fueling network to ensure market penetration of FCEVs throughout Connecticut and the Northeast. The 2017 Northeast Regional Hydrogen Economy Fuel Cell Electric Vehicle Fleet Deployment Plan[103] recommends deployment goals for Connecticut of 591 FCEVs and 6 to 7 hydrogen fueling stations by 2025. To date, there are 2 FCEVs registered and 2 publicly accessible hydrogen fueling stations in the state. To improve the value of FCEVs to consumers and enable continued growth and distribution of fuel cell technology into the market place, continued, consistent effort is needed to coordinate the development of a hydrogen fueling network in Connecticut.

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[100] The 12-state TCI region is comprised of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia, plus the District of Columbia.

[101] Accelerating Development of Northeast EV Corridors. Georgetown Climate Center. Retrieved July 8, 2019 from https://www.georgetownclimate.org/transportation/development-ev-corridors.html.

[102] California's Public Utilities Commission, Energy Division, established utility data collection and reporting requirements (D.18-01-024, D.18-05-040, and D.18-09-034) for investor-owned utility programs under SB 350 – The Clean Energy and Pollution Reduction Act. Retrieved July 2, 2019 from Data Collection Template. https://www.cpuc.ca.gov/sb350te/.

[103] 2017 Fuel Cell Electric Vehicle Fleet Deployment Plan. Northeast Regional Hydrogen Economy. 2017. Retrieved August 12, 2019 from http://chfcc.org/wp-content/uploads/2019/03/2017_Regional_H2_Fleet.pdf.

5.3 Ownership models for public charging infrastructure

To optimize public EVSE buildout, it is important to consider the advantages and disadvantages of the various EVSE ownership models. Relevant stakeholders should be identified, including, but not limited to, EDCs, EVSE manufacturers, EV service providers, auto manufacturers, drivers, and EVSE site hosts. Moreover, the expertise of each stakeholder should be leveraged to lower costs, improve operations, and drive innovation. It is fundamental to assess the appropriate role of EDC investment and risk management within the charging ecosystem. The EDCs' technical expertise and energy demand forecast modeling place them in a unique position to inform EVSE site selection to produce optimal grid and societal benefits, and ensure that EV charging stations provide safe and reliable electricity to users.

Existing ownership models in the public EVSE market for Level 2 charging and DCFC include: make-ready, private, third-party profit-sharing, EDC owner-operator, and EDC-incentivized models. There is no "one size fits all" EVSE ownership model to meet Connecticut's vision for a diverse public charging network and a hybrid ownership model will be necessary to meet public charging infrastructure demand. Each given EVSE ownership model may be more or less preferable for different geographic locations and applications. Under the EDC owner-operator model, the EDC oversees EVSE installation and operation, which may hinder market competition. Conversely, all non-EDC owner-operator models may spur greater market competition and innovation, but would rely upon separate entities to ensure successful EVSE operation and maintenance, site security, and call center support for customers.[104] Any investment of public dollars to support DCFC deployment will need to ensure provision of adequate funds for operations and maintenance (O&M) costs to ensure that these resources, whose primary function is to reduce range anxiety, are reliably available for use by EV drivers.

5.3.1 Make-ready ownership model

The make-ready ownership model has been approved by public utility commissions (PUCs) in several states and is viewed as a foundational model for building out statewide charging networks. Under the make-ready model, EDCs invest in the site's required electrical infrastructure and upgrades up to, but not including, the EVSE, thereby making the site ready for EVSE installation. Make-ready investments may include transformer and service capacity upgrades, wiring, conduit, metering upgrades, and trenching and running cables to parking lots or garages. The site host oversees the procurement, installation, and ownership of the EVSE.

The make-ready model allows site hosts to benefit from EDC investment to lower capital costs, enables site hosts to choose the EVSE provider and the charging price scheme, and spurs competition in the EVSE marketplace. However, PURA would need to determine cost recovery for the EDCs' investments.[105] Furthermore, by itself, the make-ready model may not be successful for driving equitable infrastructure investment in low-income and underserved communities. First and foremost, private developers seek to deploy EVSE in communities that will generate the highest return on investment, which undermines their business case for deploying EVSE in low-income and underserved communities where charging infrastructure is likely to be underutilized in the near-term. A hybrid investment approach may be a preferable approach to ensure equitable access to charging infrastructure for low-income and underserved communities.

5.3.2 Private ownership model

Under the private ownership model, private site hosts oversee and fund all aspects of EVSE deployment including on-site electrical infrastructure upgrades and EVSE procurement, installation, and operation and maintenance. Private site hosts also determine payment requirements for use of the equipment and keep all revenues.[106] Private ownership may prevent costs for EVSE from being passed onto ratepayers and non-EV

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[104] Bansal, Saurabh. EV Charging Infrastructure: The Evolving Business Models. West Monroe Partners. April 2016. Retrieved October 10, 2019 from https://www.westmonroepartners.com/Insights/Newsletters/West-News-Energy-and-Utilities-April-2016/EV-Charging-Infrastructure.

[105] Accelerating the Electric Vehicle Market. M.J. Bradley & Associates. March 2017. Retrieved August 15, 2019 from https://www.mjbradley.com/sites/default/files/MJBA_Accelerating_the_Electric_Vehicle_Market_FINAL.pdf.

[106] Plug-In Electric Vehicle Handbook for Public Charging Station Hosts. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. April 2012. Retrieved August 15, 2019 from https://www.afdc.energy.gov/pdfs/51227.pdf.

drivers. One example of a private ownership model is BlueIndy, an EV and ESVE service provider. BlueIndy oversees the maintenance of its EVSE and allows EV owners to charge at its stations through annual, monthly, weekly, or immediate service subscriptions.[107] This total cost approach has been deployed in various jurisdictions and provides a benefit insofar as it places the risk on the EVSE owner, although the approach is still unproven as a scalable business model due to uncertainties regarding profit margin realized by charging station companies.

Using a modified approach in Virginia, EVgo was recently selected to assist the state in building out statewide DCFC infrastructure. Virginia will use $14 million from VW settlement funds with EVgo sharing the cost of construction in exchange for 100 percent of charging revenue from the partnership.[108] This type of cost-sharing approach may help to make the private ownership model more viable in the near term.

5.3.3 Third-party profit-sharing ownership model

Under the third-party profit-sharing model, a third-party company can assist a site host with site design, EVSE selection, network management, data collection and visibility, demand response programs, and payment requirements. Such a model could also consist of the EDCs providing make-ready infrastructure upgrades and capital contribution, a third-party providing the EVSE and management software, and the site host providing the remaining capital and EVSE maintenance, with each entity receiving a share of the charging revenue. This model minimizes upfront costs and administrative responsibilities, which helps site hosts like retail businesses reap the benefits of attracting EV-friendly clientele while expanding EVSE buildout.[109] Depending on the charging ecosystem created, the profit-sharing model could enable EDCs to collect and analyze EV charging data that help ensure the electrical grid is prepared to accommodate forecasted EV growth. Similar to a make-ready model, the third-party profit-sharing ownership model, on its own, may not maximize the EDCs' technical expertise or lead to an equitable distribution of charging infrastructure in low-income and underserved communities. In addition, there are concerns that this model may create an overly complex charging ecosystem that does not encourage strategic planning and deployment for EVSE.[110]

5.3.4 EDC owner-operator model

Under the EDC owner-operator model, an EDC invests in the electrical infrastructure and upgrades at a site, while also overseeing EVSE installation and operation. This model provides a streamlined investment and administrative approach as EDCs oversee all stages of EVSE siting, installation, interconnection, marketing, operation, and maintenance. EDCs have been performing many of these functions with decades of experience and EDCs can collect and transparently report charger use data to inform future EVSE development. EDCs, with their ability to recover investment costs, may prove helpful in ensuring EVSE buildout reaches low-income and underserved communities where adequate funding may not be available, as well as less populated areas.[111] The EDC owner-operator model may be most efficient for rapidly scaling the deployment of public charging infrastructure, and allows EDCs to apply real-time situational awareness and take actions to protect the electric grid if charging clusters compromise grid reliability.[112] However, if overused, the EDC owner-operator model may lead to less competition and few, if any, EVSE investments from alternative providers. This model also presents

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[107] FAQ. BlueIndy. https://www.blue-indy.com/faq.

[108] Governor Northam Announces Selection of EVgo to Develop Statewide Public Electric Vehicle Charging Network. Commonwealth of Virginia. August 9, 2018. Retrieved September 3, 2019 from https://www.governor.virginia.gov/newsroom/all-releases/2018/august/headline-828389-en.html.

[109] Plug-In Electric Vehicle Handbook for Public Charging Station Hosts. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. April 2012. Retrieved August 15, 2019 from https://www.afdc.energy.gov/pdfs/51227.pdf.

[110] Accelerating the Electric Vehicle Market. M.J. Bradley & Associates. March 2017. Retrieved August 15, 2019 from https://www.mjbradley.com/sites/default/files/MJBA_Accelerating_the_Electric_Vehicle_Market_FINAL.pdf.

[111] Jones et al. The Future of Transportation Electrification: Utility, Industry and Consumer Perspectives. Berkeley Lab. August 2018. Retrieved August 15, 2019 from https://www.nclc.org/images/pdf/energy_utility_telecom/electric_vehicles_evs/future-transportation-report-2018.pdf.

[112] Jones et al. The Future of Transportation Electrification: Utility, Industry and Consumer Perspectives. Berkeley Lab. August 2018. Retrieved August 15, 2019 from https://www.nclc.org/images/pdf/energy_utility_telecom/electric_vehicles_evs/future-transportation-report-2018.pdf.

the potential for ratepayers to shoulder the burden of financing EVSE infrastructure buildout and the stranded costs if the EVSE is underutilized.[113]

5.3.5 EDC-incentivized ownership model

Under the EDC-incentivized model, EDCs offer site hosts financial incentives toward installation of EVSE such as equipment and electric infrastructure upgrade rebates.[114] These rebates can be financed using VW settlement funds or other funding sources. This model reduces upfront EVSE costs for developers and drivers while providing the potential for EDCs to incentivize EVSE utilization such as reduced charge pricing during off-peak times or managed charging. However, the EDC-incentivized model may not provide O&M support from EDCs beyond the electrical infrastructure upgrades.

5.3.6 Ensuring equitable public investment in EV charging infrastructure

In their respective docket proceedings, both the California and Massachusetts PUCs ultimately backed the make-ready ownership model with specific requirements for EV charging infrastructure investment in low-income and underserved communities. For example, the California PUC approved Pacific Gas & Electric's (PG&E) hybrid make-ready model[115] and Southern Con Edison's make-ready model,[116] with both establishing requirements for minimum investment in underserved communities. PG&E's hybrid make-ready model enables the EDC to own up to 35 percent of charging stations deployed in MUDs, underserved communities, and workplaces under its program. The California PUC ruled that PG&E ownership would help the EV infrastructure program reach underserved markets and the 35 percent EDC ownership limit would help mitigate any anticompetitive impacts.[117] The Massachusetts Department of Public Utilities approved Eversource Energy's proposal to rate-base $45 million in make-ready infrastructure investments with a minimum of 10 percent to be sited in environmental justice communities as identified by the state.[118]

PUCs across the U.S. have approved cost-recovery approaches for various EV charging infrastructure deployment and ownership models justified by varying conditions. While some PUCs view EDCs as most capable of filling in charging stations gaps, other PUCs view EDCs as the primary driver for rapidly building a robust public charging network to meet charging demand. It is anticipated that private EVSE developers will continue to prioritize siting public EVSE charging in locations with high utilizations rates most likely to offer higher returns on investment, raising concerns that low-income and underserved communities will not be included in the resulting public charging network buildout.

Each of the ownership models above has its benefits and drawbacks, and in an emerging charging station market each may have its place. In PURA's ZEV Docket, DEEP will recommend parameters within which the EDCs should be permitted to rate-base make-ready investment. DEEP will also recommend that PURA find that the EDCs can own and operate charging infrastructure in low-income and underserved communities where private investment is not forthcoming. Public engagement on issues regarding location and accessibility of such infrastructure will be necessary to ensure that it serves its intended purpose. DEEP recommends that PURA consider making a determination of the minimum requirements for EVSE investment in low-income and underserved communities as well as criteria for site selection in these communities.

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[113] Accelerating the Electric Vehicle Market. M.J. Bradley & Associates. March 2017. Retrieved August 15, 2019 from https://www.mjbradley.com/sites/default/files/MJBA_Accelerating_the_Electric_Vehicle_Market_FINAL.pdf.

[114] Accelerating the Electric Vehicle Market. M.J. Bradley & Associates. March 2017. Retrieved August 15, 2019 from https://www.mjbradley.com/sites/default/files/MJBA_Accelerating_the_Electric_Vehicle_Market_FINAL.pdf.

[115] Decision 16-02-065, Decision Directing Pacific Gas and Electric Company to Establish an Electric Vehicle Infrastructure and Education Program. December 15, 2016. Retrieved August 19, 2019 from http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M171/K539/171539218.PDF.

[116] Decision 16-01-023, Decision Regarding Southern California Edison Company's Application for Charge Ready and Market Education Programs. January 14, 2016. Retrieved August 19, 2019 from http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M157/K835/157835660.PDF.

[117] Decision 16-02-065, Decision Directing Pacific Gas and Electric Company to Establish an Electric Vehicle Infrastructure and Education Program. December 15, 2016. Retrieved August 19, 2019 from http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M171/K539/171539218.PDF.

[118] D.P.U. 17-05, ORDER ESTABLISHING EVERSOURCE'S REVENUE REQUIREMENT. Department of Public Utilities, The Commonwealth of Massachusetts. November 30, 2017. Retrieved August 12, 2019 from https://www.mass.gov/files/documents/2018/01/26/17-05_Final_Order_Revenue_Requirement_11-30-17.pdf.

DEEP recommends that PURA consider a variety of questions in determining how to adequately incentivize EV charging infrastructure deployment, as set forth below.

Policy Recommendations: Expanding EV charging infrastructure

Building codes and permitting requirement recommendations:

1. DEEP recommends that the State Codes and Standards Committee and the State Building Inspector consider the following:
    a. Update State Building Code standards to: (1) require that all new MUDs and commercial construction be pre-wired to accommodate Level 2 EV charging equipment; (2) require that 10 percent of parking spaces be pre-wired to accommodate Level 2 EV charging equipment and outfitted with a 120-volt power outlet for Level 1 EV charging; and (3) establish ADA-compliant requirements for EV charging stations.
    b. Draft voluntary municipal building code and zoning ordinance templates with more stringent EV pre-wiring requirements.
    c. Consolidate and streamlining the permitting and inspection process for Level 2 EVSE and DCFC installations.
    d. Update and publish guidelines for the installation of EVSE at state-owned facilities and public and private EV charging stations.

Siting recommendations

2. Use TCI's EV Corridor Analysis Tool to assess and prioritize suitable locations for EV charging infrastructure development that require minimal infrastructure investment to support new demand for EV charging loads.

Data collection to inform planning recommendations:

3. DEEP recommends that PURA, in its ZEV Docket, provide guidance and establish compliance requirements for the EDCs to do the following:
    a. Publish to their websites annual reports that demonstrate how the EDCs are integrating EV charging load projections into their distribution system planning in compliance with statute.
    b. If a means of accessing EV registration data by street address becomes available, the EDCs should create more granular, technology-agnostic hosting capacity maps to evaluate localized grid impacts to substations and transformers, and distribution system capacity to accommodate EV chargers (220-volt and higher).
    c. Establish a voluntary program with appropriate consumer privacy protections to collect and aggregate EV charging data, including the dates, times, durations, and electricity usage as well as total monthly electric load.

Public charging infrastructure ownership recommendations:

4. In PURA's ZEV Docket, DEEP intends to recommend parameters within which the EDCs should be permitted to rate-base make-ready investment.
5. DEEP will also recommend that PURA approve EDC ownership and operation of charging infrastructure in low-income and underserved communities where private investment is not forthcoming.
6. PURA should consider making a determination of the minimum requirements for EVSE investment in low-income and underserved communities as well as criteria for site selection in these communities.

    In addition to the above recommendations, DEEP recommends that PURA consider a variety of questions in determining how to adequately incentivize EV charging infrastructure deployment, to include:

a. Should a "hurdle-rate" type of model, or some other methodology, be used to determine what make-ready costs may be recovered in rates?
b. Should a phased-in investment approach for make-ready deployment be adopted to allow PURA and/or the EDCs to collect and analyze data to determine program effectiveness and allow for program modifications? If so, how many phases should be considered and what funding amounts and timelines should be associated with each phase?
c. What are the metrics for evaluating the success of publicly funded EV charging infrastructure deployments? How will the costs and benefits of publicly funded EV charging infrastructure deployment be measured and calculated?
d. How can the state ensure there is equitable access to charging infrastructure and EVSE investment in LMI/EJ communities?
e. How should the state track the deployment of publicly funded EV charging infrastructure and what data collection requirements should be established for publicly-funded charging stations?

6 Consumer Charging Experience, Interoperability, Pricing Transparency & Future Proofing

Traditional gas stations use large overhead signs visible from a distance to routinely announce their retail prices per gallon of available unleaded and diesel gasoline fuels. Gas pumps are outfitted with point-of-sale displays that clearly disclose the retail credit price per gallon of each available fuel type and grade, the corresponding discounted price per gallon for cash payment (if offered), and any taxes included in the fuel price. Fueling a conventional ICE vehicle is quite ubiquitous. Drivers pull up to the gas pump, remit payment in cash or with a debit or credit card, select the fuel type and grade, and then fuel up their vehicles in minutes.

The experience for EV drivers is markedly different. EV drivers often use a station locator app (e.g., PlugShare, ChargeHub, Recargo, CarStations, Blink, etc.) or website on their smartphone, or may access a charging station locator via their vehicle's computer navigation system. Pricing information associated with the use of Level 2 and DCFC stations do not just include electricity consumption and demand considerations. Varying factors could influence the transaction price for a charging session. EV charging stations could be categorized by their approximate charge rates and the form of power delivered (AC or DC). Charging times for specific vehicles could vary depending on power electronics, state of charge, battery capacity, and level of charging offered by the station. Moreover, charging session costs could include service fees for managing payment transactions, maintenance, and trouble-shooting services, as well as parking lot expenses and hosting expenses.

As EV adoption ramps up, interoperability will be a key factor for each user's charging experience. Consumer interaction with public EVSE should be a convenient, consistent, and uncomplicated experience that smoothly accommodates EV drivers' needs. The EV charging experience should not be hindered by incompatible hardware and software, limited payment options, membership requirements, and network subscriptions. Critical elements of EV charging interoperability include:

- The ability for charging stations to accept multiple payment options;
- The ability of charging stations to interact with a variety of EVs that utilize different types of plugs and connections;
- The ability for networked charging stations to communicate with other charging stations, network operators, EDCs, and consumers.

6.1 Multiple payment options

Pursuant to Conn. Gen. Stat. § 16-19ggg,[119] owners and operators of public charging stations who charge a fee for using their stations cannot condition that use on a subscription or membership, but they have the discretion to bill their members or subscribers on a different price schedule. This ensures that drivers can access any public charging station in Connecticut to charge their EVs.

More importantly, Conn. Gen. Stat. § 16-19ggg requires that owners and operators of public charging stations who charge a fee for use must enable multiple payment options; however, the statute is silent on any particular payment method as the standard for such stations. Currently, the more common payment methods for EV charging include debit/credit cards, radio-frequency identification (RFID) cards, and mobile payment apps. Users who are subscribers or members of charging networks are additionally able to pay via their internet-based subscriptions and memberships. While charging station operators are under no obligation to offer all of these modes of payment, some drivers with more limited means for payment could find themselves without a way to pay for their charging session. In planning Connecticut's public charging infrastructure, it will be important to ensure that accessible modes of payment are available. This topic should be included in the engagement process envisioned above. Public charging station owners and operators should endeavor to offer the widest variety of payment options they deem feasible in order to provide accessibility to as many EV drivers as possible.

6.2 Compatibility of charging station connectors with EVs

Recharging an EV at a public charging station requires users to first determine the compatibility of their EV with the charging station's available connector or connectors. The most commonly used plug-in connector is the SAE J1772, which is the standard connection for Level 1 and Level 2 charging and is supported by all major vehicle manufacturers and charging system manufacturers.[120] This standardized connector makes virtually every EV compatible with every non-fast charging station.[121]

A standardized connector compatible with all EVs for DCFCs has yet to materialize. Rather, most of the DCFC-capable EVs in North America are compatible with at least one of three commonly available connectors. The two most commonly used connectors for DCFC are CHAdeMO and SAE Combo (CCS).[122] CHAdeMO is the standard connector utilized by Japanese auto manufacturers, and CCS is the standard connector for American and European automakers.[123] Tesla Motors currently uses its own proprietary connector, thereby limiting use of their Tesla charging stations to Tesla vehicles only. However, through the use of adapters, Tesla vehicles can also be charged at non-Tesla charging stations.

The present lack of a DCFC connection standard fosters a level of uncertainty, which influences range anxiety and could make EVs less attractive for prospective car buyers. When opting for fast charging, EV users must not only locate a DCFC, they must also confirm that the DCFC has a compatible connector. Currently Connecticut imposes no requirement for privately owned and operated charging stations to have multiple types of connectors available; however, it is likely that most for-profit charging stations would offer multiple connection options in order to not limit their potential customer base. Until an industry-wide standard connector is

[119] Sec. 16-19ggg. Public electric vehicle charging stations. Parking restrictions. (a) The owner or operator of a public electric vehicle charging station, as defined in section 16-19f, that requires payment of a fee shall provide multiple payment options that allow access by the public. (e) (1) Owners or operators of public electric vehicle charging stations that require payment of a fee shall not require persons desiring to use such public electric vehicle charging station to pay a subscription fee or otherwise obtain a membership in any club, association or organization as a condition of using such public electric vehicle charging station.(2) Notwithstanding subdivision (1) of this subsection, owners or operators of public electric vehicle charging stations that require payment of a fee may have different price schedules that are conditioned on a subscription or membership in a club, association or organization.

[120] "Vehicle Charging." Energy.gov. Retrieved September 10, 2019 from https://www.energy.gov/eere/electricvehicles/vehicle-charging.

[121] "Vehicle Charging." Energy.gov. Retrieved September 10, 2019 from https://www.energy.gov/eere/electricvehicles/vehicle-charging.

[122] 2019 Definitive Guide on How to Charge an Electric Car. ChargeHub. Retrieved August 21, 2019 from https://chargehub.com/en/electric-car-charging-guide.html.

[123] Halvorson, Bengt. Reality Check: CHAdeMO Fast-charging Stations Still Outnumber CCS Ones. Green Car Reports. August 20, 2019. Retrieved August 23, 2019 from https://www.greencarreports.com/news/1124639_chademo-fast-charging-stations-still-outnumber-ccs-ones.

established, the state should require all publicly-funded DCFC stations to have, at a minimum, one CHAdeMO connector and one CCS connector available for use.

6.3 Open charge point protocol

Most public charging stations are part of EV charging networks. Opportunities exist for improving interoperability through the communications systems utilized by EV charging networks. An Open Charge Point Protocol (OCPP) is a communications system designed to allow a high level of interoperability for charging station site hosts, EV drivers, and charging station network operators.[124] Open communication protocols allow for communication between different networks, as opposed to brand-specific networks which utilize proprietary communications systems that can only relay communications between the EV chargers operating under the same network brand.

OCPP has the major benefit of reducing the risk of stranded assets if a charging network provider goes out of business.[125] Under proprietary communications systems, if a charging network provider goes out of business, its station will likely become a stranded asset, as another network provider cannot simply take over the operation of that station. Under OCPP, another network service provider can easily assume operation without the need to replace the station's existing hardware and software systems.[126] An OCPP system also provides site hosts the ability to change network service providers without costly changes to system hardware and software. This ability fosters a competitive environment between charging network providers, and ultimately benefits consumers.[127] Of further benefit, an OCPP system enables network operators to communicate with each other, potentially allowing for customers with network subscriptions or memberships to "roam" between networks, without holding multiple subscriptions or memberships in a manner not dissimilar to what is offered by many wireless cell phone plans. [128]

OCPP has been widely adopted at a global level. While charging network operators in the U.S. are moving towards non-proprietary communications systems, OCPP has yet to be established as the standard.[129] Due to the high level of interoperability that can be achieved, Connecticut should require that any new charging stations that are networked, and installed or operated through public funding, use open communications protocols.

6.4 Pricing transparency

At traditional gas stations, retail prices per gallon of available unleaded and diesel gasoline fuels are displayed on large overhead signs and via point-of-sale displays on the gas pumps. Users need only understand the standard metric of dollars per gallon to easily compare prices between the gas stations in their proximity, and to figure out their likely fueling cost.

As EV adoption ramps up, consumers will expect pricing interactions to similarly be convenient, consistent and uncomplicated. NESCAUM cites three reasons for having a policy discussion on pricing transparency:

- Pricing information is not always clearly disclosed at charging stations;
- Pricing for charging varies from station to station, depending on factors such as the cost of electricity and parking, whether the EV driver is a member of the charging network, and any additional fees that may be assessed by the site owner; and

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[124] Electric Vehicle Charging Interoperability. M.J. Bradley & Associates. May 13, 2019. Retrieved August 20, 2019 from https://mjbradley.com/sites/default/files/MJB&A Interoperability Issue Brief May 2019.pdf.
[125] Electric Vehicle Charging Interoperability. M.J. Bradley & Associates. May 13, 2019. Retrieved August 20, 2019 from https://mjbradley.com/sites/default/files/MJB&A Interoperability Issue Brief May 2019.pdf.
[126] Villareal, Bethany. Introducing OCPP: What It Is and How It Benefits Your Property. SemaConnect. June 14, 2018. Retrieved August 23, 2019 from https://www.semaconnect.com/blog/introducing-ocpp/.
[127] Ibid.
[128] Why We Need Open Charge Protocols for Electric Cars in the U.S. PluginCars.com. Retrieved August 23, 2019 from https://www.plugincars.com/open-charge-alliance-sets-out-fix-electric-car-charging-industry-128417.html.
[129] Electric Vehicle Charging Interoperability. M.J. Bradley & Associates. May 13, 2019. Retrieved August 20, 2019 from https://mjbradley.com/sites/default/files/MJB&A Interoperability Issue Brief May 2019.pdf.

- The unit of sale may vary, as pricing may be based on the electricity consumed, by some unit of time, on a flat fee for the charging session, or by membership in the charging network.[130]

Therefore, determination of a comprehensive pricing transparency policy for EV charging stations in Connecticut would ensure fair and consistent disclosure of pricing information on the face of the charger, on the screen used for payment, and via apps on mobile devices in real time. Moreover, pricing information should be provided to customers prior to initiating the charging session. The state should explore the best means to provide pricing and consumption transparency.

6.5 Uptime

Maximizing uptime, the amount of time that a fueling/charging station is functioning properly and available for use, is important to establishing a reliable network and building consumer confidence.[131] User experience declines when a station is inoperable due to regular maintenance or because it is broken and needs repair. To maximize uptime, private EVSE providers such as ChargePoint, EVgo, and Greenlots have firmly established operations and maintenance programs outlined in their service contracts for all charging stations they own and/or operate. Publicly-funded charging stations need similar measure in place to minimize and prevent equipment downtime. To ensure that publicly-funded charging equipment remains operable, owners and operators of stations, through their EVSE service contracts, must identify the personnel or parties responsible for conducting regularly scheduled inspections and maintenance, diagnosing problems, and repairing service issues.

In addition to minimizing downtime, effectively communicating to EV drivers when a publicly-funded charging station is not working, for example, through a mobile app or signage, is also important to instill confidence in the EVSE network and prevent stranding drivers in need of a charge.

6.6 Signage (wayfinding and at-station)

Signage serves two distinct purposes: wayfinding, or navigating drivers to charging station locations, and communicating applicable usage and enforcement regulations. A number of apps are available to help drivers locate EV charging stations, but wayfinding signage along highways, exits, and streets is necessary to guide drivers to charging station locations. In addition, highly visible signage can alleviate range anxiety for current and prospective EV drivers.[132]

It is recommended that Connecticut coordinate with other TCI and NESCAUM member states to adopt uniform wayfinding and charging station signage throughout the Northeast and Mid-Atlantic regions. Clear and uniform signage is critical to ensuring a positive, consistent consumer experience driving electric. These regional efforts are currently underway along interstate highway corridors.[133] DEEP recommends CT DOT and municipalities consider adoption of Federal Highway Administration (FHWA) standards for EV and alternative fuel vehicle wayfinding signage set forth in the *Manual on Uniform Traffic Control Devices*.[134] Signage along state highways such as I-84 and I-91 should also indicate the beginning and end of alternative fuel corridors with 8” text that is easily read at speeds of 50-plus miles per hour. For large parking lots and garages, additional signage may be helpful for drivers to find the exact location of charging equipment.

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[130] Section 1.8, Pricing Transparency, Northeast Corridor Regional Strategy for Electric Vehicle Charging Infrastructure 2018 – 2021. Northeast States for Coordinated Air Use Management. May 16, 2018. Retrieved August 12, 2019 from https://www.nescaum.org/documents/northeast-regional-charging-strategy-2018.pdf/.

[131] Section 1.7, Uptime, Northeast Corridor Regional Strategy for Electric Vehicle Charging Infrastructure 2018 – 2021. Northeast States for Coordinated Air Use Management. May 16, 2018. Retrieved August 12, 2019 from https://www.nescaum.org/documents/northeast-regional-charging-strategy-2018.pdf/.

[132] Section 1.9, Signage, Northeast Corridor Regional Strategy for Electric Vehicle Charging Infrastructure 2018-2021. Northeast States for Coordinated Air Use Management. May 16, 2018. Retrieved August 12, 2019 from https://www.nescaum.org/documents/northeast-regional-charging-strategy-2018.pdf/.

[133] Electric Vehicle Charging Signing: Recommended Practices. Multi-State ZEV Task Force. June 2015. Retrieved August 12, 2019 from https://www.zevstates.us/wp-content/uploads/2015/09/EV-Charging-Signing-Recommended-Practices.pdf.

[134] Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 Edition. Federal Highway Administration. Revised May 2012. Retrieved August 12, 2019 from https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf.

On-site charging station signage must communicate a variety of information to consumers, including parking space access (whether limited to EVs only or not), time limits for charging sessions, station hours of operation, and enforcement penalties such as fines or citations. Parking spaces can be painted to reinforce signage posted at the stations as well.[135] In lieu of agreed upon standards from states in the Northeast and Mid-Atlantic regions, Connecticut municipalities should refer to TCI's *Siting and Design Guidelines for Electric Vehicle Supply Equipment* and *Lessons from Early Deployments of Electric Vehicle Charging Stations* for on-site charging station signage best practices.

6.7 Protecting EV-designated parking spaces

The term "ICE-ing" refers to the practice of drivers parking ICE vehicles in parking spaces specifically designated for EV charging.[136] ICE-ing, whether unintentional or not, inconveniences EV drivers and prevents them from charging their vehicles. Unplugged EVs parked in EV charging spaces represent another inconvenience to EV drivers needing to charge their vehicles.

In 2016, Connecticut enacted Public Act 16-135, which made it illegal for ICE vehicles to park in a public EV parking space reserved for battery electric vehicles BEVs and PHEVs.[137] Public Act 16-135 also enables owners and/or operators of public EV charging stations to set forth restrictions on the amount of time that an EV may be charged at its station. The statute does not establish civil fines for infractions nor does it address unplugged EVs parked in spaces designated for EV charging. To date, five states have passed legislation penalizing infractions for ICE-ing.[138] Massachusetts General Laws Section 22A of Chapter 40 authorizes a penalty of up to $50 for parking in areas restricted to zero-emission vehicles. In addition, easily disseminated educational materials should be prepared to assist municipal officials with enforcement of such penalties.

6.8 Future-proofing

To date, 50 kW stations are the standard for many fast charging networks, however as EV battery capacity increases, the industry is trending toward higher-powered stations. Many EVs coming to market in 2020 will be able to utilize charging stations rated for up to 150 kW, with one manufacturer planning to offer a vehicle capable of charging at up to 320 kW.[139] Across the U.S., 150 to 350 kW charging stations are being deployed to meet the demands of longer-range EVs with faster charging capabilities. As the market penetration of long-range EVs increases, lower powered DCFC stations will be less likely to meet drivers' needs and become obsolete, creating stranded or underutilized assets. To avoid stranded assets and costly future electric grid upgrades, new investments in the electrical infrastructure supporting DCFC stations should enable the installation of charging stations with a minimum capacity of 150 kW. This requirement will allow for station operators to install 50kw charging stations to meet the needs of most EVs that are on the road today, but will also allow for future charging station upgrades without modifying utility infrastructure as advances in battery technology call for a faster rate of charge.

As greater numbers of high-powered DCFC stations are deployed in Connecticut, efforts must be taken to avoid exacerbating peak demand periods. This will benefit station owners and consumers as lower electricity demand results in lower demand charges, improving the business case for DCFC station ownership and reducing costs passed on to consumers. On-site battery storage has the potential to manage demand at DCFC locations. At sites with multiple EV charging ports, releasing stored energy from batteries will help curb the high demand caused by multiple vehicles charging simultaneously. Site hosts could potentially reduce demand even further by pairing

[135] Signage for Plug-In Electric Vehicle Charging Stations. Alternative Fuels Data Center, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. Retrieved August 12, 2019 from https://afdc.energy.gov/fuels/electricity_charging_station_signage.html.
[136] Coren, Michael J. Tesla owners are being "ICE-ed" out of charging stations by trucks. Quartz. December 24, 2018. Retrieved August 12, 2019 from https://qz.com/1506901/trucks-are-ice-ing-tesla-owners-from-charging-stations/.
[137] Public Act 16-135: AN ACT CONCERNING ELECTRIC AND FUEL CELL ELECTRIC VEHICLES. https://www.cga.ct.gov/2016/ACT/pa/pdf/2016PA-00135-R00HB-05510-PA.pdf.
[138] Legislation Reference – Reserved Parking for Plug-In Vehicle Charging. PlugInSites.org. Retrieved July 26, 2019 from https://pluginsites.org/plug-in-vehicle-parking-legislation-reference/.
[139] Electrify America installing 150/350 kW fast chargers at more than 100 Walmart locations. Green Car Congress. April 18, 2018. Retrieved October 11, 2018 from https://www.greencarcongress.com/2018/04/201080418-walmart.html.

on-site battery storage with on-site generation. When selecting a charging station location, site hosts and developers should consider existing and future needs for incorporating on-site distributed energy resources, and prioritize areas that can easily accommodate these assets, which in turn could reduce the cost of future upgrades.

Many charging station locations will likely require the installation of additional chargers and connectors as EV penetration rates increase. Site hosts should consider whether there is adequate real estate at a charging location to accommodate additional chargers if needed. Furthermore, EDCs should consider site expansion with additional chargers when installing electrical infrastructure. By installing electrical infrastructure that is capable of accommodating additional charging port installations, site hosts can minimize future installation costs associated with site expansion.

Policy Recommendations: Consumer charging experience, interoperability, pricing transparency and future proofing

1. DEEP will coordinate with other state agencies and stakeholders to implement the following recommendations:
    a. Develop a mechanism for enforcement of the provisions set forth in Conn. Gen. Stat. § 16-19ggg regarding the operation of publicly accessible EV charging infrastructure.
    b. Require public charging infrastructure installed or operated using public funding to have accessible modes of payment, particularly in LMI communities.
    c. All DCFC station sites, installed or operated with the use of public funding, should be required to have both CHAdeMO and CCS connections available on site.
    d. Any networked charging stations, installed or operated using public funding, should be required to operate using open communications protocols.
    e. Establish a pricing transparency policy for public EV charging stations in Connecticut that would ensure fair and consistent disclosure of pricing information.
    f. Establish a unit price and determine any other information that public EV charging stations must conspicuously display or post.
    g. Require public EV charging stations provide the kW per dollar spent at the end of each charging session.
    h. Require that new electrical infrastructure installed at publicly funded DCFC locations be capable of supporting 150 kW charging stations or greater.
    i. Encourage charging station developers to evaluate the potential to pair charging stations with DERs when assessing and selecting a charging station location.
    j. Consider the potential future need for additional charging stations when installing electrical infrastructure and selecting the placement of charging stations at specific locations.
    k. Identify, for publicly-funded charging stations, the entity responsible for station maintenance and repair, and ensure adequate resources are available to conduct regular inspections, diagnose problems, and service stations in a timely manner.
    l. Coordinate with TCI and NESCAUM member states to adopt uniform signage for wayfinding and charging station use and enforcement.
    m. Consider establishing a fine for ICE-ing and enable state and municipal police and parking enforcement authorities to ticket vehicles in violation of the law.

7 Residential & Workplace Charging

7.1 Residential charging at single-family homes

At-home charging is an affordable and convenient charging option for most drivers.[140] Most drivers charging at home plug in and charge their vehicles in the late afternoon and early evening hours when they return home from the workplace. These hours typically coincide with peak demand, particularly during the summer.[141] While Level 1 charging allows for overnight EV charging, albeit at the slowest speed, some users opt to upgrade to a residential Level 2 charger to take advantage of the faster charging speed. In either case, promoting off peak charging—which is most likely to occur overnight in residential settings—must be the priority of Connecticut's EV policy. Accordingly, robust regulatory frameworks must be established to incent installation of residential charging infrastructure and develop rate designs that incent off-peak charging at home.

As residential Level 2 chargers become more prevalent, Connecticut should consider the benefits of promoting the use of networked Level 2 chargers with demand response capability. Networked chargers (connected to the internet via Wi-Fi), which provide EDCs with data insight into EV charging behaviors, are ideal for deploying managed charging strategies during peak demand periods. Furthermore, networked chargers may be paired with EV-specific TOU rates to integrate a sub-meter with the EVSE through a wireless connection. This approach would enable customers on such a rate tariff to charge their EV on a rate separate from the rest of the household, thereby avoiding the installation of a separate meter and the high associated costs.

While EV adoption rates are still low, Connecticut has the opportunity to lay the framework for establishing networked EVSE for residential charging as the standard. Adopting such a standard can help consumers avoid the potentially high costs of future upgrades, and streamline the implementation of future demand response measures. In Vermont, Green Mountain Power (GMP) offers customers purchasing a new EV a networked Level 2 charger (a $600 value)[142] that shares access with GMP during periods of peak demand and allows the EDC to curtail charging.[143] These networked chargers provide GMP with valuable residential charging data insights and have enabled the EDC to pilot off-peak TOU rate charging.

It is important to assess whether the incremental revenues from electricity sales to residential EV customers, and/or the avoided distribution system costs associated with optimized charging times, would support the deployment of networked residential chargers by offsetting the entire cost, or a portion of the cost, of EDC-approved Level 2 EVSE hardware equipped with a revenue grade meter, for Connecticut residents who purchase a new EV. Data collected (dates, times, durations, and electricity usage (kWh) per charging session) through these networked chargers can help EDCs understand the localized grid impacts of clustered EV charging in residential neighborhoods with high EV penetration and inform future statewide forecasting and distribution system planning. Furthermore, these data collection efforts will help EDCs optimize existing grid assets to serve current and future EV-related loads, and may inform the development of demand response programs and EV-specific TOU rates that can shift load and alleviate grid impacts during peak demand periods. Revenues from incremental electric sales from EV charging will offset the costs of networked Level 2 chargers. In addition, the avoided cost of on-peak charging at public charging infrastructure from deploying Level 2 chargers to residential EV owners may provide further cost justification for this investment.

Building on the effort, DEEP recommends that PURA explore, in its ZEV Docket, the potential for developing demand response programs that incentivize EV users to charge during off-peak periods. In particular, DEEP recommends that PURA assess opportunities for subscribing residential customers with networked Level 2 EV

[140] Charging at Home. Department of Energy. Retrieved November 5, 2018 from https://www.energy.gov/eere/electricvehicles/charging-home.
[141] Eversource and United Illuminating identify on-peak hours as 12:00 p.m. – 8:00 p.m.
[142] In-Home Level 2 EV Charger. Green Mountain Power. Retrieved June 28, 2019 from https://greenmountainpower.com/product/home-level-2-ev-charger/.
[143] Vermont's Renewable Energy Standard, Tier III requires electric distribution utilities to utilize an increasing portion of annual retail sales for energy transformation projects that reduce fossil fuel consumption by customers, until reaching 12 percent of annual retail sales in 2032. Retrieved from https://publicservice.vermont.gov/content/tier-iii-renewable-energy-standard. Green Mountain Power customers receiving this rebate are responsible for the cost of installation and commissions of the charging equipment.

chargers in a managed charging program where the EDCs can automate charging to occur during off-peak periods and opportunities to curtail charging during specific peak events as identified by the EDCs. The costs and benefits of sub-metering residential charging of EV loads to allow for more attractive rate designs and TOU signals could also be assessed. Moreover, the docket should explore the appropriate price signals, such as EV TOU rates or bill credits, and communication forms that will most effectively incentivize off-peak charging.

Table 5 below estimates the annual cost of implementing an incentive program for networked Level 2 EVSE to Connecticut residents who purchase a new EV. The total cost of the EVSE hardware was assumed to be $600.[144] Program costs are evaluated based on annual vehicle sales at the required rate of adoption for Connecticut to meet its ZEV MOU targets.

Table 5: *EVSE Incentive Program – High EV Adoption Scenario*

Year	Annual Sales (number of EVs)	Rebate 100%	Rebate 50%	Rebate 25%
2020	6,055	$3,633,282.12	$1,816,641.06	$908,320.53
2021	8,779	5,267,239.84	2,633,619.92	1,316,809.96
2022	12,727	7,636,020.16	3,818,010.00	1,909,005.04
2023	18,450	11,070,087.12	5,535,043.56	2,767,521.78
2024	26,748	16,048,520.87	8,024,260.43	4,012,130.22
2025	38,776	23,265,853.20	11,632,926.60	5,816,463.30
Total Cost		$66,921,003.32	$33,460,501.66	$16,730,250.83

7.2 Residential charging at multi-unit dwellings and off-street parking

While installing EVSE at single-family homes with off-street parking is relatively straight forward, installing charging stations at MUDs, such as condominiums and multi-unit rental properties,[145] often presents a number of challenges. High up-front costs such as upgrades to electrical infrastructure, wiring, and trenching can be a substantial barrier to installing EVSE at MUDs.[146,147,148] In addition, charging solutions vary from location to location depending on factors such as the parking layout, design, and ownership model (e.g., garden apartments with assigned parking in adjacent surface parking lots; high rise condos with deeded spaces in multi-level garages; sprawling mid-rise apartments with shared parking open to all; etc.). Questions such as who pays for the costs of EVSE installation, operation and maintenance at MUDs must also be addressed.[149] For all these reasons, getting approval from condominium associations or property managers to install EVSE can be difficult and time consuming.

Roughly 10 percent of Connecticut residents live in MUDs, especially those in urban areas.[150] EV charging access for residents living in MUDs may be restricted due to leasing agreement conditions or condominium association's declarations of covenants, conditions and restrictions. High upfront costs associated with electrical infrastructure upgrades and physical limitations to parking facilities are also barriers to installing EVSE in MUDs.

[144] $600 is identified as the median cost of networked Level 2 EVSE.
[145] MUDs refers to condominiums and residential apartment complexes with two or more units.
[146] Act 164: Final Report for EV Charging Station Multi-Unit Dwelling Working Group. Hawaii Department of Business, Economic Development, and Tourism. December 17, 2015. Retrieved August 12, 2019 from http://energy.hawaii.gov/wp-content/uploads/2013/07/Act-164_EV-Working-Group-Report_FINAL.pdf.
[147] Enabling Electric Vehicle Charging in Condominiums. Canadian Condominium Institute-Toronto and Plug,n Drive. Retrieved August 12, 2019 from http://www.plugndrive.ca/wp-content/uploads/2017/05/Enabling-EV-Charging-in-Condominiums.pdf.
[148] Opportunities for Vehicle Electrification in the Denver Metro Area and Across Colorado. County and City of Denver. December 2017. Retrieved July 30, 2019 from http://www.denvergov.org/content/dam/denvergov/Portals/771/documents/EQ/EV/EVFinalReport.pdf.
[149] Hirzel, Kevin. Electric Vehicle Charging: Keep Your Condo Association Current! June 5, 2017. Retrieved August 12, 2019 from https://micondolaw.com/2017/06/05/electric-vehicle-charging-stations-keep-your-condominium-association-current/.
[150] Quick Facts: Resident Demographics. National Multifamily Housing Council. Updated September 2018. Retrieved August 13, 2019 from https://www.nmhc.org/research-insight/quick-facts-figures/quick-facts-resident-demographics/.

In California, multi-unit residential lessees[151] and homeowners[152,153] are allowed to install EVSE in their designated parking spaces, unless installation is infeasible. In February 2019, Massachusetts signed into law a Home Rule Petition for the City of Boston that allows Boston condominium owners to install EVSE on or near their parking spaces, subject to reasonable condominium association restrictions.[154] The Massachusetts law establishes installation requirements similar to California's statewide law and provides a template for municipalities to lead on right-to-charge laws. Connecticut should work to identify pathways to prohibit MUDs and condominium associations from restricting lessees or condominium owners with designated parking spaces from installing EV charging equipment and associated metering equipment.

7.3 Workplace Charging

Level 2 chargers, which can deliver about 25 miles of range per charging hour, represent the most commonly installed EVSE at workplaces where charging is offered because they create a manageable load for EDCs and meet the needs of EV drivers at work.[155] Level 1 charging is often overlooked as a workplace charging solution due to its slow rate of charge, but because more than 90 percent of employees in the U.S. commute less than 35 miles,[156] employers can deploy a combination of Level 1 and Level 2 charging infrastructure to meet employee refueling needs.

Employers considering offering workplace charging should begin by distributing the U.S. Department of Energy's Workplace Charging Challenge Employee Survey or designing their own survey to gauge employee interest. It will be important for employers to identify, by mileage, the commute times of all employees and not just those who drive an EV. The availability of workplace charging may cause some employees to give further consideration to purchasing an EV for their next personal vehicle (although DEEP discourages "free" workplace charging that could encourage employees to charge on-peak at work rather than off-peak at home). Employers introducing workplace charging should contact their electricity provider early on in the planning process. The EDCs possess deep knowledge of commercial customers' energy usage, technical information regarding electrical infrastructure, and electricity demand management.[157] Given this expertise, the EDCs are well-suited to help employers deploy EVSE. Along with EVSE installers, EDCs can help businesses estimate the cost of EVSE installation at specific sites and, with regulatory approval may offer financial incentives toward the purchase of the EVSE.

Administrators of workplace charging programs should create an organizational flow chart outlining the individuals responsible for operation, maintenance, employer payment of charging costs, and enforcement. Parking spaces where EVSE is installed must comply with the ADA requirements for parking. The U.S. Department of Energy provides Americans with Disabilities Act Requirements for Workplace Charging Installation guidelines to assist employers with meeting these requirements for accessibility. Additional considerations include designating EV charging-only parking spaces, determining how to set appropriate price signals for charging, and posting signage that communicates charging rules and limitations such as the maximum duration of charging sessions. Employers considering workplace charging should refer to the U.S. Department of Energy's resources for Managing Workplace Charging and best practices set forth in the New York State Energy Research and Development Authority's Workplace Electric Vehicle Charging Policies Guide.

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[151] California Civil Code1947.6 and 1952.7.
[152] Senate Bill 1016, 2018, and California Civil Code 4745 and 6713.
[153] For the purposes of these laws and regulations, the State of California defines homeowners as property owners in common interest developments, which include community apartment projects, condominium projects, planned developments, and stock cooperatives.
[154] Massachusetts House Bill 4069. Chapter 370 of the Acts of 2018. https://malegislature.gov/Bills/190/H4069.
[155] Jones et al. The Future of Transportation Electrification: Utility, Industry and Consumer Perspectives. Berkeley Lab. August 2018. Retrieved July 30, 2019 from http://eta-publications.lbl.gov/sites/default/files/feur_10_transportation_electrification_final_20180807_v2.pdf.
[156] U.S. Department of Transportation (DOT) Bureau of Transportation Statistics' October 2003 OmniStats report, Volume 3, Issue 4.
[157] Lommele, S. and Dafoe, W. Utilities Power Change: Engaging Commercial Customers in Workplace Charging. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. June 2016. Retrieved August 12, 2019 from https://www.afdc.energy.gov/uploads/publication/engaging_commercial_customers_wpc.pdf.

As EV adoption increases, workplace charging has the potential to overlap with peak demand, however, workplace charging data collected by Eversource in its EV Rate Rider pilot program demonstrates that average weekday usage was highest during commuting hours and not coincident with peak demand periods.[158] A 2016 report by the Rocky Mountain Institute found that if by 2030 EVs made up 25 percent of New England's vehicle fleet, the region's energy consumption associated with workplace charging could increase from less than 1 percent to nearly 3 percent.[159] While impacts on the peak may not be significant in the near term, it is important that the EDCs monitor and analyze the impacts of workplace charging on the distribution system to ensure that peak demand is not exacerbated as EV deployment increases. Workplaces should establish best practices to ensure that employees don't develop suboptimal charging behaviors, and charging behavior that is sustainable as EV deployment increases should be incentivized. Therefore, as with residential charging, networked Level 2 charging stations with demand response capability should be considered for the workplace. In addition to this, employers should be encouraged to offset on-peak vehicle charging with on-site DERs where possible.

In Connecticut, roughly 52 percent of drivers commute less than 10 miles to work and 30 percent of drivers commute between 10 and 24 miles to work.[160] These commute distances, when paired with the amount of time employees' vehicles spend parked during the workday, build a strong case for employers to invest in Level 1 charging plugs. Level 1 charging equipment does not require substantial infrastructure investment, and can deliver about four miles of range per charging hour.[161] The practicality of Level 1 charging should not dissuade employers from investing in Level 2 EVSE as Level 1 equipment will not meet the commuting needs of all employees. DEEP recommends that employers install Level 1 charging plugs, as physically feasible, in at least 10 percent of parking spaces to add additional charging opportunities for employees whose EV needs can be reasonably met by Level 1 charging.

Policy Recommendations: Residential and workplace charging

1. Connecticut should consider a right-to-charge law that prohibits MUDs and condominium associations from restricting lessees or condominium owners with designated parking spaces from installing EV charging equipment and associated metering equipment.

2. PURA may wish to consider, in its ZEV docket, approaches to promoting the use of networked Level 2 chargers with demand response capability and investigate potential demand-response programs, such as managed charging and EV-specific TOU rates, for optimizing networked Level 2 EV charger deployment in homes and workplaces.

3. DEEP encourages employers to equip 10 percent of their total parking spaces with Level 1 charging plugs and evaluate opportunities for installing Level 2 EVSE, in order to help support statewide EV adoption targets.

8 Rate Design

Given the ZEV MOU requirement of deploying 125,000 – 150,000EVs by 2025 and the GC3 projected need to deploy 500,000 EVs by 2030, it is imperative to develop strategies which minimize the impacts of increased electric demand from EV charging. At a low penetration rate of 5 percent, it is likely that unmanaged charging, charging done regardless of time of day or electricity demand, would only increase peak demand by around 3.5

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[158] Eversource Energy, "Electric Vehicle Rate Rider Pilot – Two Year Update," Attachment 1-2, PURA Docket No.13-12-11, Request of CL&P for Approval of Electric Vehicle Rate Rider Pilot (Jun. 24, 2016).

[159] Nelder, Chris, Newcomb, James, and Fitzgerald, Garrett. Electric Vehicles as Distributed Energy Resources. Rocky Mountain Institute. June 2016. Retrieved September 25, 2019 from https://rmi.org/wp-content/uploads/2017/04/RMI_Electric_Vehicles_as_DERs_Final_V2.pdf.

[160] Connecticut…on the move! Transportation Fast Facts 2015. Connecticut Department of Transportation. Retrieved July 12, 2019 from https://www.ct.gov/dot/lib/dot/documents/dcommunications/2015_ct_fastfacts_final.pdf.

[161] Vehicle Charging. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. Retrieved July 11, 2019 from https://www.energy.gov/eere/electricvehicles/vehicle-charging.

percent and would have minimal impact on the state's grid.[162] However, as the penetration rate of EVs climbs to over 20 percent, the increase in peak demand from unmanaged charging could reach levels of 20 percent.[163] A 20 percent increase in the peak demand would likely result in the need for additional generation, transmission, and distribution capacity, and increased costs for ratepayers, thus demonstrating the priority to limit charging during peak demand periods and minimize related infrastructure investment.[164]

It should be noted that EVs also hold the potential for supplying electricity back to the electric grid. Using vehicle-to-grid (V2G) technologies, EVs could be charged during periods of low demand or when renewable energy generation is peaking, and could later discharge stored electricity back to the grid during periods of high demand. This technology is still in its early stages of development and feasibility, and therefore does not require examination in this EV Roadmap, however V2G could warrant future consideration from PURA and energy officials as the technology develops and the EV market continues to mature.

8.1 EV-specific time-of-use rates for residential customers

Connecticut's EDCs stipulate Monday through Friday between noon and 8 p.m. as peak demand periods, regardless of season. Typically, EV users plug in their vehicles and begin charging upon returning from the workplace, which adds load to peak demand and increases stress on the electric grid. Given the potential for residential EV charging to exacerbate peak demand, it will be important for EDCs to incentivize off-peak charging. For Connecticut to realize the greatest benefits and minimize negative grid impacts from EV charging, it is imperative that electric rate structures induce optimal charging behavior. Effective EV charging rates should ensure that the choices customers make to minimize their costs are consistent with charging behaviors that minimize system costs as a whole. Consumer behavior would dictate that EV owners charge their vehicle when electricity is at its lowest price; however, it can be difficult to change consumer habits. A multi-year study conducted by the San Diego Gas and Electric Company on EV pricing and technology found there was a learning curve on new rates for EV customers. The study concluded that for EV rates to be effective they should be developed early on to prevent EV owners from developing less than optimal charging habits.[165]

At the customer level, control over EV charging costs and electricity usage can be achieved through managed charging. In its most basic form, managed charging refers to an EV driver electing to charge their vehicle during off-peak hours in order to minimize their charging costs. This behavior is encouraged through effective TOU rates that incentivize EV owners to charge their vehicles during off-peak hours. Without effective TOU rates it is likely that EV owners will charge their vehicles whenever it is most convenient, in many cases during peak hours, as there is no disincentive for charging during periods of high demand. TOU rates may be applied to an isolated load such as an electric vehicle (with sub-metering equipment), or to the load of an entire household. In their simplest form TOU rates correspond with peak and off peak periods, while other TOU rates may include "shoulder" or "block" periods around peaks. Some EDCs are also offering dynamic TOU rates that allow customers to plan their electricity usage around electricity prices provided by the EDC in real time, as well as a day ahead of time. EV charging, which constitutes one of the largest and most flexible loads on the electric grid, makes EV-specific TOU rates -- coupled with managed charging -- an attractive tool for incentivizing consumers to shift charging behaviors to off-peak periods.

EV-specific TOU rate structures enable EV owners to isolate their charging load from the rest of their household. EV charging is billed on a TOU rate while the rest of the household remains on a regular residential rate. A major benefit of EV specific TOU over whole house TOU rates is that they do not require a drastic shift in a customer's day-to-day household electricity usage. An Idaho National Laboratory study found that 78 to 85 percent of

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[162] Nelder, Chris, Newcomb, James, and Fitzgerald, Garrett. Electric Vehicles as Distributed Energy Resources. Rocky Mountain Institute. 2016. Retrieved October 10, 2018 from http://www.rmi.org/pdf_evs_as_DERs.
[163] *Ibid.*
[164] *Ibid.*
[165] "Final Evaluation for San Diego Gas & Electric's Plug-in Electric Vehicle Pricing and Technology Study," February 20, 2014. Retrieved September 10, 2019 from https://www.sdge.com/sites/default/files/SDGE%20EV%20%20Pricing%20%26%20Tech%20Study.pdf.

owners on EV specific TOU rates charged their vehicles during off-peak hours.[166] Furthermore, EV TOU rates have also been proven to reduce customers charging costs, a study of the top five cities for EV sales in the United States (Los Angeles, San Francisco, Atlanta, San Diego, and Portland, Oregon) found that EV TOU rates saved customers between $116 and $237 per year.[167] However, traditional TOU rates, whether EV specific or applied to an entire household, have some potential drawbacks. These rates are static, and cannot be easily changed, and customer habits may be difficult to break once adopted. As PURA further develops a strategy for TOU rates as part of its anticipated evaluation of advanced metering infrastructure, it may wish to consider specific implications and opportunities for EV TOU rates.

Dynamic TOU rates are not static; instead prices are hourly and are typically provided to customers a day ahead of time. Dynamic pricing allows EDCs to send price signals to customers based on grid constraints, current demand, and weather patterns in order to optimize EV charging load. ComEd, an Illinois based EDC, offers customers a Basic Electric Service Hourly (BESH) rate.[168] On this rate plan customers pay the hourly wholesale market price for electricity. Customers are able to manage costs by shifting their electricity usage based on hourly pricing alerts received via text, email, or automatic phone calls. Customers also have access to day-ahead prices and can plan their electricity usage accordingly. Since the program began in 2007, participants have saved $19 million, reduced 47 million kWh, and prevented the release of 42,569 metric tons of CO_2. These rates are traditionally applied to an entire household load, however the possibility of applying dynamic pricing specifically to EV charging should be given consideration.

For TOU rates to be effective at shifting charging to off-peak hours, the peak-to-off peak price ratio must be significant enough to influence behavior. TOU rates with a low ratio may not provide an effective incentive to charge during off-peak hours. A residential EV charging pilot in which San Diego Gas and Electric tested three TOU rates with varying price ratios found that EV users were more likely to alter their charging behavior in response to higher peak-to-off-peak ratios.[169] A recent study of 31 EV-specific TOU rates across the U.S. calculated a median ratio of 3.5-to-1, with some EDCs using a ratio as high as 14-to-1 to incentivize off-peak EV charging.[170]

In some cases the adoption of EV specific TOU rates has been hindered by the requirement of a separate utility meter. A separate meter, assuming no subsidization, is cost prohibitive for most customers as installation costs range from $2,000 to $3,000. These costs will most likely negate much of the cost savings from dedicated TOU rates.[171] However, the high cost of installing a separate utility meter for customers who wish to utilize an EV TOU rate could be avoided through the use of metering technologies. For these technologies to be effective they must be revenue grade, meaning that utilities can bill customers based on electricity usage reported from the sub-meter with a high degree of accuracy. And, since some of these technologies rely on a wireless connection, reliable internet connectivity is also a requirement. For dynamic TOU rates to be applied to a specific load, such as an EV, the same technologies could potentially be utilized, however the metering technology would need to be capable of measuring usage in hourly intervals.

To date, the most prominent metering pilot project has occurred in California. The California PEV sub-metering pilot project, offered by all three of the state's major EDCs, was launched to investigate the use of metering

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[166] EVs 101: A Regulatory Plan for America's Electric Transportation Future. Advanced Energy Economy. September 10, 2018. Retrieved September 17, 2019 from https://info.aee.net/hubfs/EV%20Issue%20Brief%20Final%20(9.10.18)-2.pdf.
[167] Ibid.
[168] Current Rates & Tariffs. ComEd. Retrieved September 15, 2019 from https://www.comed.com/MyAccount/MyBillUsage/Pages/CurrentRatesTariffs.aspx.
[169] Hledik, R., Higham, J., and Faruqui, A. Emerging Landscape of Residential Rates for EVs. Fortnightly Magazine. May 2019. Retrieved August 12, 2019 from https://www.fortnightly.com/fortnightly/2019/05/emerging-landscape-residential-rates-evs?authkey=a156bf22c30ce08fdd0ccbd32b88b6445671698e2ca1b51abea38a7fa0488378.
[170] Ibid.
[171] Heidell, Jim, and Diana Lai. Should Targeted EV Programs Be Subsidized by All Utility Customers or Have Separate Rates? Utility Dive, November 7, 2018. Retrieved September 10, 2019 from https://www.utilitydive.com/spons/should-targeted-ev-programs-be-subsidized-by-all-utility-customers-or-have/541535/.

technologies to offer EV specific TOU rates to PEV owners without the need for utility upgrades. The pilot utilized both standalone sub-meters and sub-meters integrated into the EVSE. Data was collected by a third party and was provided to the utility for customer billing purposes. The results from the pilot found that the majority of participants were satisfied with the program, participants shifted their charging load to off-peak hours, and participants saved a considerable amount on money by forgoing the installation of a second meter.[172] The pilot results also showed that there were issues with billing and accuracy that would need to be addressed before wide scale deployment could occur.[173]

Although this section has been primarily dedicated to shifting charging behavior to off-peak periods through effective rate design, it should be noted that other programs and policies could also prove beneficial in shifting consumer charging behavior. For example, Con Edison in partnership with FleetCarma, has launched SmartCharge New York, a voluntary rewards program for EV charging. Program participants are provided with a FleetCarma C2 device which plugs directly into the on board diagnostic system of an electric vehicle.[174] The device provides drivers with information on vehicle performance, battery health, and avoided emissions. In addition, the device tracks vehicle charging and participants earn rewards points for charging during off peak hours.[175] Rewards points are redeemable in the form of electronic gift cards and other cash equivalent options. Programs like SmartCharge New York only reward drivers for charging off-peak, they do not penalize a driver if they charge during a period of peak demand. DEEP recommends monitoring incentive program designs in other jurisdictions while maintaining a primary focus on rate design and demand response.

8.2 Fleet charging

Fleet charging presents a new set of challenges for organizations investing in fleet electrification. Fleet vehicles' mileage, operating schedules, and usage cases often vary on a per vehicle basis, making it difficult for many fleet managers to develop a straightforward charging strategy. And where possible, simultaneous charging of an entire fleet overnight may incur costly demand charges depending on the number of vehicles, rate of charge, and overall electricity consumption. Moreover, fleets are likely to be charged with Level 2 or DCFC EVSE, with the latter increasing the potential impact of demand charges from meeting high power demand for a large quantity of vehicles. As such, fleet vehicle charging is likely to be spread throughout the day and may require deliberate coordination to optimize EV deployment and maximize electrification cost savings.

Fleet managers should engage their EDC early on in the planning process. The EDCs can coordinate with fleet managers to identify EVSE sites that require minimal infrastructure upgrades and may offer commercial fleet charging electric rates separate from traditional TOU rates. In California, PG&E proposed a new commercial EV charging rate to encourage fleet electrification and provide more bill certainty to commercial customers. The proposed commercial EV charging rate would replace demand charges costly to DCFC stations with a subscription pricing model that "allows customers to choose the amount of power they need for their charging stations, similar to choosing a data plan for a cell-phone bill."[176] These rates are intended to lower fleet charging costs and improve the business case for building DCFC stations, which in turn will accelerate EV adoption and stabilize electric rates for all customer classes. DEEP recommends that PURA explore the potential for establishing a commercial EV fleet rate that incentivizes off-peak charging and minimizes adverse impacts to the electric grid.

[172] California Statewide PEV Submetering Pilot – Phase 2 Report. Nexant. April 26, 2019. Retrieved September 15, 2019 from https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442461657.
[173] Ibid.
[174] SmartCharge New York Program Guide. FleetCarma. Retrieved September 15, 2019 from https://www.fleetcarma.com/smartchargenewyork/setup/.
[175] Ibid.
[176] PG&E Proposes to Establish New Commercial Electric Vehicle Rate Class. Pacific Gas & Electric. November 5, 2018. Retrieved August 29, 2019 from https://www.pge.com/en/about/newsroom/newsdetails/index.page?title=20181105_pge_proposes_to_establish_new_commercial_electric_vehicle_rate_class.

8.3 Impact of demand charges

The widespread adoption of EVs is contingent upon having sufficient charging infrastructure in place to support the vehicles on the road. DCFC stations are critical to instilling range confidence as they allow drivers to recharge their vehicles quickly rather than requiring an extended stay at a charging location. DCFC are particularly important to EV drivers without access to home charging, those who commute long distances, and drivers making long distance trips for business or recreation. DCFC could become the most optimal method of public charging. However, demand charges can have a significant impact on the development of a robust network of DCFC stations in Connecticut.

A demand charge is intended to cover an EDC's fixed costs for providing a certain level of capacity to customers under a given rate tariff and to distribute those costs evenly across all customer classes. The demand charge reflects the cost of the reserve capacity associated with larger users that require peaks of power that the grid needs to be built to accommodate.

Demand charges can often represent the majority of utility costs for DCFC station owners when station utilization rates are low. Under current levels of EV adoption it is not uncommon for demand charges to represent 90 percent or more of a station operator's utility bill.[177] Under low station utilization rates, station owners are paying mostly for capacity without having a sufficient amount of revenue producing output (charging sessions) to justify charging station operation.

Public fleets are in a unique position and face real challenges that deserve particular attention when PURA considers rate design options. Clean public transit is a key solution to decarbonizing the transportation sector, thus we must develop solutions that make public fleet electrification cost-effective.

DEEP recommends that, in its ZEV Docket, PURA investigate the impacts of demand charges on the development of EV charging infrastructure, and identify mechanisms to ensure EV charging infrastructure is economically viable for owners while utilization rates are ramping up.

Policy Recommendations: Rate design

1. DEEP will request that PURA explore EV rate structures in its ZEV Docket, including the following:
    a. Develop EV-specific TOU rate pilots;
    b. Determine the feasibility of using dynamic TOU rates in Connecticut;
    c. Define more specific off-peak and on-peak periods that will have the least impact on the grid, while maximizing benefits to ratepayers;
    d. Evaluate shifting peaks caused by high penetration rates of renewable generation in Connecticut, and their effect on EV charging;
    e. Set peak and off-peak price ratios that are effective in influencing consumer behavior;
    f. Evaluate the impact of different TOU approaches on LMI customers and considering alternative rate designs based on income;
    g. Investigate the use of metering technologies that allow for the adoption of load specific rates without the need for an additional utility meter;
    h. Review the efficacy of non-rate utility programs and strategies that reward beneficial EV charging;
    i. Explore the potential for the EDCs to establish commercial EV fleet rates; and
    j. Investigate the impacts of demand charges on EV infrastructure development and identify mechanisms to alleviate those impacts.

[177] Fitzgerald, G. and Nelder, C. EvGo Fleet and Tariff Analysis. Rocky Mountain Institute. March 2017. Retrieved October 6, 2018 from https://www.rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pdf

9 Innovation

Connecticut is home to many innovative and industry leading, technology-based businesses, including EVSE suppliers EVSE LLC and Juice Bar. Building upon this foundation, the state seeks to become a test bed for cutting-edge technology providers and mobility solutions businesses to deploy innovative vehicle electrification technologies and programs.

Public Act 15-5, which enables the EDCs to submit proposals for distributed energy resource pilot programs,[178] represents a potential catalyst for optimizing the integration of EVs into the electric grid and maximizing the value provided to ratepayers. The Hamden Bus Pilot provides a model for the investigation and evaluation of innovative approaches to managing EV deployment in a manner that can benefit the grid.

9.1 Maximizing existing infrastructure to support EVSE deployment

In order to minimize investment costs associated with expanding Connecticut's public EV charging network, the state must maximize the electrical infrastructure currently supported by the grid.

In particular, electrical infrastructure sites with excess load capacity make attractive candidates for deploying charging stations. Retrofitting streetlights and curbside lampposts to support EV charging is an innovative strategy for expanding public charging options in communities where residents have limited or no access to private parking spaces. In New York City, Ubitricity is partnering with multiple citywide agencies as part of a pilot program to repurpose existing light pole infrastructure to support curbside EV charging.[179] Specifically, Ubitricity's technology enables EV drivers with their own smart charging cables with built-in meters to connect to lampposts outfitted with electrical outlets. The pilot program aims to minimize the costs to infrastructure investment while expanding availability of charging infrastructure. The Bureau of Street Lighting in Los Angeles fully embraced this strategy and has successfully installed EV charging stations on 132 streetlights in the city.[180] DEEP recommends that the EDCs and charging station developers partner on a pilot program to identify existing locations with excess load capacity that can support the deployment of publicly accessible curbside EV charging.

9.2 Vehicle-to-grid

V2G is a form of managed charging that enables bi-directional flows of energy between EVs and the grid.[181] Using an EV's onboard software and an inverter built into either the EV or EVSE, the energy stored in a vehicle's battery can be discharged back to the electric grid during peak demand periods or demand response events.[182] This two-way power flow has the potential to transform EVs into virtual power plants that can help regulate frequency and provide an additional source of revenue for EV owners. That being said, V2G relies on EV owners to more frequently recharge/discharge and has potential to shorten EV battery life.

To date, V2G via light-duty vehicles has not yet materialized in the U.S. for a number of reasons, including auto manufacturers voiding EV battery warranties due to the increased stress on batteries from V2G services, limiting access to auto manufacturer-certified inverter technologies, and inadequate financial compensation.[183] The V2G ecosystem, which consists of auto manufacturers, EV owners, and electric grid operators must be formulated in

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[178] Public Act No. 15-5. AN ACT IMPLEMENTING PROVISIONS OF THE STATE BUDGET FOR THE BIENNIUM ENDING JUNE 30, 2017, CONCERNING GENERAL GOVERNMENT, EDUCATION, HEALTH AND HUMAN SERVICES AND BONDS OF THE STATE. https://www.cga.ct.gov/2015/act/pa/pdf/2015PA-00005-R00SB-01502SS1-PA.pdf.

[179] Turning light poles into electric chargers. SmartCitiesWorld. August 15, 2018. Retrieved September 3, 2019 from https://www.smartcitiesworld.net/news/news/turning-light-poles-into-electric-chargers-3237.

[180] EV Charging Stations. Bureau of Street Lighting, Los Angeles Department of Public Works. Retrieved September 3, 2019 from http://bsl.lacity.org/smartcity-ev-charging.html.

[181] Steward, Darlene. Critical Elements of Vehicle-to-Grid (V2G) Economics. National Renewable Energy Laboratory. September 2017. Retrieved September 4, 2019 from https://www.nrel.gov/docs/fy17osti/69017.pdf.

[182] Vehicle to Grid: Your electric car as a power station. OVOenergy. Retrieved September 3, 2019 from https://www.ovoenergy.com/guides/electric-cars/vehicle-to-grid-technology.html.

[183] Deign, Jason. Why is Vehicle-to-Grid Taking So Long to Happen? Greentech Media. March 19, 2018. Retrieved September 3, 2019 from https://www.greentechmedia.com/articles/read/why-is-vehicle-to-grid-taking-so-long-to-happen#gs.0pmtfp.

a manner that adequately compensates EV owners for services they provide to the electric grid using auto manufacturer-certified inverter technologies.

Auto manufacturers have begun partnering with EVSE providers to deploy EV charging infrastructure that can take advantage of V2G capabilities. For example, Princeton Power Systems introduced a commercially available EV charger/inverter, which operates under OCPP and is certified Nissan Leaf V2G compatible, to enable Nissan Leafs to provide backup power to buildings.[184] The National Renewable Energy Laboratory is currently testing and exploring strategies for scaling V2G integration with building energy management systems, utility grids, and renewable energy sources,[185] but V2G applications for light-duty vehicles may not come to scale in the immediate future or at all.[186]

V2G applications for electric school buses have been piloted in several states, including California, New York, and Virginia. Electric school buses are an ideal candidate for V2G services because the vehicles remain inactive during summer months at the conclusion of the academic year. During these months, electric school buses can be configured to charge their batteries overnight when electricity is cheapest and discharge this stored energy back to the grid during peak demand periods. V2G services transform electric school buses into valuable grid assets that can help reduce stress on the grid by flattening peak loads while providing additional revenue to school districts. Various studies estimate that an individual electric school bus could generate from $6,000 to $15,000 per year via V2G services.[187] Furthermore, EDCs around the country have begun to recognize the ancillary benefits to deploying electric school buses and have become some of the vehicles' most prominent advocates.[188]

In Virginia, Dominion Energy unveiled a proposal to electrify 1,050 school buses given the EDC can use the vehicles' batteries to provide V2G services.[189] Under the first phase of the plan, Dominion Energy will spend $13.5 million to deploy 50 electric school buses and associated charging infrastructure.[190] Schools receiving electric buses will be responsible for operation and maintenance costs equivalent to roughly $700 per vehicle per month. If the program is expanded to 1,050 buses, it would amount to a rate increase of less than $1 per month to ratepayers. In 2018, White Plains School District in New York State piloted a small fleet of electric school buses in Westchester County. Con Edison contributed $500,000 toward the purchase of the buses provided the EDC can use the batteries to store energy during summer months when the buses remain inactive.[191] As with managed charging, the flexible loads of electrified medium- and heavy-duty vehicles such as school buses can provide valuable services to the electric grid if configured properly.

Policy Recommendations: Innovation

1. DEEP will continue to study V2G technology and consider pilot approaches in the future.
2. DEEP will continue to move forward with the Hamden Bus Pilot.

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[184] Overview: V2X Fast Charger – CA-30/CA-10. Princeton Power Systems. 2019. Retrieved September 3, 2019 from http://www.princetonpower.com/images/products/pdf/CA10-CA30-SellSheet-April2019.pdf.

[185] Vehicle Testing and Integration Facility. National Renewable Energy Laboratory. March 2015. Retrieved September 3, 2019 from https://www.nrel.gov/docs/fy15osti/63744.pdf.

[186] Gaton, Bryce. V2G: What's the state of play with vehicle-to-grid, vehicle-to-home technology. Retrieved October 19, 2019 from https://thedriven.io/2018/10/19/v2g-whats-the-state-of-play-with-vehicle-to-grid-vehicle-to-home-technology/.

[187] Paying for Electric Buses, Financing Tools for Cities and Agencies to Ditch Diesel. U.S. PIRG Education Fund. 2018. Retrieved September 6, 2019 from https://uspirg.org/sites/pirg/files/reports/National%20-%20Paying%20for%20Electric%20Buses.pdf.

[188] Benoit, Charles. Electric V2G school bus pilot grow, but schools asleep at the wheel. Electrek. August 23, 2019. Retrieved September 6, 2019 from https://electrek.co/2019/08/23/electric-v2g-school-bus-pilots-grow/.

[189] Electric School Buses. Dominion Energy. Retrieved September 6, 2019 from https://www.dominionenergy.com/ourpromise/innovation/electric-school-buses.

[190] Parscale, Jordan. Dominion Energy Will Buy Virginia Electric School Buses…If They Can Use the Batteries. WAMU. August 29, 2019. Retrieved September 6, 2019 from https://wamu.org/story/19/08/29/dominion-energy-will-buy-virginia-electric-school-buses-if-they-can-use-the-batteries/.

[191] Zucker, Dave. New York's First All-Electric School Buses Just Debuted in White Plains. Wester Chester Magazine. November 27, 2018. Retrieved September 6, 2019 from http://www.westchestermagazine.com/First-Electric-School-Buses-White-Plains/.

10 Leveraging Incentives to Promote Equitable, Affordable EV Adoption

10.1 Role of incentives

While the total cost of ownership for an EV in Connecticut may be lower than a comparable ICE vehicle, initial up-front costs are often a primary barrier for consumers and could ultimately result in limited market growth. According to NESCAUM's *Multi-State ZEV Action Plan: 2018-2021*, the majority of new ICE vehicles sold in the U.S. in 2016 had a base price of less than $25,000, whereas the majority of new EVs sold for more than $35,000 during that same time frame before federal, state, and auto manufacturer incentives.[192] Advances in battery technology will continue to bring EVs closer to price parity with ICE vehicles, but until the market reaches maturity, financial incentives will remain essential to accelerating EV adoption.

Since its launch in 2015, the DEEP-administered Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) pilot program has provided incentives for 5,347 EVs.[193] Since late 2017, uptake of incentives has increased largely related to the introduction of the Tesla Model 3. Of the 5,347 EVs awarded incentives, 48 percent were for pure battery electric vehicles, or BEVs (e.g., Chevy Bolt EV, Nissan Leaf, BMW i3, and Tesla Model 3). And of those incentives provided for BEVs, 47 percent went to purchasers of Tesla Model 3s (651 Rear-Wheel Drive and 569 All-Wheel Drive). The recently passed Public Act 19-117 provides $15 million over five years for CHEAPR program incentives. As discussed below, to establish a successful incentive program DEEP will need to leverage additional funding sources or adjust incentive levels based on future policy considerations and ongoing analysis of market response.

An additional source of funding for electric vehicles and infrastructure in Connecticut is the VW Mitigation Trust from which Connecticut received $55.7 million, of which 15 percent is eligible for EVSE grants. Efficiently deploying the VW mitigation funding should build on lessons learned from the past four years of the CHEAPR program, as the two programs can work hand in hand to provide appropriate incentives for both the vehicles and infrastructure to further Connecticut's mobile source transformation. The analysis of policy considerations for VW funding will also look at what lessons can be learned from the work of other states using VW mitigation funding.

10.2 Federal tax credits

Federal government efforts to increase EV adoption have primarily come in the form of tax credits for new EV purchases and the installation of EV charging infrastructure. Currently, the federal Internal Revenue Service provides a tax credit up to $7,500 per new EV purchased for use in the U.S.[194] The amount of the tax credit is based on the battery capacity of the vehicle purchased. A study by UC Davis found that up to 30 percent of EV sales can be attributed to the presence of this specific incentive.[195] This credit exists until individual manufacturers reach 200,000 sales of qualified vehicles, at which point the credit begins to phase out for that manufacturer. Currently only Tesla and General Motors have reached that threshold with Nissan anticipated to meet it later this year.[196] In 2018, a group of automakers and utilities asked Congress to extend the tax credit.[197]

The federal income tax incentive, when paired with the CHEAPR rebate, creates an incentive package that can in some cases (depending on battery range) reduce the cost of an EV by over $10,000. Until price parity with ICE

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[192] Multi-State ZEV Action Plan: 2018-2021 – Accelerating the Adoption of Zero Emission Vehicles. Northeast States for Coordinated Air Use Management. June 20, 2018.

[193] Data current as of September 15, 2019.

[194] Electric Vehicles: Tax Credits and Other Incentives. Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy. Retrieved July 31, 2019 from https://www.energy.gov/eere/electricvehicles/electric-vehicles-tax-credits-and-other-incentives.

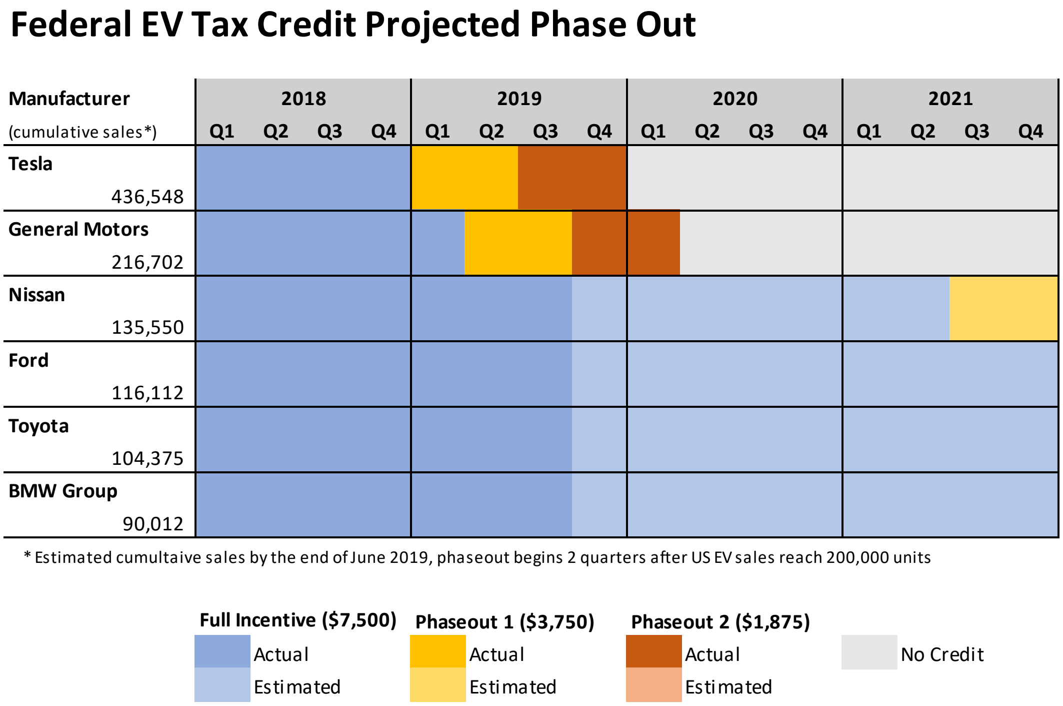
[195] *Tal, Gil; Nicholas, Michael A. (2016). "Exploring the Impact of the Federal Tax Credit on the Plug-In Vehicle Market". Transportation Research Record: Journal of the Transportation Research Board.*

[196] Malone, Wade. UPDATE: Tesla Has Officially Confirmed Passing 200k, Credit Safe until December. InsideEVs. July 12, 2018. Retrieved September 10, 2019 from https://insideevs.com/news/339391/update-tesla-has-officially-confirmed-passing-200k-credit-safe-until-december/.

[197] Yingling, Bill. Utilities ask Congress to keep electric vehicle tax credit. Daily Energy Insider. March 20, 2018. Retrieved September 10, 2019 from https://dailyenergyinsider.com/news/11363-utilities-ask-congress-keep-electric-vehicle-tax-incentive/.

vehicles can be reached, the combination of federal and state incentives help to offset the incremental price of EVs over conventional vehicles. Planning for CHEAPR incentive levels must be cognizant of potential shifts in federal incentives, either due to phase out, reauthorization or changes to underlying regulatory programs.[198]

Figure 8: Federal EV tax credit phase-out



Source: Federal EV Tax Credit Phase Out Tracker By Automaker. EVAdoption. Retrieved August 14, 2019 from https://evadoption.com/ev-sales/federal-ev-tax-credit-phase-out-tracker-by-automaker/.

10.3 Connecticut's CHEAPR incentive program

In 2015, in an effort to close the upfront price gap between ICE vehicles and EVs, DEEP launched the CHEAPR Program.[199] CHEAPR is a crucial component to satisfying Connecticut's commitment under the ZEV MOU and to ensure that EV sales and vehicle placement occurs in the state. The program provides a point-of-sale rebate, up to $5,000, for Connecticut residents, businesses and municipalities for the purchase or lease of a new eligible BEV, FCEV or PHEV. CHEAPR was the first EV incentive program in the country to allow the rebate to be applied to the purchase price of the vehicle right at the dealership. The consumer can also opt to retain all or a portion of the rebate, for example, to offset the cost of installing home charging equipment.

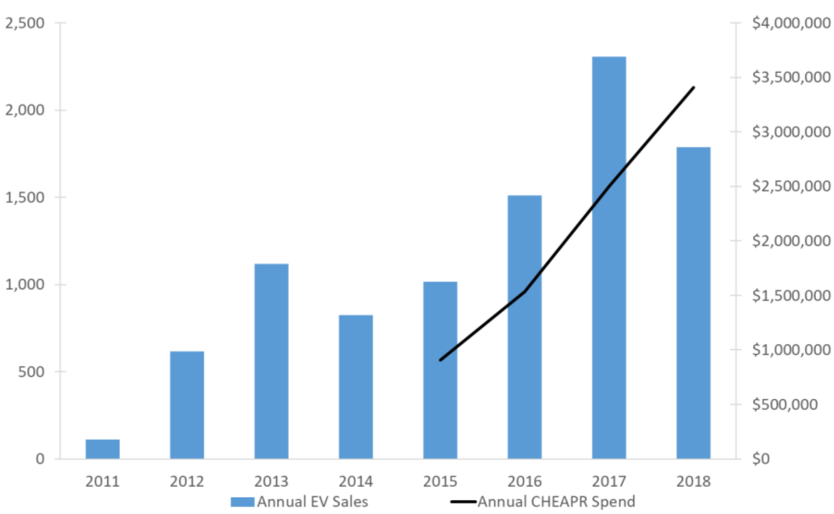
The initial success of the CHEAPR program was due to the collaboration between DEEP, CARA, and the EDCs in designing a program that would change how EV incentives were delivered to consumers. The retention of a contractor with knowledge in administering EV incentive programs helped the program to be designed efficiently and flexibly to meet changing needs. The CHEAPR program requires partnership and participation of CARA and its members to help promote EVs in the showrooms when a consumer is considering a new vehicle purchase. In addition, paperwork for the rebate is filled out by the dealership using an online application at the time of sale of the vehicle. When designing the existing CHEAPR program, DEEP recognized the importance of not only the dealers' time and cost of participation in processing rebate applications but also their enthusiasm for promoting these new vehicles. As such, the CHEAPR program initially provided a dealer incentive tied to each

[199] EVConnecticut CHEAPR Resources. Connecticut Department of Energy and Environmental Protection. 2018. Retrieved September 10, 2019 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=561434&deepNav_GID=2183.

rebate at a value of $300, an amount that, like the rebate itself, has since been adjusted downward to align limited funding dollars to increased sales.

As of September 15, 2019, the CHEAPR Program has provided approximately $10 million in rebates toward the purchase or lease of over 5,347 EVs.[200] PHEVs have comprised nearly two thirds of the vehicles receiving incentives under the program, and about 44 percent of all program dollars—reflecting the smaller rebate size allowed for PHEVs. BEVs, which reduce more greenhouse gas emissions and receive higher incentive levels under the CHEAPR program, have comprised 43 percent of sales and more than half of program incentive dollars (see Figure 10).

Figure 9: Annual EV sales and CHEAPR investment



Source: IHS Polk. Auto Alliance Advanced Technology Vehicle Sales Dashboard. Retrieved August 9, 2019 from https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

Figure 10: CHEAPR funding and rebate totals

		Rebate Dollars	Rebates
PHEV	Plug-in hybrid electric vehicle (electricity and gasoline)	$4,390,500	2,914
BEV	Highway capable, four-wheeled, all-electric vehicle	$5,579,000	2,215
Total		$9,969,500	5,129

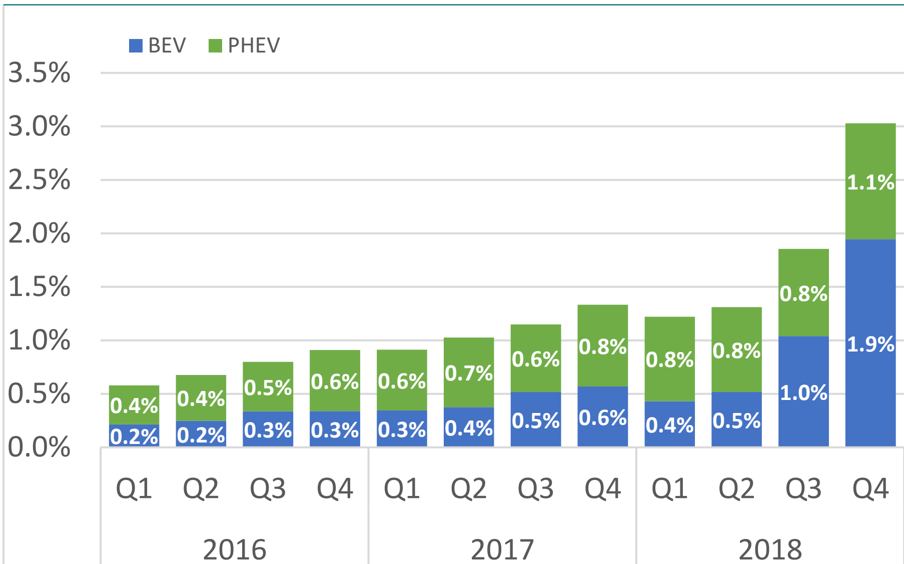
Source: Center for Sustainable Energy. Connecticut Department of Energy and Environmental Protection Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Data retrieved August 9, 2019 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

To date, program funding of over $10 million dollars (see Figure 10), has come from a variety of sources. The program was originally established and funded through settlement funds associated with the merger of Northeast Utilities (now Eversource) and NSTAR in April 2012. CHEAPR has also benefited from a funding commitment by Avangrid as part of a broader commitment to electric vehicles and other clean technologies set forth in a settlement agreement between Iberdrola USA and UIL Holdings Corporation. DEEP also utilized a number of supplemental environmental project funds from clean air enforcement actions against large upwind power plants that violated federal CAA new source review permitting programs.

[200] Center for Sustainable Energy (2019). Connecticut Department of Energy and Environmental Protection. Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data Last updated August 30, 2019. Retrieved September 4, 2019 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=565018&deepNav_GID=2183.

A number of changes to the program have been necessary as it has evolved. Over the last four years of the pilot, DEEP has worked with the utilities and the program contractor to adjust incentive levels in light of changing market conditions and funding shortfalls. Understanding the EV market and advances in vehicle technology has been the most important aspect of administration of the CHEAPR pilot and is critically important for managing the future CHEAPR program. The number of available EV models, the type of available models, and highly anticipated model releases affect the program utilization rate. Learning from past experience, it is sometimes necessary to react quickly to changing market conditions to ensure funding stability and program viability, which are both critical for ongoing program success. For example, Figure 11 illustrates the share of EV sales in the state that have adopted the California Zero Emission Vehicle Program.

Figure 11: EV Share of light-duty vehicles sales in §177 ZEV states



Source: Center for Sustainable Energy. Connecticut Department of Energy and Environmental Protection Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Data retrieved August 9, 2019 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

The existing CHEAPR pilot program experimented with several criteria (e.g., battery size and electric vehicle range) before settling with a framework that set rebate amounts based on each vehicle's all-electric range. As such, BEVs received, on average, a larger rebate than PHEVs. As new and more popular BEV models are introduced, the average vehicle rebate increases and the number of vehicles that can be funded decreases. As shown during the pilot program, it is vitally important to be able to react to these market changes to ensure that the state's limited funding puts as many EVs on the road as possible.

Incentive levels must recognize, and evolve with, advancing EV technology and free-ridership associated with market evolution. DEEP has worked with the Center for Sustainable Energy (CSE) and CARA to amend incentive levels three times in order to maximize limited program funds to stimulate EV uptake in Connecticut. The below tables includes the historical rebate levels as organized in program bins for the CHEAPR program.

May 2015 – June 30, 2016:
Vehicle MSRP must not exceed: $60,000 (PHEV/BEV/FCEV)

Any Eligible Vehicle	
Rebate Amount	Required Battery Capacity
$3,000	Greater than 18 kWh or any fuel cell electric vehicle
$1,500	7 to 18 kWh
$750	Less than 7kWh

July 1, 2016 – August 14, 2017:
Vehicle MSRP must not exceed: $60,000 (PHEV/BEV/FCEV)

Plug-In Hybrid Electric Vehicle (PHEV)	
Rebate Amount	Required Battery Capacity
$3,000	Greater than 18 kWh
$1,500	10 to 18 kWh
$750	Less than 10 kWh

Battery Electric Vehicle (BEV)	
Rebate Amount	Required Battery Capacity
$3,000	Greater than 25 kWh
$1,500	20 to 25 kWh
$750	Less than 20 kWh

Fuel Cell Electric Vehicle (FCEV)	
Rebate Amount	Required Battery Capacity
$5,000	Any fuel cell electric vehicle

August 15, 2017 - October 14, 2018:
Vehicle MSRP must not exceed: $60,000 (PHEV/BEV/FCEV)

Plug-In Hybrid Electric Vehicle (PHEV)	
Incentive Amount	EPA Rated Electric Range
$2,000	40 miles or greater
$500	Less than 40 miles

Battery Electric Vehicle (BEV)	
Incentive Amount	EPA Rated Electric Range
$3,000	175 miles or greater
$2,000	100-174 miles
$500	Less than 100 miles

Fuel Cell Electric Vehicle (FCEV)	
Incentive Amount	EPA Rated Electric Range
$5,000	Any fuel cell electric vehicle

October 14, 2018 – October 14, 2019: Vehicle MSRP must not exceed: $50,000 (PHEV/BEV), $60,000 (FCEV)

Plug-In Hybrid Electric Vehicle (PHEV)	
Incentive Amount	EPA Rated Electric Range
$1,000	45 miles or greater
$500	Less than 45 miles

Battery Electric Vehicle (BEV)	
Incentive Amount	EPA Rated Electric Range
$2,000	200 miles or greater
$1,500	120-199 miles
$500	Less than 120 miles

Fuel Cell Electric Vehicle (FCEV)	
Incentive Amount	EPA Rated Electric Range
$5,000	Any fuel cell electric vehicle

October 15, 2019 - Current: Vehicle MSRP must not exceed: $42,000 (PHEV/BEV),$60,000 (FCEV)

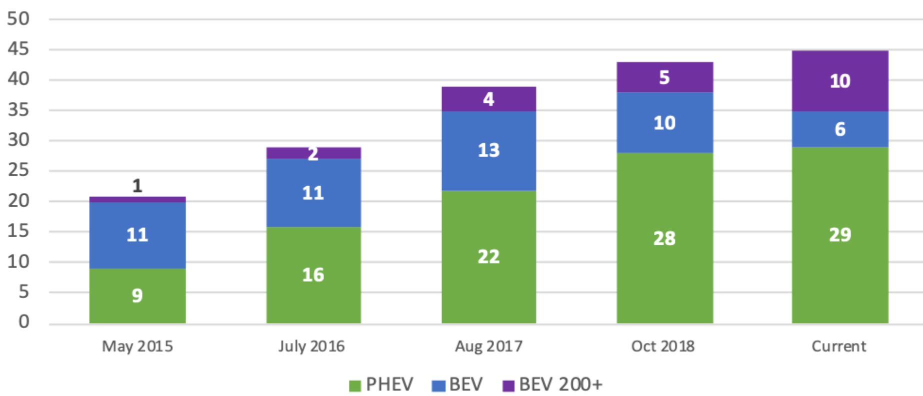
Plug-In Hybrid Electric Vehicle (PHEV)	
Incentive Amount	EPA Rated Electric Range
$500	Any PHEV

Battery Electric Vehicle (BEV)	
Incentive Amount	EPA Rated Electric Range
$1,500	200 miles or greater
$500	Less than 200 miles

Fuel Cell Electric Vehicle (FCEV)	
Incentive Amount	EPA Rated Electric Range
$5,000	Any fuel cell electric vehicle

To better understand how model availability affects rebate types and funding expenditures, incentive levels within the CHEAPR pilot program must be contrasted against the changing availability of vehicle types at the time of program adjustments. As the number of 200+ mile range BEVs increases, not only are more vehicles available for sale, but consumer confidence (and therefore the potential for free ridership) also grows due the reduced range anxiety. Tracking metrics such as vehicle model types and range availability will be important for the future of the program to help determine when bins should be adjusted. (See Figure 12)

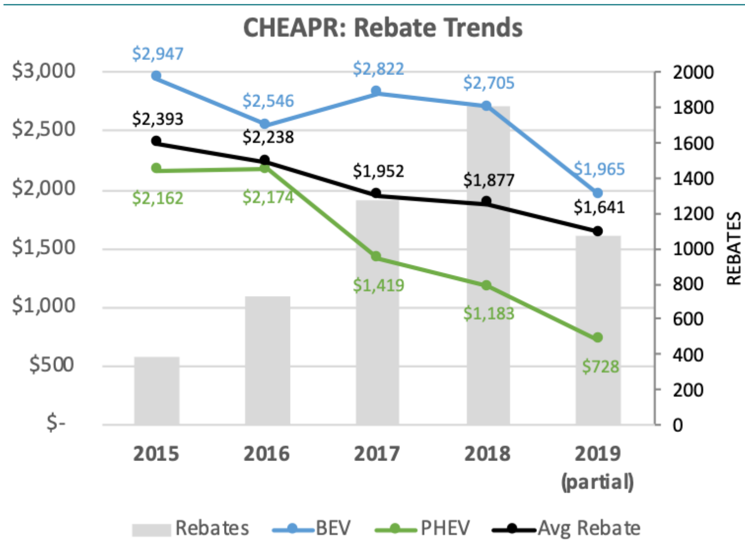
Figure 12: CHEAPR U.S. model availability at time of bin changes



Source: Center for Sustainable Energy. Connecticut Department of Energy and Environmental Protection Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Data retrieved August 9, 2019 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

As the number of rebates has increased due to market growth, new models, and higher awareness, adjustments in rebate bins have helped manage average rebate levels and ensure efficient use of limited program funds. As vehicle ranges increase in the future, further adjustments will be necessary to incentivize uptake of those EVs that serve the purpose of shaping the transformation of the EV market while reducing the differential acquisition cost to a comparable ICE vehicle.

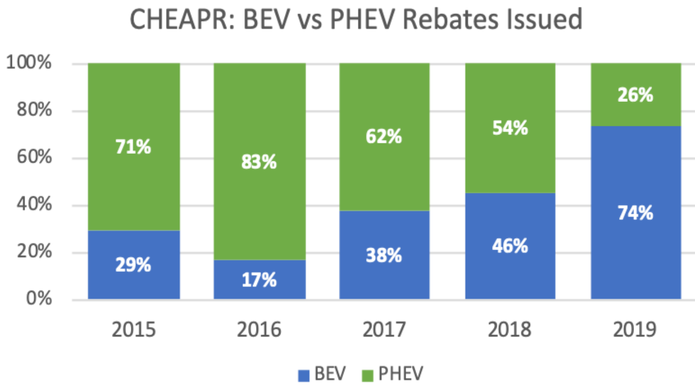
Figure 13: Rebate averages and trends



Source: Center for Sustainable Energy. Connecticut Department of Energy and Environmental Protection Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019.

As battery technology continues to improve and all electric driving ranges continue to increase, the share of rebates going to BEV vehicles has begun to overtake those going to PHEV vehicles. CHEAPR data suggests that BEVs will vastly overtake sales of PHEVs in the coming years (see Figure 14). Some EV manufacturers have stated their intention to eliminate their existing PHEV models and focus solely on BEVs, or only introduce new BEV models,[201] while others are taking a more diverse to product development.

Figure 14: Rebate percentages by vehicle type over time



Source: Center for Sustainable Energy. Connecticut Department of Energy and Environmental Protection Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Data retrieved September 10, 2019 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

As noted above, the CHEAPR program has been funded to date from settlements and other one-time, special purpose funds. This has made it difficult to provide for incentive levels that can scale with the increased EV sales activity that has been observed in recent years, particularly for BEVs. Section 94 of Public Act 19-117 established a new statutory framework including a stable five-year funding source and a new governing Board, which will consist of representatives from state agencies, environmental organizations, environmental justice communities, and the Connecticut Green Bank. For the first time, Section 94 provides funding stability and certainty by allocating $3 million dollars annually for five years (2020-2025) in rebates for Connecticut residents who (1) purchase or lease a BEV, PHEV, or FCEV, or (2) purchase a used FCEV or EV. This funding will become available beginning in January 2020.

Coincident with the time of issuance of this draft *EV Roadmap*, DEEP identified that the currently available funding for CHEAPR incentives would not be sufficient to continue the program through the beginning of 2020. Moreover, given increased volume of BEV sales, DEEP concluded that the program would likely exceed the $3 million in annual funding in 2020. DEEP was presented the option of halting the rebate program when funds ran out in the fall of 2019, and resuming the program when Public Act 19-117 funds become available in 2020. DEEP concluded that this option would inflict long-term damage on the program, by causing customer confusion and undermining dealer confidence in availability of the rebate. DEEP therefore considered the alternative option of reducing incentive levels and lowering the MSRP cap for eligible vehicles. DEEP estimates that this revised incentive level will be sufficient to provide rebates for new and used vehicles within the $3 million annual budget authorized under Public Act 19-117.

The CHEAPR board will establish and revise, as necessary, appropriate rebate levels and maximum income eligibility for used EV and FCEV rebates. The board also will evaluate the CHEAPR program on an annual basis. There are a number of different factors that must be tracked in order to increase awareness of the CHEAPR program, administer it, and keep it running in light of funding restrictions and the evolving market. The pilot program administrator, CSE, has gathered data to analyze trends and better inform these goals. These factors are discussed below and include: tracking vehicle model types, ranges, and releases; consumer feedback; rebate location; and projected funding. The following sections explain how these factors weigh into program effectiveness, how DEEP has responded to changes in the past, and how these factors should be used going forward to promote an effective incentive program. Learning from the program's past will be important for the

[201] Hanley, Steve. GM, VW Say They Won’t Build Hybrids Or Plug-in Hybrids, Only Battery Electric Cars. CleanTechnica. August 13, 2019. Retrieved August 25, 2019 from https://cleantechnica.com/2019/08/13/gm-vw-say-they-wont-build-hybrids-or-plug-in-hybrids-only-battery-electric-cars/.

board to develop an enduring and effective EV rebate program. Below are a number of factors that the board should consider when formulating the CHEAPR program for the next five years.

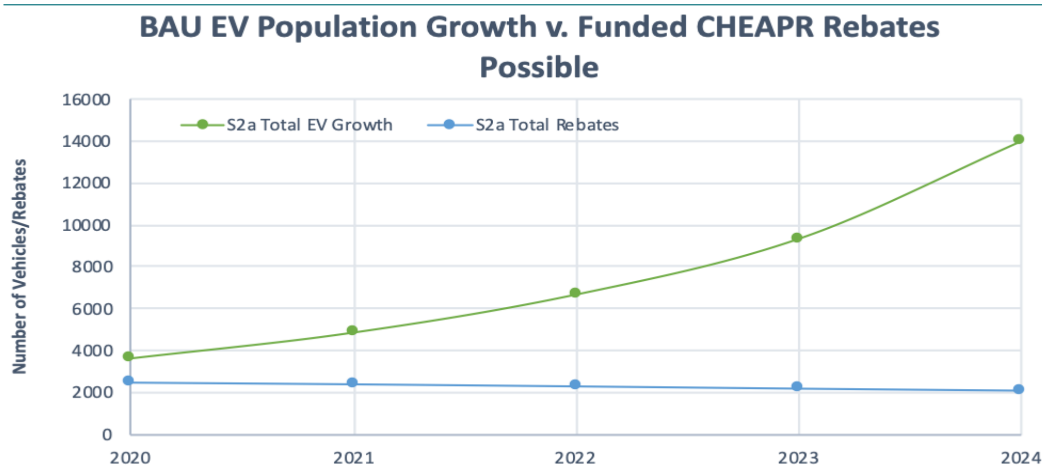
10.3.1 Adapting CHEAPR incentives to EV market changes and Connecticut's environmental goals

The future CHEAPR program should be aligned with the electrification, emission reduction, and climate change goals set forth by state policy drivers such as the Global Warming Solutions Act and the Act Concerning Climate Change Planning and Resiliency, the ZEV MOU which established goals for EV adoption for 2025 of 150,000 aggregate vehicle sales by 2025, and the GC3, which established a goal of 500,000 aggregate vehicle sales by 2030. [202,203]

Implementation of CHEAPR beyond the pilot phase should include steps to scale deployment to meet these goals. As noted above, the Governor's budget allocates $15 million over the next five years to fund the program—including both new and, for the first time, used rebates—at a level of $3 million per year. DEEP examined three EV growth scenarios using registration data from the Connecticut DMV to determine how many rebates the new funding will support. DEEP conducted each scenario with and without the existing dealer incentive, as the dealer incentive reduces the number of overall rebates available to EV purchasers.

Based on incentive levels that will be effective on October 15 2019, but not accounting for the phase out of federal tax incentives, DEEP estimates the $15 million in new funding should support between 11,000 and 14,500 EV rebates. Providing incentives at these levels for all EV sales identified by the ZEV MOU will require market transformation and a steady and increase scale of deployment. This significant funding gap highlights the need for sustainable funding beyond the $3 million per year provided in Section 94 of Public Act 19-117 in order to meet Connecticut's ZEV MOU commitment.

Figure 15: Expected Vehicle Growth v. Funded Rebates



Connecticut DMV registration data was used to create a business as usual vehicle population growth given increasing BEV sales and current CHEAPR rebate levels we used to estimate how many funded rebates would be possible using allocated funding at current rebate levels.

Assuming no downturn in the EV market or in general economic conditions, and assuming that demand for EVs continues to grow, the available funding will cover an increasingly smaller percentage of necessary annual EV

[202] State Zero-Emission Vehicle Programs—Memorandum of Understanding. Northeast States for Coordinated Air Use Management. Signed October 24, 2013.

[203] The GC3 recommended an interim goal of 45% below 2001 levels by 2030, which was codified by Public Act 18-82. Building a Low Carbon Future for Connecticut, Achieving a 45% GHG Reduction by 2030. Connecticut Department of Energy and Environmental Protection. December 2018.

sales. The new CHEAPR program will need to resolve this challenge in order to avoid operational and funding gaps in the program, which have negatively impacted other state programs as discussed above.

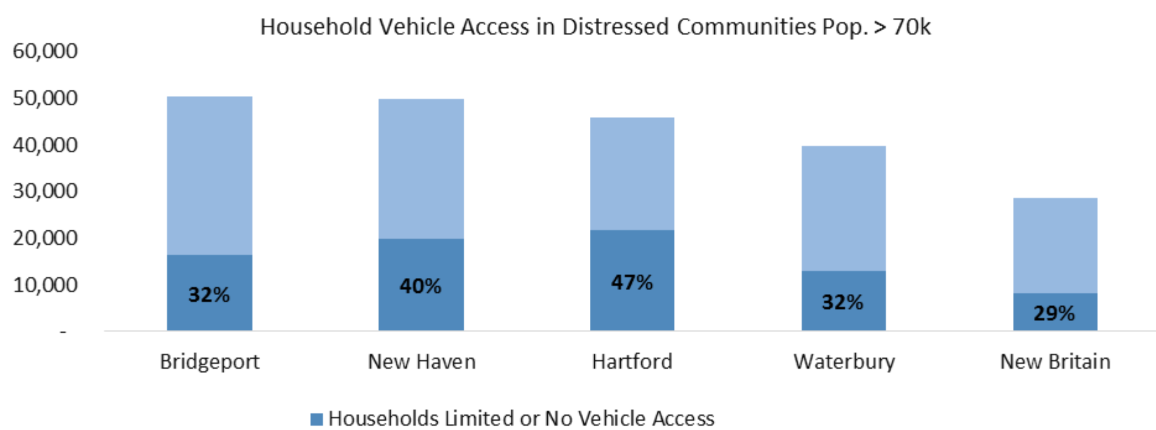
Funding stability is crucial to prevent market disruptions. Research by UC Davis indicates that as EV awareness increases, the need for incentives also increases as the presence of an incentive becomes a major tipping point for choice of vehicle purchase.[204] If the federal incentive is not continued, it becomes even more important for Connecticut's program to carefully calibrate incentives to keep the momentum of the growing EV market until price parity can be reached. At the same time, it is important to track projected vehicle lineups, total vehicle model availability, and projected sales for new and potentially popular models because EV manufacturers typically rely on a three to five year product planning cycle. As such, it will likely be necessary to recalibrate future CHEAPR incentive levels on at least an annual basis to reflect changing market dynamics.

10.3.2 Increasing access to EV transportation for LMI residents

Ensuring equitable access to EVs for LMI consumers is critical as LMI and environmental justice communities often abut major transportation infrastructure such as highways and ports and therefore bear a disproportionate impact from transportation-related air pollution. While electrification of mass transit is an important factor in reducing emissions in these areas, an LMI component for the CHEAPR program is necessary to make the program equitable and inclusive.

For some low-income households, vehicle ownership is simply not viable due to financial constraints or ease-of-use concerns, or holds less appeal when available public transit or alternative travel modes prove more budget-friendly. Among Connecticut's 25 most economically distressed municipalities,[205] a significant share of households lack access to personal vehicles and rely on public transit to meet their mobility needs.[206] Therefore, the state's approach should harmonize automobile ownership-based solutions with inclusive EV ridesharing, community bicycle access, and public transit initiatives that, when implemented together, offer low-income households and underserved communities a range of reliable options to get to destinations more efficiently and affordably, while helping to reduce GHG emissions and drive down pollution.

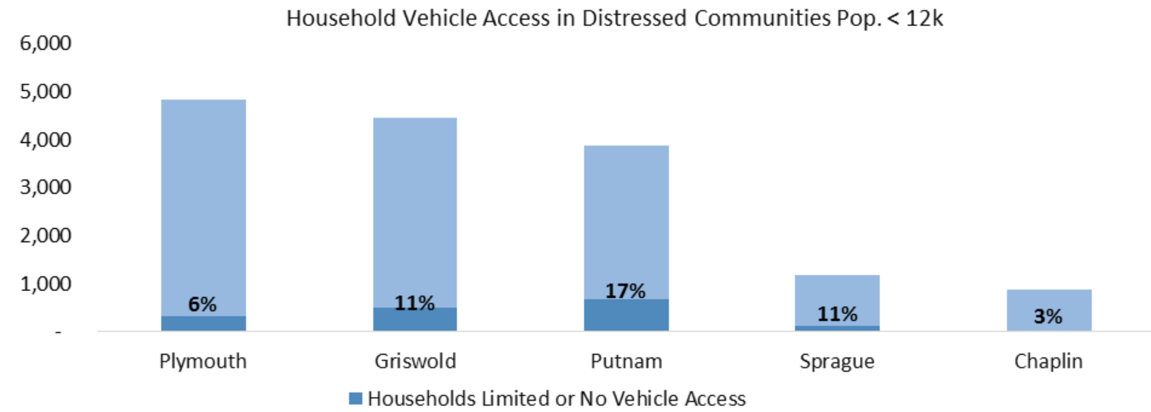
Figure 17: Vehicle access in Connecticut's distressed communities



[204] *Tal, Gil; Nicholas, Michael A. (2016). "Exploring the Impact of the Federal Tax Credit on the Plug-In Vehicle Market". Transportation Research Record: Journal of the Transportation Research Board.*

[205] The Connecticut Department of Economic and Community Development identifies distressed municipalities using statistical indicators that measure the fiscal capacity of each municipality based on tax base, personal income of residents, and the residents' need for public services. Methodology can be accessed at https://portal.ct.gov/DECD/Content/About_DECD/Research-and-Publications/02_Review_Publications/Distressed-Municipalities.

[206] U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates, S0802: MEANS OF TRANSPORTATION TO WORK BY SELECTED CHARACTERISTICS. Retrieved August 8, 2019 from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.



Sources: MEANS OF TRANSPORTATION TO WORK BY SELECTED CHARACTERISTICS 2013-2017, American Community Survey 5-Year Estimates; HOUSEHOLD SIZE BY VEHICLES AVAILABLE, Universe: Households 2013-2017 American Community Survey 5-Year Estimates B08201; Connecticut 2015 Income Statistics 2011-2015 American Community Survey 5-year Estimates, compiled by Department of Economic and Community Development Research; 2017 Designated Distressed Municipalities List.

*Limited access to vehicles: Households of 3 or more people with access to only 1 vehicle.

DEEP recommends the CHEAPR Board identify and support opportunities to motivate EV adoption in low-income and underserved communities. Despite the financial hardship of vehicle ownership, many residents in low-income households—particularly in areas where housing, employment, and other fundamental destinations are dispersed and not easily accessible by public transit—continue to rely on personal vehicles to meet mobility needs. Although high upfront costs, reduced access to low-interest financing, and reduced opportunity to benefit from federal tax credits hinder LMI residents' opportunities to purchase EVs, the state can equitably broaden low-income residents' access to EVs through innovative incentive programs.

One area worthy of further exploration by the CHEAPR Board is inclusion of a supplemental rebate for low-income residents purchasing an EV, pending income verification. California and Oregon offer $2,000[207] and $2,500,[208] respectively, to qualifying low-income residents purchasing EVs, in addition to each state's base rebate amount. Income-verified low-income residents purchasing a used EV via a dealership are eligible for a $2,500 rebate under Oregon's Charge Ahead Rebate program.[209] In California, 12,538 low-income EV purchase rebates have been redeemed since March 29, 2016, when LMI residents became eligible for increased rebate amounts under the state's Clean Vehicle Rebate Project.[210]

Ensuring equitable access to EVs for LMI consumers is critical as underserved communities bear a disproportionate impact from transportation-related air pollution. LMI and environmental justice communities are often adjacent to major transportation infrastructure such as highways and ports. While electrification of mass transit is an important factor in reducing emissions in these areas, an LMI component for the CHEAPR program will help make all electrified transportation options available to all Connecticut residents.

[207] FAQs - Are there special incentives for low- and moderate-income consumers? California Clean Vehicle Rebate Project. Retrieved October 24, 2018 from https://cleanvehiclerebate.org/eng/faqs.

[208] Chapter 340, Division 270, Zero-Emission and Electric Vehicle Rebates. Oregon Secretary of State, Department of Environmental Quality. Retrieved October 24, 2018 from https://secure.sos.state.or.us/oard/displayDivisionRules.action%3bJSESSIONID_OARD=oSKLJGXVbB9W0IP09w0GUbUhXNjlDOgKBn-Bw1IjrQog00NyEBa8%21-1740555568?selectedDivision=4539.

[209] Requirements for Charge Ahead Applicants. Air Quality Programs, Oregon Department of Environmental Quality. Retrieved June 18, 2019 from https://www.oregon.gov/deq/aq/programs/Pages/Charge-Ahead-Rebate.aspx.

[210] Center for Sustainable Energy (2019). California Air Resources Board Clean Vehicle Rebate Project, Rebate Map. Data last updated June 26, 2019. Retrieved July 30, 2019 from https://cleanvehiclerebate.org/cvrp-rebate-map.

10.3.3 CHEAPR used vehicle rebates

Public Act 19-117 requires the Board to develop a rebate for pre-owned EVs, with an associated income-level cap. This component will serve to expand the program into the secondary EV market and will be a benefit to many Connecticut residents who primarily purchase pre-owned vehicles. In 2018 consumers purchased only 17.3 million new vehicles compared to 40.2 million used vehicles.[211]

When expanding the EV rebate program to include an income cap, there are a number of factors to consider that are not included in the current program. According to the Connecticut DMV, there are over 1600 used car dealers in Connecticut.[212] Under current rules, only new car dealers qualify, of which there are approximately 270. Dealer outreach and education would need to increase immensely under the new program. Additionally, the inclusion of income eligibility necessitates eligibility forms that could implicate privacy concerns depending on how eligibility is determined, potentially requiring increased security and process in verifying applications.

Information on program structure and administration can also be gained from other states such as California and Oregon who have implemented their own LMI rebate options, as noted above. Connecticut should prioritize contracting with a program administrator with experience in the development and implementation of rebate programs that include income eligibility requirements.

10.3.4 Incentives for fuel cell electric vehicles

Connecticut recognizes that the successful penetration of EVs is dependent on insuring that a robust mix of EVs is available to consumers. Many advances have been made in the deployment of an EV charging network across the state and similar efforts are needed for the deployment of an economically viable hydrogen fueling network to ensure market penetration of FCEVs throughout Connecticut and the Northeast. The 2017 Northeast Regional Hydrogen Economy Fuel Cell Electric Vehicle Fleet Deployment Plan[213] recommends deployment goals for Connecticut of 591 FCEVs and 6 to 7 hydrogen fueling stations by 2025. To date, there are two FCEVs registered and one publicly accessible hydrogen fueling station in the state. To improve the value of FCEVs to consumers and enable continued growth and distribution of ZEV technology into the marketplace, continued and consistent effort is needed to coordinate the development of a hydrogen fueling network in Connecticut. Currently, FCEVs receive the maximum possible rebate of $5,000. This rebate level should be maintained throughout the entirety of the next five years of the program as a comprehensive strategy for FCEV deployment is developed.

10.3.5 Program awareness

Understanding rebate applicants and how they learned of CHEAPR is important to make the program more effective in the future. Program awareness is critical to success, and can be increased through marketing or through information shared at the dealership. It can also be improved by understanding basic information about past applicants, such as that gathered from the consumer survey completed at the dealership and analyzed by CSE to help inform program planning processes.

Survey data includes information on cars being replaced, rebated vehicle costs, household income, and rebate importance in the buying process. For example, through December 2018:

- 79 percent of vehicles purchased using the CHEAPR rebate were replacing an existing ICE vehicle and almost 45 percent of vehicles replaced are model years 2011 and earlier;
- 62 percent of vehicles purchased using the CHEAPR rebate had an MSRP between $30,000 -$39,000; and
- More than 80 percent of EV drivers said the CHEAPR rebate was very or extremely important to their clean vehicle acquisition, with 63 percent saying they would not have leased/purchased their EV without the CHEAPR rebate.

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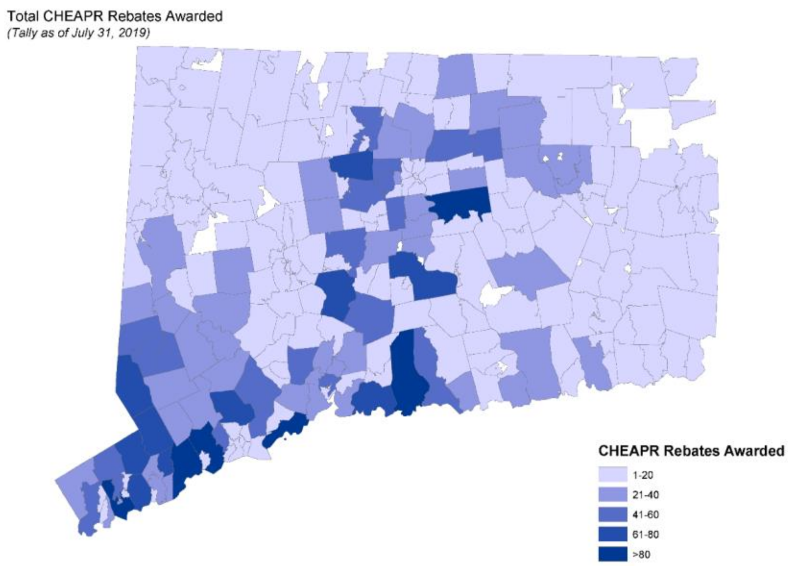
[211] Davies, Alex. Now on Used Car Lots: Great Electric Vehicles for Cheap. Wired. August 5, 2019. Retrieved August 6, 2019 from https://www.wired.com/story/now-used-car-lot-great-electric-vehicles-cheap/?verso=true.

[212] Connecticut Department of Motor Vehicles, Motor Vehicle Dealers and Repairers Data, Retrieved September 9, 2019 from https://portal.ct.gov/DMV/Dealers-and-Repairs/Dealers-and-Repairs/Licensed-Dealers-and-Repairers-in-Connecticut.

[213] Fuel Cell Electric Vehicle Fleet Deployment Plan. Northeast Regional Hydrogen Economy. 2017. Retrieved September 10, 2019 from http://chfcc.org/wp-content/uploads/2019/03/2017_Regional_H2_Fleet.pdf.

Additional data beyond the consumer survey can also help to inform program awareness and accessibility. Data such as location of rebates (see Figure 11) and uptick of rebate applications informs the scope of the program's reach and may also serve to inform where EVSE may best be implemented around Connecticut.

Figure 18: *CHEAPR rebates by location*



Source: Center for Sustainable Energy. Connecticut Department of Energy and Environmental Protection Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Data retrieved August 9, 2019 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

Over the course of the CHEAPR pilot, DEEP (in conjunction with CSE) has used this data to make adjustments to the program that improve its effectiveness. The future CHEAPR program should continue these efforts, and expand to gather more information, particularly where it can assess equitable participation in the program. With appropriate consumer protections in place, the CHEAPR survey could evolve into an auto-enrollment, with opt-out, in EDC-offered programs designed to optimize EV integration—such as at-home Level 2 charger installation, and EV rate designs with TOU and managed charging capabilities.

10.4 Dealership incentives and recognition

Until 2018, the ZEV Program operated with a "travel provision" that enabled auto manufacturers to accrue compliance credits in Connecticut for EVs sold in California.[214] The expiration of this provision, which previously allowed auto manufacturers to double-count a portion of their EV sales without selling EVs in Connecticut, will result in the delivery of greater numbers of more diverse EV models to Connecticut. Dealership education will be essential to increasing consumer awareness and EV sales. At the consumer level, barriers to EV adoption such as range anxiety associated with battery capacity or a perceived lack of public charging infrastructure, can be alleviated by dealership personnel that possess a strong working knowledge of vehicle capabilities and Connecticut's charging infrastructure.

Auto dealerships' expertise in marketing new products to prospective customers puts them in a unique position to accelerate EV adoption. That said, the EV market is still considered nascent and many consumers are unaware of the vehicles' operational capabilities and charging needs, or the financial incentives offered by federal and state governments.[215] Moreover, many consumers are unaware of EDC incentives for both the vehicles and charging infrastructure, and the administrative paperwork required to obtain such incentives. Within this

[214] What is ZEV? Union of Concerned Scientists. Updated October 31, 2016. Retrieved August 12, 2019 from https://www.ucsusa.org/clean-vehicles/california-and-western-states/what-is-zev.
[215] Edmonds, Ellen. Why Aren't Americans Plugging in to Electric Vehicles? AAA Newsroom. May 9, 2019. Retrieved August 12, 2019 from https://newsroom.aaa.com/2019/05/why-arent-americans-plugging-in-to-electric-vehicles/.

ecosystem, auto manufacturers and dealerships play a pivotal role in promoting educational awareness of the vehicles through marketing, advertising, and customer service experience that will ultimately lead to higher levels of EV adoption. Auto dealerships that invest time and effort to promote and educate customer awareness will ultimately be rewarded with greater revenues from EV sales. Connecticut's CHEAPR Program provides individual dealerships with a $150 incentive for each EV they sell.

According to the Sierra Club's 2016 multi-state study of EV shopping at 308 dealerships, *Rev Up EVs*, there is room for improvement in EV education and promotion at dealerships.[216] The study found that almost half of dealerships failed to display their EVs and many study participants had trouble locating a single EV in sales lots. Other participants reported that dealership representatives failed to mention state and federal EV purchase incentives, and some EVs could not be test-driven due to insufficient charge levels. Connecticut dealerships visited as part of this study scored between 3.0-3.9 on a 1-5 scale on their knowledge of state and federal purchase incentives, and received a middle-of-the-pack score for prominently displaying EV models on sales lots. It is worth noting that 14 Connecticut auto dealerships received the highest possible score for overall EV shopping experience, and it's entirely possible that dealerships across the state have progressed since the study's publication in 2016.

When designing the existing CHEAPR program with CARA, DEEP recognized the importance of the dealer's participation in processing the rebate applications and their enthusiasm for promoting EVs and new technologies. As such, the CHEAPR program initially provided a dealer incentive tied to each rebate at a value of $300, and amount that has since been decreased to $150.

As the Board considers the future of the program it will have to decide if continuing the dealer purchase incentive is fruitful. CSE survey data suggests that, while it does help to increase consumer awareness, the majority of dealer incentives are not distributed to salespeople and only results in a moderate change in incentive to sell EVs.[217] While the dealer incentive may have been necessary during the program's beginning, the presence of more widespread EVs from manufacturers and the need to maximize the number of grants available for the funding may necessitate reevaluation of future dealer incentives

As EVs continue to grow in popularity, it is likely that consumers interested in buying EVs, but lacking EV experience, will seek out dealerships with EV expertise and experience. DEEP should expand the existing voluntary recognition program, created in 2014, for dealerships that are leaders in accelerating EV adoption in Connecticut. Recognition should be based on metrics such as inventory quantity and variety, test-drive availability, use of EV loaners by service departments, EV sales, marketing campaigns, and education and outreach efforts. A recognition program could motivate dealerships to sell more EVs, and will signal consumers as to which dealerships are leaders in the Connecticut EV market.

10.5 Learning from other states

Other state programs provide a critical resource to determine what works and what doesn't in addition to Connecticut's own experiences with the CHEAPR pilot program. Lessons can be gained from other state experiences that may help instruct the newly formed CHEAPR program. Oregon and California's programs include elements to enhance participation of LMI customers, while Maryland and Georgia provide valuable lessons regarding momentum and gap funding. A description of these experiences follows.

Maryland

[216] Rev Up EVs. Sierra Club. August 12, 2016. Retrieved August 8, 2019 from https://content.sierraclub.org/press-releases/2016/08/first-ever-multi-state-study-electric-vehicle-shopping-experience.

[217] Evaluating the Connecticut Dealer Incentive for Electric Vehicle Sales. Center for Sustainable Energy. June 2017. Retrieved September 10, 2019 from https://energycenter.org/sites/default/files/docs/nav/research/CT-Dealer-IncentiveEvaluation-CSE-2017.pdf.

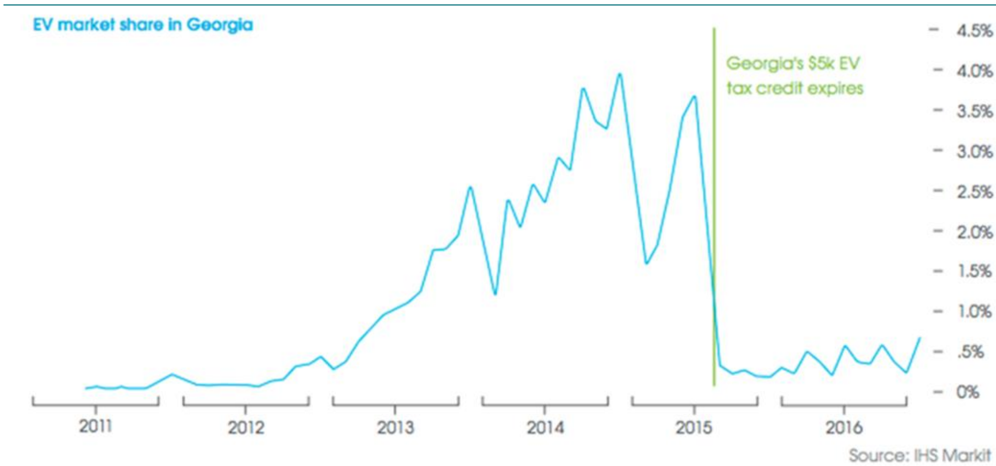
Maryland's EV rebate credit provides up to $3,000 for the purchase of a new vehicle, and will provide credits for fleets for up to ten vehicles. Maryland's program is funded at a level of $6 million dollars per year, and upon depletion of the funding the program establishes a waiting list for future rebates. [218] As of July 1, 2019, program funds have been depleted, and the waiting list will currently subsume the $6 million in funding for next year as well.[219]

While the Maryland program has been extremely effective at incentivizing EV purchases, and shows that demand is exceptionally high, it provides an important cautionary note for the future CHEAPR design. Depletion of funding, fleet eligibility, and the creation of a waiting list when funds are depleted have stalled the Maryland program for the next fiscal year and threatens to curb the momentum the program has built. The California Clean Vehicle Rebate Project (CVRP) also ran out of funding in 2018 and has established a wait list for eligible vehicle purchases or leases until more funding is allocated. Disruptions such as these can hamper consumer confidence and affect vehicle purchasing patterns.

Georgia

In 2001, the state of Georgia introduced a generous $5,000 tax credit for BEVs, which for a number of reasons including lack of vehicle models, did not drive significant EV adoption until 2013-2014. In 2012, there were 1,743 EVs registered in Georgia, but by the end of 2014[220], that number jumped to 15,729 (an increase of 802 percent). When Georgia lawmakers repealed its BEV tax credit, vehicle sales plummeted to 2,435 EVs in 2016 and 2,427 in 2017 as demonstrated in Figure 12. Georgia sold a combined 6,004 PHEVs and BEVs in 2018 as available models increased, but without any EV incentives the EV market has not and will likely not match its 2013-2014 sales numbers. The absence of the tax credit, along with the introduction of an annual EV fee greatly slowed the market for EVs and slowed the momentum that had built up in the state.

Figure 19: *Effect of the Georgia state EV tax credit repeal on Georgia's EV adoption rates*



Source: Elimination of federal tax credits likely to kill U.S. EV market. Edmunds. April 2017. Retrieved August 12, 2019 from *https://static.ed.edmunds-media.com/unversioned/img/industry-center/analysis/EV_Report_April17.pdf.*

Oregon

In 2018, Oregon introduced a rebate program that provides a rebate of up to $2,500, for vehicles with a base price of $50,000 or less. Oregonians who qualify as LMI (with a household income of less than 120 percent of the area median income for the closest metropolitan statistical area) can receive the "Charge Ahead" rebate, which

[218] Titling – Excise Tax Credit for Plug-in Electric Vehicles. Motor Vehicle Administration, Maryland Department of Transportation. Retrieved August 14, 2019 from http://www.mva.maryland.gov/About-MVA/INFO/27300/27300-71T.htm.
[219] Dance, Scott. Maryland's electric vehicle rebate is so popular it ran out of money even before the fiscal year began July 1. The Baltimore Sun. July 8, 2019. Retrieved August 14, 2019 from https://www.baltimoresun.com/news/environment/bs-md-electric-vehicle-credit-20190702-story.html.
[220] Badertscher, Nancy. Electric car sales hit the brakes as tax credit axes and fee added. Atlanta Journal-Constitution. November 1, 2015. Retrieved August 14, 2019 from https://www.ajc.com/news/state--regional-govt--politics/electric-car-sales-hit-the-brakes-tax-credit-axed-and-fee-added/mbDCLQx6HZEnb5Xjp9XoyJ/.

is an additional $2,500 rebate. Applicants for the rebate must indicate on their application that they intend to apply for the Charge Ahead rebate. The Oregon Department of Environmental Quality (DEQ) contacts the Charge Ahead applicant at a later date to obtain the information necessary to meet those requirements.

The DEQ program is not yet fully implemented and there is little data on its overall effect, but Oregon's implementation of an additional LMI qualification can help to inform the next iteration of CHEAPR. Adding an LMI component will require additional program enhancements, including processing the use of qualification criteria, and the implementation of safe-guards to protect sensitive and confidential personal financial information. Tools such as the Charge Ahead Rebate Income Eligibility Calculator[221] could be helpful additional resources to assist LMI applicants. Providing this relief to LMI customers could help significantly with overcoming barriers to an equitable and inclusive rollout of EV ownership.

California

The California Clean Vehicle Rebate Project (CVRP) created in 2007 provides up to $7,000 dollars toward the purchase of a new EV by an individual or business owner. Due to the size of California and increased demand in the state for EVs, California has gone through a number of iterations of the CVRP. Adjustments in rebate levels have been required to utilize existing funding, while additional funding has also been added throughout the program. As of March 2016, California had provided $291 million dollars for over 137,000 vehicles. The CVRP currently has a waiting list due to funding shortages. The CVRP contains an LMI element that was introduced in 2014, and an income cap introduced in 2016.

New York

In 2017 New York announced the Drive Clean Rebate, a $70 million program designed to provide rebates for EV purchases. The New York State Energy Research and Development authority (NYSERDA) administers the program, which provides rebates of up to $2,000 for the purchase or lease of an EV. NYSERDA directed $55 million of the funding to rebates, while $15 million is being used for EV awareness and marketing.[222] Vehicle rebate levels are based on electric range.

Limited data is available regarding the New York program due to its relative age compared to other programs, however with the size of the program, and its proximity to Connecticut, it is critical to monitor for future CHEAPR planning.

Massachusetts

Massachusetts developed the MOR-EV (Massachusetts Offers Rebates for EVs) program in 2014, and it has provided over $30 million for nearly 15,000 EV rebates. Rebates were capped at $2,500 for both BEVs and PHEVs at the outset of the program and have been adjusted since. The program, funded through a portion of Massachusetts's revenue from the Regional Greenhouse Gas Initiative on an ad hoc basis, was never provided a sustainable funding source. As such, Massachusetts has reduced rebates for BEVs to $1,500 while completely eliminating rebates for PHEVs. The program was extended for the last time this past year and will stop providing rebates as of September 30, 2019.

Annual evaluations of the MOR-EV program can be found on their website.[223] Chief among the recommendations found in the annual reports is the need for more dealer outreach, as only one-third of survey respondents in the program reported hearing about the rebate from a dealership. Additionally, as mentioned

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[221] Charge Ahead Rebate Income Eligibility Calculator. Oregon Department of Environmental Quality. Retrieved August 14, 2019 from https://www.deq.state.or.us/ocvrp.

[222] Governor Cuomo Launches $70 Million Electric Car Rebate and Outreach Incentive. Office of Governor Andrew M. Cuomo. New York State. March 21, 2017. Retrieved August 14, 2019 from https://www.governor.ny.gov/news/governor-cuomo-launches-70-million-electric-car-rebate-and-outreach-initiative.

[223] MOR-EV. Massachusetts Offers Rebates for Electric Vehicles. Retrieved August 14, 2019 from https://mor-ev.org/.

above, program data can be invaluable at planning for infrastructure, as only one-third of respondents reported having access to a workplace charging unit.[224]

Policy Recommendations: Leveraging incentives to promote equitable, affordable EV adoption

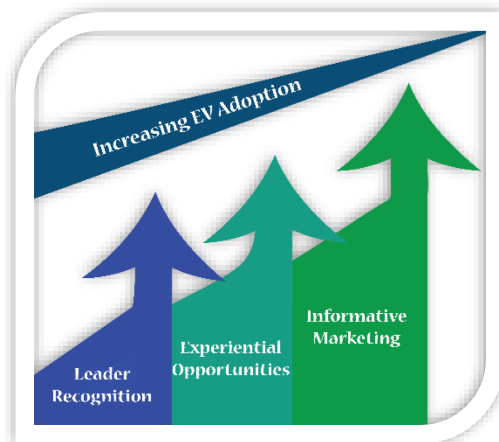
Short-term purchase incentives will continue to be critically important to offset the higher purchase price of EVs until there is full price parity (including the cost of at-home charging infrastructure) with comparable ICE powered vehicles. Connecticut should support the extension of the Federal EV Tax Credit and explore additional funding sources to ensure program stability as initial EV demand created by early users wanes. Additional funding sources are necessary to incentivize the adoption of significant numbers of EVs necessary to meet GHG reduction targets and health-based air quality standards.

Public Act 19-117 requires annual evaluation of the CHEAPR program. The current CHEAPR program has made three rebate and eligibility adjustments over the previous four years of the program. These changes are in response to factors such as draw down rate (which can fluctuate when new, popular models are released), vehicle technology improvements, other available incentives such as the federal tax credit, and vehicle eligibility changes. Following are several recommendations for the future CHEAPR program.

1. Adjust incentive levels and MSRP eligibility for the current CHEAPR pilot program to prevent any program interruption and ensure a smooth transition to the next program.
2. Continue to collect and analyze CHEAPR purchase survey data to implement changes that improve overall program effectiveness.
3. Move expeditiously to implement the revised CHEAPR program per Public Act 19-117, including:
    a. Establish a rebate program capable of launch on January 1, 2020.
    b. Establish rebate parameters, including rebate levels, bins, LMI components, MSRP, eligibility and strategy to communicate program adjustments.
    c. Consider implementation options with and without dealer incentive.
    d. Maintain and expand education, marketing and outreach.
    e. Develop strategies to manage exhaustion of funding each year.
    f. Retain a program administrator familiar with used electric vehicle rebates.
    g. Establish metrics necessary to maintain program health and funding.
4. Support expansion and extension of the Federal EV Tax Credit.
5. Work to develop market-based incentives to support EV adoption through TCI, the EDCs, and Original Equipment Manufacturers (OEMs).
6. Maintain FCEV rebates at current levels through the next five years of the program along with the development of infrastructure to incentivize the deployment of FCECs.

[224] MOR-EV, Year Three Report (July 2016 – October 2017). Massachusetts Department of Energy Resources. October 2018. Retrieved August 14, 2019 from https://mor-ev.org/sites/default/files/docs/MOR-EV_Year_Three_Report.pdf.

11 Education and Outreach



Increased advertising can have a significant effect, given changing EV purchaser demographics. Consumer survey data suggests that many rebate applicants thus far have been what would be termed "early adopters," people who were already familiar with EVs when they began the purchasing process.[225] Increased education, outreach and marketing is necessary to increase awareness among the general public and accelerate EV adoption more broadly. Government incentives and infrastructure availability can have a positive impact on EV adoption rates, but such policies and tools must be understood and recognized by the consumer in order to improve the perception of EVs and increase uptake.[226]

Research by UC Davis indicates a key barrier to EV adoption is consumer awareness/education. A 2014-2016 survey[227] of the eight states in the NESCAUM concluded that two barriers to EV uptake are a lack of consumer awareness that EVs are available for sale, and a lack of consumer experience with EVs. The study indicates that consumers consistently characterize their knowledge of EVs as well below that of the average ICE vehicle. When asked to indicate if they were familiar enough with BEVs to determine if BEVs would be a right choice for their household, consumers across the NESCAUM states consistently indicated weak familiarity, and what little familiarity they had was mostly not through driving experience.[228] Consumers also indicate significant range concerns when considering purchasing an EV. This lack of information and hands on experience can prevent consumers from even considering EVs as an option, and that in itself could limit a state from achieving its EV goals.

Having identified these key barriers to increasing EV deployment, Connecticut, along with the other NESCAUM states, recognized the need to educate and engage with consumers about the advantages of EVs. Connecticut, specifically DEEP, understands that the education, marketing and outreach strategy employed must be comprehensive, and requires regional coordination to identify and implement best practices. An effective outreach strategy should also include the use of visual and informative marketing, positive recognition of leadership in the field, and the availability of experiential opportunities. Efforts are currently underway to implement these strategies and it is necessary that Connecticut and the region maintain momentum on these fronts to narrow the gap that exists between our EV deployment goals and the number of EVs on the road today. In Connecticut, that gap is approximately 140,000 EVs, the difference between the 150,000 EVs the state aims to have on the road by 2025 and the 10,339 EVs registered in Connecticut today.[229] DEEP also recognizes that a successful outreach program will require leveraging the expertise and perspectives of various stakeholders and interest groups, such as OEMs, car dealerships and the utilities.

Launched in 2018, the Drive Change. Drive Electric" (DCDE)[230] campaign, was formed through a partnership between NESCAUM, NYSERDA, OEMs and several states, to address the need to increase EV awareness and understanding. The northeast states through NESCAUM developed a strategy that includes three platforms:

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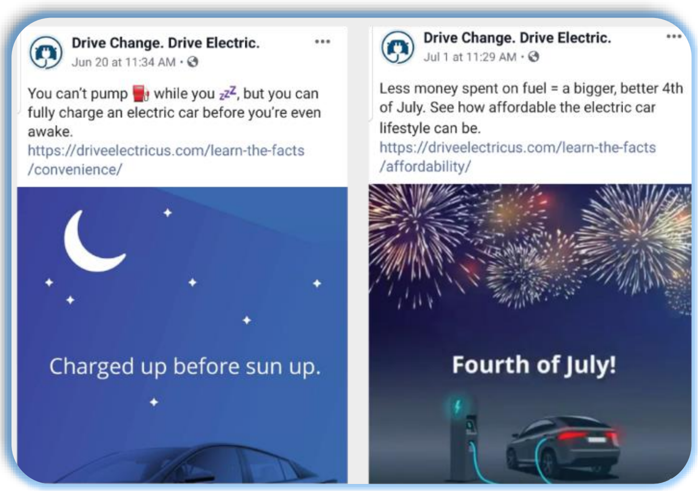
[225] 45% of respondents reported that they were "only interested" in purchasing an EV. Center for Sustainable Energy Consumer Survey Report.
[226] Zeinab Rezvani, Johan Jansson, and Jan Bodin, "Advances in Consumer Electric Vehicle Adoption Research: A Review and Research Agenda," *Transportation Research*, 34, (Jan 2015): 122-136. doi: 10.1016/j.trd.2014.10.010. Retrieved from https://www.sciencedirect.com/science/article/pii/S1361920914001515
[227] Kurani, Kenneth and Caperello, Nicolette. New Car Buyers' Valuation of Zero-Emission Vehicles: California. Institute of Transportation Studies, University of California, Davis. 2016.
[228] Ibid.
[229] Number of Electric Vehicles Registered in Connecticut. Connecticut Department of Motor Vehicles. Retrieved September 10, 2019 from https://www.ct.gov/dmv/cwp/view.asp?a=807&q=600850.
[230] Drive Change. Drive Electric. Retrieved August 14, 2019 from https://driveelectricus.com/.

webpage, social media, and news media, with the webpage serving as the primary medium for the education campaign.[231] Social and news media, the campaign's secondary platforms, provide the campaign with an efficient and cost-effective opportunity to reach the audience identified by market research as those most likely to embrace electrified transportation. The goal of these platforms is to provide informative EV related highlights that direct the public to the webpage for the full scope of the outreach campaign.

DCDE, in an effort to build consumer knowledge and showcase that EVs can fit into consumers' lifestyles now, engaged in a basic education campaign to address the key areas identified as barriers to ZEV adoption: a lack of knowledge regarding EV technology and charging infrastructure, model options, and pricing. For example, to address range anxiety, the DCDE webpage and social media platforms were designed to provide information regarding vehicle range, opportunities for workplace and overnight charging and the availability of software applications that can assist drivers with finding charging infrastructure. Similarly, concerns regarding affordability and vehicle choice are directly addressed through demonstrating vehicle options in the explorer tool on the DCDE webpage. The explorer tool allows users to compare maintenance and refueling cost, provide current information on financial incentives available in each of the partner states and showcases first hand driver experiences of current EV owners. Each of these concepts is fully described on the DCDE webpage and highlighted through the social media streams (see the social media examples in Figure 20).

Figure 20. Examples of DCDE social media content



The Destination Electric Program, a component of the DCDE campaign, is a recognition system for EV friendly businesses, venues, and attractions that is designed to demonstrate how easily EVs can be integrated into the lives of drivers by highlighting the availability of EV infrastructure and their proximity to local destinations. Currently, there are over 140 Destination Electric businesses in 14 cities across 7 campaign states.[232] Connecticut's initial destination cities are New Haven and Madison with an intent to expand to other cities and towns across the state.

The Destination Electric program, which launched in the summer of 2019, aims to attract locals and visitors alike, by showing both EV drivers and potential EV drivers that EVs are more than simply "commuter cars." The businesses and venues that elect to participate in the Destination Electric program receive a Destination Electric Toolkit, which includes window decals, postcards, and other promotional signage. The promotional materials indicate the destination's walkability to an EV charging station and highlights Destination Electric's webpage and social media platforms as a source of more EV information. The cities and locations participating in the program are among some of the local leaders for EV infrastructure deployment. The leadership and support of many local

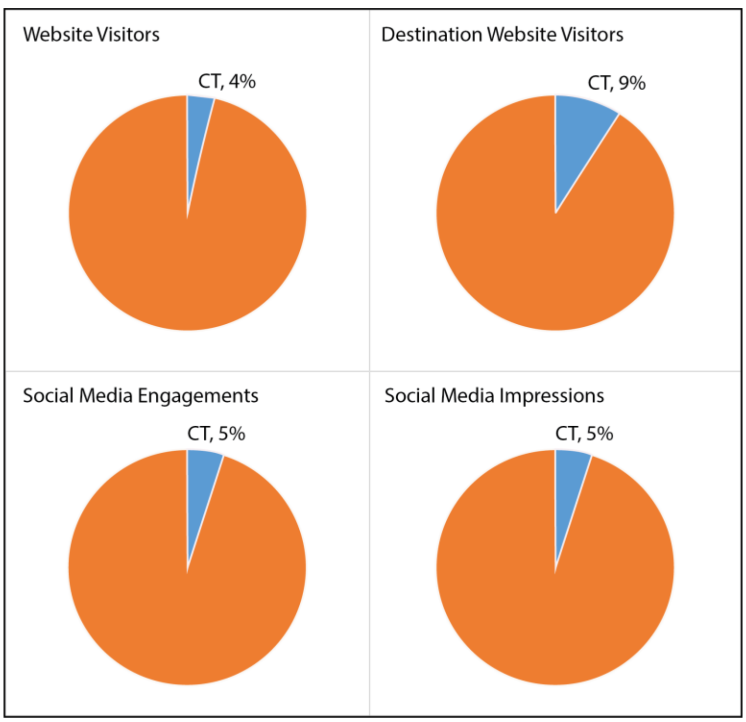
[231] Retrieved August 14, 2019 from https://www.facebook.com/DriveElectricUS/ , https://twitter.com/driveelectricUS, https://www.instagram.com/driveelectricUS/.
[232] Destination Electric. Drive Change. Drive Electric. Retrieved August 14, 2019 from https://driveelectricus.com/destination-electric/.

businesses, towns, and cities in the Northeast in promoting awareness of the availability of EV infrastructure, and by extension the viability of EVs, is key to implementing a successful program and increasing EV adoption.

The program has brought additional attention through, for example, features in lifestyle media outlets, which has elevated discussions around EVs as a more sustainable travel option. *Inside Hook* featured the campaign in a July 9, 2019, article[233] that brought additional awareness and excitement to the campaign and the businesses that are supporting it. In fact, during this period (June 13, 2019 through July 11, 2019) the campaign generated over 11,000 visits to the website, over 1 million impressions, and grew the social media following by over 5 percent. As of July 11, 2019, the campaign was featured in over 85 local news outlets including some of Connecticut's own local news outlets such as *The Post-Chronicle* of Hamden and New Haven, *The Connecticut Bulletin* of Milford and Orange, *The Dolphin News* of Mystic, and *The West Hartford News*.

The campaign has driven interest in the web and social media content regionally. Connecticut's goal is to improve the campaign's visibility among residents. Connecticut viewers comprise approximately 5 percent of each of the web and social media metrics with the exception of visits to the Destination Electric portion of the website (see Figure 21 below). As such, Connecticut's priority is to increase consumer engagement with the campaign to assure the education outreach efforts increasingly impact EV awareness in Connecticut. The apparent interest Connecticut viewers have in the Destination Electric program, as depicted in Figure 21, may indicate this program is a valuable tool for continued outreach to Connecticut audiences and should be further utilized.

Figure 21. Web and social media traffic of Connecticut viewers compared to whole campaign



11.1 Recognizing leaders in EV sales

Automotive sales teams are uniquely positioned to convey information regarding EV attributes, including technology, availability, affordability, and comfort to prospective EV drivers. The Connecticut EV market will only be a success if all partners are invested and their value is recognized.

[233] Gab, Shari. An East Coast Road-Trip Guide for Eco-Conscious Drivers. Inside Hook. July 9, 2019. Retrieved September 30, 2019 from https://www.insidehook.com/article/travel-new-york/destination-electric-east-coast-road-trip-guide-for-eco-conscious-drivers.

The CHEAPR Dealer Award, originally called the R***EV***olutionary Dealer award is the first effort to publicly recognize EV auto dealers who champion EV sales. DEEP, in partnership CARA, annually provides a plaque of recognition to dealerships with the greatest impact on EV proliferation throughout the state.[234]

11.2 Experiential opportunities: EV ride and drives

Ride and drive events offer consumers an interactive learning experience. Studies[235] show that providing consumers with the opportunity to experience an EV firsthand is helpful in overcoming the vehicles' perceived drawbacks. There are some opportunities for ride and drive events in Connecticut throughout the year but due in part to limited support, the offerings are not consistent.

One event is the Connecticut International Auto Show. Hosted annually by CARA, the auto show has featured ride and drives as part of the event. The Clean Cities Coalitions, tasked with fostering the nation's economic, environmental, and energy security by working locally to advance affordable transportation fuels, energy efficient mobility systems, and other fuel-saving technologies and practices, have also hosted a number of successful ride and drive events over the years.

Additionally, the Sierra club, Plug-In America and the Electric Auto Association have collaborated to host events all over the country for the annual National Drive Electric Week (NDEW). This is a grassroots effort to increase consumer interaction with EVs. For a week in September, each year, the partners employ volunteers from around the nation to bring EVs, speakers and other activities to celebrate and educate the public about EVs. NDEW provides an ideal opportunity to host a series of coordinated ride and drive events across the state. Each year there are often a number of ride and drives planned as part of this event but due, in part, to minimal funding and resources, these ride and drives are often limited to a vehicle owner putting their EV on display and offering a question and answer forum around their experience rather than a true ride and drive, where event participants have the opportunity to test drive an EV and get their own feel for the vehicle. However, the continued offerings of Drive Electric Week events across the state demonstrates a core interest in EVs and a desire to broaden understanding and acceptance of the technology. Funding and other resources to support these events would have a visible impact on their scope and reach. These events have the opportunity to build new consumer awareness increasing the reach to consumers beyond traditional market channels such as print, radio and television.

The DCDE campaign has realized the potential EV ride and drive events hold for reaching a broad audiences. Through the Destination Electric program, the campaign is exploring opportunities to cross promote events that could be mutually beneficial to Destination Electric as well as NDEW. Specifically, Destination Electric could promote NDEW events on its webpage and social media platforms and would in turn have the opportunity to participate and promote Destination Electric at NDEW events. This collaboration would provide both programs with an opportunity to reach a larger audience.

The success of ride and drive events requires reliable partnerships. Over the years, DEEP has partnered with Clean Cities, CARA and local groups. DEEP has also hosted and participated in NDEW ride and drive events offered in Connecticut. It's important to maintain the momentum of increasing EV awareness and the impact EV ride and drive events have on increasing said awareness is evident. Connecticut has partnered with many businesses and organizations to increase EV awareness and the partnerships that have been established have been necessary for developing the current education and outreach framework. EV deployment is far from meeting established goals. More education and outreach is needed, requiring the state to build new partnerships as well as build on existing ones.

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[234] EVConnecticut: Dealer Awards. Connecticut Department of Energy and Environmental Protection. Retrieved August 14, 2019 from https://www.ct.gov/deep/cwp/view.asp?A=2684&Q=539780.

[235] Jensen, Anders, Cherchi, Elizabetta, and Mabit, Stefan. On the Stability of Preferences and Attitudes Before and After Experiencing an Electric Vehicle. *Transportation Research*, 25, (Dec 2013): 24-32. doi: 10.1016/j.trd.2013.07.006. Retrieved from https://www.sciencedirect.com/science/article/pii/S1361920913001077

DEEP has identified several areas where new and existing partners could provide valuable insight and resources for improving communication and the outreach necessary to increase EV adoption rates. For example:

- Utilities can provide data associated with charging use to help municipalities and private industry deploy infrastructure in priority areas. This information could benefit station developers and operators by allowing them to properly anticipate operation and maintenance costs and avoid demand charges through services such as time of use rates, smart chargers or other power management options.
- Utilities can provide data and communications regarding the implementation of make-ready programs in other states to inform pre-planning efforts in Connecticut.
- Utilities can participate in ongoing marketing efforts to avoid duplication efforts and to expand consumer awareness.
- OEMs can provide independent print, radio and television marketing for their EV models available for sale in Connecticut and the other Northeastern states.

As part of its ZEV Docket, PURA should consider utility investment in marketing and education to support full utilization of any utility investment in EV charging infrastructure.

Policy Recommendations: Education and outreach

1. Continue to support and participate in the regional DCDE campaign and the Destination Electric Program to build upon and increase consumer awareness in the state and the region.
2. Explore additional marketing opportunities by OEMs of the EVs available for sale in Connecticut and the region.
3. Conduct focused outreach in underserved communities to inform the development of integrated approaches for deploying electrified transportation services strategically and addressing barriers to EV ownership by low-income households.
4. Consider utility investment in marketing and education as part of the PURA ZEV Docket.

12 Funding Mechanisms to Support Sustainable Incentive and EV Infrastructure Programs

12.1 Transportation Climate Initiative

The 2019 TCI Regional Policy Design Process represents one potential source of future incentive funding. Currently nine Northeast and Mid-Atlantic states and the District of Columbia are working to develop a regional low-carbon transportation policy proposal that would cap and reduce carbon emissions from the combustion of transportation fuels through a cap-and-invest program.[236] If implemented, the resulting policy would generate proceeds that Connecticut can reinvest in cost-effective low-carbon transportation solutions such as, but not limited to, light-, medium, and heavy-duty vehicle electrification, transit oriented development, smart growth, travel demand management, traffic flow improvements in urban and suburban areas, and complete streets development (pedestrian and bicycle access expansion). As a part of the TCI regional policy design process DEEP and CT DOT will jointly engage with stakeholders to elicit feedback on potential investment strategies of program proceeds. This outreach will include a focus on engaging with LMI and underserved communities to ensure equitable investment solutions.

12.2 Volkswagen settlement

In late 2015, Volkswagen (VW) publicly admitted that it had deliberately installed defeat device - software designed to cheat emissions tests and deceive federal and state regulators in nearly 500,000 VW and Audi branded 2.0-liter diesel vehicles and 83,000 3.0-liter diesel vehicles sold to American consumers. In Connecticut,

[236] TCI Regional Policy Design Process 2019. Transportation & Climate Initiative. Retrieved August 12, 2019 from https://www.transportationandclimate.org/main-menu/tcis-regional-policy-design-process-2019#Anchor%202.

an estimated 11,911 vehicles were sold.[237] The use of the defeat devices has resulted in increased emissions of nitrogen oxides (NOx) in Connecticut and throughout the United States. NOx significantly contributes to the formation of ground-level ozone, which negatively impacts the respiratory system and cardiovascular health.

Through a series of three partial settlements,[238] EPA resolved their civil enforcement case against VW. As a result of these partial settlements, VW agreed to pay $2.7 billion dollars into a mitigation trust fund (Trust) that would be apportioned to the states. Connecticut is expected to receive over $55 million for use towards offsetting the excess NOx emissions caused by VW's actions through extensive mitigation projects to reduce NOx from a wide array of mobile sources. With NOx reduction being its primary focus, the Trust provides funding for the replacement of existing diesel equipment, engines or vehicles with new diesel, alternate fueled or zero emission equipment, engines or vehicles. Connecticut currently has seven years in which to utilize this funding and has, in its Beneficiary Mitigation Plan,[239] preserved all replacement options under the Trust. As a result, diesel-to-diesel replacements are eligible for funding under the Plan. While electrification is the goal, these projects provide an opportunity to maximize cost effective NOx reductions in the short-term and realize immediate health benefits in environmental justice communities and those that have historically borne a disproportionate share of the adverse impacts of air pollution. Although the Plan allows for all options under the Trust, in its first round of funding, Connecticut has allocated more funding to electrification projects than any other project type. Of ten projects totaling $12.18 million[240] Connecticut has funded, $6.28 million was awarded for electrification projects, $1.2 million for alternate fuel projects, and $4.71 million for diesel projects.

12.2.1 Volkswagen: Light-duty zero emission vehicle supply equipment

Under the terms of the trust agreement, up to 15 percent of allocated funds—approximately $8.4 million, can be used towards the acquisition, installation, operation and maintenance of publicly accessible light-duty zero emission vehicle supply equipment in Connecticut. Specifically, funding is allowed under the Trust for Level 1, Level 2, DCFCs and hydrogen refueling stations that are located in public places and Level 1, Level 2 and DCFCs located at workplaces and MUDs.

Connecticut has not yet made any funding opportunity available for the $8.4 million allocated for zero emission vehicle supply equipment. In anticipation of releasing this funding in the near term, close attention has been paid to how other states have utilized or plan to utilize their funds. The planned usage of VW Mitigation Trust Funds on EVSE by other jurisdictions across the country falls into several categories and is outlined below.

Table 6: Summary of planned usage for VW Trust EVSE allocation in applicable states

State	Highway Projects (DCFC)			Community Projects (Level 2 and DCFC)				(Hydrogen) Fuel Cell Refueling Stations	Multi-Round Funding	Existing EVSE Programs (non VW generated)	Separate funding programs for community vs. highway
	New DCFC Projects	EVSE Network Gap Filling	Repair / Upgrade of Existing	MUD / Workplace charging	Gov. Property Charging	Destination Charging	EJ Community Projects				
CA				x		X	x	x		x	
CO	x	x		x	x	X				x	x
CT											
ID	x	x									

[237] Connecticut Volkswagen Mitigation Plan. Connecticut Department of Energy and Environmental Protection. Retrieved August 14, 2019 from https://www.ct.gov/deep/lib/deep/air/mobile/vw/CT_VW_Final_Mitigation_Plan.pdf.

[238] Third Partial and 3.0L second Partial and 2.0L Partial and Amended Consent Decree. U.S. Environmental Protection Agency. Retrieved September 25, 2019 from https://www.epa.gov/enforcement/third-partial-and-30l-second-partial-and-20l-partial-and-amended-consent-decree.

[239] Connecticut Volkswagen Mitigation Plan. Connecticut Department of Energy and Environmental Protection. Retrieved August 14, 2019 from https://www.ct.gov/deep/lib/deep/air/mobile/vw/CT_VW_Final_Mitigation_Plan.pdf.

[240] Administrative Archive, Volkswagen Mitigation Plan. Connecticut Department of Energy and Environmental Protection. Retrieved August 14, 2019 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=602744&deepNav_GID=1619.

ME	x										
MD	x			x	x					x	
MA				x	x	X	x	x	x	X	
MI	x	x				X		x	x		
MN	x			x					x		
MT				x	x	X					
NE	x			x		X					
NV	x	x								x	
OH	x	x		x	x	X					
OK	x	x		x		X					
OR		x	x	x						x	
PA	x	x		x	x	X					x
RI	x	x									
UT	x	x		x		X					
VT				x	x	X		x			
WA	x	x								x	
WY						X					

States are taking very different approaches to utilizing their VW EVSE funding as each state is influenced by a number of internal factors such as existing programs, prior investment, and other unique needs. The recommendations below include a mixture of these strategies to most effectively deploy EVSE across the state.

12.3 Electrify America

As part of the VW settlements, VW established Electrify America in 2016 as a new entity to oversee the investment of $2 billion, $800 million in California and $1.2 billion in the other 49 states, in electric vehicle infrastructure over a 10-year period. Under the terms of the VW settlements, Electrify America is managing these investments over four 30-month planning cycles targeted at fast charging EV infrastructure, public outreach and programs to drive EV awareness and access.

The infrastructure investments by Electrify America over the next decade will play a central role in EV market development in the Northeast Corridor. Cycle 1[241] of Electrify America's investment plan primarily focused on building out their initial nationwide DCFC and L2 networks along major highway routes. Cycle 2, which is currently under implementation,[242] will see an investment of $300 million nationally between July 1, 2019 and December 31, 2021. Approximately $250M of that investment will be directed towards infrastructure, especially retail, mobility, and multi-unit dwelling locations and the continued build-out of their nationwide DCFC network along highway and regional routes. Approximately $35 million will be used for education, awareness, and marketing, with the balance of the funds used for program overhead. Cycle 2 is focusing on 18 metropolitan areas in the United States, including Bridgeport, Connecticut.[243] Currently, there are two currently operational Electrify America DCFC stations in Connecticut, in Waterford and Stratford. Two additional Electric America DCFC stations are proposed for Wallingford and Manchester as part of the Cycle 2 investment.

While Electrify America will identify regions in which they will seek to invest in EVSE, they proceed discreetly during their site selection process. As such, site locations are unknown until disclosed by Electrify America. This presents a challenge for Connecticut in that there are significant gaps in the state's fast charging network outside of southwestern Connecticut, including major travel corridors such as the I-91 between Hartford and New Haven, or the I-84 both west and east of Hartford. Until the scope of Electrify America's investments in Connecticut are known, it is more important for Connecticut to focus its relatively small VW EVSE fund on areas that Electrify America has not indicated an interest in.

[241] See Electrify America, National ZEV Investment Plan: Cycle 1, Public Version – April 9, 2017.
[242] See Electrify America, National ZEV Investment Plan: Cycle 2, Public Version – February 4, 2019.
[243] Ibid, page 39.

Policy Recommendations: Volkswagen EVSE

These recommendations are framed based on the ongoing and significant investments by Electrify America and the potential for PURA authorizing utilities to invest in "make-ready" improvements and may require adjustment as the regulatory process advances. Connecticut's VW EVSE investment ($8.4 million) could be allocated in the following ways:

1. Distribute funding over several cycles so as to complement emerging investments and technological developments by Electrify America and regulatory proceedings before PURA, and to the extent possible 'future proof' Connecticut's EVSE investments.
2. Focus on supporting deployment of public chargers to support use patterns of current EV drivers, while also strengthening the perception that the state's charging network is sufficiently robust to eliminate range concerns. According to the U.S. Office of Energy Efficiency & Renewable Energy, drivers do more than 80 percent of their charging at home, including MUDs. Prioritizing installation of public chargers at long-dwell-time locations such as apartments and condos will open the EV market to a significant portion of consumers who would otherwise be unable to reliably access charging equipment.
3. Assess the feasibility of funding a DAS's EV infrastructure pilot under the Governor's Executive Order No. 1 that could represent a transformational deployment of EVs and associated infrastructure in Connecticut's state fleet.
4. Participate in the PURA ZEV Docket to consider options for leveraging VW funding as part of a broader utility EV infrastructure deployment model.
5. Focus on the future of zero emission transportation and support hydrogen vehicle fueling needs.

DEEP should allocate the maximum allowed by the VW settlements to light-duty zero emission vehicle infrastructure to support the deployment of electrified transportation options and further enhance the State's efforts to improve air quality and to reduce greenhouse gas emissions from the transportation sector. Under the terms of the VW Settlement, funding for infrastructure is limited to light-duty vehicles. Cost savings associated with reduced spending on petroleum can then be redirected to other areas within the State's economy. Proposals for eligible mitigation projects under the light-duty zero emission vehicle infrastructure plan will also be evaluated to determine the extent to which they leverage additional resources to support transformative technological changes and further the energy and economic benefits of the State and whether they also provide a firm base of support for emerging fuel cell or other alternative fuel transportation technologies.

13 Conclusion

Public Acts 08-98 and 18-82 establish mandatory economy-wide GHG reduction targets of 10 percent below 1990 levels by 2020, and 45 and 80 percent below 2001 levels by 2030 and 2050. The transportation sector is the largest source of statewide GHG emissions, accounting for 38 percent, of which the majority arise from the combustion of fossil fuels in passenger cars and light-duty trucks.[244] As identified in the GC3 GHG pathways reduction analysis, the primary solution for achieving the state's mandatory reductions is wide-scale EV deployment.

Although EV sales are a relatively small percentage of overall sales in Connecticut compared to ICE vehicles, the market is growing at a rapid pace. This is due largely to advances in battery technology, expanded vehicle range, increased model availability, and state policies and regulations to reduce emissions and incentivize EV adoption. Competing needs for funding for incentives for vehicle purchases and infrastructure development will require strategic planning to optimize dollars spent while ensuring they are spent equitably. The transition from ICE vehicles to electric vehicles raises a number of opportunities and challenges, including developing adequate charging infrastructure to meet consumer's charging needs, addressing increased electricity demand, maximizing the potential for more efficient use of the electric grid in order to lower electric rates for all

[244] 2016 Connecticut Greenhouse Gas Emissions Inventory. Connecticut Department of Energy and Environmental Protection. Retrieved July 30, 2019 from https://www.ct.gov/deep/lib/deep/climatechange/publications/ct_2016_ghg_inventory.pdf.

ratepayers, and ensuring that low income residents and underserved communities are able to benefit from vehicle electrification.