2020

Electric Vehicle Roadmap for Connecticut

A Policy Framework **to Accelerate Electric Vehicle Adoption**

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Executive Summary

The *Electric Vehicle Roadmap for Connecticut* (*EV Roadmap*) represents a comprehensive strategy for accelerating the deployment of electric vehicles (EVs) through policies and regulatory tools addressing transportation equity, purchasing incentives, consumer education, charging infrastructure expansion, consumer protection, integration of EVs into the electric grid, utility investment, and utility rate design.

Connecticut suffers from some of the worst air quality in the country, especially along heavily-traveled transportation corridors where criteria air pollutants are most densely concentrated. Poor air quality exposure exacerbates 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.[1] EV deployment is one of several measures that will greatly reduce emissions from mobile sources—particularly light-duty vehicles (LDVs) and medium- and heavy-duty trucks—which account for approximately 66 percent of nitrogen oxides (NOx), a harmful component of smog and other hazardous air pollutants.

Connecticut's transportation sector is also responsible for 38.1 percent of the state's greenhouse gas (GHG) emissions. After analyzing pathways for GHG reduction, the Governor's Council on Climate Change (GC3) identified transportation electrification via wide-scale EV deployment to be among the primary solutions for achieving the state's statutorily required economy-wide GHG reductions targets of 45 percent and 80 percent below 2001 levels by 2030 and 2050, respectively. Other important transportation sector strategies include retaining stringent fuel economy standards, increasing the use of public transit and alternative modes of transportation, supporting transit-oriented development (TOD), and encouraging sustainable land-use planning.

The *EV Roadmap* focuses specifically on the pathways to achieve wide-scale EV deployment, which complements these other transportation sector GHG strategies, and will correspondingly drive reductions in harmful criteria pollutants from the transportation sector, help the state meet federal health-based air quality standards, and mitigate communities' exposure to mobile air source toxicants.

As one of several states signing onto the Zero-Emission Vehicle Memorandum of Understanding (ZEV MOU), Connecticut has committed to an ambitious goal of putting 125,000 to 150,000 EVs on the road by 2025. Electric vehicle supply equipment (EVSE) deployment should be scaled to reduce range anxiety and encourage higher EV penetration rates as consumers become more confident in charging accessibility.

Electric vehicles provide many benefits to consumers, including lower maintenance costs and often lower fuel costs. To date, there are nearly 2.4 million light-duty passenger cars and trucks registered in Connecticut. Annual sales of new LDVs in Connecticut fluctuate each year from roughly 150,000 to 180,000, and EVs account for only 2 percent of annual sales. This indicates that EVs are still in an early adoption phase.

As of December 31, 2019, there are 11,677 EVs registered in-state and, of these, approximately 70 percent are Tesla models, which are supported by Tesla's proprietary EVSE charging network. Tesla's charging network accounts for 25 percent of publicly-available charging infrastructure in Connecticut, and includes 36 destination charging stations with 79 charging connectors, and 20 direct current fast charger (DCFC) stations with 160 charging connectors. However, these publicly-available stations utilize a proprietary connector and remain inaccessible to non-Tesla drivers. In building out the publicly-accessible charging infrastructure network in the state, Connecticut should take Tesla's charging network into account, while ensuring that publicly-funded, publicly-accessible charging stations are brand agnostic and support charging for all makes and models.

[1] 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.

Significant EV penetration and EVSE deployment will require strategic action in response to current and future policy landscapes. The regulatory framework that requires auto manufacturers to enable consumer choice by producing EVs for sale is under threat. On March 30, 2020, the federal government finalized a regulatory rollback of Corporate Average Fuel Economy (CAFE) and vehicle GHG emission standards. In September 2019, the federal government finalized a rule rescinding the legal authority through which California—and by extension Connecticut and many other states—adopt and implement stricter emission standards under the federal Clean Air Act (CAA). These emissions standards benefit consumers by improving the fuel efficiency of traditional vehicles, and by requiring the production and sale of increasing numbers of EVs in participating states. The combined market share of these states represents almost 40 percent of the national annual new LDV market. Connecticut is one of many states challenging these unprecedented federal actions in court.

Regardless of these challenges, Connecticut's clean air, clean energy, and GHG reduction targets require an ever increasing percentage of EV market penetration. The state is moving to adopt further policies to support EV deployment, including sustained funding of $3 million each year through 2025 to provide EV purchase incentives for up to 2,000 new and used EVs. It is important to note that the list below, which summarizes key focus areas of the *EV Roadmap,* is ordered neither by priority nor potential impact on EV adoption. Many of these key focus areas will be continually assessed by DEEP and other state agencies to adjust to the rapidly evolving EV landscape.

The EV Roadmap's Key Focus Areas

- **Public and Private Fleets:** Fleet vehicles' high annual mileage, operational costs, and public exposure make them cost-effective and attractive candidates for electrification. Compared to internal combustion engine (ICE) vehicles, EVs can be cheaper to run when accounting for the operable lifetime costs of maintenance, fuel, and other ancillary costs.
- **Medium- and Heavy-Duty Vehicle Electrification:** It is anticipated that by 2035, heavy-duty vehicles will contribute 61 percent more NOx emissions than LDVs due to decreasing LDV emissions as a result of stronger new vehicle standards. The electrification of medium- and heavy-duty vehicle classes such as trucks and buses will be vital to ensuring the state remains on track with emission reduction targets.
- **Expanding EV Charging Infrastructure:** Eliminating range anxiety is a key barrier to customer adoption of EVs. There are 376 publicly-accessible EV charging stations with a total of 966 charging connectors in the state, including 50 DCFC locations with 212 charging connectors. A significant increase in workplace Level 2 charging connectors, public Level 2 charging connectors, and public DCFC connectors will be necessary to supplement residential charging and meet future charging demands. To date, private investment in EVSE deployment has not scaled at the pace necessary to meet Connecticut's 2025 ZEV MOU target. As such, some public funding will be necessary to build out the state's Level 2 and DCFC EVSE network to support current and future charging demand in support of Connecticut's ZEV MOU commitment and GHG emission reduction targets.
- **Consistency of the Consumer Charging Experience:** Fueling a conventional ICE vehicle is simple. To increase adoption levels, the same must be true for EVs. In order to ensure a positive experience driving electric, publicly-accessible EV charging stations should meet certain criteria regarding interoperability, pricing transparency, acceptable payment methods, Americans with Disabilities Act (ADA) compliance, and "ICE-ing" infractions, especially stations that are publicly-funded.
- **Minimizing Grid Impacts through Demand Reduction Measures:** As the market penetration rate of EVs grows, so-called "managed charging"[2] can reduce the need for costly investments in the electric

[2] Managed charging allows a utility, grid operator, 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.

distribution system infrastructure to support increased charging loads. Through innovative managed charging strategies, both active and passive, EV charging can be optimized to meet the transportation needs of EV users while minimizing impacts on the electric distribution system and ratepayers in general.

- **Demand Charges:** Demand charges often represent the majority of utility costs for DCFC station owners and EV fleet operators when utilization rates are low. Demand charges can hinder the business case for early-stage DCFC deployment and EV adoption as a result. Strategies to address the impacts of demand charges will be vital to DCFC deployment, and to electrifying medium- and heavy-duty transit and school bus fleets.
- **Innovation:** Connecticut is home to many innovative and industry-leading technology-based businesses, including EVSE suppliers EVSE LLC and Juice Bar. The state will explore opportunities for developing pilot programs that encourage economic development in Connecticut while maximizing the benefits of transportation electrification to all electric ratepayers.
- **Building Codes and Permitting Requirements:** Building codes, zoning ordinances, and permitting requirements enable state and municipal governments to set a foundation that supports EVSE deployment in new construction and parking facilities.
- **Leveraging Incentives to Promote Equitable, Affordable EV Adoption:** Purchase price remains the most significant barrier to EV adoption. Advances in battery technology will continue to bring EVs closer to price parity with ICE vehicles. Until the market reaches maturity, financial incentives, like the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR), will remain essential to accelerating EV adoption.
- **Education, Marketing, and Outreach:** Education, marketing, and outreach efforts are essential for increasing consumer awareness and putting more EVs on the road. Regional collaborations between auto manufacturers and state partners have been successful in expanding consumer awareness and increasing EV sales. Educational materials, experiential ride-and-drive events, and social media awareness campaigns developed through multi-stakeholder and regional efforts remain critical to EV penetration in Connecticut.
- **Volkswagen EVSE:** Connecticut has allocated the maximum $8.4 million of its Volkswagen (VW) Mitigation Trust funds to support the acquisition, installation, and operation and maintenance (O&M) of publicly-accessible light-duty ZEV EVSE in the state. DEEP has recommended a number of investment opportunities for deploying Level 2 EVSE in public and workplace charging settings, multi-unit dwellings (MUDs), and state agency facilities. In addition, VW EVSE funding can be allocated to support the development of DCFC and FCEV refueling stations.

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Abbreviations

AC – alternating current
ACT – Advanced Clean Trucks Regulations
ADA – Americans with Disabilities Act
AFLEET – Alternative Fuel Life-Cycle Environmental and Economic Transportation
ATV – alternative technology vehicle
BAU – business as usual
BESH – Basic Electric Service Hourly
BEV – battery electric vehicle
BNEF – Bloomberg New Energy Finance
CAA – Clean Air Act
CAFE – Corporate Average Fuel Economy
CALGreen – California Green Building Standards Code
CARA – Connecticut Automotive Retailers Association
CARB – California Air Resources Board
CHEAPR – Connecticut Hydrogen and Electric Automobile Purchase Rebate
CO_2 – carbon dioxide
C-PACE – Commercial Property Assessed Clean Energy
CSE – Center for Sustainable Energy
CT – Connecticut
CVRP – California Clean Vehicle Rebate Project
DAS – Connecticut Department of Administrative Services
DCDE – Drive Change. Drive Electric.
DCFC – direct current fast charger/charging
DEEP – Connecticut Department of Energy and Environmental Protection
DER – distributed energy resource
DMV – Connecticut Department of Motor Vehicles
DOE – U.S. Department of Energy
DOT – Connecticut Department of Transportation
EDC – electric distribution company
EPA – U.S. Environmental Protection Agency
EV – electric vehicle
EVSE – electric vehicle supply equipment
FCEV – fuel cell electric vehicle
FHWA – Federal Highway Administration
FTA – Federal Transit Administration
GBTA – Greater Bridgeport Transit Authority
GC3 – Governor's Council on Climate Change
GHG – greenhouse gas
GIS – geographic information system
GMP – Green Mountain Power
GPS – global positioning system
GREET – Greenhouse gases, Regulation Emissions, and Energy use in Transportation
GWSA – Global Warming Solutions Act
HOV – high occupancy vehicle
ICC – International Code Council
ICE – internal combustion engine
IECC – International Energy Conservation Code
kWh – kilowatt hour
LED – light-emitting diode
LMI – low- and moderate-income
Low-No – Low- or No-Emission Grant program
MOR-EV – Massachusetts Offers Rebates for EVs
MSRP – manufacturer suggested retail price
MUD – multi-unit dwelling
MY – model year
NAAQS – National Ambient Air Quality Standards
NDEW – National Drive Electric Week
NESCAUM – Northeast States for Coordinated Air Use Management
NHEC – New Hampshire Electric Co-op
NHTSA – National Highway Traffic Safety Administration
NOx – nitrogen oxides
NREL – National Renewable Energy Laboratory
NYSERDA – New York State Energy Research and Development Authority
O&M – operation and maintenance
OCPI – Open Charge Point Interface
OCPP – Open Charge Point Protocol
OEM – original equipment manufacturer
OpenADR – Open Automated Demand Response
OSCP – Open Smart Charge Protocol
PG&E – Pacific Gas and Electric Company
PHEV – plug-in hybrid electric vehicle
PM-2.5 – particulate matter 2.5
PUC – public utility commission
PURA – Public Utilities Regulatory Authority
RMI – Rocky Mountain Institute
SDG&E – San Diego Gas and Electric Company
SIR – Savings-to-investment ratio
SO_2 – sulfur dioxide
SUV – sport utility vehicle
TOD – transit-oriented development
TCI – Transportation and Climate Initiative
TOU – time-of-use
UC Davis – University of California Davis
V2B – vehicle-to-building
V2G – vehicle-to-grid
VIN – vehicle identification number
VOC – volatile organic compound
VMT – vehicle miles traveled
VW – Volkswagen
ZEV – zero emission vehicle
ZEV MOU – Zero-Emission Vehicle Memorandum of Understanding

Connecticut's Policy Framework for Accelerating Electric Vehicle Adoption

1 Roadmap Overview

Connecticut's transportation sector is the largest source of statewide greenhouse gas (GHG) emissions, responsible for 38 percent in 2017, the most recent year for which data is available.[3] 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).[4] Reducing GHG emissions from the transportation sector is required to achieve Connecticut's economy-wide targets of at least 45 percent below 2001 levels by 2030,[5] and 80 percent below 2001 levels by 2050, [6] 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 ozone.[7]

Reducing GHG emissions and other harmful pollutants from the transportation sector will require implementation of several complementary strategies, including reducing vehicle miles traveled (VMT) through increased use of public transit services and alternative modes of transportation (such as walking and biking); promoting telework as an alternative to commuting; advancing transit-oriented development (TOD) and sustainable land use policies; promoting the efficient movement of goods and services, also known as freight movement; and wide-scale adoption of electric vehicles (EVs). All of these strategies will be necessary to accelerate Connecticut's transition toward a modern, clean transportation system.

The *EV Roadmap* focuses specifically on the policy and investment strategies needed to replace LDVs (i.e., passenger cars and light-trucks) and medium- and heavy-duty vehicles, such as freight trucks and school buses that utilize internal combustion, with vehicles that are powered by electricity. These strategies complement investments in transit and transportation infrastructure, and will significantly reduce harmful pollution, including ground-level ozone and GHG emissions.

A broad shift to EVs will also reduce Connecticut's dependence on foreign fossil fuels and total energy consumption (for all fuels) from the transportation sector, due to the fact that EVs use energy more efficiently than ICE vehicles.[8] According to Bloomberg New Energy Finance's (BNEF) 2019 Electric Vehicle Outlook, by 2040,

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[3] 2017 Connecticut Greenhouse Gas Emissions Inventory. DEEP. Retrieved January 20, 2020 from https://www.ct.gov/deep/lib/deep/climatechange/publications/2017_ghg_inventory_date_edited.pdf.

[4] Air Pollutant Emissions Trends Data, Air Emissions Inventories. U.S. Environmental Protection Agency. Updated May 31, 2019. Retrieved December 31, 2019 from https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.

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

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

[7] 40 C.F.R. parts 50-52 and 58; *see also* 42 U.S.C. §§ 108-109.

[8] Saving on Fuel and Vehicle Costs. Office of Energy Efficiency & Renewable Energy, DOE, Retrieved September 5, 2019 from https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs.

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.[9]

Pursuant to the recommendations of the *2018 Comprehensive Energy Strategy*,[10] the Connecticut Department of Energy and Environmental Protection (DEEP) has developed this *Electric Vehicle Roadmap for Connecticut* (*EV Roadmap*). The purpose of the *EV Roadmap* is to evaluate the current state of EV deployment in Connecticut, ascertain 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.

The draft *EV Roadmap* was released on October 11, 2019, following a public outreach process which included a scoping meeting held on December 14, 2018, and two technical meetings held on February 8, and November 8, 2019. Written comments and oral comments received during these public meetings were incorporated into the draft document, while comments received after the draft *EV Roadmap* was released have been addressed within the revisions to this final document. A more in-depth explanation of the process to develop the *EV Roadmap* and a summary of comments received can be found in the Appendix.

This *EV Roadmap* begins with an overview of the Connecticut laws, regulations, and policy directives that drive vehicle electrification and an analysis of potential benefits, costs, and barriers to widespread adoption. Next, it evaluates EV charging infrastructure and electric utility rate design, identifying potential pilot programs, policies and regulatory tools. Lastly, the *EV Roadmap* discusses the role of marketing and outreach to improve customer awareness, and provides policy recommendations for strategic deployment of funds from the CHEAPR program and VW Mitigation Trust funds.

Underserved communities, communities disproportionately impacted by vehicle emissions, and residents with low incomes 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 recommendations and pathways to inclusive engagement are integrated throughout the *EV Roadmap* in order to signal the importance of integrated sustainable solutions versus stand-alone fixes.

Some of the issues discussed in this *EV Roadmap* are primarily relevant to electric utility regulatory frameworks over which the Public Utilities Regulatory Authority (PURA) has jurisdiction. At time of issuance of this *EV Roadmap*, PURA has reopened its grid modernization docket to focus specifically on EV deployment in Docket No. 17-12-03RE04, *PURA Investigation into Distribution System Planning of the Electric Distribution Companies—Zero Emission Vehicles* (ZEV Docket). DEEP will advance the relevant recommendations of the *EV Roadmap* through its participation in the ZEV Docket and other related PURA proceedings to support the adoption of a utility regulatory framework necessary for implementation. DEEP will also pursue opportunities to implement the

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

[10] 2018 Comprehensive Energy Strategy. DEEP. February 8, 2018. Retrieved August 28, 2019 from https://www.ct.gov/deep/lib/deep/energy/ces/2018_comprehensive_energy_strategy.pdf.

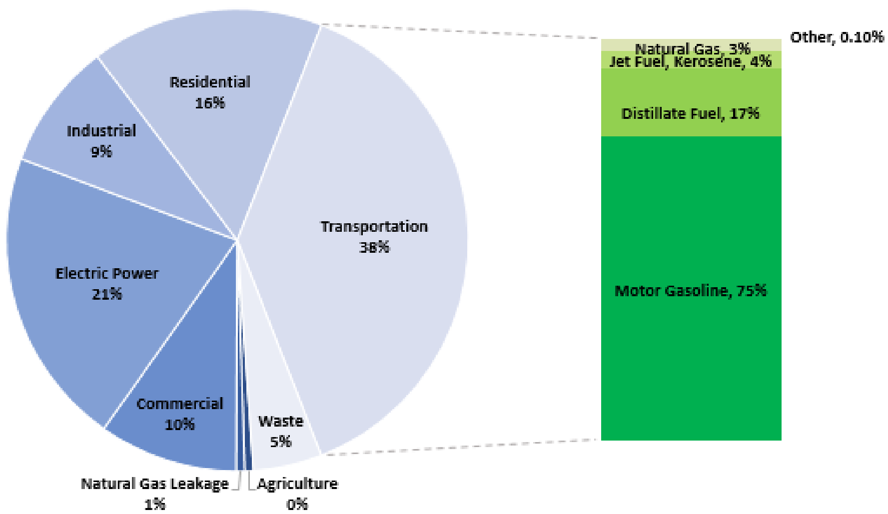
recommendations of this *EV Roadmap* through appropriate policies and programs under DEEP's jurisdiction, as well as through support for legislative action needed to unlock additional EV deployment potential in the state.[11]

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

Enacted in 2008, Connecticut's GWSA 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 amended by 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.[12]

At 38 percent, transportation sector emissions continue to be the largest source of GHG emissions, primarily from the combustion of motor gasoline in more than 2.4 million light-duty passenger-cars and light-duty trucks registered in Connecticut (Figure 1). As of January 1, 2020, 11,677 of these total registrations are EVs.[13] In 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,* the GC3 determined that Connecticut must reduce transportation sector emissions 29 percent below 2014 levels by 2030 in order to meet the GWSA's statutory 45 percent GHG emission reduction target.[14]

Figure 1: 2017 Connecticut GHG emissions by sector



Source: 2017 Connecticut Greenhouse Gas Emissions Inventory. DEEP. Released January 2, 2020. Retrieved January 17, 2020 from https://www.ct.gov/deep/lib/deep/climatechange/publications/2017_ghg_inventory_date_edited.pdf.

[11] Related programs under DEEP's jurisdiction include the CHEAPR rebate program, the VW grant program, the Conservation and Load Management (C&LM) program, see Conn. Gen. Stat. § 16-245m, as well as DEEP's authority, subject to review and approval by PURA, to advance grid modernization pilot programs pursuant to Section 103 of Public Act 15-5, see Conn. Gen. Stat. § 16-244w.

[12] *See* Conn. Gen. Stat. § 22a-200a.

[13] Number of Electric Vehicles Registered in Connecticut. Connecticut Department of Motor Vehicles. Retrieved January 21, 2020 from https://www.ct.gov/dmv/cwp/view.asp?a=807&q=600850.

[14] Building a Low Carbon Future for Connecticut, Achieving a 45% GHG Reduction by 2030. DEEP. 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.

The GC3 found that meeting the GWSA will require facilitating access to low- and zero-emitting LDVs, cleaner public transit options, alternative modes of travel, TOD, and the efficient movement of goods and services. With regard to LDVs, the GC3 analysis projected that a pathway for meeting the GWSA targets will depend on converting 20 percent of the statewide light-duty fleet, or 500,000 vehicles, to EVs by 2030.

In addition to achieving statutorily required 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.[15] Connecticut air quality monitors record some of the highest ozone levels in the eastern United States, especially along heavily-traveled 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 facing the state. 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.[16] Reduction of emissions from mobile sources—particularly LDVs and medium- and heavy-duty trucks—which account for approximately 66 percent of all ozone precursor emissions in the state—is necessary for Connecticut to attain the NAAQS for ground-level ozone.

To date, Connecticut has adopted several regulatory programs designed to reduce GHG emissions and harmful air pollutants from mobile sources. While federal law generally preempts states from establishing new motor vehicle tailpipe standards, the state of California has a special right to seek a preemption waiver under Section 209 of the CAA.[17] Section 177 of the CAA authorizes any state to adopt the state of California's new motor vehicle emissions standards in lieu of less stringent federal requirements.[18] Pursuant to Public Act 04-84, *An Act Concerning Clean Cars*, as amended, Connecticut has 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.[19]

The ZEV Program requires auto manufacturers to deliver ZEV credit-eligible vehicles to auto dealers for sale or lease in the state as a percentage of all vehicle deliveries in a given year. The delivery requirements establish a compliance obligation which must be met through credits generated from vehicle deliveries in a given year or credits banked from previous years' deliveries. 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). 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.

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[15] *See* 40 C.F.R. parts 50-52 and 58; *see also* 42 U.S.C. §§ 108-109.
[16] 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.
[17] *See* 42 U.S.C. § 7543.
[18] *See* 42 U.S.C. § 7507.
[19] *See* Conn. Agencies Regs. § 22a-174-36b and §22a-147-36c.

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%

Source: California Code of Regulations § 1962.2, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles. Retrieved October 11, 2019 from https://ww2.arb.ca.gov/sites/default/files/2019-07/cleancomplete%20lev-ghg%20regs%2010-19.pdf.

In October 2013, Connecticut and seven other states entered into the ZEV MOU.[20] Now endorsed by 10 states and under consideration by several more, the ZEV MOU 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 to 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 *Multi-State ZEV Action Plan 2018-2021* to propel rapid adoption of light-duty ZEVs over the next several years.[21]

The federal GHG emission and CAFE standards also are key drivers for reducing emissions from passenger vehicles and LDVs. In 2012, the U.S. Environmental Protection Agency (EPA), pursuant to its authority under the CAA, adopted GHG emission standards for MY 2017-2025 LDVs, and the National Highway Traffic and Safety Administration (NHTSA), pursuant to its authority under the Energy Policy and Conservation Act, adopted CAFE standards for MY 2017-2021 and augural standards for MY 2022-2025 LDVs.[22] EPA and NHTSA also committed to conduct a mid-term evaluation to determine if the GHG and CAFE standards for MY 2022-2025 were still appropriate.[23] In January 2017, after completing a technical assessment review, EPA issued a final determination concluding that the GHG standards remained appropriate.[24]

[20] State Zero-Emission Vehicle Programs—Memorandum of Understanding. NESCAUM. Signed October 24, 2013. Retrieved March 3, 2020 from https://www.nescaum.org/documents/zev-mou-10-governors-signed-20191120.pdf/.
[21] 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.
[22] 77 Fed. Reg. at 62,632.
[23] 77 Fed. Reg. at 62,784.
[24] EPA, *Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation* (Jan. 12, 2017), https://19january2017snapshot.epa.gov/sites/production/files/2017-01/documents/420r17001.pdf (accessed Apr. 17, 2020).

However, in April 2018, the Trump administration asserted that the GHG standards were "too stringent" and withdrew the 2017 final determination.[25] In August 2018, EPA and NHTSA issued a proposed rule, captioned The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for MYs 2021-2026 Passenger Cars and Light Trucks,[26] seeking to significantly weaken the GHG emission and CAFE standards and revoke the CAA waiver that permits California to set tailpipe emissions standards more stringent than the federal standards.[27] In opposition to the proposed rule, Connecticut joined 23 states and Puerto Rico in signing The Nation's Clean Car Promise.[28]'

In September 2019, EPA and NHTSA finalized part of the SAFE Vehicles Rule by issuing issued a final rule referred to as The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program, which purports to revoke California's GHG emission and ZEV standard preemption waiver.[29] In response, Connecticut, as part of a coalition of 26 jurisdictions, promptly filed a complaint in federal court challenging the rule.[30] This litigation is ongoing. The coalition states that have adopted California GHG and ZEV standards comprise more than 35 percent of the domestic LDV market in the United States.

On March 30, 2020, in the midst of the COVID-19 pandemic—a public health emergency caused by a highly transmissible respiratory disease—EPA and NHTSA finalized the remainder of the SAFE Vehicles Rule, which purports to establish GHG emission and CAFE standards significantly weaker than the existing standards.[31] The final SAFE Vehicles Rule requires an annual 1.5 percent increase in the stringency of GHG emission and CAFE standards for vehicles sold in MYs 2021-2026, a substantial loosening of the previous standards, which required a 5 percent annual increase over the same period.[32] The final SAFE Vehicles Rule is fundamentally flawed in numerous technical and legal respects and is unlikely to survive judicial scrutiny.

In light of the uncertainty created by the SAFE Vehicles Rule, five auto manufacturers, who support the GHG emission and ZEV standards established in 2013 by California under its CAA waiver, have agreed in principle to comply with voluntary GHG emission standards that extend California's MY 2025 standard until 2026 and adjust

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[25] EPA, *Notice; withdrawal. Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light Duty Vehicles. U.S. Environmental Protection Agency*, 83 Fed. Reg. 16077 (Apr. 13, 2018).

[26] EPA and NHTSA, Safer Affordable Fuel-Efficient Vehicles Rule for MYs 2021-2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42986 (Aug. 24, 2018).

[27] Section 209 of the CAA permits California to seek a waiver of the preemptive effect of the CAA, which otherwise prohibits states from enacting emission standards for new motor vehicles stricter than federal standards. Under the CAA, California may request a waiver to set emissions standards more stringent than the federal government. If approved, other states may then adopt California's standards.

[28] The Nation's Clean Car Promise. United States Climate Alliance. July 9, 2019. Retrieved December 17, 2019 from https://static1.squarespace.com/static/5a4cfbfe18b27d4da21c9361/t/5d24ad4393429e0001badc20/1562684740094/Nations+Clean+Car+Promise+Statement.pdf.

[29] EPA and NHTSA, *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program*, 84 Fed. Reg. 51310 (Sept. 27, 2019); EPA, Press Release, *Trump Administration Announces One National Program Rule on Federal Preemption of State Fuel Economy Standards* (Sept. 19, 2019), https://www.epa.gov/newsreleases/trump-administration-announces-one-national-program-rule-federal-preemption-state-fuel.

[30] *California v. Chao*, No. 1:19-cv-02826 (D.D.C. filed Sept. 20, 2020). The coalition includes 23 states, the District of Columbia, and the cities of Los Angeles and New York.

[31] EPA and NHTSA, *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks* (Mar. 30, 2020) (pre-publication), https://www.epa.gov/sites/production/files/2020-03/documents/final-fr-safe-preamble-033020.pdf.

[32] *Id.*

requirements in interim years from 2022 through 2025.[33] These voluntary standards require reductions in GHG emissions 3.7 percent annually from 2022 to 2026.[34]

In addition to legislation requiring GHG reductions, the Connecticut General Assembly has passed specific statutes regarding EV 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*, 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 vehicles.[35] Under Section 5 of Public Act 16-135, *An Act Concerning Electric and Fuel Cell Electric Vehicles*, Eversource Energy (Eversource) and The United Illuminating Company (UI), the electric distribution companies (EDCs) in Connecticut, 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.[36] Furthermore, Public Act 16-135 requires DEEP, in its 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."[37] This *EV Roadmap* satisfies that obligation and will be incorporated into the upcoming Integrated Resources Plan.[38]

3 Equitable Access to Clean Transportation

A successful transition to a safer, cleaner, and more reliable transportation system will require equitably meeting the mobility needs of all Connecticut residents, and ensuring that LMI, rural, and underserved communities share in the benefits of a clean transportation system. LMI and underserved communities often abut major transportation corridors and centers such as highways and ports. As such, these communities have borne disproportionate public health impacts from transportation-related air pollution. In an effort to mitigate these impacts, DEEP has prioritized emissions reduction in environmental justice communities and distressed municipalities as a criterion for allocating funding under several grant programs directed at replacing older transit buses, school buses, and other heavy-duty vehicles used for a variety of purposes such as waste hauling and freight movement, with newer, cleaner alternatives. Long-term improvements to the state's transportation system must be varied, and include strategies for electrifying all modes of transportation that operate in LMI and underserved communities as technology allows.

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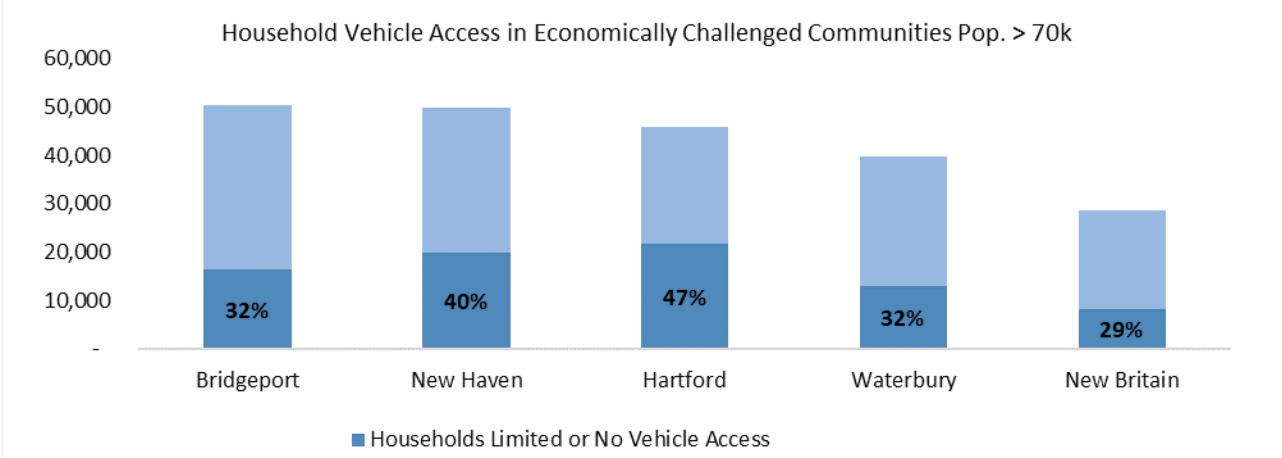
[33] California and major auto manufacturers reach groundbreaking framework agreement on clean emission standards. California Air Resources Board. July 25, 2019. Retrieved September 4, 2019 from https://ww2.arb.ca.gov/news/california-and-major-automakers-reach-groundbreaking-framework-agreement-clean-emission. The original four automakers were BMW, Ford, Honda, and VW. Volvo announced its intent to comply with the voluntary standards shortly after the SAFE Vehicles Rule was finalized. *Volvo Opts for California's Stricter Fuel Economy Rules*. Consumer Reports. Retrieved April 1, 2020 from https://www.consumerreports.org/volvo/volvo-opts-for-californias-stricter-fuel-economy-rules/.
[34] In September 2019, the U.S. Department of Justice (DOJ) launched an investigation into whether the agreement violated federal antitrust law. DOJ terminated the investigation in February 2020.
[35] Conn. Gen. Stat. § 4a-67d.
[36] Conn. Gen. Stat. § 16-19f(b).
[37] Conn. Gen. Stat. § 16a-3e.
[38] *See generally*, DEEP, Energy Filings, Section 16a-3a—Integrated Resources Plan, http://www.dpuc.state.ct.us/DEEPEnergy.nsf/$EnergyView?OpenForm&Start=1&Count=30&Expand=8&Seq=1.

Traditionally, LMI households spend a far greater share of income on transportation services than wealthier households, with some LMI households spending more than 15 percent of their total income on transportation.[39] For many such 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 financially accessible. Among Connecticut's 25 most economically challenged municipalities,[40] a significant share of households do not have access to personal vehicles and rely on public transit to meet their mobility needs.[41] Therefore, the state's approach to creating an equitable and inclusive clean transportation system should harmonize automobile ownership-based solutions with inclusive EV ridesharing, community bicycle access, and public transit initiatives that, when implemented together, offer LMI households a range of reliable options to get to destinations more efficiently and affordably, while helping to reduce GHG emissions and drive down air pollution.

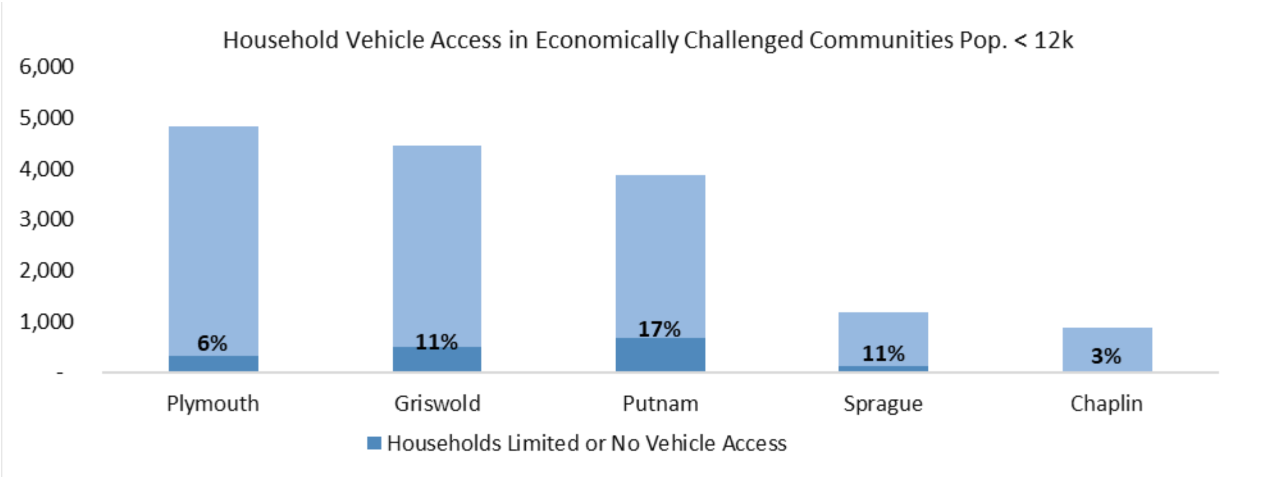
Figure 2: *Vehicle access in Connecticut's economically challenged communities*



[39] Household Expenditures and Income. The Pew Charitable Trusts. March 2016. Retrieved January 10, 2020 from https://www.pewtrusts.org/-/media/assets/2016/03/household_expenditures_and_income.pdf.

[40] 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.

[41] 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.

Throughout this *EV Roadmap*, DEEP makes recommendations for developing a more equitable, safe, clean, and affordable statewide transportation system that benefits LMI households and traditionally underserved communities. However, DEEP recognizes that it must engage directly with underserved and overburdened communities to develop approaches that are responsive to communities' needs. DEEP looks to leverage existing partnerships with other state agencies and local communities, including current efforts through the GC3 and DEEP's ongoing community engagement through its environmental justice program, to gather input on how best to meaningfully meet the mobility needs of LMI households and underserved communities through strategic electrification. Focused sessions could be hosted in coordination with other relevant state agencies, municipal transit districts, local community groups, non-profits, EDCs, financing organizations, and auto dealers, 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, electrifying mobility options from the first to the last mile, and opportunities for lowering costs to EV ownership through financial incentives. Local community input, when integrated with technical expertise from state agencies, will result in a more holistic and equitable approach to transportation planning.

4 EV Market Trends and Projected Deployment Needs

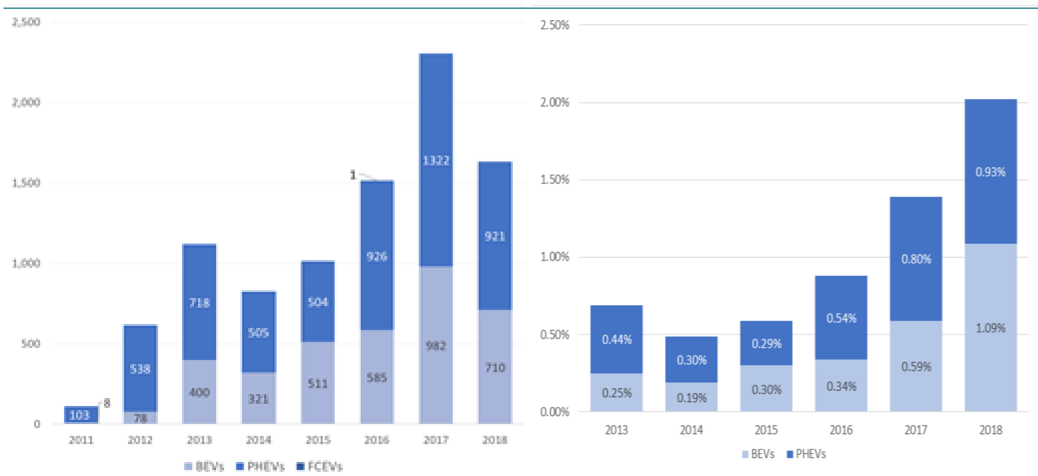
While the market share of light-duty EV sales has increased 45 percent from 2017 to 2018, EVs only accounted for two percent of all LDVs sold in-state in 2018 (see Figure 3).[42] In 2019, 4,120 EVs were registered in Connecticut for the first time and of these, 1,832 or 44.6 percent were Tesla models. One year earlier, 4,083 EVs were registered in-state for the first time and of these 1,514 or 37 percent were Tesla models. Comparing projections of the business as usual (BAU) market share of EV sales to the market share of EV sales needed to achieve key statutory and regulatory targets demonstrates that under forecast conditions (see Figure 4), EV sales will need to increase substantially to achieve sales volume needed to reach the ZEV MOU target of 125,000 to 150,000 vehicles in

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

2025.[43] Recent economic conditions surrounding the COVID-19 pandemic could make this target more challenging to reach. Targeted policy support will likely 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 (see Figure 4). Moreover, the ZEV regulatory program requirements will create competition among states for a limited number of available EVs due to the availability of credit pooling,[44] 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[45] are expected to influence the pace at which consumers purchase EVs over ICE vehicles. Battery prices continue to decline, reducing the overall cost of EVs while increasing vehicle range, and several auto manufacturers have announced their intent to produce a wider variety of models to address the needs and preferences of a broader range of customers. Connecticut ranks 19th nationwide in total advanced technology vehicle[46] sales as of December 2019.[47]

To achieve the rate of sales needed out to 2030, it is essential that Connecticut continue to implement policies and programs to support this rapidly evolving market. This includes, but is not limited to, continuing to provide targeted vehicle purchase rebates, increasing consumer education and outreach, designing electric rates that incent both EV adoption and off-peak charging, and building a robust public charging infrastructure network.

Figure 3: *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 March 12, 2019. Retrieved August 10, 2019 from https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

[43] 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 ZEV MOU.

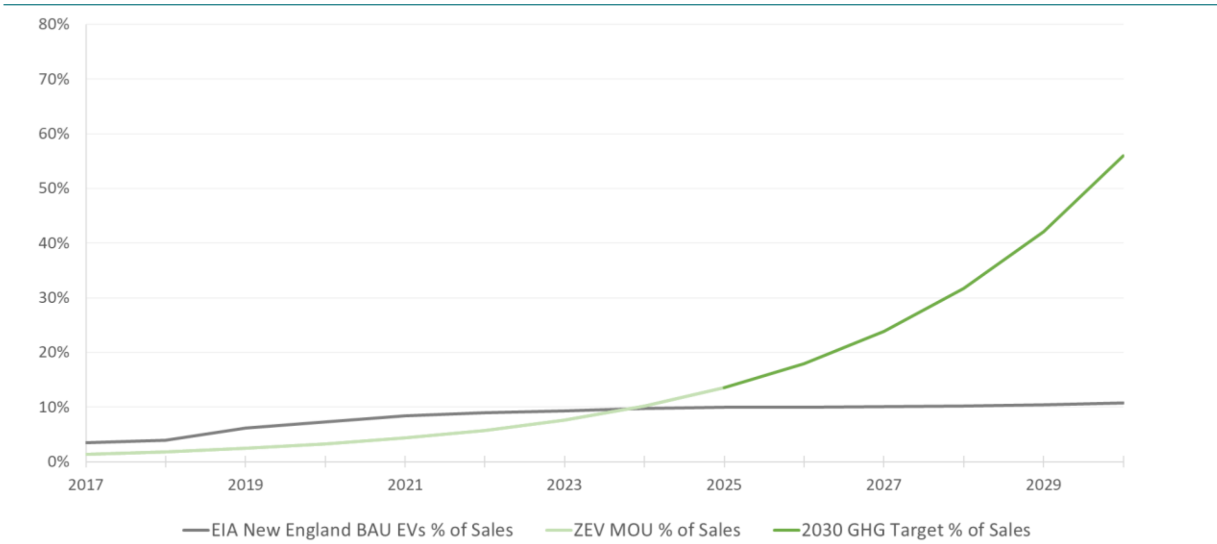
[44] Pursuant to section 1962.2 of the California Code of Regulations, auto manufacturers are allowed to meet the yearly credit obligation for one state by transferring excess credits earned from the delivery of vehicles in another state. The regulation creates two "pools" where this is possible, an 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.

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

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

[47] 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 August 20, 2019. Retrieved December 17, 2019 from https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

Figure 4: 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 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 to 150,000 ZEVs on the road by 2025 and (2) achieving EV deployment levels of 500,000 or 54 percent 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.[48] Highly visible, accessible, and reliable EV charging infrastructure is also a crucial component of demonstrating proof of concept and alleviating range anxiety. There are currently three forms of charging infrastructure, defined by voltage and power level: Level 1 chargers, Level 2 chargers, and Direct Current Fast Chargers (DCFC). Note that the installation costs for Level 2 chargers and DCFCs provided in the Table 2 below are highly variable depending upon the potential required electrical upgrades, hardware, and labor costs.

Table 2: EV charging technologies

Type of EV Charger	Level 1	Level 2	DCFC
Electrical Specifications	110 – 120 Volts AC 12 – 16 Amps	208/240 Volts AC 32 Amps	208 – 480 Volts DC 70 – 125 Amps
Rate of Charge	1 kW	3 kW – 19.2 kW	20 kW +
Mileage Range Per Hour of Charging	5	25	250
Estimated Charger Cost	–	$379 – $999	$25,000
Estimated Installation Costs	–	$1,200 – $2,000	$75,000 – $100,000

48 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.

Type of EV Charger	Level 1	Level 2	DCFC
Primary Locations	Residential homes (mostly single-unit dwellings)	Residential homes (single- and multi-unit dwellings), workplaces, public chargers, destination charging locations	Highways, interstate transit corridors, destination charging locations

Sources: 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; Level 2 Home Chargers. PlugStar. Retrieved August 14, 2019 from https://plugstar.com/chargers; 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; and 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.

While at-home Level 1 or Level 2 charging can meet the needs of most EV drivers, the presence of publicly-accessible DCFCs, in addition to publicly-accessible Level 2 chargers, contributes to decreasing range anxiety and augments regional connectivity along interstate travel corridors such as Interstate 95.[49] However, DCFC deployment is inhibited by high equipment costs and soft costs associated with installation. Soft costs include communications between EDCs and EV charging station developers, future-proofing, easement processes, complex building codes, and permitting restrictions, and vary by proposed site location, existing electric distribution system capacity at proposed sites, and labor costs.[50] Although DCFC equipment costs are anticipated to decline as the EV industry matures, installation costs will continue to vary depending on the complexities of each proposed DCFC location and relevant code and permitting processes. 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 order to sufficiently accelerate EV adoption to meet the trajectory shown in Figure 4, deployment of EV charging infrastructure, both public and private, will have to support and encourage this pace. Connecticut's EDCs have partnered with public agencies to build out regional EV charging infrastructure in addition to the efforts undertaken by Electrify America, which is discussed Section 15. DEEP, through the EVConnecticut program, partnered with Eversource 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 376 publicly accessible[51] EV charging stations with a total of 966 charging connectors in the state.[52] This number includes 50 DCFC locations with 212 charging connectors, some of which do not utilize a CHAdeMO connector, the standard connector for Japanese auto manufacturers.

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[49] 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.

[50] Nelder, Chris and Rogers, Emily. Reducing EV Charging Infrastructure Costs. Rocky Mountain Institute. December 2019. Retrieved January 9, 2020 from https://rmi.org/insight/reducing-ev-charging-infrastructure-costs/.

[51] The DOE, Alternative Fuels Data Center, includes Tesla charging stations in its publicly available charging station inventory despite these stations being exclusively accessible to Tesla vehicles, which use a proprietary charging connector. For consistency purposes, they were included here as well.

[52] Alternative Fueling Station Locator. Office of Energy Efficiency & Renewable Energy, DOE. Retrieved March 5, 2020 from https://afdc.energy.gov/stations/#/analyze?region=US-CT&country=US&fuel=ELEC&lpg_secondary=true&hy_nonretail=true&ev_levels=all.

The National Renewable Energy Lab's (NREL) Pro-Lite tool provides estimates for states or cities regarding the number of charging connectors needed to support a specific number of vehicles under a variety of scenarios. Assuming full support for PHEV drivers, i.e. drivers would not have to use gasoline in a typical day, the NREL Pro-Lite tool estimates that deployment of 5,858 workplace Level 2 charging connectors, 3,848 public Level 2 charging connectors, and 282 public DCFC connectors would be necessary to support the 125,000 EVs called for by 2025 under the ZEV MOU.[53] Assuming that only half of the support necessary for PHEVs is provided changes the numbers for workplace and Level 2 charging connectors to 3,103 and 2,034, respectively. While the number of chargers required to support the ZEV MOU depends on a variety of assumptions, it is clear that further investments in charging infrastructure will be critical to expanding public charging access in the state. However, publicly-funded charging infrastructure should be fully publicly-available. Tesla's privately-funded charging network provides Tesla drivers with exclusive access to its state- and nation-wide network of destination and DC fast charging stations. As of February 2020, Tesla's network in Connecticut includes 36 destination charging stations with 79 charging connectors and 20 DCFC stations with 160 charging connectors. Publicly-accessible, publicly-funded charging infrastructure must meet the charging demands of all EV drivers, regardless of make or model. Section 7 of the *EV Roadmap* includes, *inter alia*, recommendations for ensuring that public charging expansion meets the needs of all EV drivers.

4.1 Current and projected EV vehicle model availability

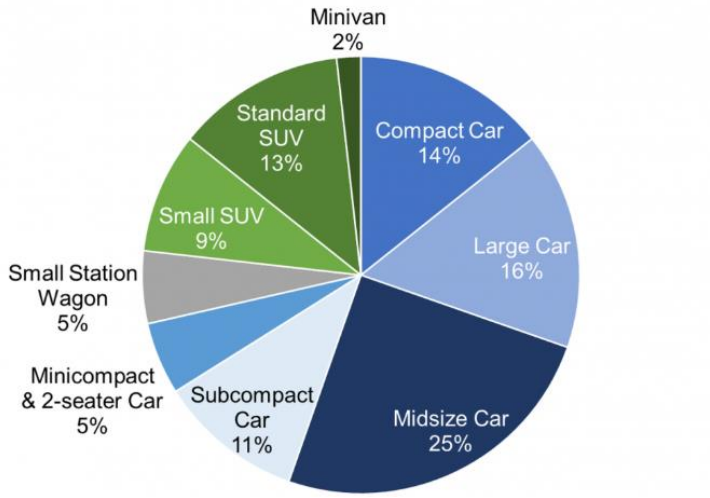
Greater availability of a variety of vehicle models and types will be essential to increase EV adoption rates. As of November 2019, there were 22 BEV models, 25 PHEV models, and 3 FCEV models available for purchase in the U.S.[54] However, not all models are currently available for purchase in Connecticut.[55] As noted above, actual deliveries of EV models in Connecticut will be influenced in part by auto manufacturers' strategies for meeting ZEV mandates in the participating states. Auto manufacturers are expected to deploy EV models to those states with the most robust rebates and other EV-friendly policies, anticipating quicker sales and faster ZEV compliance. These conditions place Connecticut in direct competition with surrounding states to provide attractive incentives and policies.

[53] 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 percent PHEVs—50 mile range, 12 percent EVs—100 mile range, and 41 percent EVs—250 mile range) and the Electric Vehicle Infrastructure Project Tool (EVI-Pro) Lite tool developed by NREL and the California Energy Commission. Increasing the ratio of BEVs to PHEVs increases the number of DCFC charging connectors required while decreasing the number of workplace chargers required. These assumptions assume that 100% of EV owners have access to home charging.

[54] EV Models Currently Available in the US. EVAdoption. Updated November 22, 2019. Retrieved December 17, 2019 from https://evadoption.com/ev-models/.

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

Figure 5: 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 EVs 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 3: Examples of vehicle types and available models

Vehicle Type	BEV Sample Models	PHEV Sample Models
Compact and subcompact cars	VW e-Golf *(MSRP: $31,895 - $38,895; Range 125 miles)* Fiat 500e *(MSRP: $33,320; Range 87 miles)*	Volvo S60 AWD PHEV *(MSRP: $55,400 - $64,800; Range 22 electric miles, 510 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: $30,315; Range 124 miles)* Chevrolet Bolt *(MSRP: $37,495; Range 259 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 250 miles)*	Toyota Prius Prime *(MSRP: $27,750 - $33,650; Range 26 electric miles, 640 total range)* Ford Fusion Energi Plug-in Hybrid *(MSRP: $35,000; Range 26 electric miles, 610 total range)* Honda Clarity *(MSRP: $33,400; Range 47 electric miles, 340 total range)* Hyundai Sonata *(MSRP: $31,400 - $37,000; Range 28 electric miles, 600 total range)*
SUVs and pickups	Hyundai Kona Electric BEV *(MSRP: $36,490; Range 258 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 *(MSRP: $74,800; Range 204 miles)* Jaguar i-Pace *(MSRP: $69,500; Range 234 miles)* Tesla Model X *(MSRP: $84,990; Range 328 miles)* Tesla Model Y AWD Long Range (*MSRP: $52,990; Range 316 miles)*	Volvo XC60 AWD *(MSRP: $54,595 - $69,500; Range 17 electric miles, 500 total range)* Mitsubishi Outlander *(MSRP: $36,295; Range 22 electric miles, 310 total range)*
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. Retrieved January 16, 2020 from 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 vehicle lineups over the next decade. VW, for example, has committed to a lineup of 70 all-electric vehicle models by 2028,[56] with other auto manufacturers announcing similar goals and timelines. While some production goals may be delayed as a result of supply chain issues related to the COVID-19 pandemic, the scale of these commitments, shown in Table 4 below, highlights the auto industry's sharp pivot toward an electrified future. By 2022, the number of EV models available in the U.S should increase to 81, including electrified SUVs, cross-overs, and pick-up trucks.[57] 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.

Moreover, 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

[56] VW 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#.
[57] Electric Vehicle Market Status. M.J. Bradley & Associates. May 2019. Retrieved August 5, 2019 from https://www.mjbradley.com/sites/default/files/ElectricVehicleMarketStatus05072019.pdf.

foreseeable growth in ICE part innovation, and faster than anticipated demand for EVs.[58] And in September 2019, German auto manufacturer Daimler announced that the company has no plans to develop a next-generation combustion engine and instead will focus on new electric powertrains.[59]

Table 4: Auto manufacturer commitments to expand EV offerings

Auto Manufacturer	Commitment
Ford	$11 billion in investments and 40 BEVs and PHEVs by 2022.[60]
General Motors	20 new all-electric models by 2023.[61]
Honda	Introduce a new dedicated EV platform by 2025 and electrify two thirds of its global vehicle lineup by 2030.[62]
Hyundai	Under *FCEV Vision 2030* – commit to producing 700,000 fuel cell systems/year by 2030, including 500,000 units for FCEVs.[63]
Nissan	12 new ZEVs by 2022.[64]
Toyota	6 new EVs between 2020 and 2025, and half of all global sales by 2025.[65]
VW	70 new EV models by 2028 and 22 million EVs produced over the next 10 years.[66]

In addition to commitments from traditional auto manufacturers, innovative all-electric vehicle manufacturers are following Tesla's pathway into the EV market. Tesla continues to expand its vehicle offerings from the Roadster, Model S, Model 3, and Model X to the Model Y and Cybertruck, slated for release in 2020-21 and 2022, respectively.[67] EV startup Rivian, which received $1.55 billion in investments from Amazon.com Inc., Cox Automotive, and Ford Motor Co. in 2019, intends to produce long-range, all-electric pick-up trucks and SUVs for sale in late 2020.[68] Other all-electric auto manufacturers looking to sell various types and models of EVs in the U.S.

[58] 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.
[59] Lambert, Fred. Daimler stops developing internal combustion engines to focus on electric cars. Electrek. September 19, 2019. Retrieved October 1, 2019 from https://electrek.co/2019/09/19/daimler-stops-developing-internal-combustion-engines-to-focus-on-electric-cars/.
[60] 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.
[61] '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.
[62] 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.
[63] 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/.
[64] 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/.
[65] 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/.
[66] VW 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#.
[67] Electric Cars, Solar Panels & Clean Energy Storage. Tesla. Retrieved January 17, 2020 from https://www.tesla.com/.
[68] Ohnsman, Alan. Electric Truck Unicorn Rivian, Backed by Amazon and Ford, Lands $350 Million Investment from Cox. Forbes. September 10, 2019. Retrieved January 17, 2020 from

in the near future include Byton, Lucid Motors, and Canoo, the latter of which is marketing as a subscription-only EV pod that includes the cost of auto insurance, operation, and maintenance in an affordable monthly price.[69]

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[70] to $156/kWh in 2019.[71] 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.[72] Experts predict that the battery share of total EV costs will further decline to 20 percent by 2025. The International Energy Administration predicts that battery prices will drop to between $80-$120/kWh by 2030,[73] while BNEF more optimistically forecasts battery prices to fall to $62/kWh by 2030.[74] These developments have led BNEF to predict that EVs could reach price parity with ICE vehicles in 2022, two years earlier than its previous forecast. Furthermore, the International Council on Clean Transportation predicts that 150-mile, 200-mile, and 250-mile range BEVs could reach cost parity with the average U.S. ICE vehicle by 2024, 2025, and 2027, respectively.[75]

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https://www.forbes.com/sites/alanohnsman/2019/09/10/electric-truck-unicorn-rivian-backed-by-amazon-and-ford-lands-350-million-investment-from-cox/#5f5b92485964.

[69] Tahaney, Ed. Meet the Canoo, a Subscription-Only EV Pod Coming in 2021. Automobile Magazine. September 25, 2019. Retrieved January 17, 2020 from https://www.automobilemag.com/news/2021-canoo-electric-vehicle-subscription-ev/.

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

[71] Battery Pack Prices Fall As Market Ramps Up With Market Average at $156/kWh in 2019. Bloomberg New Energy Finance. December 3, 2019. Retrieved December 17, 2019 from https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/.

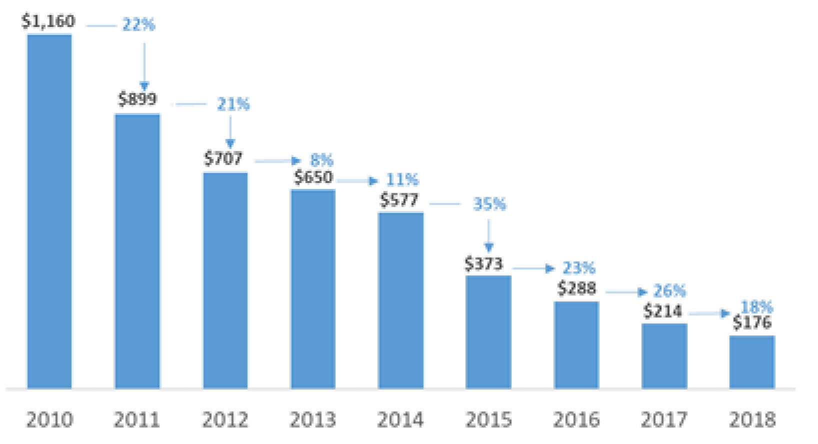
[72] Bullard, Nathaniel. Electric Car Price Tag Shrinks Along With Battery Cost. Bloomberg. April 12, 2019. Retrieved August 8, 2019 from https://www.bloomberg.com/opinion/articles/2019-04-12/electric-vehicle-battery-shrinks-and-so-does-the-total-cost.

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

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

[75] 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.

Figure 6: 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 secondary 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.[76] The development of a used vehicle market for EVs can meet this increasing demand. There are positive indicators to support the development of a robust secondary EV market underway in Connecticut. 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 EVs come off of their leases it is likely that they will be offered on the used vehicle market. Initial results from experts at the University of California Davis (UC Davis) undertaking a secondary EV market study revealed that, in California, most used EVs entered the secondary market after only two to three years of usage by the original driver, still under warranty, and with 23,400 miles logged on average.[77]

Generally, consumers can purchase three-year old used BEVs and PHEVs with advanced safety features for roughly one-third of the original manufacturer's suggested retail price (MSRP).[78] And because EVs have far fewer moving parts, consumers need to be less 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 used vehicle sales in the U.S.[79] 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

[76] 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.
[77] Plug-in Hybrid & Electric Vehicle Research Center, UC Davis. Retrieved September 4, 2019 from https://phev.ucdavis.edu/research/.
[78] 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/.
[79] 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.

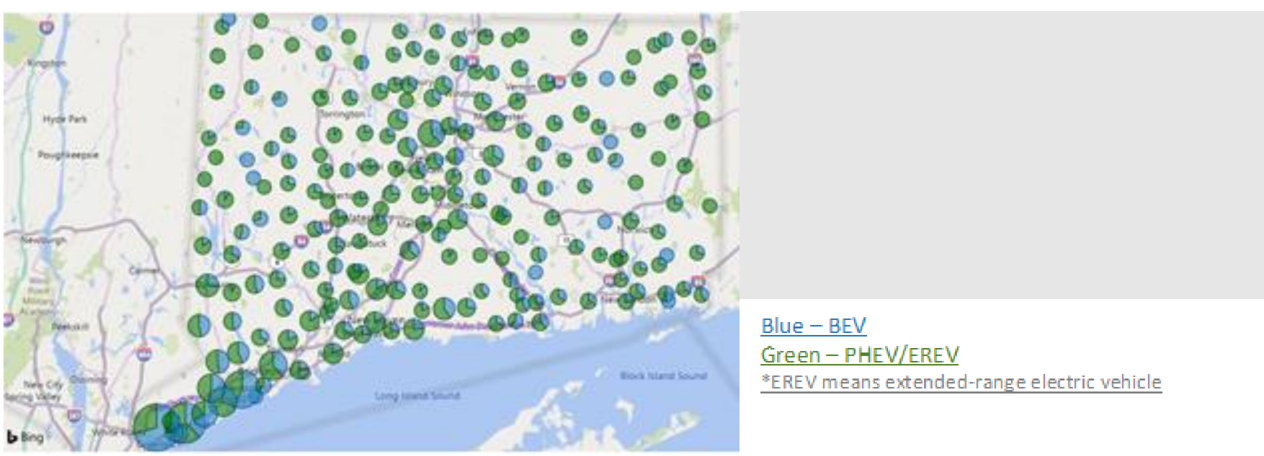
available EVs can already meet 87 percent of all commuter trips.[80] Moving forward, Connecticut must continue to consider strategies to develop the secondary EV market and retain off-lease EVs in the state in order to reach statutorily required GHG reduction targets and ZEV goals. The CHEAPR Board, created under Public Act 19-117, is currently developing parameters for providing CHEAPR rebates toward the purchase of used EVs.

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 7). While EVs are also registered in more rural parts of the state, adoption rates tend to be 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.[81] Some of the barriers for rural drivers include range anxiety, inadequate charging infrastructure, and availability of EV models to meet their performance needs, such as driving in snow or on unpaved roads.

On a daily basis, rural drivers drive further distances to work, to stores, and for other daily activities, so a larger portion of their monthly income is spent on transport fuels, more frequent vehicle repairs, and increased emissions. The potential savings and benefits for rural residents who 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."[82] Programs and policies that target drivers in rural areas will be necessary to maximize these benefits and reach the state's emissions reduction goals.

Figure 7: *EVs registered in Connecticut by location*



Source: EvaluateCT Data Dashboard. CT Transportation Electrification Toolkit, Atlas Public Policy. Retrieved October 11, 2019 from https://atlaspolicy.com/rand/transportation-electrification-toolkit-for-connecticut/.

[80] 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/.
[81] 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/.
[82] *Id.*

5 Public and Private Light-Duty Vehicle 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.[83] 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 provides direct ride-and-drive opportunities that increase employee exposure and may lead to 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.[84] The Clean and Efficient Transportation Impact Team created by Executive Order No. 1 has helped inform the recommendations regarding Connecticut's state fleet as set forth in this section.

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.[85] Many of these fleet vehicles depart from and return to the same location every day, and their recorded trips totaling 50 miles per day on average 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, places Connecticut in a strong 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.[86] To put Connecticut on a pathway to achieve this goal, the state should establish a detailed fleet transition plan outlining annual vehicle procurement targets, beginning with a recommended 5 percent of procured vehicles in 2020. The fleet transition plan should

[83] 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.
[84] 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.
[85] 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.
[86] Conn. Gen. Stat. § 4a-67d.

include a target date after which the state would only procure EVs, with very limited exceptions. For procurements, DAS and Connecticut state agencies should consider BEVs first, PHEVs second, and hybrid vehicles third. For use cases in which BEVs are unavailable for purchase or would compromise public health and safety, DAS should allow exceptions to procure ICE vehicles. Converting the state fleet from ICE vehicles to EVs will require significant investments in charging infrastructure as well as a commitment to invest in education to achieve buy-in from state agencies necessary to produce optimal results.

To optimize the achievement of an annual procurement target, the state is piloting the deployment of 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 (global positioning system) 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. Public and private fleet managers are likely to require, or at minimum prefer, day-to-day benchmarking data pertaining to the operational costs and vehicle performance of existing fleet vehicles and EVs prior to investing in a new vehicle technology. In particular, useful benchmarking data include but is 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 account for Connecticut-specific variables such as weather and traffic patterns, driving habits, and fueling practices will help fleet managers identify, by ranking and with confidence, what fleet vehicles are most suitable for electrification.

The use of telematics is also practical for electric vehicle supply equipment (EVSE) infrastructure planning and optimizing infrastructure deployment to fleet 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 EV, fleet managers should utilize a total cost of ownership approach when procuring new vehicles, instead of focusing on upfront costs. While EVs typically have higher 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 light-duty 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 cost 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-powered vehicles, hybrid vehicles, and PHEVs. The results demonstrate that over a nine-year period, including EVSE costs, the Nissan Leaf could realize $8,748 (21 percent) in savings compared to the gas-powered Ford Fusion, the traditional option for NYCDCAS' passenger car fleet. DEEP recognizes that any cost savings associated with converting ICE vehicles to EVs in the state fleet will vary by vehicle usage, fuel prices, and deployment scenarios.

To maximize the benefits of any telematics systems and EV fleet 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 *Smart Columbus 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.[87] In addition to the DAS fleet 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,[88] and the AFLEET tool is designed to help fleet managers forecast petroleum consumption, GHG and air pollutant emissions, and vehicle cost of ownership.[89]

Fleet electrification, which contributes to Connecticut's overall efforts to meet GHG reduction targets, requires organizations to allocate time and resources to fuel switching.[90] 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.[91] 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 Connecticut fleet recognition program could 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. DAS should develop a detailed light-duty fleet transition plan that outlines annual EV procurement targets for the state fleet, beginning with a 5 percent target of eligible state vehicles in 2020, in order to meet ZEV procurement requirements in accordance with Public Act 19-117.
2. Public and private fleet managers should utilize vehicle telematics systems, as DAS is currently piloting, 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. Public and private 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 look to partner with other interested state agencies to create a web-based resource center dedicated to fleet electrification with helpful resources for public and private fleet managers, including case studies, best practices, and vehicle benchmarking tools.

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[87] Playbook, Smart Columbus. Retrieved August 9, 2019 from https://smart.columbus.gov/playbook.
[88] Energy Systems, GREET Model. Argonne National Laboratory. https://greet.es.anl.gov/.
[89] AFLEET Tool. Argonne National Laboratory. https://afleet-web.es.anl.gov/home/.
[90] 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.
[91] The Green Fleet Awards. 100 Best Fleets. Retrieved August 9, 2019 from http://www.the100bestfleets.com/gf_about.htm.

5. An awards program should be established to recognize Connecticut municipalities and commercial organizations leading in fleet electrification.

6 Medium- and Heavy-duty Vehicle Electrification

Medium- and heavy-duty vehicles, including but not limited to school and transit buses, freight and refuse trucks, and delivery vans, are significant contributors to CO_2, NOx, volatile organic compounds (VOCs), sulfur dioxide (SO_2), fine particulate matter ($PM_{2.5}$), ground-level ozone, and black carbon in Connecticut.[92] It is anticipated that by 2035, heavy-duty vehicles will contribute 61 percent of all on-road NOx emissions due to decreasing light-duty vehicle emissions as a result of more stringent new LDV emission standards and greater penetration of EVs (see Figure 8). Given that many medium- and heavy-duty vehicles travel at slow speeds and make frequent stops, especially those primarily operating in densely populated urban areas that abut heavily traveled interstate corridors and where freight distribution routes generally end, electrification in this market segment could yield significant air quality benefits in communities most impacted by criteria pollutants and demonstrate greater operational cost savings for municipal and business fleets.

Aside from battery electric transit buses, vehicle electrification has mostly occurred in the LDV market segment. Over 70 models of zero-emission vans, trucks, and buses are commercially available from a variety of auto manufacturers. However, many applications in the medium- and heavy-duty market segment lack affordable and viable electrified substitutes.[93] In addition, the available electrified substitutes have higher upfront costs than their ICE counterparts and may require significant electrical infrastructure investment to support their large charging loads. As battery prices drop and technology continues to improve, the total cost of ownership for electrified medium- and heavy-duty vehicle fleets will also decline, bolstering the economic case for fuel switching.

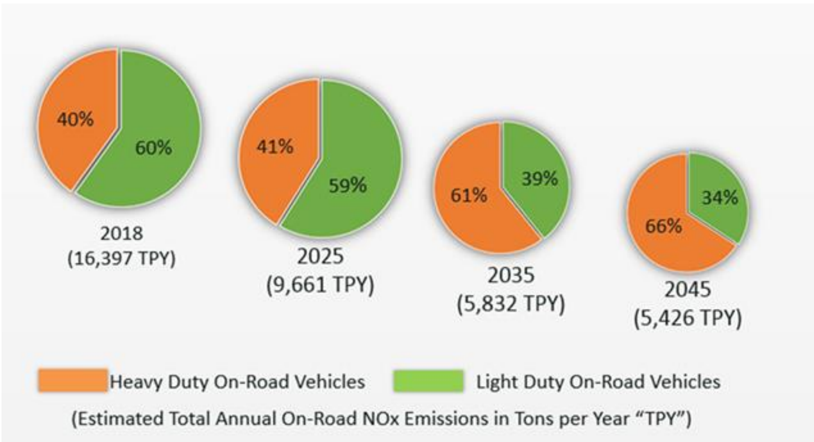
DEEP has made efforts to incent early adoption of cleaner heavy-duty diesel and electric vehicles. Existing incentive program mechanisms have been driven by the EPA's Diesel Emission Reduction Act (DERA) funding program, which is designed to provide grants through the states to replace older diesel vehicles with cleaner ICE vehicles or electric vehicles.[94] Additionally, DEEP has provided funding for similar heavy-duty vehicle replacements through two cycles of the VW Mitigation Trust Fund Grant (VW Grant), which is discussed at length in Section 15.2.

Continued movement by regulators and industry toward medium- and heavy-duty fleet electrification will be driven by California's Advanced Clean Truck (ACT) regulations, which were proposed October 25, 2019.[95] The proposed regulations would require Class 2B to Class 8 medium- and heavy-duty vehicle manufacturers to sell zero-emission trucks as an increasing percentage of their annual sales for 2024 through 2030 model years. The regulations also would establish requirements for large employers including retailer, manufacturers, brokers, and

[92] Mobile Sources. DEEP. Last updated September 10, 2018. Retrieved December 17, 2019 from https://www.ct.gov/deep/cwp/view.asp?a=2684&Q=322142&deepNav_GID=1619.
[93] Advanced Clean Trucks (ACT) Fact Sheet. California Air Resources Board. July 2, 2019. Retrieved December 12, 2019 from https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-act-fact-sheet.
[94] Diesel Emissions Reduction Act (DERA) Funding. EPA. Updated March 18, 2020. Retrieved April 20, 2020 from https://www.epa.gov/dera.
[95] Proposed Advanced Clean Trucks Regulation. California Air Resources Board. Retrieved December 12, 2019 from https://ww2.arb.ca.gov/rulemaking/2019/advancedcleantrucks.

others to report on their existing fleet operations. These reporting requirements are intended to help identify future strategies to ensure that fleets purchase available zero-emission trucks and place them in service in applications to which they are suited.[96]

Figure 8: NOx contribution by vehicle sector based on MOVES2014 data



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.

DEEP intends to assess the energy and environmental costs and benefits associated with electrification of significant numbers of medium- and heavy-duty vehicles, and evaluate the potential benefits of promulgating regulations to adopt California's ACT regulations as authorized by Section 177 of the federal CAA. On December 12, 2019, seven states, including Connecticut, and the District of Columbia signed a Statement of Intent committing the signed jurisdictions to the development of a multi-state MOU to support and accelerate the deployment of medium- and heavy-duty ZEVs through a collaborative process facilitated by Northeast States for Coordinated Air Use Management (NESCAUM).[97]

Further electrification of freight trucks will come through the development of EV applications for freight hauling semi-trucks. The electrification of freight 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. Approximately 80 percent of freight trips in the U.S. travel distances less than 250 miles, highlighting potential opportunities to electrify freight trucks.[98] According to the U.S. Department of Energy's (DOE) Alternative Fuels Data Center, there are a combined 14 electric, plug-in hybrid electric, and hydrogen fuel cell vehicles currently available for purchase within the vocational/cab chassis and tractor classes.[99]

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[96] Advanced Clean Trucks (ACT) Fact Sheet. California Air Resources Board. July 2, 2019. Retrieved December 12, 2019 from https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-act-fact-sheet.

[97] Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Initiative—Statement of Intent. NESCAUM. Signed December 12, 2019. Retrieved March 3, 2020 from https://www.nescaum.org/documents/nescaum-press-release_12-12-19.pdf/.

[98] Freight Facts and Figures, 2017. Bureau of Transportation Statistics, U.S. Department of Transportation. Retrieved February 28, 2020 from https://www.bts.dot.gov/sites/bts.dot.gov/files/docs/FFF_2017.pdf.

[99] Alternative Fuel and Advanced Vehicle Search. Alternative Fuels Data Center, DOE. Retrieved March 3, 2020 from https://afdc.energy.gov/vehicles/search/results/?view_mode=grid&search_field=vehicle&search_dir=desc&per_page=8&current=true&display_length=25&fuel_id=9,41,57,-1&category_id=17,13,-

These truck manufacturers include new startups as well as traditional freight truck manufacturers. To help close the high upfront cost gap between electric- and conventional-freight trucks and lower the total cost of ownership, California[100] and New York[101] have implemented voucher incentive programs to accelerate the electrification of freight truck fleets. Data for New York's truck voucher program is not yet publicly available, but California's voucher program, which also incents transit and school buses, refuse trucks, and delivery vehicles, has helped fund the deployment of more than 4,000 vehicles and low NOx-emitting engines in California since 2009.[102] And of these vehicles, 57 percent have been deployed and operate primarily in disadvantaged communities.[103] Scarce funding resources limit the potential development of an in-state truck voucher program. However, DEEP will continue to monitor the success of these programs in incentivizing the adoption of electric freight trucks.

To date, electrification in the medium- and heavy-duty vehicle market segments has been focused on transit buses. Transit bus electrification, when carefully and properly planned, can result in increased ridership, operational savings, and reduced GHG emissions and criteria pollutants, while creating a disincentive to the use of single-occupancy vehicles, which can lead to less traffic congestion.[104] As of August 2019, 46 states, including Connecticut, have received a total of $450 million in funding for electric buses and related charging infrastructure through the Federal Transit Administration (FTA) Low- or No-Emission (Low-No) Grant program.[105] In addition, some states, like California,[106] and cities, like Seattle[107] and New York City,[108] have thrown their full support behind transit bus electrification by enacting policies that set deadlines for 100 percent fleet electrification.

DOT oversees a statewide fleet of 600 diesel transit buses that serves large numbers of transit-dependent Connecticut residents (36 percent and 38 percent of ridership are people of color and people with low incomes, respectively).[109] DOT replaces on average 50 buses per year at the conclusion of their 12-year useful life cycle, or

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1&manufacturer_id=365,377,211,235,410,215,223,225,379,219,213,209,351,385,275,424,361,387,243,227,239,425,263,217,391,349,381,383,237,221,347,395,67,117,394,139,0,426,415,201,113,205,71,5,408,9,13,11,458,81,435,57,195,416,141,197,417,121,53,397,418,85,414,17,21,143,23,398,27,399,31,207,396,107,193,460,125,35,419,37,147,405,199,-1.

[100] California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project. Retrieved March 3, 2020 from https://www.californiahvip.org/.

[101] NY Truck Voucher Incentive Program. New York State Energy Research and Development Authority. Retrieved March 3, 2020 from https://www.nyserda.ny.gov/All-Programs/Programs/Truck-Voucher-Program.

[102] Program Numbers. California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP). Retrieved March 3, 2020 from https://www.californiahvip.org/.

[103] *Id.*

[104] Toolkit for Advanced Transportation Policies. M.J. Bradley & Associates. October 2018. Retrieved December 27, 2019 from https://www.mjbradley.com/sites/default/files/mjba_transportation_toolkit.pdf.

[105] Smith, Conner. 46 States Have Received Funding for Electric Transit Buses. EV Hub Weekly Digest, Atlas Public Policy. August 5, 2019. Retrieved December 27, 2019 from https://www.atlasevhub.com/weekly_digest/46-states-have-received-funding-for-electric-transit-buses/.

[106] California transitioning to all-electric public bus fleet by 2040. California Air Resources Board. December 14, 2018. Retrieved December 27, 2019 from https://ww2.arb.ca.gov/news/california-transitioning-all-electric-public-bus-fleet-2040.

[107] Transitioning to a zero-emissions bus fleet. King County Metro. Retrieved December 27, 2019 from https://kingcounty.gov/depts/transportation/metro/programs-projects/innovation-technology/zero-emission-fleet.aspx.

[108] MTA Deploys First All-Electric Articulated Bus Fleet to 14th Street Busway. Metropolitan Transportation Authority. December 15, 2019. Retrieved December 27, 2019 from http://www.mta.info/press-release/nyc-transit/mta-deploys-first-all-electric-articulated-bus-fleet-14th-street-busway.

[109] Docket 17-12-03RE04 Correspondence, PURA_CTDOT_ZEV Final_20191118.pptx. DOT. Filed November 19, 2019. Retrieved December 27, 2019 from http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/09e20ef847d7b119852584b7006e8cb8?OpenDocument.

roughly 8.33 percent of its total fleet. Pursuant to Section 93 of Public Act 19-117, "on and after January 1, 2030, at least thirty per cent of all buses purchased by the state shall be zero-emission buses."[110] In addition to this legislative mandate, DOT has committed to 100 percent electrification for its transit bus fleet.[111]

To jumpstart its electrification efforts, DOT launched electric transit bus pilots for the fleets operating in Bridgeport and Hamden. In 2018, DOT, in partnership with the Greater Bridgeport Transit Authority (GBTA), applied for and received an FTA Low-No grant to partially fund the purchase of five all-electric transit buses to be operated by GBTA. And in 2019, DOT applied for and received approximately $4.9 million under Cycle 1 of Connecticut's VW Grant to partially offset the cost of deploying 12 fully-electric transit buses.[112] Ten of these buses will be deployed in Hamden (Hamden Bus Pilot) and two more will be deployed in Stamford. The remaining funds for this $15 million project will come from FTA funding for bus replacements and capital facility improvement projects along with DOT Bureau of Public Transportation capital funds. In February 2020, DOT released a request for proposals (RFP) to procure 35-foot and 40-foot low floor, heavy-duty battery electric powered transit buses. Alongside these 10 electric transit buses in Hamden, DOT plans to deploy 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. In the early planning stages of the Hamden Bus Pilot, DOT opened communication channels with UI, the EDC serving the bus depot. UI is assisting DOT in evaluating strategies for implementing managed charging solutions and minimizing electrical distribution system upgrades at the site. Fleet managers considering the electrification of medium- and heavy-duty fleets would be best served to engage their EDC as early as possible in the planning process. Moreover, the EDCs should coordinate with DOT and other fleet managers to incorporate the increased loads caused by medium- and heavy-duty fleet charging into their distribution planning, and target underutilized circuits for such charging in order to reduce the need for distribution system upgrades to accommodate increased load. Further discussion of the issues surrounding fleet charging can be found in Sections 5, 7.5, and 9.3.

School buses represent another class of heavy-duty vehicles well-suited for electrification. Existing diesel-powered school buses emit harmful criteria pollutants, such as NOx and $PM_{2.5}$, which cause and exacerbate asthma and respiratory illness among populations of vulnerable school children. The environmental and public health impacts resulting from exposure have been documented in several studies,[113] including studies specifically examining the health impacts to children from exposure to diesel exhaust emitted from school buses.[114] Electric school buses

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110 Public Act 19-117, *An Act Concerning the State Budget for the Biennium Ending June 30, 2021, and Making Appropriations*, sec. 93, https://www.cga.ct.gov/2019/act/Pa/pdf/2019PA-00117-R00HB-07424-PA.PDF, codified at Conn. Gen. Stat. § 4a-67d.

111 Docket 17-12-03RE04 Correspondence, PURA_CTDOT_ZEV Final_20191118.pptx. DOT. Filed November 19, 2019. Retrieved December 27, 2019 from http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/09e20ef847d7b119852584b7006e8cb8?OpenDocument.

112 VW Award Letter—DOT. DEEP. November 13, 2018. Retrieved December 27, 2019 from https://www.ct.gov/deep/lib/deep/air/mobile/vw/VW_Award_Letter_-_CT_DOT_201809805.pdf.

113 The Harmful Effects of Vehicle Exhaust. Environment & Human Health, Inc. 2006. Retrieved March 4, 2020 from https://www.ehhi.org/exhaust06.pdf.

114 Children's Exposure to Diesel Exhaust on School Buses. Environment & Human Health, Inc. 2002. Retrieved March 4, 2020 from http://www.ehhi.org/reports/diesel/diesel.pdf.

produce zero-tailpipe emissions and reduce children's exposure to harmful air pollutants.[115] Electric school buses, which cost between $120,000[116] and $250,000[117] more than diesel school buses, are eligible for funding of up to $20,000 per bus under EPA's DERA School Bus Rebate Program.[118] On a per-vehicle basis, electric school buses will realize approximately $170,000 in lifetime O&M savings compared to their diesel counterparts.[119] In addition, school buses' long daily and summer dwell times make them attractive candidates for providing vehicle-to-grid (V2G) or vehicle-to-building (V2B) services, which may generate additional revenue or offset higher upfront costs. V2G and V2B services enable the electric school buses' batteries to store large quantities of energy and discharge it back to the electric grid or a building during peak demand periods or demand response events. V2G services provided through electric school bus fleets is currently being piloted in California, New York, and Virginia, and is discussed in greater detail in Section 12.2.

Electric school bus deployment is starting to gain momentum in Connecticut. In November 2019, DEEP awarded DATTCO, Inc. $122,689 toward the cost of deploying an electric school bus in Middletown under Cycle 2 of the VW Grant.[120] And Fairfield's Sustainable Fairfield Task Force recently issued an RFP for a contractor to provide two electric school buses for student transportation.[121] DEEP will continue to engage in outreach with Connecticut municipalities regarding electric school bus deployment opportunities available through the VW Grant.

Electrified models are also being piloted around the country for refuse collection, airport ground support equipment, and other applications. In early 2020, the Los Angeles Bureau of Sanitation (LASAN) committed to fully electrifying its fleet of refuse trucks by 2035, and the LASAN expects refuse truck procurements to be fully electric within two years.[122] The stop-and-go nature of refuse collection enables the trucks' regenerative braking system to recharge the vehicles' batteries. And in Seattle, the Seattle-Tacoma International Airport received federal and

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[115] Casale, Matt. With Electric School Buses, Kids Can Breathe a Little Easier. U.S. Public Interest Research Group. September 16, 2019. Retrieved December 27, 2019 from https://uspirg.org/blogs/blog/usp/electric-school-buses-kids-can-breathe-little-easier.

[116] 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.

[117] 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/.

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

[119] 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.

[120] Governor Lamont Announces Release of $6 Million in Volkswagen Settlement Funds to Support Clean Air Projects in Connecticut. The Office of Governor Ned Lamont. November 25, 2019. Retrieved December 27, 2019 from https://portal.ct.gov/Office-of-the-Governor/News/Press-Releases/2019/11-2019/Governor-Lamont-Announces-Release-of-6-Million-in-Volkswagen-Settlement-Funds.

[121] Some Other "Green Wheels" On the Near Horizon: Town Will Examine Potential of Electric School Buses. Sustainable Fairfield Task Force, Town of Fairfield. October 16, 2019. Retrieved December 27, 2019 from https://www.fairfieldct.org/sftfnews/?FeedID=3106.

[122] Crunden, E. A. Los Angeles commits to 100% electric sanitation fleet by 2035. Other cities aren't ready to follow. Utility Dive. January 29, 2020. Retrieved February 14, 2020 from https://www.utilitydive.com/news/los-angeles-sanitation-truck-fleet-100-percent-electric/571338/.

state grant funding[123] to electrify its entire petroleum-powered ground support equipment (baggage tugs, belt loaders, and pushback tractors) and install over 300 charging stations at the airport to support the electrified equipment.[124] Conversion of this airport's ground support equipment will amount to the avoided combustion of one million gallons of gasoline annually.

Fleet managers and operators considering the conversion of medium- and heavy-duty vehicles to electric or other advanced technology models can take advantage of the NREL Fleet DNA tool. This tool provides users with data summaries and visualizations that resemble real world operating conditions for medium- and heavy-duty vehicles.[125] This information can be useful for fleet operators to gain a better understanding of the operational range of vehicles based on use profile and weight class.

In advance of DEEP's third round of VW Grant solicitations, with an intended focus on the electrification of medium and heavy-duty vehicles, the agency has begun engaging with municipalities and fleet operators. This outreach process is aimed at providing education and resources that will assist municipalities with identifying and overcoming barriers to heavy-duty fleet electrification. On March 5, 2020, DEEP hosted the Municipal Collaborative on Fleet Electrification. The event brought together municipalities, fleet managers, state officials, and industry experts to share experience, information, and to address concerns regarding vehicle electrification. DEEP intends to continue the engagement process as it prepares to issue the next round of VW Grant funding.

Policy Recommendations: Medium- and heavy-duty vehicle electrification

1. DEEP will continue to evaluate the benefits of adopting California's ACT regulations. A CARB staff report summarizing the initial statement of reasons for adopting the rule was proposed in October 2019.
2. DEEP will continue to monitor the effectiveness of freight truck voucher incentive programs in accelerating the adoption of freight trucks.
3. DEEP will continue to engage in outreach with Connecticut municipalities through the Municipal Collaborative on Fleet Electrification regarding electric school bus and other medium and heavy duty fleet deployment opportunities available through the VW Grant.

7 Expanding EV Charging Infrastructure

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.[126] In order to support the levels of EV adoption required to meet Connecticut's 2025 ZEV MOU and 2030 GHG emission reduction targets, EV charging

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[123] Sea-Tac and Alaska Air Group Achieve Sky-High Results with Electric Ground Support Equipment. Alternative Fuels Data Center, DOE. January 26, 2016. Retrieved December 30, 2019 from https://afdc.energy.gov/case/2329.

[124] Ryan, John. Sea-Tac wants to curb carbon without limiting your travel. That's a steep climb. KUOW Puget Sound Public Radio. January 25, 2018. Retrieved December 30, 2019 from https://kuow.org/stories/sea-tac-wants-curb-carbon-without-limiting-your-travel-thats-steep-climb/.

[125] Fleet DNA: Commercial Fleet Vehicle Operating Data. National Renewable Energy Laboratory. Retrieved February 14, 2020 from https://www.nrel.gov/transportation/fleettest-fleet-dna.html.

[126] 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.

infrastructure must be scaled across the state in all settings, including residential, workplace, and public charging settings. The challenges and recommendations for expanding EV charging infrastructure accessibility, which vary by location and setting, is discussed in detail later in this report.

Public charging, defined as charging infrastructure that is publicly accessible to all EV drivers, is found at a variety of destinations, including but not limited to, along interstate highways and heavily-traveled corridors, at shopping malls and retail plazas, on university campuses, and at event venues. The type of charging infrastructure in publicly-accessible locations tends to vary based on the typical vehicle dwell times at the location and the intended use of the equipment. For example, Level 2 charging infrastructure is most appropriate at hotel and lodging locations where a patron’s vehicle remains parked for several hours overnight, whereas DCFC infrastructure is most appropriate along interstate highway corridors where drivers are more likely to travel long distances and seek faster charging options.

Residential charging, which takes place at single-family dwellings and MUDs, offers the most affordable and convenient charging option for the majority of drivers, and potentially the most affordable option depending on available rate structures.[127] However, not all homes are equipped with the electrical infrastructure necessary to support at-home charging. This is especially true of single-unit homes without garages, and MUDs in general.

Workplace charging, which typically includes Level 2 charging but can also include Level 1 charging, enables employees to charge their vehicles while they remain parked during the workday. Employers that invest in workplace charging infrastructure can demonstrate their sustainability leadership and accommodate the refueling needs of employees.

Fleet charging, or charging infrastructure designed to support fleet vehicles, varies by a number of factors, including vehicle quantity, class, and operating cycle. LDV fleets are more likely to utilize Level 1 and Level 2 charging infrastructure, whereas medium- and heavy-duty vehicle fleets are more likely to rely on DCFC infrastructure due to the vehicles’ larger battery size.

In particular, public and workplace charging infrastructure expansion will be critical to alleviating range anxiety and meeting the collective demand of EV drivers in Connecticut. In these two charging segments, infrastructure deployment will need to increase substantially in order to support the 2025 ZEV MOU target. The challenge for Connecticut is building the proper regulatory framework and identifying cost-effective strategies to enable a robust public charging infrastructure network that supports and accelerates EV adoption while providing benefits and minimizing risks to electric ratepayers by prioritizing siting on underutilized circuits and incentivizing usage at off-peak times.

7.1 Utilizing data to inform infrastructure siting and planning

As Connecticut seeks to expand EV charging infrastructure statewide, the integration of new and existing data and resources will be vital to ensuring optimal network build out. These data concern EV registrations, existing public charging infrastructure, EDC hosting capacity maps, and resource tools developed through multi-state collaborations like the Transportation and Climate Initiative (TCI).

[127] Charging at Home. Department of Energy. Retrieved November 5, 2018 from https://www.energy.gov/eere/electricvehicles/charging-home.

7.1.1 Vehicle registration data

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.[128] Identifying more specifically where EVs are registered is important for the EDCs to improve load forecasting and overall distribution system planning while safely and reliably serving new EV-related loads in their service territories. Providing the EDCs with access to EV registration data by street address would also help them target new products and services, such as EV-specific time-of-use (TOU) rates, managed charging programs, or EVSE incentives, to their customers that own or lease EVs. In California, the state DMV can disclose to an EDC an EV driver's address and vehicle type as long as the information is used exclusively to identify where the EV is registered.[129] Connecticut should explore options for providing the EDCs with registration data for incorporation into their distribution system planning, including facilitating the provision of registration data to the EDCs through the CHEAPR rebate (discussed in Section 13.2) with appropriate consumer privacy protections.

If the EDCs can identify residential addresses with EVs, they should develop a voluntary program to collect and aggregate charging data (i.e., dates, times, durations, and electricity usage (kWh) per charging session as well as monthly total electric load (kWh) from EV charging, and other pertinent data) from EV drivers with Level 2 charging equipment.[130] To protect confidentiality, the 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 the 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) that would shift loads and alleviate grid impacts during peak demand periods.

7.1.2 Mapping current and potential charging station locations

As of March 2020, there are 375 publicly accessible Level 2 and DCFC EV charging stations in Connecticut.[131] It will be important to map these current charging infrastructure deployments before targeting potential future locations. Interactive maps containing the street addresses of all public charging stations in Connecticut are available via DOE's Alternative Fueling Station Locator. The EV Corridor Analysis Tool[132] developed through the Clean Vehicles and Fuels workgroup of the TCI[133] is another resource that Connecticut should utilize for its public charging infrastructure build out. This GIS- and Microsoft Excel-based tool identifies public charging infrastructure gaps as well as potential charging site host locations along travel corridors and interstate highways. The tool evaluates by site the current distribution system infrastructure and planning needs to accommodate Level 2 and DCFC charging equipment, based on existing EV charging stations, population, vehicle travel data, and commercial

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[128] Conn. Gen. Stat. § 14-12(l).

[129] California Vehicle Code 1808.23.

[130] 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/.

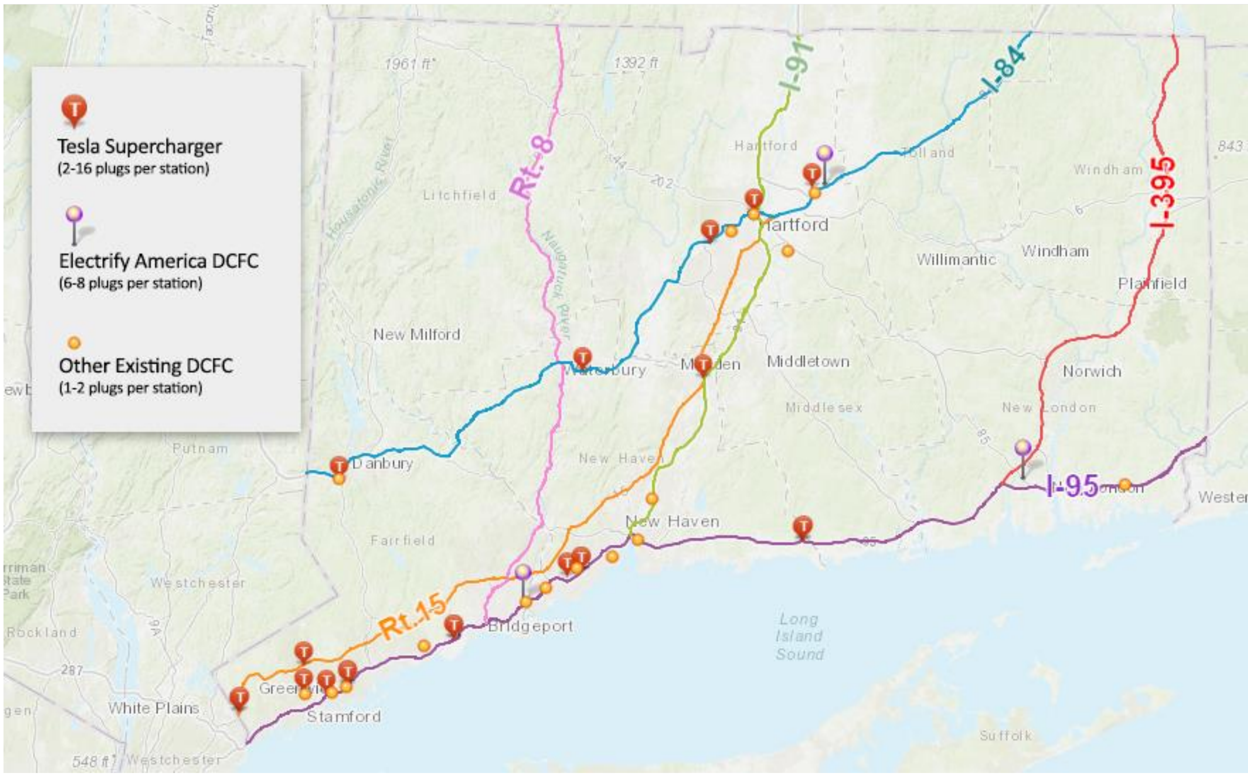
[131] Alternative Fueling Station Locator. Office of Energy Efficiency & Renewable Energy. DOE. Retrieved March 5, 2020 from https://afdc.energy.gov/stations/#/analyze?region=US-CT&country=US&fuel=ELEC&lpg_secondary=true&hy_nonretail=true&ev_levels=all.

[132] EV Corridor Analysis Tool. M.J. Bradley & Assocs. Retrieved April 20, 2020 from https://www.mjbradley.com/mjb_form/EV-tools.

[133] The TCI Clean Vehicles and Fuels workgroup, 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.

activity.[134] In addition to the Level 2 and DCFC locations depicted in Figure 9, Figure 10 provides a conceptual representation of potential new statewide DCFC infrastructure with 24 new station locations approximately 20 miles apart. The visual is provided for illustrative purposes only and as a preliminary planning tool for identifying gaps in the current public charging infrastructure network. More detailed analysis will be necessary as part of an ongoing planning process.

Figure 9: Connecticut's existing DCFC network (March 2020)

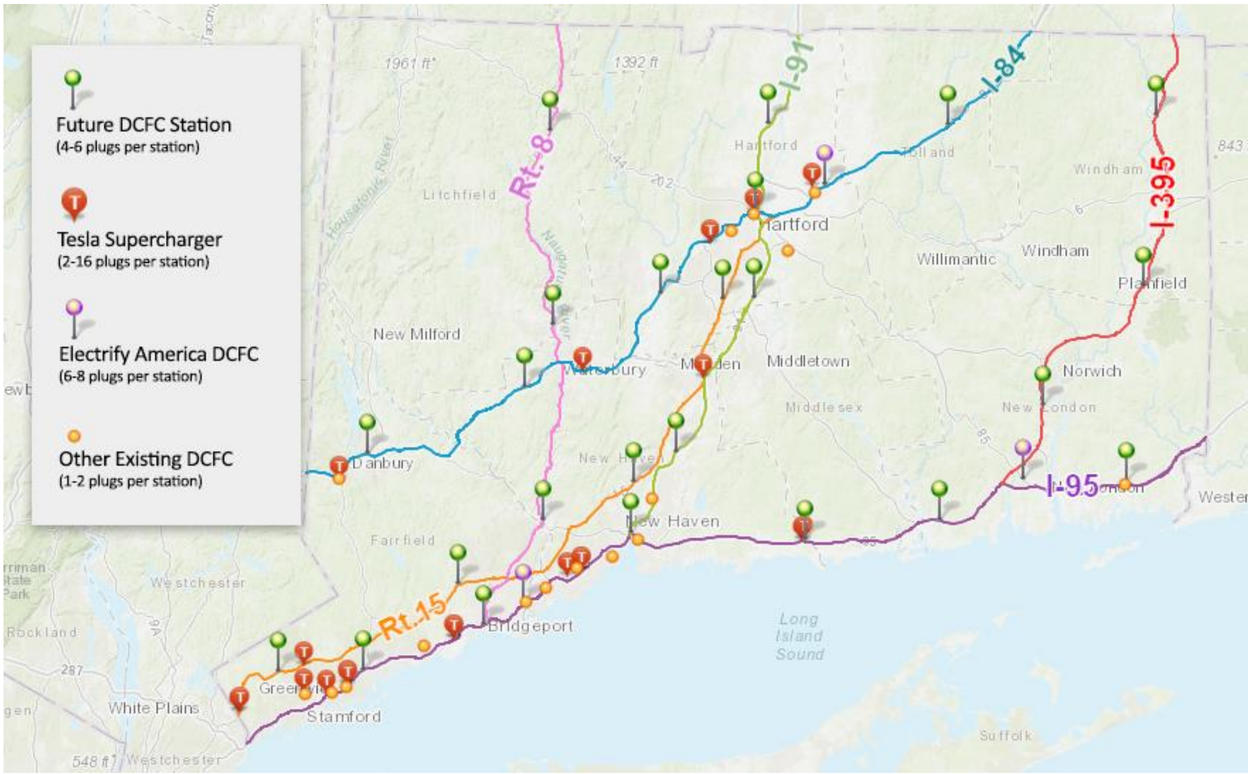


Map created by CT DEEP, March 2020.
Notes:

- *Existing DCFC network map does not include DCFC located at auto dealerships.*
- *Existing DCFC network based on DOE Alternative Fueling Station Locator as of March 4, 2020.*

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

Figure 10: Potential future DCFC network (one DCFC every 20 miles)



Map created by DEEP, March 2020.
Notes:

- *Future DCFC network adds 24 hypothetical stations to Connecticut, the majority of which have at least 4 connectors, for a total of 90 new DCFC connectors. In reality, future stations should be future-proofed to accommodate at least 8 connectors.*
- *Approx. distance of 20 miles between stations in hypothetical future DCFC network.*
- *Future DCFC designed only by evenly distributing charging station locations among specified routes with very minor alterations based on existing DCFC locations. Did not consider any other factors such as travel density, rest area locations, or city locations.*
- *As of March 2020, there were 20 Tesla Supercharger locations in Connecticut. Some of these are located on both sides of roadways so individual locations are not distinguishable as separate locations on maps above.*
- *Does not include any proposed/coming soon locations for Tesla or Electrify America.*

DEEP will continue its efforts to develop baseline inventory maps that overlay EV registrations by zip code, public charging infrastructure gaps, and opportunities for infrastructure expansion in-state. These efforts will include incorporating into DEEP's planning TCI's EV Corridor Analysis Tool and NESCAUM's Northeast Corridor Regional Strategy for Electric Vehicle Charging Infrastructure 2018-2021 (NESCAUM EV Strategy), which provides recommendations and best practices for expanding DCFC charging networks and leveraging public-private partnerships to optimize charging infrastructure build out in the region.[135] As with much EV deployment policy, leveraging regional coordination with other TCI-participating states can provide additional benefits given shared transportation corridors.

7.1.3 Electric distribution system mapping

To help plan for the EVSE expansion necessary to support greater statewide EV penetration, the EDCs need to understand EV charging impacts on local distribution system assets in communities with high concentrations of EVs. Section 16-244w of the General Statutes requires the EDCs to prepare hosting capacity maps to estimate the

[135] NESCAUM EV Strategy. NESCAUM. May 16, 2018. Retrieved April 20, 2020 from https://www.nescaum.org/documents/northeast-regional-charging-strategy-2018.pdf/.

amount of generation that can be accommodated without adversely affecting power quality or reliability, and without requiring infrastructure upgrades.[136] Such maps are typically useful for evaluating solar installations, but have not previously included EV charging loads.

Under Section 5 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, and publish related annual reports on their websites.[137] The development of more detailed, publicly available hosting capacity maps with high-level estimates for local distribution system capacity will enable identification of preferable locations that optimize existing distribution system assets and minimize infrastructure investments, which would help prospective site hosts and EV charging station developers to more efficiently identify least cost options for charging locations. Updated hosting capacity maps would also be a valuable asset for the EDCs and fleet managers when siting EVSE to support medium- and heavy-duty EVs such as electric transit buses. Moving forward, the EDCs should be required to comply with this statutory requirement to help the EDCs plan for increased levels of EV adoption across all vehicle segments.

Together, EV registration data, baseline inventory maps of existing charging infrastructure, TCI's EV Corridor Analysis Tool, and hosting capacity maps can help private and public entities prioritize EVSE deployment in locations that extend the geographic range of EVs along travel corridors and potentially minimize infrastructure investment costs by adding capacity to underutilized circuits. Combining these resources for planning of publicly-accessible EVSE will meet the dual goals of reducing range anxiety while ensuring the electric grid is not overburdened. DEEP recommends that PURA establish a process by which PURA, DEEP, the EDCs, and other stakeholders such as municipalities and EVSE providers can coordinate, share, and develop data and resources to inform the efficient development of Connecticut's statewide public charging infrastructure network.

Policy Recommendations: Utilizing data to inform infrastructure siting and planning

1. DEEP will engage with the CHEAPR Board on opportunities to encourage CHEAPR rebate recipients to share EV registration data by street address with the utilities to aid in load forecasting. DEEP will with work with interested stakeholders to identify and apply appropriate tools such as NESCAUM's EV Strategy or TCI's EV Corridor Analysis Tool to assess and prioritize locations for EV charging infrastructure development with the purpose of reducing range anxiety.
2. The EDCs should integrate EV charging load projections into their distribution system planning, identify underutilized circuits with the potential to support charging station infrastructure development, and publish to their websites related annual reports pursuant to Public Act 16-135.
3. The EDCs should create more granular, technology-agnostic hosting capacity maps to evaluate localized grid impacts of EV adoption to substations and transformers, and distribution system capacity to accommodate EV chargers (220-volt and higher).
4. The EDCs should establish a voluntary program, with appropriate consumer privacy protections, for the EDCs to collect and aggregate anonymized EV charging data, including the dates, times, durations, and electricity usage as well as total monthly electric load.

[136] Conn. Gen. Stat. § 16-244w.
[137] Conn. Gen. Stat. § 16-19f(b).

7.2 Public charging infrastructure development

Public charging infrastructure must evolve to meet consumers' on-the-go charging needs and expand consumer confidence in EV technologies.[138] Higher visibility of public charging infrastructure has been shown to correlate with higher rates of EV adoption.[139] As the deployment of EVs ramps up, public charging infrastructure will be essential to meet the needs of out-of-state drivers and local 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.[140] A 2017 McKinsey study found that EV adoption already outpaced EV infrastructure investment, even before popular long-range models like the Tesla Model 3 became widely available.[141] With the rapid growth of ride- 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.

To support the expansion of its public charging network, Connecticut should continue to identify key destination locations for EVSE installation coincident to Connecticut's efforts to fill infrastructure gaps. Travel and tourism statistics could be analyzed to identify prime locations for destination charging. Potential locations should include interstate highways, parking lots and garages, airports, transit centers, retail sites, state parks, 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 analyses to adopt models that can help inform EVSE charger siting.

7.2.1 Ownership and investment models for public charging infrastructure

To date, over 75 percent of Connecticut's publicly-accessible charging stations were funded and deployed through the EVConnecticut program, with the remainder of publicly-accessible stations funded and deployed by the private sector. Under the private investment model, an EVSE developer or private site host oversees and funds all aspects of EVSE deployment including on-site electrical infrastructure upgrades and EVSE procurement, installation, and O&M. This investment model enables site hosts to determine payment requirements for use of the equipment and keep all revenues.[142] While private investment may help prevent costs for EVSE permitting and

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[138] 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.

[139] 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.

[140] 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.

[141] 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.

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

installation from being passed on to ratepayers and non-EV drivers, this model on its own has not enabled Connecticut's public charging network to scale at the pace needed to meet its ZEV deployment goals. The private investment model has been deployed in various jurisdictions and provides a benefit insofar as it places the risk on the EVSE owner.

The state of Virginia utilized a modified private investment model and selected EVSE developer, EVgo, to assist the state in building out its public DCFC network. 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.[143] This type of cost-sharing approach, implemented through a competitive process, may help to leverage private investment to help scale Connecticut's public charging network in the near term.

Before investing any public funding in public charging infrastructure buildout in Connecticut, it is important to consider the advantages and disadvantages of the various EVSE investment and ownership models for deployment under varying scenarios. Existing public investment models in the publicly-available charging market for Level 2 charging and DCFC include: make-ready, third-party profit-sharing, EDC owner-operator, and EVSE rebate models. There is no "one size fits all" EVSE public investment model to meet Connecticut's vision for a diverse public charging network and a hybrid model may be necessary to meet public charging infrastructure demand. Each given model may be more or less preferable for different geographic locations and applications. For example, under the EDC owner-operator model, the EDC oversees EVSE installation, operation, and maintenance 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 O&M, site security, and call center support for customers.[144]

In determining the appropriate public investment approaches for publicly-accessible charging infrastructure in Connecticut, relevant stakeholders within the charging ecosystem should be identified, including, but not limited to, the EDCs, EVSE manufacturers, EVSE developers, auto manufacturers, EV users, and EVSE site hosts. 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 assist with site host recruitment and to inform EVSE site selection to produce optimal grid and social benefits, and to ensure that EV charging stations provide safe and reliable electricity to drivers. On the other hand, EDC ownership of public charging infrastructure may raise concerns over competition in the market.

Make-ready public investment model

The make-ready public investment model has been approved at various funding levels and under various conditions 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, the 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

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[143] 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.

[144] 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.

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. PURA review and approval would be necessary for the EDCs to adopt a version of this model and recover their costs.[145] By itself, the make-ready model may not be successful for driving equitable infrastructure investment in LMI and underserved communities. First and foremost, private developers seek to deploy EVSE in communities that will generate the highest return on investment. The business case for deploying EVSE in underserved communities where charging infrastructure is likely to be underutilized in the near-term may not be strong. A hybrid investment approach may be a preferable approach to ensure equitable access to charging infrastructure for LMI and underserved communities.

Third-party profit-sharing public investment 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. Subject to PURA review and approval, 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.[146] Depending on the charging ecosystem created, the profit-sharing model could enable the 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 model, on its own, may not maximize the EDCs' technical expertise or lead to an equitable distribution of charging infrastructure in 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.[147]

EDC owner-operator model

Under the EDC owner-operator model, an EDC invests in the electrical infrastructure and upgrades at a site, while also owning and operating the EVSE. This model provides a streamlined investment and administrative approach as the EDCs oversee all stages of EVSE siting, installation, interconnection, marketing, operation, and maintenance. The EDCs have been performing many related functions and the EDCs can collect and transparently report charger use data to inform future EVSE development. The EDCs, given the ability to recover investment costs from their ratepayers, may prove helpful in ensuring EVSE buildout reaches underserved communities where

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[145] 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.

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

[147] 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.

adequate funding may not be available, as well as less populated areas.[148] The EDC owner-operator model may be most efficient for rapidly scaling the deployment of public charging infrastructure, and allows the EDCs to apply real-time situational awareness and take actions to protect the electric grid if charging clusters compromise grid reliability.[149] However, if allowed to proliferate, the EDC owner-operator model could lead to a less competitive market and fewer investments from alternative EVSE providers. This model also presents the potential for ratepayers to shoulder the burden of financing EVSE infrastructure buildout and the stranded costs if the EVSE is underutilized.[150]

EVSE rebate model

Under the EVSE rebate model, the EDCs offer site hosts financial incentives toward installation of EVSE such as equipment and electric infrastructure upgrade rebates.[151] These rebates could be financed using VW EVSE funds or other funding sources. This model reduces upfront EVSE costs for developers and drivers while providing the potential for the EDCs to incent EVSE utilization such as reduced charge pricing during off-peak times or managed charging. However, the EVSE rebate model may not provide O&M support from the EDCs beyond the electrical infrastructure upgrades.

Ensuring equitable and inclusive public investment in EV charging infrastructure

PUCs across the U.S. have approved cost-recovery approaches for various EV charging infrastructure deployment and public investment models justified by varying conditions. While some PUCs view EDCs as most capable of filling in charging stations gaps, other PUCs view the 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 underserved communities will not be included in the resulting public charging network buildout.

In their respective docket proceedings, both the California and Massachusetts PUCs ultimately backed the make-ready public investment model with specific requirements for EV charging infrastructure investment in low-income and underserved communities. For example, the California PUC approved Pacific Gas and Electric's (PG&E) hybrid make-ready model[152] and Southern Con Edison's make-ready model,[153] 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

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[148] 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.

[149] *Id.*

[150] 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.

[151] *Id.*

[152] 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.

[153] 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.

anticompetitive impacts.[154] The Massachusetts Department of Public Utilities approved Eversource'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.[155]

Each of the public investment models above has its benefits and drawbacks, and in an emerging charging station market each may have its place. DEEP supports incentivizing and tracking publicly-available charging infrastructure development through a series of competitive processes that can leverage private investment to maximize public value. A staged approach would facilitate faster implementation of solutions that provide the best business case and eliminate major infrastructure (range anxiety) gaps, allow for the evolution of the market and available technologies to reduce stranded costs, and identify challenges that require more complex approaches or further stakeholder engagement. In order to create a sustained funding source to support an equitable and inclusive approach to charging infrastructure deployment, the EDCs should be permitted to own and operate charging infrastructure in rural and underserved communities or other locations where private investment is not forthcoming through competitive processes. A public engagement strategy, informed by equity principles developed by the GC3's Equity and Environmental Justice Work Group, will be helpful in identifying if such investment serves its intended purpose.

Any public funding for EVSE should be conditioned on meeting baseline parameters such as those set forth in the Consistency of the Consumer Experience section of this report. Guiding principles should be developed for any procurement for public charging network buildout, aligned with the public policy goals the program is designed to achieve. For example, Duquesne Light Company in Pennsylvania established six principles to govern the EDC's EV ChargeUp pilot program, including: (1) support state and local EV policies and goals; (2) support a competitive charging market while maintaining market neutrality; (3) maintain site host choice and control; (4) ensure equipment is installed safely and maintained efficiently; (5) require detailed data from program participants; and (6) manage program operations and costs.[156] Along with the *Pennsylvania Electric Vehicle Roadmap*, these principles have helped bring all the relevant stakeholders together to guide the next stages in EV growth and EVSE deployment in the state.[157] Guiding policy principles for EVSE development in Connecticut could also include minimizing grid impacts by prioritizing underutilized circuits, decreasing range anxiety, minimizing ratepayer costs, maximizing revenues to ratepayers, promoting economic development, and ensuring equitable and inclusive distribution of charging infrastructure. Scoring criteria for competitive procurements could include these guiding principles, which could be weighted differently over time as the market evolves and gaps in infrastructure are identified. A transparent tracking mechanism with data collection and regular reporting would provide for ongoing program evaluation and modification.

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[154] 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.

[155] D.P.U. 17-05, ORDER ESTABLISHING EVERSOURCE'S REVENUE REQUIREMENT. Department of Public Utilities, 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.

[156] Duquesne Light Company, Distribution Rate Case, Docket No. R-2018-3000124. Pennsylvania Public Utility Commission. Filed March 28, 2018. Retrieved December 30, 2019 from http://www.puc.pa.gov/pcdocs/1560095.pdf.

[157] Trabish, Herman K. The Keystone State may have found the key to the next wave of transportation electrification. Utility Dive. January 11, 2019. Retrieved December 30, 2019 from https://www.utilitydive.com/news/the-keystone-state-may-have-found-the-key-to-the-next-wave-of-transportatio/545008/.

Policy Recommendations: Public charging infrastructure development

1. DEEP supports a multi-phase, competitive approach for expanding publicly-accessible charging infrastructure, open to a variety of investment models to maximize competition and, thus, ratepayer value.
2. DEEP recommends that all publicly-funded, publicly-accessible EVSE meet baseline criteria as well as guiding policy principles.
3. DEEP recommends that the EDCs be permitted to own and operate EVSE in low-income, rural, and underserved communities where private investment is not forthcoming.
4. DEEP recommends that any publicly-funded charging infrastructure deployment program require a transparent tracking mechanism with regular reporting to provide for program effectiveness evaluation and modification based upon lessons learned, technological advances, and market maturation.

7.3 Residential charging

At-home charging is an affordable and convenient charging option for most drivers.[158] 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.[159] While Level 1 charging allows for overnight EV charging, albeit at the slowest speed, some drivers opt to upgrade to a residential Level 2 charger to take advantage of the faster charging speed or to fuel a longer commute. In either case, promoting off-peak and managed charging—which is most likely to occur overnight in residential settings—must be the priority of Connecticut's EV policy. Accordingly, robust regulatory frameworks should be established to incent installation of residential charging infrastructure capable of managed charging 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 the EDCs with data insight into EV charging behaviors, are ideal for deploying managed charging strategies during peak demand periods. Furthermore, networked chargers with integrated revenue grade sub-meters operating through a wireless connection may be paired with EV-specific TOU rates. This approach would enable residential customers on such a rate tariff to charge their EV on a rate separate from the rest of the household, while avoiding the installation of a separate meter and the associated costs. Managed charging, rate design, and dynamic pricing are discussed in greater detail below.

7.3.1 Residential charging at single-family homes

Installing Level 2 EVSE at single-family homes with off-street parking is relatively straightforward. Single-family home EVSE is most commonly found in residential garages or under carports. Typically, single-family homeowners interested in installing Level 2 EVSE contact an electrician to assess the residence's electrical capacity, obtain the proper permits, and pay the electrician for any necessary electrical upgrades associated with the installation. Level 2 EVSE hardware costs vary by brand and functionality, ranging from $200 to $900, and electrical wiring and panel upgrades also vary by location and labor intensity.

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[158] Charging at Home. Department of Energy. Retrieved November 5, 2018 from https://www.energy.gov/eere/electricvehicles/charging-home.

[159] Eversource and UI identify on-peak hours as 12:00 p.m. to 8:00 p.m.

Opportunities should be assessed for incentivizing residential Level 2 EVSE, and more specifically, networked Level 2 chargers. As mentioned above, networked Level 2 EVSE can enable managed charging and pair well with EV-specific TOU rates. In Vermont, Green Mountain Power (GMP) offers customers purchasing a new EV a networked Level 2 charger (a $600 value)[160] that shares access with GMP during periods of peak demand and allows the EDC to curtail charging.[161] These networked chargers provide GMP with valuable residential charging data insights and enable the EDC to pilot off-peak TOU rate charging. In 2019, the California PUC approved PG&E to launch its Empower Electric Vehicle Charger Incentive and Education Program, which provides $4 million for targeted education and outreach efforts and EV charger incentives for up to 2,000 households with low- and moderate-incomes within PG&E's service territory.[162] More specifically, the Empower program will provide a $500 rebate to income-verified households to cover the installation costs of a Level 2 charger, including an additional rebate up to $2,000 if installation requires electrical upgrades. PG&E customers receiving these incentives will be enrolled in TOU rate programs designed to achieve the greatest level of savings for participating households and PG&E's customers, generally.

Connecticut has the opportunity to create a framework for establishing networked Level 2 EVSE with demand response capability as the standard for residential charging deployment. Adopting such a standard now for any publicly-funded residential Level 2 EVSE can help consumers avoid the potentially high costs of future upgrades, and streamline the implementation of future demand response measures. The incremental revenues from off-peak electricity sales to residential EV customers and the avoided distribution system costs associated with optimized charging times could offset the entire cost, or a portion of the cost, of EDC-approved Level 2 EVSE hardware equipped with a revenue-grade meter. In the near term, EV purchasers could be given a choice between participating in TOU rates or a managed charging pilot program in exchange for an EVSE incentive.

Customers participating in any available program for residential EVSE incentives could pair such incentives with financing from the Connecticut Green Bank's Smart-E Loan or other financing sources to cover any incremental costs of the EVSE or necessary infrastructure upgrades. Consideration should be given to providing additional compensation to LMI-verified households to help cover such incremental costs.

Data collected (dates, times, durations, and electricity usage (kWh) per charging session) through these networked chargers can help the EDCs understand the localized grid impacts of clustered EV charging in residential neighborhoods with high EV penetration and inform future statewide load forecasting and distribution system planning. Furthermore, these data collection efforts will help the 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.

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[160] In-Home Level 2 EV Charger. Green Mountain Power. Retrieved June 28, 2019 from https://greenmountainpower.com/product/home-level-2-ev-charger/.

[161] 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.

[162] Decision 19-09-006. Decision Approving the Application of Pacific Gas and Electric Company for the Empower Electric Vehicle Charger Incentive and Education Program. California Public Utilities Commission. Issued September 19, 2019. Retrieved September 29, 2019 from http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M314/K145/314145047.PDF.

In addition to being networked and demand-response capable, any EV chargers incentivized with public funding should be EnergyStar-certified. EV chargers spend 85 percent of their useful life, which averages about 10 years,[163] in standby mode.[164] The useful life of an EV charger depends on the model, usage, maintenance, weather conditions, and other factors. EnergyStar-certified EVSE models use 40 percent less energy in standby mode than non-EnergyStar models, or the equivalent of 30 kWh/year.[165]

7.3.2 Residential charging at multi-unit dwellings

Roughly 10 percent of Connecticut residents live in MUDs, especially in urban areas.[166] Ideally, the opportunities available to single-family home dwellers to own EVSE and participate in active or passive demand response programs would also be available to those who live in MUDs. However, EV charging access for residents living in MUDs may be restricted due to lack of dedicated parking spaces, conditions of leasing agreements, or by the covenants, bylaws, or other restrictions of common interest communities like condominium associations. Creative solutions for EV charging at MUDs will be critical to reach that segment of the market. DEEP will explore pilot programs that bring landlords and other stakeholders to the table.

Several jurisdictions have enacted laws to address tenant and condominium-owners' right to install EVSE. In California, for example, residential and commercial condominiums, cooperatives, and planned communities, and residential and commercial lessors, may not unreasonably restrict unit owners and lessees from installing EVSE in their designated parking spaces.[167] Oregon law protects the rights of residential lessees, planned community homeowners, and condominium owners to install EVSE.[168] Colorado protects the right of common interest community homeowners and residential property tenants to install EVSE,[169] while Florida law extends the right to residential and commercial condominium owners.[170] Hawaii[171] and New York[172] have enacted similar legislation applicable to multi-family residential dwellings and townhouses, and condominiums, respectively. Massachusetts signed into law a home rule petition for the City of Boston that grants a right to Boston condominium owners to install EVSE on or near their parking spaces.[173] This approach provides a potential template for municipalities to lead on right-to-charge laws. In each of these jurisdictions, the right to charge is subject to reasonable restrictions like completing an application, complying with building codes, and maintaining liability insurance. All installation, maintenance, removal, and electricity usage costs are borne by the unit owner or lessee.

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[163] Financial Viability of Non-Residential Electric Vehicle Charging Stations. Luskin Center for Innovation, UCLA Luskin School of Public Affairs. August 2012. Retrieved September 30, 2019 from https://luskin.ucla.edu/sites/default/files/Non-Residential%20Charging%20Stations.pdf.

[164] Electric Vehicle Supply Equipment (EVSE). EnergyStar.gov. Retrieved October 1, 2019 from https://www.energystar.gov/products/other/evse.

[165] *Id.*

[166] 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/.

[167] *See* Cal. Civ. Code. §§ 4745, 4745.1, 1947.6, 1952.7 and 6713.

[168] *See* Or. Rev. Stat. §§ 90.462, 94.762, 100.626-100.627.

[169] *See* Colo. Rev. Stat. §§ 38-12-601 and 38-33.3-106.8.

[170] *See* Fla. Stat. § 718.113(8).

[171] *See* Haw. Rev. Stat. § 196-7.5.

[172] *See* N.Y. Real Prop. Law § 339-ll.

[173] *See* 2018 Mass. Acts ch. 370.

Connecticut should enact statewide right-to-charge legislation that helps remove barriers to EVSE installation in MUDs by prohibiting rental properties and condominium associations from unreasonably restricting lessees and unit owners from installing EV charging equipment and associated metering equipment.

Beyond legally empowering unit owners and lessees, two jurisdictions have taken innovative approaches to enable charging access on-site at and in close proximity to MUDs. In Austin, Texas, publicly-owned Austin Energy's Plug-In EVerywhere initiative includes offers increased rebates of $4,000 or $10,000 for hosting Level 2 or DC fast charging stations that must be available to all residents of a multi-family property.[174] The City of Berkeley, California, offers the Residential Curbside Electric Vehicle Charging Pilot ("Curbside Pilot"), which brings curbside EV charging to residents when on-site opportunities do not exist and cannot be created.[175] Applicants to the Curbside Pilot are responsible for the purchase and installation of EVSE. Originally scheduled to end in December 2017, the pilot has been extended through December 2020. The City of Berkeley intends to assess if the pilot removes barriers to EV adoption. PURA should consider investigating these novel approaches to EV charging at MUDs in the ZEV Docket.

Policy Recommendations: Residential charging

1. A residential Level 2 EVSE incentive program tied to participation in TOU rates or a managed charging pilot program should be implemented in the near-term so that it can be scaled up to meet market growth while minimizing grid impacts.
2. DEEP will explore pilot programs for EVSE deployment at MUDs.
3. Connecticut should enact right-to-charge legislation that prohibits condominium associations and landlords from restricting condominium owners or lessees with designated parking spaces from installing EV charging equipment and associated metering equipment.

7.4 Workplace charging

Employers considering offering workplace charging should begin by distributing DOE's Workplace Charging Challenge Employee Survey or designing their own survey to gauge employee interest and determine charging infrastructure needs. It will be important for employers to identify, by mileage, the commute times of all employees and not just those who already drive an EV, because the availability of workplace charging may incent some employees to further consider purchasing an EV. Employers that decide to offer workplace charging should contact their EDC early on in the planning process. The EDCs possess deep knowledge of their customers' energy usage, technical information regarding electrical infrastructure, and electricity demand management. Given this expertise, the EDCs are well-suited to help employers select and deploy EVSE that meets the demands of employers. Along with EVSE installers, the EDCs can help employers estimate the cost of EVSE installation at specific sites and, with regulatory approval, could consider offering financial incentives toward the purchase of the EVSE.

Employers that offer workplace charging enable their employees to conveniently charge their EVs while demonstrating their sustainability leadership. Typically, employees' personal vehicles spend several hours per day

[174] Austin Energy. Plug-In Austin Electric Vehicles, Multifamily Charging. Retrieved April 20, 2020 from https://austinenergy.com/ae/green-power/plug-in-austin/multifamily-charging.

[175] City of Berkeley. Residential Curbside Electric Vehicle Charging Pilot. Retrieved April 20, 2020 from https://www.cityofberkeley.info/EVcurbside/.

in parking lots and garages, which is ideal for gradually and efficiently refueling over the course of the workday. Currently, 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 most EV drivers at work.[176]

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.[177] 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 is often overlooked as a workplace charging solution due to its slow rate of charge, but this type of charging does not require substantial infrastructure investment and can deliver up to 5 miles of range per charging hour.[178] However, 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.

Commercial Property Assessed Clean Energy (C-PACE) funding, which is currently offered by the Connecticut Green Bank, can also be used to finance EVSE deployment at commercial properties. Under the Green Bank's current program, EVSE can qualify for C-PACE funding if certain energy improvement and savings-to-investment ratio (SIR) criteria are met.[179] Connecticut should support legislation that enables EVSE at commercial properties to qualify for C-PACE funding regardless of meeting any SIR criteria because these deployments support the state's climate and ZEV deployment goals.

Administrators of workplace charging programs will need to plan for O&M of chargers, employer payment of charging costs, enforcement, and Americans with Disabilities Act (ADA) compliance for EV charging spaces. DOE provides Americans with Disabilities Act Requirements for Workplace Charging Installation guidelines to assist employers with meeting ADA requirements for accessibility.[180] 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.

Workplaces should establish best practices to ensure that employees don't develop suboptimal charging behaviors. For established best practices, employers should refer to DOE's resources for managing workplace

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[176] 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.

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

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

[179] ChargeUpCTBuildings. Connecticut Green Bank. Retrieved March 9, 2020 from https://chargeupctbuildings.com/.

[180] ADA Requirements for Workplace Charging Installation, Guidance in Complying with Americans with Disabilities Act Requirements. DOE. November 2014. Retrieved Apr. 20, 2020 from http://www.dpuc.state.ct.us/DOCKCURR.NSF/60903cc7b9de44728525746b006e8ffb/78a25b4e83776981852583b50057c9d1/$FILE/171046RE01-030619.pdf.

charging and the New York State Energy Research and Development Authority (NYSERDA) Workplace Electric Vehicle Charging Policies Guide.[181]

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 of workplace chargers is highest during morning commute hours and is not coincident with peak demand periods.[182] A 2016 report by the Rocky Mountain Institute (RMI) 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 roughly 3 percent.[183] 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. In order to help minimize adverse distribution system impacts that could stem from widespread peak workplace charging, DEEP recommends that employers installing Level 2 charging stations strongly consider networked chargers that can enable demand response services and co-location of DERs to help offset charging loads.

Policy Recommendations: Workplace charging

1. DEEP encourages employers considering workplace charging solutions to distribute a survey to gauge employee interest and determine charging infrastructure needs.
2. DEEP recommends that employers considering workplace charging solutions contact their EDC as early as possible in the planning process to assist with site evaluation, equipment selection, cost estimates, and possibly even financial incentives for EVSE.
3. DEEP encourages employers to equip at least 10 percent of their total parking spaces with Level 1 charging plugs and evaluate opportunities for installing networked Level 2 EVSE with co-located DERs to meet the refueling needs of employees.
4. Connecticut should support legislation that more broadly enables EVSE at commercial properties to qualify for C-PACE funding.

7.5 Fleet charging infrastructure

Fleet operators and managers electrifying their fleets will have varying charging infrastructure needs and costs. Light-duty fleets are most likely to utilize Level 2 EVSE and will see lower electrical infrastructure upgrade costs to support fleet electrification. In contrast, medium- and heavy-duty fleets will rely on DCFC infrastructure to meet refueling needs, which has greater upfront infrastructure costs and is more likely to require costly upgrades to distribution system infrastructure, depending on the capacity needed at charging depots. Moreover, large quantities of vehicles charging simultaneously or even in managed charging patterns, regardless of vehicle class, will likely lead to costly demand charges (discussed in more detail in Section 10). Fleet operators and managers are encouraged to work with their EDC to identify solutions that will minimize distribution system impacts and help realize greater cost savings, including managed charging specific to the fleet use case (discussed in more

[181] Workplace Electric Vehicle Charging Policies, Best Practices Guide. NYSERDA. Dec. 2015. Retrieved April 19, 2020 from https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/ChargeNY-Workplace-EV-Charging-Policies.pdf.

[182] Eversource, "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).

[183] 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.

detail in Section 9.3), deployment of DERs, and optimizing infrastructure buildout based on the specific needs of the fleet.

Policy Recommendation: Fleet charging

1. DEEP suggests that fleet operators and managers work with their EDC to identify solutions that will minimize distribution system impacts and help realize greater cost savings, including managed charging specific to fleet use case, deployment of DERs, and optimizing infrastructure buildout for their use case.

8 Consistency of the Consumer Charging Experience

Across Connecticut, the refueling experience for drivers of ICE vehicles is relatively consistent. Traditional gas stations use large overhead signs visible from a distance to display their retail prices per gallon of available unleaded and diesel gasoline fuels. Individual 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. ICE vehicle 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 refueling or charging experience for EV drivers is markedly different. Unlike ICE vehicles that are refueled at gas stations in between destinations, 80 percent of EV charging takes place at home and any remaining charging mostly takes place at a public charging station at or nearby the driver's destination.[184] EV drivers often use a station locator app (e.g., PlugShare, ChargeHub, Recargo, CarStations, Blink) or website on their smartphone, or their vehicle's computer navigation system to locate and access a publicly-available charging station. EV charging stations may be categorized by their approximate charge rates and the form of power delivered (AC or DC). Charging session costs for public charging stations (Level 2 and DCFC) are influenced by a variety of factors such as electricity consumption, time of use, and demand charges. Moreover, charging session costs may include service fees for managing payment transactions, maintenance, and trouble-shooting services, as well as parking lot expenses and hosting expenses. And the charging times for specific vehicles may vary depending on power electronics, state of charge, battery capacity, and level of charging offered by the station.

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 drivers. Consistency in positive consumer experience at public charging stations is fundamental to the successful adoption of EVs. As such, consumer interaction with public EVSE should be a convenient, consistent, and uncomplicated experience that smoothly accommodates EV drivers' needs. Wayfinding signage should guide drivers to public charging stations, and at-station signage should provide visible and transparent pricing information. Public charging stations should be compliant with ADA standards and easy to access. Charging equipment at these stations should be fully operational, interoperable with any EV make and model, and accept multiple accessible payment options.

Gas stations around the U.S. have begun partnering with EVSE developers to deploy charging stations; however, use of these charging stations to date has not mirrored the experience for refueling ICE vehicles. For example, most EV charging stations do not have similar branding or large, well-lit signs indicating the price of electricity at

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

the station. For those drivers who are not prepared to embrace the refueling paradigm shift mentioned above, it may be advantageous to create a charging experience similar to refueling ICE vehicles. McDonald's in Sweden has begun deploying DCFC charging stations with signage that prominently displays EV charging rates beneath its famous golden arches.[185] And in September 2019, the U.S. saw the first ever gas station to be fully converted to an EV charging station in Takoma Park, Maryland. The charging station, which was jointly funded by the Electric Vehicle Institute and the Maryland Energy Administration, features four DCFC ports that connect to a 200 kW system. Each charging port enables an EV to recharge to 80 percent battery capacity in 20 to 30 minutes. The station is also supported by a certified repair facility capable of providing all aspects of EV servicing, including battery replacement and disposal.[186]

8.1 Interoperability

The public charging experience should not be hindered by incompatible hardware and software, limited payment options, membership requirements, and network subscriptions. Recharging at a public charging station requires drivers to first determine the compatibility of their EV with the charging station's available connector or connectors. Currently, 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.[187] This standardized connector makes virtually every EV compatible with every non-fast charging station.[188]

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 DCFCs are CHAdeMO and SAE Combo (CCS).[189] CHAdeMO is the standard connector for Japanese auto manufacturers, and CCS is the standard connector for American and European automakers.[190] Tesla currently uses its own proprietary connector, thereby limiting use of their Tesla Superchargers to only Tesla vehicles. However, through the use of adapters, Tesla vehicles can also be charged at non-Tesla DCFC stations.

The present lack of a universal 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 drivers must not only locate a DCFC, they must also confirm that the DCFC operates a connector compatible with their vehicle. Currently, Connecticut imposes no requirement for public charging stations to have multiple types of connectors available; however, it is likely that most public, for-profit charging stations would offer multiple

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[185] Pressman, Matt. McDonald's Wants to Charge Your Electric Car. Evannex. September 27, 2019. Retrieved October 1, 2019 from https://evannex.com/blogs/news/mcdonalds-wants-to-charge-your-electric-car.

[186] Maryland Opens First Fully Converted Gas-to-Electric Refueling Station in the United States. The Office of Governor Larry Hogan. September 26, 2019. Retrieved October 1, 2019 from https://governor.maryland.gov/2019/09/26/maryland-opens-first-fully-converted-gas-to-electric-refueling-station-in-the-united-states/.

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

[188] *Id.*

[189] 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.

[190] 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.

connection options in order to not limit their potential customer base. Until an industry-wide standard connector is established, the state should require all publicly-funded, publicly-available DCFC station sites to have, at a minimum, one CHAdeMO connector and one CCS connector available for use.

8.2 Future-proofing

To date, 50 kW stations are the standard for many DC fast charging networks, however as auto manufacturers increase EV battery capacity, 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 auto manufacturer planning to offer a vehicle capable of charging at up to 320 kW.[191] 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. And 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, all new investments in the make-ready portion of electrical infrastructure (all conduit and wiring up to the charger stub) supporting DCFC stations should support chargers with a minimum capacity of 150 kW. This requirement will allow for station operators to install 50 kW charging stations to meet the needs of most EVs that are on the road today, but will also provide for future charging station upgrades without modifying the make-ready portion of 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. 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 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, the EDCs should consider potential opportunities for site expansion with additional chargers when installing the make-ready portion of 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.

8.3 Uptime

Maximizing uptime—the amount of time that a charging station is functioning properly and available for use—is important to establishing a reliable EVSE network and building consumer confidence.[192] Consumer experience declines when a charging 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

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[191] 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.

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

established operations and maintenance programs outlined in their service contracts for all charging stations they own or operate. Publicly-funded charging stations need a similar measure in place to minimize and prevent equipment downtime. To ensure that public 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, the provision of public funding for public charging equipment should be conditioned on an agreement from the recipient of the funding to ensure the O&M of the equipment consistent with accepted operational and maintenance schedules and standards.

In addition to minimizing downtime, effectively communicating to EV drivers in real time when a public charging station is inoperable, for example, via signage, a mobile phone app, or onboard technology installed in EVs, is also important to instill confidence in the EVSE network and prevent stranding drivers in need of a charge. Drivers would stand to benefit greatly if the public charging infrastructure network can provide them with status alerts on the availability of open chargers and parking spaces, as well as notifications of scheduled maintenance plans.

8.4 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. Drivers 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. In contrast, the unit of sale between different EV charging stations may differ based on the preferences of the site host.

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

1. Pricing information is not always clearly disclosed at charging stations;
2. 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
3. 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.[193]

Therefore, determination of a comprehensive pricing transparency policy for public EV charging stations in Connecticut is necessary to 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 and electricity consumption information should be transparently provided to customers both prior to the initiation and upon completion of a charging session.

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

In December 2019, California's Division of Measurement Systems finalized regulations that amended the state's Electric Vehicle Fueling Systems Specifications, effective January 1, 2020.[194] The regulations prohibit charging station operators from billing by the minute, and require charging stations to display on their face the rate of charge, unit price (in whole cents or tenths of one cent) per mega joule or kWh at which the EVSE dispenses electricity during a transaction, and total kWh delivered per charging session. The regulations apply to all Level 2 chargers and DCFCs installed after 2021 and 2023, respectively. DEEP will work with the Connecticut Department of Consumer Protection's Division of Food and Standards to evaluate the advantages and disadvantages of the publicly-accessible charging station billing standards set forth in California.

8.5 Multiple payment options

Pursuant to Section 16-19ggg of the General Statutes, owners and operators of public charging stations who impose 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.[195] This ensures that drivers can access any public charging station in Connecticut to charge their EVs.

More importantly, Section 16-19ggg requires that owners and operators of public charging stations who impose 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.[196] Currently, the more common payment methods for EV charging include debit/credit cards, radio-frequency identification (RFID) cards, and mobile payment apps. Other less common forms of payment include mobile wallets or contactless credit/debit cards. Drivers 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 if stations restrict the accepted forms of payment to RFID and mobile payment apps. Research shows that nearly 75 percent of EV drivers in California currently pay for fuel at gas stations using a credit, debit, or prepaid card,[197] and the state is considering new regulations that would require EV charging stations to accept credit/debit card payment via chip readers as a means to ensure that all drivers have equitable access to charging.[198] In Nevada and Vermont, DCFC station hosts that receive VW Settlement grant funding are required to install credit card

[194] Electric Vehicle Fueling Systems Specifications in the CCR Title 4, §§ 4001 and 4002.11. California Secretary of State. December 16, 2019. Retrieved December 30, 2019 from https://www.cdfa.ca.gov/dms/pdfs/regulations/EVSE-FinalText.pdf.

[195] *See* Conn. Gen. Stat. § 16-19ggg(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."); *id.* § 16-19ggg(e)(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.").

[196] *See* Conn. Gen. Stat. § 16-19ggg(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.")

[197] Report on the Economic Well-Being of U.S. Households in 2016. Board of Governors of the Federal Reserve System. May 2017. Retrieved October 1, 2019 from https://www.federalreserve.gov/publications/files/2016-report-economic-well-being-us-households-201705.pdf.

[198] AB-1424 Electric Vehicle Charging Station Open Access Act (2019-2020). California Legislative Information. Published August 13, 2019. Retrieved December 30, 2019 from http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB1424.

readers at the station.[199] It is worth noting that credit card reader requirements have prompted a variety of concerns from industry leaders regarding high installation and retrofit costs as well as cybersecurity and consumer protections issues.

In planning Connecticut's public charging infrastructure expansion, it will be important to ensure that accessible modes of payment are available for all drivers, while implementing appropriate consumer protections. Public charging station owners and operators who have received public funding should be required to offer a variety of payment options, including credit/debit card payment, in order to provide accessibility to as many EV drivers as possible.

8.6 Open communications protocols

Most public charging stations are part of EV charging networks. Opportunities exist for improving interoperability through the communications protocols utilized by EV charging networks. Protocols are a set of rules and requirements that establish the process for data interaction between communicating devices, or systems.[200] In other words, protocols are a method for exchanging information. Most protocols are voluntary and are offered for adoption by industries without being mandated by policy.[201]

Many industry stakeholders advocate for open, non-proprietary communications messaging protocols to reduce the cost of managed charging implementation and prevent future stranded assets.[202] Open communications protocols provide improved interoperability over proprietary protocols as they are not unique to any one business system or network.[203]

There are a number of open protocols being utilized for EV charging today, each with its own capabilities. Different protocols allow for communication between different elements of the EV charging asset chain. Table 5 provides a high level description of some of the open protocols commonly in use today.[204] DEEP does not recommend that any one protocol, or combination stack of protocols, be used over another, rather the decision should be left to site hosts, utilities, and charging station operators based on their business needs. However, DEEP does recommend that any publicly-funded charging station operate using open non-proprietary communications protocols in order to avoid stranding assets and to improve the interoperability within the public charging network.

[199] New regulations may make it difficult for companies to continue growing charging infrastructure. InsideEVs. July 10, 2019. Retrieved December 30, 2019 from https://insideevs.com/news/359071/electric-car-charging-infrastructure-regulations-negative/.
[200] A Comprehensive Guide to Electric Vehicle Managed Charging. Smart Electric Power Alliance. May 2019.
[201] *Id.*
[202] *Id.*
[203] *Id.*
[204] New protocols are regularly being developed, and newer versions of existing protocols are regularly being issued. Table 5 provides examples of what is being used in the market today, and is not an exhaustive list of protocols available. DEEP recommends consulting with developers, charging alliances, and other industry leaders for the most up to date information on what open protocols are currently available as the market is perpetually evolving.

Table 5: Open non-proprietary communications protocols

Standard	Description
OCPP/OSCP	Open Charge Point Protocol (OCPP) and Open Smart Charge Protocol (OSCP) allow for communications between the EVSE and the charging network administrator. These protocols allow changing network administrators without creating a stranded physical asset. OSCP allows for communication between the EVSE and an energy management system and can be used for smart charging support and load balancing.
OpenADR 2.0	The Open Automated Demand Response (OpenADR) provides an open standardized way for electric providers and system operators to communicate with EV charging network operators. OpenADR was originally developed as a peak load management tool.
OCPI	The Open Charge Point Interface (OCPI) protocol supplies correct charge station information such as location, availability and pricing, manages bilateral roaming, and allows for real-time billing and mobile access to charging stations.
ISO/IEC 15118	This protocol enables the managed charging capabilities of a vehicle. This protocol specifies the communication between the EV and EVSE and supports EV authentication, metering, and pricing messages.
IEEE 2030.5/SEP 2.0	Capable of exchanging information pertaining to pricing, demand response, and energy use. This protocol can integrate a variety of DER including EVs and EVSE.

Sources: Interoperability, Research - Elaad NL. Retrieved January 7, 2020, from https://www.elaad.nl/research/interoperability/. and A Comprehensive Guide to Electric Vehicle Managed Charging. Smart Electric Power Alliance. May 2019.

8.7 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 public charging stations, but wayfinding signage along highways, exits, and streets remains necessary to guide drivers to public charging station locations. In addition, highly visible signage can alleviate range anxiety for current and prospective EV drivers.[205]

Connecticut should coordinate with other TCI and NESCAUM member states to adopt uniform wayfinding and public 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.[206] DEEP recommends 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*.[207] Signage along state highways such as I-84 and I-91 should

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

[206] 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.

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

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 public charging equipment.

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 also can be painted to reinforce signage posted at the stations as well.[208] 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*[209] and *Lessons from Early Deployments of Electric Vehicle Charging Stations*[210] for on-site charging station signage best practices.

8.8 ADA compliance

The design and installation of public charging stations, like all public parking facilities, must comply with ADA standards and be accessible to all consumers. In accordance with the ADA, general design considerations include accessibility, ease of use, and safety for disabled drivers; however, federal standards specifying the number or design of EV charging station-equipped parking spaces do not currently exist.[211,212] In the next Connecticut State Building 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 parking spaces. In 2016, California became the first state in the nation to codify ADA requirements for EVSE in its state building code.[213] The California building code revisions could serve as a blueprint for revising the Connecticut State Building Code. Absent specific ADA compliance requirements for EV charging stations in the State Building Code, DEEP recommends that public

[208] Signage for Plug-In Electric Vehicle Charging Stations. Alternative Fuels Data Center, Office of Energy Efficiency & Renewable Energy, DOE. Retrieved August 12, 2019 from https://afdc.energy.gov/fuels/electricity_charging_station_signage.html.

[209] Siting and Design Guidelines for Electric Vehicle Supply Equipment. WXY Architecture + Urban Design. November 2012. Retrieved April 20, 2020 from https://www.transportationandclimate.org/sites/default/files/EV_Siting_and_Design_Guidelines.pdf.

[210] Lessons From Early Deployments of Electric Vehicle Charging Stations. Logios. May 2013. Retrieved April 20, 2020 from https://www.transportationandclimate.org/sites/default/files/Lessons%20From%20Early%20Deployments%20of%20EV%20Charging%20Stations.pdf.

[211] ADA Requirements for Workplace Charging Installation, Guidance in Complying with Americans with Disabilities Act Requirements. DOE. November 2014. Retrieved Apr. 20, 2020 from http://www.dpuc.state.ct.us/DOCKCURR.NSF/60903cc7b9de44728525746b006e8ffb/78a25b4e83776981852583b50057c9d1/$FILE/171046RE01-030619.pdf.

[212] 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, DOE'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.

[213] California Building Code, title 24, part 2, vol. 1, ch. 11B (2019), https://codes.iccsafe.org/content/CABCV12019/chapter-11b-accessibility-to-public-buildings-public-accommodations-commercial-buildings-and-public-housing.

charging station developers follow the ADA accessibility recommendations set forth in DEEP's *Guidelines for the Installation of Electric Vehicle Charging Stations at State-Owned Facilities*[214] and published best practices.

8.9 ICE-ing

The term "ICE-ing" refers to the practice of drivers parking ICE vehicles in spaces specifically designated for EV charging.[215] ICE-ing, whether intentional 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 enables owners and operators of public EV charging stations to set forth restrictions on the amount of time that an EV may be charged at its station.[216] Public Act 16-135 also made it illegal for ICE vehicles to park in a public EV parking space reserved for BEVs and PHEVs. In 2019, Connecticut enacted Public Act 19-161, which amended Section 16-19ggg(c) to establish that ICE-ing shall be an infraction. [217] The statute does not address unplugged EVs parked in spaces designated for EV charging, but the Connecticut Centralized Infractions Bureau set a $60 fine with additional fees for $43 for a total penalty of $103 for ICE-ing.[218] To date, Connecticut and 11 other states have passed legislation penalizing infractions for ICE-ing.[219] To help spread awareness of ICE-ing and infraction enforcement, DEEP should collaborate with state and municipal law enforcement authorities to develop easily disseminated educational materials to assist with enforcement of such penalties.

Policy Recommendations: Consistency of the consumer experience

Interoperability

1. All publicly-accessible Level 2 and 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.

Future-proofing

2. The make-ready portion of electrical infrastructure installed at publicly-funded, publicly-accessible locations should be capable of supporting chargers with a minimum 150 kW capacity.

3. Charging station developers should be encouraged to evaluate the potential to pair charging stations with on-site DERs when assessing and selecting a charging station location.
4. The potential future need for additional charging stations should be considered when installing make-ready electrical infrastructure and selecting the placement of charging stations at specific locations.

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[214] DEEP, *Guidelines for the Installation of Electric Vehicle Charging Stations at State-Owned Facilities* (revised Sept. 9, 2014), https://portal.ct.gov/-/media/DEEP/air/mobile/EVConnecticut/GuidelinesfortheInstallationofElectricVehicleChargingStationsatStateFacilitiespdf.pdf?la=en.
[215] 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/.
[216] Conn. Gen. Stat. § 16-19ggg(d).
[217] Conn. Gen. Stat. § 16-19ggg(c).
[218] Chart A Book—Superior Court, State of Connecticut. Centralized Infractions Bureau. Effective October 1, 2019. Retrieved December 31, 2019 from https://www.jud.ct.gov/webforms/forms/INFRACTIONS.pdf.
[219] Legislation Reference—Reserved Parking for Plug-In Vehicle Charging. PlugInSites.org. Retrieved December 31, 2019 from https://pluginsites.org/plug-in-vehicle-parking-legislation-reference/.

Uptime

5. Identify in contracts, for publicly-funded charging stations, the entities 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.

Multiple payment options

6. A mechanism should be developed for enforcement of the provisions set forth in Section 16-19ggg regarding the operation of publicly accessible EV charging infrastructure.
7. Each newly installed publicly-funded, publicly-accessible charging station should be required to accept payments, with appropriate consumer protections, via credit card reader and at least one other accessible form of payment as set forth in Section 16-19ggg.

Pricing transparency

8. DEEP will work with the Connecticut Department of Consumer Protection's Division of Food and Standards to establish a pricing transparency policy for all publicly-funded EV charging stations in Connecticut that would ensure fair and consistent disclosure of pricing information prior to, during, and after each charging session.

9. DEEP will work with the Connecticut Department of Consumer Protection's Division of Food and Standards to evaluate publicly-accessible charging station billing standards set forth in California.

Open communications protocols

10. Any publicly-funded networked charging station should be required to operate using open source non-proprietary communications protocols.

Signage (wayfinding and at-station)

11. Connecticut should continue to coordinate with TCI and NESCAUM member states to adopt uniform signage for wayfinding and charging station use and enforcement.

ADA compliance

12. The design and installation of all publicly-funded, publicly-accessible charging stations should adhere to best practices for compliance with the Americans with Disabilities Act.

ICE-ing

13. DEEP will collaborate with state and municipal law enforcement authorities to develop educational materials to assist with enforcement of ICE-ing infractions.

9 Minimizing Grid Impacts and Maximizing Benefits through Demand Reduction Measures

In New England, an EV penetration rate of 5 percent could result in an increase in peak demand of approximately 3.5 percent due to uncontrolled charging.[220] If vehicle penetration rates in the region reach 25 percent by 2030, peak demand could increase by nearly 20 percent if charging is not properly managed, which could require

[220] 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.

significant investment in the electric grid.[221] 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.[222] Given Connecticut's commitment to deploying 125,000 to 150,000 EVs by 2025 under the ZEV MOU, and the GC3-projected need to deploy 500,000 EVs by 2030, it is imperative to develop strategies that minimize the distribution system impacts of increased electric demand from EV charging. At a low penetration rate of 5 percent, it is likely that unmanaged charging, regardless of time of day or electricity demand, would only increase peak demand by around 3.5 percent and would have minimal impact on the state's grid. However, as the EV penetration rate climbs to over 20 percent, the increase in peak demand from unmanaged charging could exceed 20 percent. Peak demand increases at this level would likely result in the need for additional generation, transmission, and distribution capacity, and increased costs for ratepayers.

Although charging behavior, in most cases, will ultimately be dictated by the transportation needs of a driver, it is important that policies and practices are developed early on to ensure that optimal vehicle charging takes place, whenever possible, as the market penetration rate of EVs continues to grow.

Managed charging allows a utility, grid operator, 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 has the potential to provide a variety of benefits to EV drivers and ratepayers in general. Managed charging can help to flatten peak demand, improve the reliability of the grid, and maximize utilization of the grid and of clean energy sources. Managed charging programs in other states are most often administered by the EDCs via a networked charging station, onboard vehicle software, or behavioral load control through a mobile phone app and Wi-Fi connected toggle device.[223] Depending on the platform used to administer the program, EV drivers may schedule their charging sessions in response to price signals or their EDC may automatically manage their charging during demand response events. 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.

9.1 Active managed charging

Active management of EV charging relies on communication signals originating from an EDC or grid operator being sent to a charging station, or to a vehicle's onboard computer system, in order to control the power flow to a vehicle battery.[224] Active managed charging allows grid operators or EDCs to either curtail or halt the power flow to participants' EVs during periods of high electricity demand. It also allows for staggered charging between multiple EVs while still ensuring that the needs of program participants are met. For example, if multiple EVs on a circuit were plugged in at the same time, rather than charging all at once, each participant could indicate their desired state of charge by a certain time, and the EDC could intelligently coordinate the power flow to the vehicles so that each driver's needs are timely met while minimizing the impact of charging on the grid.

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[221] *Id.*
[222] 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.
[223] A Comprehensive Guide to Electric Vehicle Managed Charging. Smart Electric Power Alliance. May 2019.
[224] *Id.*

Due to active managed charging's reliance on communications signals, technologies must be utilized which allow for remote access to a charging station or a vehicle itself. Networked EVSE can provide these capabilities, particularly in a residential EV charging setting where a customer's Internet connection can enable communication between an EDC and the EVSE. Utilizing networked EVSE for actively managing residential vehicle charging is, however, limited to when a driver is plugged in at home. Several active managed charging programs have been piloted or implemented around the U.S. Regionally, Vermont's GMP offers customers who own EVs a free networked Level 2 charging station in exchange for allowing GMP to curtail power flow during demand response events.[225]

DEEP will explore the potential to pilot active managed charging programs that incent EV drivers to charge during off-peak periods, as this will become of increased importance in load management as EV adoption increases. A pilot program subscribing residential customers with networked Level 2 EV chargers where the EDCs can automate charging to occur during off-peak periods and curtail charging during specific peak events would provide useful data regarding the price signals necessary to influence charging behavior and maximize the benefits to participants and non-participants alike.

Many EVs currently being sold in the United States are equipped with sophisticated onboard computer systems capable of receiving wireless communications. This technology holds the potential for enabling managed charging through the vehicle itself rather than through the EVSE. One major advantage to controlling power flow through the vehicle is that managed charging can take place while the vehicle is plugged into virtually any charging station as connection to a networked EVSE is not required. However, drivers charging at public stations, especially those that charge a time-based fee, could be charged a higher cost per kWh should a curtailment occur during a charging session. Reducing the rate of charge for vehicles charging at public stations could also result in a vehicle being plugged in for longer periods of time, thereby limiting charging access for other drivers.

Utilizing onboard computer systems to actively manage EV charging requires collaboration between original equipment manufacturers (OEMs) and EDCs. For example, BMW partnered with California-based PG&E to develop the BMW ChargeForward pilot program, an active managed charging initiative in which eligible BMW EV drivers received incentives for their participation in exchange for allowing BMW to strategically manage their charging any time PG&E signaled a demand response event.[226] DEEP will engage with OEMs to identify opportunities for pilot programs similar to the ChargeForward pilot.

Active managed charging programs should prioritize the transportation needs of each EV driver and allow drivers to charge their vehicles when necessary. Therefore, most active charging management programs do allow participating customers to opt out during demand response events when they cannot forego charging their vehicles at that time.

9.2 Passive managed charging

Passive managed charging relies on the ability of EV drivers to receive price signals or demand response signals, and shift their charging behavior in response to these signals. It is likely that many drivers would be willing to forego or delay their EV charging, whenever possible, in exchange for incentives or reduced electricity costs. EV

[225] *Id.*
[226] BMW ChargeForward. BMW USA. Retrieved January 6, 2020 from https://www.bmwchargeforward.com/#/home.

charging can be passively managed through rate structures and incentives that effectively persuade EV drivers to charge during off-peak hours.

TOU rates have proven to be an effective tool for shifting residential EV charging to off-peak hours. Without TOU rates, EV drivers will likely charge their vehicles whenever it is most convenient. In many cases, charging is done during peak hours, as there is currently no rate disincentive for charging during periods of high demand. TOU rates can be applied to an isolated load such as an EV (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 have even begun offering dynamic TOU rates that allow customers to plan their electricity usage around electricity prices provided by an 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 an attractive tool for incentivizing consumers to shift charging behaviors to off-peak periods. EV-specific TOU rate structures enable EV drivers 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 significant benefit of EV-specific TOU rates 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 drivers on EV-specific TOU rates charged their vehicles during off-peak hours.[227] Furthermore, EV-specific TOU rates have also been proven to reduce customers charging costs. A study of the top five U.S. cities in EV sales (Los Angeles, San Francisco, Atlanta, San Diego, and Portland, Oregon) found that EV-specific TOU rates saved customers, on average between $116 and $237 per year.[228]

Traditional TOU rates, whether EV-specific or applied to an entire household, have some potential limitations. These rates are static and cannot be easily changed, and customer habits may be difficult to adjust once adopted. Effective EV charging rates should ensure that the choices customers make to minimize their costs are consistent with charging behaviors that minimize distribution system costs as a whole. Consumer behavior would dictate that EV drivers charge their vehicles 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 (SDG&E) on EV pricing and technology found that there was a learning curve on new rates for EV customers. The study concluded that for EV rates to be effective, they should be established early on (in advance of widespread vehicle electrification) to prevent EV drivers from developing less than optimal charging habits.[229]

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 SDG&E tested three TOU rates structures with varying price ratios found that EV drivers were more likely to alter their charging behavior in response to

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[227] 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.
[228] *Id.*
[229] Final Evaluation for San Diego Gas & Electric’s Plug-in Electric Vehicle Pricing and Technology Study. Nexant Inc. February 20, 2014. Retrieved September 10, 2019 from https://www.sdge.com/sites/default/files/SDGE%20EV%20%20Pricing%20%26%20Tech%20Study.pdf.

higher peak-to-off-peak ratios.[230] And 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 incent off-peak EV charging.[231] Both Eversource and UI provided testimony in the ZEV Docket that their current rate tariff offerings provide an adequate financial incentive to shift EV user charging to off-peak periods.[232,233] This issue should be explored further in the EDCs' next rate cases.

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.[234] However, the high cost of installing a separate utility meter for customers who wish to utilize an EV-specific TOU rate could be avoided through the use of a metering device built directly into the EVSE or sub-meters dedicated to EV charging. For these technologies to be effective they must be revenue grade, meaning that the EDCs can bill customers based on electricity usage reported from the secondary metering technology with a high degree of accuracy. And, since some of these technologies rely on a wireless connection, reliable Internet connectivity is also a requirement. Where those conditions are not easily met, customers should be encouraged to opt in to the EDCs' standard 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 an EDC to send price signals to customers based on grid constraints, current demand, and weather patterns in order to optimize EV charging load. Commonwealth Edison, an Illinois-based EDC, offers its customers a Basic Electric Service Hourly rate plan under which customers pay the hourly wholesale market price for electricity.[235] Customers can 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 dynamic TOU rates to be applied to a specific load, such as an EV, the same technologies used for other EV-specific TOU rates could potentially be utilized, but the metering technology would need to be capable of measuring usage in hourly intervals. Dynamic rates could prove valuable

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[230] 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.
[231] *Id.*
[232] Docket 17-12-03RE04 Correspondence, Eversource CT Electric Vehicle Solution Day 2 for 17-12-03RE04_FINAL.pptx. Eversource. Filed December 11, 2019. Retrieved March 6, 2020 from http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/bcc9fc75f936a254852584ce004d9794?OpenDocument.
[233] Docket 17-12-03RE04 Correspondence, 2019-12-11 UI Presentation - Zero Emission Vehicles #17-12-03RE04.pdf. Uil Holdings Corporation. Filed December 11, 2019. Retrieved March 6, 2020 from http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/a41504f3bafa5a99852584cd0063f476?OpenDocument.
[234] Heidell, Jim, and Lai, Diana. 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/.
[235] Current Rates & Tariffs. Commonwealth Edison Company. Retrieved September 15, 2019 from https://www.comed.com/MyAccount/MyBillUsage/Pages/CurrentRatesTariffs.aspx.

in their flexibility in addressing peak load as customers, specifically EV drivers, would be able to respond to low price signals which may occur during periods of high renewable generation, further incentivizing optimal charging behavior and ensuring that vehicles are being fueled with the cleanest energy available.

Although this sub-section has primarily discussed the implementation of passive managed charging through 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, launched SmartCharge New York, a voluntary rewards program for EV charging. Program participants are provided with a FleetCarma C2 device which plugs directly into their EV's onboard diagnostic system.[236] 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.[237] Rewards points are redeemable in the form of electronic gift cards and other cash equivalent options from a variety of program vendors. SmartCharge New York only rewards drivers for charging off-peak, and does not penalize drivers if they charge during peak demand periods. DEEP will continue to monitor the effectiveness of innovative program designs in other jurisdictions to incent off-peak charging.

9.3 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. Simultaneous charging of an entire fleet overnight, where possible, reduces vehicle down-time but may incur costly demand charges (further discussed in Section 10) 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 charging requires deliberate coordination and planning to optimize EV deployment and maximize electrification cost savings.

DOT's Hamden Bus Pilot, discussed in Section 6, offers a unique learning opportunity to assess how to maximize the benefits of deploying fully-electric transit buses, electric bus EVSE, and associated technologies and services, including distributed energy resources (DERs), battery storage systems, and demand response programs that may help minimize costs and impacts on both fleet managers and the distribution system. DEEP is currently conducting a proceeding pursuant to Public Act 15-5 in which it will 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.[238] Insights gained from the Hamden Bus Pilot may help inform changes to rate design (including demand charges) that could better enable deployment of future electric transit buses as well as other electrified medium- and heavy-duty vehicle fleets in Connecticut.

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

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[236] SmartCharge New York Program Guide. FleetCarma. Retrieved September 15, 2019 from https://www.fleetcarma.com/smartchargenewyork/setup/.

[237] *Id.*

[238] DEEP, Energy Filings, Public Act 15-15—Section 103—Grid-Side System Enhancements Demonstration Projects, http://www.dpuc.state.ct.us/DEEPEnergy.nsf/$EnergyView?OpenForm&Start=30&Count=30&Expand=43&Seq=4.

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."[239] 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. The potential should be explored for establishing a commercial EV fleet rate that incents off-peak charging and minimizes adverse impacts to the electric grid.

Policy Recommendations: Minimizing grid impacts and maximizing benefits through demand reduction measures

Active and passive managed charging

1. DEEP will explore the potential for an active managed charging program that incents EV drivers to charge during off-peak periods.
2. The EDCs' current TOU rate tariffs should be optimized, and EV-specific TOU rates and dynamic pricing should be evaluated as additional options, to shift charging behavior to off-peak periods.
3. DEEP will continue to monitor the effectiveness of innovative programs in other jurisdictions, unrelated to rate design, to incent off-peak charging.

Fleet charging

4. DEEP will explore options to examine distributed and grid-side technologies and services that could help to more cost-effectively integrate charging for the Hamden Bus Pilot and other fleet electrification initiatives through its Public Act 15-5 proceeding.
5. The potential should be explored for establishing a commercial EV fleet rate that incents off-peak charging and minimizes adverse impacts to the electric grid.

10 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. DCFCs 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. DC fast charging may become the most optimal method of public charging as vehicles with larger batteries capable of charging at higher speeds come to market.

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 provide a benefit to ratepayers by requiring the largest consumers of electricity to pay for the additional capacity to accommodate their needs. However, demand charges can have a significant impact on the development of a robust DCFC network in Connecticut.

Demand charges 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

[239] PG&E, News Release, PG&E Proposes to Establish New Commercial Electric Vehicle Rate Class (Nov. 5, 2018), https://www.pge.com/en/about/newsroom/newsdetails/index.page?title=20181105_pge_proposes_to_establish_new_commercial_electric_vehicle_rate_class.

or more of a station operator's utility bill.[240] 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.

According to RMI's 2019 *DCFC Rate Design Study*, demand charges complicate the economics of operating DCFCs while EV adoption and charger utilization rates are low.[241] When demand charges from DC fast charging utilization are greater than the revenue from such usage, the result is a net loss for charging station operators, which in turn hinders the deployment of DCFC infrastructure. The RMI study analyzed three load profiles,[242] each with different rate tariffs[243] and utilization rates (5 percent, 10 percent, and 30 percent).[244] The study demonstrated that RMI's sliding-scale approach created "the most consistent and predictable charging costs per mile" for three modeled utilization rates at 50 kW and 150 kW publicly-accessible DCFC stations. The study also found that light-duty fleets with short, predictable routes offer the greatest opportunity for matching charging patterns with electricity rates and electric distribution system needs. Lastly, the results found that Xcel Energy's rate tariff, which had a low fixed monthly charge, lower demand charges than normal in their service territory, and additional charges for charging during critical peak pricing periods created the lowest average cost per mile for transit bus fleets, for both partially managed and fully optimized charging to avoid on-peak charging scenarios.

In 2019, PURA approved a full demand charge waiver for Eversource on publicly-accessible DCFC for a period of three years.[245] To help mitigate cost shifts to other ratepayers while ensuring DCFC infrastructure is economically viable for publicly-accessible charging station owners and operators, DEEP recommends a reexamination of this issue for both Eversource and UI, and exploration of a demand charge structure with a sliding scale approach as recommended in RMI's *DCFC Rate Design Study.*

Public and private fleets, and in particular medium- and heavy-duty fleets, face real challenges that deserve particular attention when PURA considers rate design options. For example, public transit provides residents with a reliable, low cost mobility option that also reduces congestion and emissions by decreasing the number of single occupancy vehicles on Connecticut roadways. Demand charges present a barrier to electrifying the state's public

[240] 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

[241] Fitzgerald, Garrett and Nelder, Chris. DCFC Rate Design Study. Rocky Mountain Institute. 2019. Retrieved March 3, 2020 from http://www.rmi.org/insight/DCFC-rate-designstudy.

[242] A public DCFC charging depot with two dual-port 50 kW chargers, a public DCFC charging depot with two dual-port 150 kW chargers, and a transit bus depot with twenty-five 100 kW chargers.

[243] Xcel Energy rate tariff—low fixed monthly charge, lower demand charges than normal in their service territory, and add charges for charging during critical peak pricing periods; PG&E rate tariff—eliminates demand charges, includes a three-tier TOU pricing scheme, and a high fixed monthly subscription charged based on expected consumption; and RMI rate tariff—two-tier TOU pricing scheme with a sliding scale under which volumetric energy rates decrease and demand charges decrease over time as a function of the utilization rate.

[244] 5 percent utilization is representative of many DCFCs today, 10 percent utilization is likely within 5 years, and 30 percent utilization is likely once the EV market reaches maturation.

[245] *See* Decision, PURA Docket No. 17-10-46RE01, *Application of the Connecticut Light and Power Company d/b/a Eversource Energy to Amend its Rate Schedules—EV Rate Rider* (Mar. 6, 2019), http://www.dpuc.state.ct.us/DOCKCURR.NSF/60903cc7b9de44728525746b006e8ffb/78a25b4e83776981852583b50057c9d1/$FILE/171046RE01-030619.pdf.

transit fleet in a cost-effective manner and without a reduction in the level of service provided. DOT is required to electrify 30 percent or more its transit of its bus fleet by 2020 under Public Act 19-117.

While managed charging and co-location of DERs can assist in making the business case for fleet electrification, rate design also has a critical role to play. DEEP recommends that PURA consider commercial fleet charging 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."[246] 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. DEEP recommends exploration of the costs and benefits of a commercial EV fleet rate that incents off-peak charging and minimizes adverse impacts while maximizing benefits to the electric grid and other electric customer rate classes.

Policy Recommendations: Demand charges

1. DEEP recommends exploration of a sliding scale tariff approach for both Eversource and UI that is responsive to DCFC station utilization and EV market penetration.
2. DEEP recommends exploration of the costs and benefits of a commercial EV fleet rate that incents off-peak charging and minimizes adverse impacts while maximizing benefits to the electric distribution system and its customers.

11 Building Codes and Permitting Requirements

To better enable rapid and widespread deployment of EVs in Connecticut, state and local government building codes must advance and adhere to 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. A 2016 Cost-Effectiveness Report on EVSE in San Francisco found that for parking lots with 10 total parking spaces and two charging stations, estimated per charger infrastructure costs were $920 and $3,710 for new construction and retrofits, respectively.[247] Connecticut's 2018 State Building Code conforms to 2015 International Code Council (ICC) standards, and requires that all newly constructed residential garages be outfitted with a dedicated 20 amp, 120-volt circuit to accommodate Level 1 EV charging. 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 International Energy Conservation Code (IECC) standards.[248] In January 2020, the ICC approved new voluntary code changes that would require the installation of electrical panels, outlets, and conduits (40 amp, 208/240-volt) capable of supporting Level 2 EV charging in

[246] 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.

[247] Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco. Energy Solutions and Pacific Gas & Electric Company. November 17, 2016. Retrieved September 30, 2019 from http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-PEV-Infrastructure-Cost-Effectiveness-Report-2016.pdf.

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

single- and multi-family homes.[249] Moving forward, DAS, the 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 IECC standards for EVSE installation to keep pace with these rapidly evolving technologies.

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 MUDs and commercial developments be pre-wired for Level 2 EV charging during initial construction and reserve 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 6 below.

Table 6: EV parking space pre-wiring 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[250] for municipalities seeking to exceed the CALGreen baseline, DEEP recommends that the state consider enabling municipalities to adopt stretch codes setting forth voluntary pre-wiring requirements that 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.[251] Connecticut, with its own GHG reduction and EV

[249] Coren, Michael J. New US building codes will make every home ready for electric cars. Quartz. January 9, 2020. Retrieved January 30, 2020 from https://qz.com/1781774/new-us-building-codes-require-plugs-for-electric-cars/.

[250] 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.

[251] 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.

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 installations to meet future demand.

As discussed in Section 8.8, the design and installation of public charging stations must comply with ADA standards. General design considerations include accessibility, ease of use, and safety for disabled drivers, but federal standards specifying the number or design of EV charging station-equipped parking spaces do not currently exist.[252, 253] In the next Connecticut State Building 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 parking spaces. In 2016, California became the first state in the nation to codify ADA requirements for EVSE in its building code.[254] The California 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.[255] Some municipalities in western states such as Oakland, California and Boulder, Colorado 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.[256] The Southwest Energy Efficiency Project prepared EV-ready residential and commercial building code templates designed to meet EV market needs.[257, 258] Furthermore, municipalities can expand EVSE infrastructure installation through parking and zoning ordinances that govern the use of property by land use and occupancy type.

Some Connecticut municipalities have already begun preparing for higher levels of EV adoption. In 2018, the Planning and Zoning Commission in Middletown, Connecticut adopted a rule that requires developers with

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[252] ADA Requirements for Workplace Charging Installation, Guidance in Complying with Americans with Disabilities Act Requirements. DOE. November 2014. Retrieved Apr. 20, 2020 from http://www.dpuc.state.ct.us/DOCKCURR.NSF/60903cc7b9de44728525746b006e8ffb/78a25b4e83776981852583b50057c9d1/$FILE/171046RE01-030619.pdf.

[253] 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, DOE'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.

[254] California Building Code, title 24, part 2, vol. 1, ch. 11B (2019), https://codes.iccsafe.org/content/CABCV12019/chapter-11b-accessibility-to-public-buildings-public-accommodations-commercial-buildings-and-public-housing.

[255] 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.

[256] *Id.*

[257] 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.

[258] 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.

applications for over 25 parking spaces to include in their parking plans one EV charging station or 3 percent of total parking spaces for EVs, whichever amount is greater.[259] In addition, the rule specifies that the charging stations must be available for public use and include clearly visible signage regarding usage conditions, fees, and safety information. The Planning and Zoning Commission allows developers to apply for a waiver of these rules if they believe their project should not require EV charging infrastructure.

Other cities around the country have promoted more aggressive EV infrastructure in their zoning codes and parking ordinances. For example, in 2017 the City of Atlanta, Georgia passed its EV Ready Ordinance 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.[260] The City of Columbus, Ohio convened its Smart Columbus EV Policy workgroup, which included EV charging vendors and developers, community partners, and the Building and Zoning Services Department, to address conflicts between EV-only parking and the Columbus Zoning Code. As a result, the city passed an ordinance to revise the Columbus Zoning Code to specify that off-street parking spaces dedicated to EV charging and located outside of special parking areas are not counted toward the maximum number of off-street parking spaces, which helps ensure that EV charger buildout does not impede commercial development.[261] Prior to this parking ordinance, dedicated EV parking/charging spaces did not count toward developers' parking space calculations.

DCFC deployment is in its nascent stages and most jurisdictions have not permitted for such chargers.[262] 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*.[263] The *Electric Vehicle Charging Station Permitting Guidebook*, released by the California Governor's Office of Business and Economic Development in July 2019, also sets forth considerations and best practices for jurisdictions to streamline EVSE permitting requirements.[264] In Oregon, the State 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

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[259] Beals, Shawn R. Middletown Zoning Requires Electric Charging Stations for Large Developments. Hartford Courant. January 29, 2018. Retrieved Jan. 13, 2020 from http://www.courant.com/community/middletown/hc-news-middletown-electric-vehicles-20180126-story.html.

[260] 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=/.

[261] File #1171-2019, Legislation Details. City of Columbus. Retrieved October 8, 2019 from https://d2rfd3nxvhnf29.cloudfront.net/2019-08/City%20of%20Columbus%20EV%20Only%20Parking%20Ordinance%201171-2019.pdf.

[262] O'Grady, Elaine and Way, Jesse. Preparing our Communities for Electric Vehicles: Facilitating Deployment of DC Fast Chargers. May 2019. NESCAUM.

[263] Preparing Our Communities for Electric Vehicles: Facilitating Deployment of DC Fast Chargers. NESCAUM. May 2019. Retrieved April 20, 2020 from https://www.nescaum.org/documents/dcfc-permit-streamlining-whitepaper-final-5-14-19.pdf.

[264] Electric Vehicle Charging Station Permitting Guidebook. California Governor's Office of Business and Economic Development. July 2019. Retrieved December 30, 2019 from http://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf.

with EVSE providers, assessing a customer's site for EVSE for electric panel adequacy, obtaining a permit for applicable electrical installations (if necessary), EVSE installation by an electrician, inspection of the EVSE, and interconnecting the equipment with the grid.[265] This simplified permitting process provides for jurisdictions within Oregon to concurrently conduct building, electric, and other reviews, thus 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, O&M, and payment.[266] Given the rapid advancement in EV and EVSE technologies, and the focus on electrification of state-owned fleets as part of Executive Order No. 1, DEEP will 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.

Policy Recommendations: Building codes and permitting requirements

1. DEEP recommends that the State Building Code standards be updated 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 compliance requirements for EV charging stations.
2. DEEP recommends that the state adopt a voluntary municipal stretch building code and that municipalities adopt zoning ordinances with more stringent EV pre-wiring requirements.
3. DEEP recommends that the Codes and Standards Committee and the Office of the State Building Inspector adopt best practices for DCFC permitting and deployment Consolidate and streamline the permitting and inspection process for Level 2 EVSE and DCFC installations.
4. DEEP will update and publish guidelines for the installation of EVSE at state-owned facilities and public and private EV charging stations.

12 Innovation

Connecticut is home to many innovative and industry leading, technology-based businesses, including EVSE suppliers EVSE LLC and Juice Bar. Both companies have collaborated with municipalities and businesses across the country on sustainable EV charging solutions. Building upon this foundation, Connecticut should seek 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 DER pilot programs,[267] represents a potential catalyst for optimizing the integration of EVs into the electric grid and maximizing the value provided to ratepayers.

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

[266] Guidelines for the Installation of Electric Vehicle Charging Stations at State-Owned Facilities. DEEP. 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.

[267] 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.

12.1 Curbside charging

Across the state, municipalities have been working with the EDCs to convert streetlights and curbside lampposts to light-emitting diodes (LEDs), which greatly reduce energy consumption.[268,269] These replacement LEDs can reduce energy consumption by over 80 percent,[270] freeing up electrical capacity in streetlights and curbside lampposts, which can help expand 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.[271] 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 has fully embraced this strategy and has successfully installed EV charging stations on 132 streetlights around the city.[272] 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.

12.2 Vehicle-to-grid and vehicle-to-building technologies

V2G is a form of managed charging that enables bi-directional flows of energy between EVs and the grid, and V2B enables bi-directional flows of energy between EVs and buildings.[273] 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 or a building during peak demand periods or demand response events.[274] These two-way power flows have the potential to transform EVs into virtual power plants that can help regulate frequency and provide an additional source of revenue for EV drivers. That being said, V2G andV2B rely on EV drivers to more frequently recharge/discharge and may potentially shorten EV battery life.

To date, V2G via LDVs 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, limited access to auto manufacturer-certified inverter technologies, and inadequate financial compensation.[275] The V2G ecosystem, which consists of auto manufacturers, EV drivers, and electric grid operators must be configured in a manner that adequately compensates EV drivers for services they provide to the electric grid using auto manufacturer-certified

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[268] Zaretsky, Mark. UI conversion of streetlights to LEDs to conserve energy, save West Haven $388,000 a year. New Haven Register. October 17, 2017. Retrieved December 31, 2019 from https://www.nhregister.com/news/article/UI-conversion-of-streetlights-to-LEDs-to-conserve-12285268.php.
[269] Eversource Continues Streetlight LED Conversions in Greenwich. Greenwich Free Press. July 2, 2018. Retrieve December 31, 2019 from https://greenwichfreepress.com/around-town/eversource-continues-streetlight-led-conversions-108943/.
[270] Matulka, Rebecca. Top 8 Things You Didn't Know About LEDs. DOE. June 4, 2013. Retrieved December 31, 2019 from https://www.energy.gov/articles/top-8-things-you-didn-t-know-about-leds.
[271] 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.
[272] 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.
[273] 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.
[274] 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.
[275] 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.

inverter technologies. NREL is currently testing and exploring strategies for scaling V2G integration with building energy management systems, utility grids, and renewable energy sources,[276] but V2G applications for LDVs may not come to scale in the immediate future or at all.[277]

Auto manufacturers have begun partnering with EVSE providers to deploy EV charging infrastructure that can take advantage of V2G/V2B capabilities. For example, Princeton Power Systems introduced a commercially available EV charger/inverter, which operates under OCPP and is certified Nissan Leaf V2G/V2B compatible, to enable Nissan Leafs to provide backup power to buildings.[278] And in 2018 Nissan partnered with Fermata Energy through its Nissan Energy Share pilot to install bi-directional CHAdeMO chargers operational with Nissan Leafs at Nissan's headquarters in Franklin, Tennessee. The bi-directional chargers allow Nissan, through its Leaf EV fleet, to charge and discharge vehicle batteries to help provide electrical load to Nissan's headquarters facilities during peak demand periods and generate significant energy cost savings for the company.[279] Nissan is currently developing additional applications for V2G and V2B technologies.

V2G applications for electric school buses hold more promise and are being piloted in several states, including California, New York, and Virginia. Electric school buses are an ideal candidate to provide V2G services because they have long dwell times and 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 shortening the vehicle payback period or 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.[280]

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.[281] 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.[282] Under the first phase of the plan, Dominion Energy will spend $13.5 million to deploy 50 electric school buses and associated charging infrastructure.[283] Schools receiving electric buses will be responsible for O&M costs equivalent to roughly

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

[277] 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/.

[278] 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.

[279] Nissan to create electric vehicle 'ecosystem.' Nissan News USA. November 28, 2018. Retrieved January 1, 2020 from https://usa.nissannews.com/en-US/releases/nissan-to-create-electric-vehicle-ecosystem#.

[280] 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.

[281] 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/.

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

[283] 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/.

$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, the school district's EDC, contributed $500,000 toward the purchase of the buses provided Con Edison can use the batteries to store energy during summer months when the buses remain inactive.[284]

DEEP will continue to explore the potential for V2G/V2B pilots. 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.

12.3 Transactive energy marketplaces

Looking to the future, blockchain technologies, also known as distributive ledger technologies, and transactive energy marketplaces could create additional value for EV drivers who choose to charge their vehicles at times most beneficial to the electric grid. Blockchain is a decentralized, public ledger that securely records individual transactions in verifiable chronological order.[285] Using blockchain, these EV drivers could earn credits redeemable at merchants or retail businesses choosing to accept them as a form of currency.

In California, the Sacramento Municipal Utility Department has partnered with French utility, Électricité de France, to pilot a program that provides blockchain-based tokens to EV drivers who charge their vehicles when there is surplus renewable energy on the local grid.[286] The pilot program will utilize Chicago-based Omega Grid's digital ledger software to notify participants during periods of excess renewable generation and track participants' earned tokens. EV drivers can redeem these tokens at participating merchants. Ultimately, this pilot program will help assess the methods by which EVs and other types of DERs can participate in transactive energy marketplaces and provide greater value to the electric grid. Innogy SE, through its e-mobility startup Share&Charge, has implemented a peer-to-peer transactive energy marketplace in Germany that enables residential EV charger owners to earn compensation by renting out their chargers to EV drivers via a smart phone app.[287] The benefits of this type of peer-to-peer network, which include but are not limited to, increased availability of public charging stations, reduced range anxiety, increased utilization of existing assets, and faster payback for investments in residential EVSE, merit further monitoring and potential investigation by DEEP.

[284] 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/.

[285] Iansiti, Marco and Lakhani, Karim R. The Truth About Blockchain. Harvard Business Review. January-February 2017. Retrieved January 20, 2020 from https://hbr.org/2017/01/the-truth-about-blockchain.

[286] Thill, David. Chicago startup will help test hyperlocal electric vehicle incentive in California. Energy News Network. September 13, 2019. Retrieved October 1, 2019 from https://energynews.us/2019/09/13/west/chicago-startup-will-help-test-hyperlocal-electric-vehicle-incentive-in-california/?utm_source=newsletter&utm_medium=email&utm_content=Read%20more%20at%20Energy%20News%20Network...&utm_campaign=CEFF-%23187.

[287] Lielacher, Alex. Innogy Charges New Electric Car Fleet Using Ethereum Blockchain. Bitcoin Magazine. May 5, 2017. Retrieved January 1, 2020 from https://bitcoinmagazine.com/articles/innogy-charges-new-electric-car-fleet-using-ethereum-blockchain.

Policy Recommendations: Innovation

1. 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.
2. DEEP will explore the potential for V2G/V2B pilots.
3. DEEP will monitor potential opportunities for developing a transactive energy marketplace that rewards optimal EV charging behaviors and expands the public charging network.

13 Leveraging Incentives to Promote Equitable, Affordable EV Adoption

While the total cost of ownership for an EV in Connecticut may be lower than a comparable ICE vehicle, initial upfront costs are often a primary barrier for consumers and could limit 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.[288] Advances in battery technology will continue to bring EVs closer to price parity with ICE vehicles, but until the market reaches maturity, leveraging federal, state, and other financial incentives will remain essential to accelerating EV adoption. The following sections detail the history and potential future of incentive options.

13.1 Federal tax credits

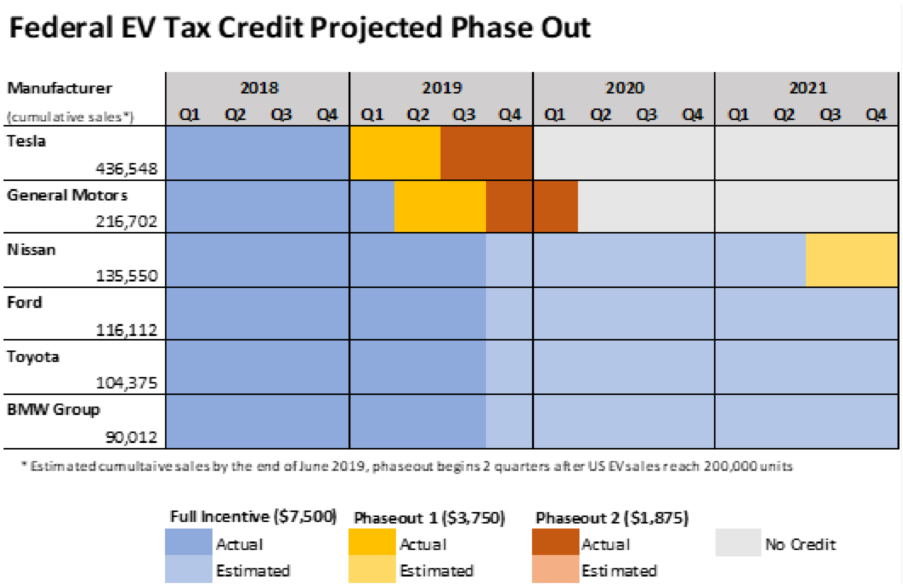
Federal government efforts to increase EV adoption have primarily come in the form of tax credits for new EV purchases and the installation of EV charging infrastructure. Currently, the federal Internal Revenue Service provides an income tax credit of up to $7,500 per new EV purchased for use in the U.S.[289] 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.[290] 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. Planning for CHEAPR program incentive levels must include consideration of potential shifts in federal incentives, either due to phase out, reauthorization, or changes to underlying regulatory programs.

[288] 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.

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

[290] 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.

Figure 11: 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/.

13.2 CHEAPR incentive program

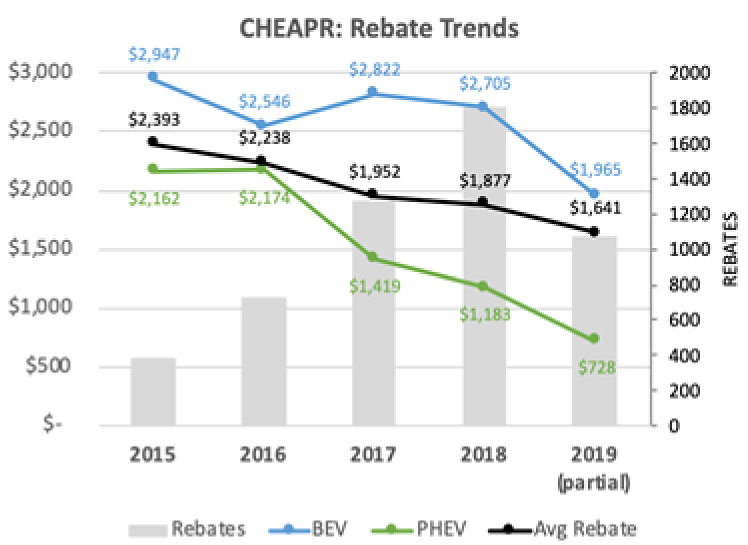
In 2015, in an effort to close the upfront price gap between ICE vehicles and EVs, DEEP launched the CHEAPR pilot program.[291] The program provides a point-of-sale rebate, up to $5,000, for Connecticut residents, businesses, and municipalities for the purchase or lease of a new eligible BEV, FCEV, or PHEV. CHEAPR was the first EV incentive program in the country to apply a rebate to the purchase price of the vehicle at the auto dealership. The CHEAPR rebate, when paired with the federal tax incentive, creates an incentive package that can in some cases (depending on battery range) reduce the cost of an EV by over $9,000. The consumer can either choose to have the rebate applied to reduce the cost of the vehicle or they may opt to retain the rebate, for example, to offset the cost of installing at-home charging equipment.

13.2.1 CHEAPR pilot program history

CHEAPR program funding historically has come from a variety of sources. Originally, CHEAPR was established and financed through settlement funds associated with the merger of Northeast Utilities (now Eversource) and NSTAR in April 2012. Funding was also provided by Avangrid as part of a broader commitment to EVs and other clean technologies set forth in a settlement agreement between Iberdrola USA and UIL Holdings Corporation. In addition, DEEP has contributed supplemental funding from clean air enforcement actions. In the past, a lack of sustainable funding made it difficult to enable incentives that scale with increased EV sales activity observed in recent years, particularly for BEVs (see Figure 12).

[291] CHEAPR Resources, EVConnecticut. DEEP. Updated October 15, 2019. Retrieved January 2, 2020 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=561434&deepNav_GID=2183.

Figure 12: Rebate averages and trends



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

At the outset, the CHEAPR program considered several criteria (e.g., battery size and vehicle range) before settling on 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. To date, the CHEAPR program has provided approximately $10.1 million in rebates toward the purchase or lease of over 5,666 EVs.[292] PHEVs have comprised 53 percent of the program-eligible vehicle sales and about 44 percent of all program dollars—reflecting the smaller rebate size allowed for PHEVs. BEVs, which reduce more GHG emissions and receive higher incentive levels under the CHEAPR program, have comprised 46 percent of program-eligible vehicle sales and more than half of program incentive dollars (see Figure 13). Since late 2017, uptake of incentives has increased largely related to the introduction of the Tesla Model 3, which accounts for 47 percent of all incentive dollars provided for BEVs (e.g. Chevy Bolt, Nissan Leaf, BMW i3, and Tesla Model 3).

Figure 13: CHEAPR funding and rebate totals

		Rebate Dollars	Rebates
PHEV	Plug-in hybrid electric vehicle (electricity and gasoline)	$4,471,000	3,047
BEV	Highway capable, four-wheeled, all-electric vehicle	$6,339,500	2,619
Total		$10,810,500	5,666

Source: Center for Sustainable Energy. DEEP Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Retrieved January 30, 2020 from https://portal.ct.gov/DEEP/Air/Mobile-Sources/CHEAPR/CHEAPR---Program-Statistics.

CHEAPR is crucial to satisfying Connecticut's commitment under the ZEV MOU and to ensuring that vehicle deliveries and EV sales occur in-state. As such, Section 94 of Public Act 19-117, passed in 2019, established a new

[292] Center for Sustainable Energy (2020). DEEP. CHEAPR, Rebate Statistics. Data Last updated February 24, 2020. Retrieved March 6, 2020 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=565018&deepNav_GID=2183.

statutory framework for CHEAPR, including a stable funding source and a new governing board consisting of representatives from state agencies, environmental organizations, environmental justice communities, and the Connecticut Green Bank.[293] The legislation allocates $3 million annually through the end of 2025 toward rebates for Connecticut residents who purchase or lease a new BEV, PHEV, or FCEV; or who purchase a used EV or FCEV. The newly established CHEAPR Board is responsible for setting appropriate rebate levels and maximum income eligibility for rebates, and will conduct annual program evaluations. To ensure the success of the new CHEAPR program, the CHEAPR Board should undertake a thorough assessment of the pilot program and its evolution over the last five years.

13.2.2 Lessons learned from the CHEAPR pilot program

Over the lifetime of the program, CHEAPR has been adjusted several times as necessary to adapt to advances in technology, evolving market conditions, and funding shortfalls. DEEP has worked closely with Connecticut's EDCs and the Center for Sustainable Energy (CSE)[294] to gather and analyze both market trends and programmatic data to inform adjustments to incentive levels and the list of eligible vehicles. The ability to adapt program parameters quickly in light of rapidly evolving market conditions and limited funding remains critical to maintaining program solvency and success.

Changes in the number of available EV makes and models, increases in all-electric range, and expanded consumer awareness have had a noticeable impact on the program utilization rate. Since BEVs receive a higher rebate, as new BEV models are introduced and popular BEV models become widely available, the average vehicle rebate increases and the number of vehicles that can be funded decreases. These conditions make it necessary to adjust rebate levels and bins in order to ensure that the state's limited funding puts as many EVs on the road as possible.

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. Figure 14 displays historical rebate levels as organized in program bins for the CHEAPR program.

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[293] Public Act 19-117, *An Act Concerning the State Budget for the Biennium Ending June 30, 2021, and Making Appropriations*, sec. 94, https://www.ct.gov/deep/cwp/view.asp?a=2684&q=602744&deepNav_GID=1619.

[294] The Center for Sustainable Energy (CSE) is the pilot program administrator responsible for data tracking and program analysis. Specifically, CSE monitors EV market trends and tracks changes in available vehicle model types, ranges, and releases; consumer feedback; rebate location; and projected program funding.

Figure 14: Historical CHEAPR rebate levels and program bins

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

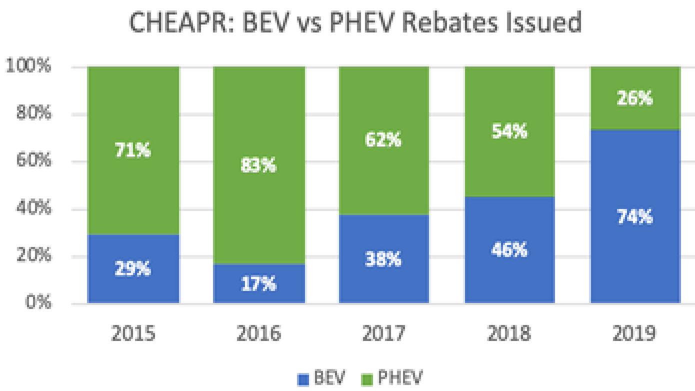
Battery Electric Vehicle (BEV)	
Incentive Amount	EPA Rated Electric Range
$1,500	200 miles or greater
$500	Less than 200 miles

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

Most recently, when funds were running out in the fall of 2019, DEEP was faced with the prospect of suspending the CHEAPR program and resuming it when funding provided by Public Act 19-117 becomes available in 2020. However, DEEP concluded that halting the program would inflict long-term damage on EV adoption by causing customer confusion and undermining auto dealer confidence in availability of the rebate. Ultimately, DEEP reduced incentive levels and lowered 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 CHEAPR program's $3 million annual budget, while the CHEAPR Board continues its deliberations on future program optimization.

As battery technology improved and all-electric driving range increased, the share of rebates going to BEVs overtook those going to PHEVs (see Figure 15). Existing CHEAPR data suggests that sales of BEVs will vastly outnumber sales of PHEVs in the coming years. Some EV manufacturers have stated their intention to eliminate their existing PHEV models and focus solely on BEVs, or only introduce new BEV models, while others are taking a more diversified approach to product development.[295]

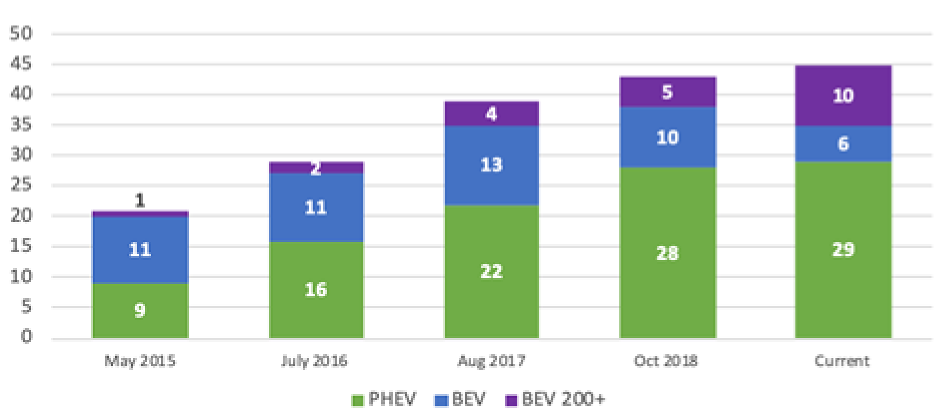
Figure 15: Rebate percentages by vehicle type over time



Source: Center for Sustainable Energy. DEEP Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Data retrieved February 28, 2020 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

To better understand exactly how model availability and increases in all-electric range affect 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 (see Figure 16). As the number of 200+ mile range BEVs increases, consumer confidence grows due to reduced range anxiety. Further advancements in battery technology and increased model type availability will help EVs reach cost parity with ICE vehicles in the next few years, but the CHEAPR program must continue adapting to market conditions until this occurs.

Figure 16: CHEAPR U.S. model availability at time of bin changes



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

[295] 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/.

As demonstrated by the figures above, tracking CHEAPR pilot program metrics such as rebate redemption by vehicle availability, model type, and all-electric range will be important to informing when and how rebate levels and program bins should be adjusted in future program iterations.

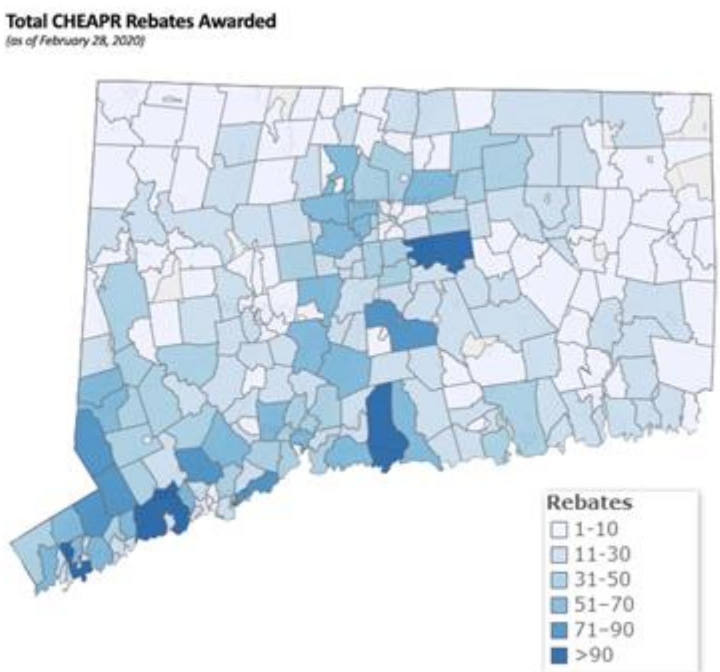
Public awareness of the CHEAPR program is critical to its success and can be increased through marketing or through information shared by the auto dealer. Understanding rebate applicants and how they became aware of CHEAPR is important to make the program more effective in the future. CSE can analyze data collected through the consumer survey completed by the auto dealer to inform program planning processes.

Survey data includes information on cars being replaced, rebated vehicle costs, household income, and the importance of the rebate to a consumer's purchase. 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 and $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.

Additional data beyond the consumer survey, such as rebate locations (see Figure 17) and uptick of rebate applications, will help inform the scope of the program's reach and may also serve to inform preferable locations for deploying EVSE in Connecticut. More specific information about rebate location, such as the customer's address, would be helpful to the EDCs in their distribution system planning, as further discussed in Section 7.1.1, and consideration should be given to requiring the provision of such information as a condition of the rebate. The CHEAPR survey could also be leveraged to refer customers into 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. The future CHEAPR program should continue awareness tracking efforts and expand those efforts to gather more information, particularly where it can be used to assess equitable participation in the program.

Figure 17: CHEAPR rebates by location



Source: Center for Sustainable Energy. DEEP Connecticut Hydrogen and Electric Automobile Purchase Rebate, Rebate Statistics. Data last updated July 26, 2019. Retrieved February 28, 2020 from https://ct.gov/deep/cwp/view.asp?a=2684&q=565018.

From its inception, the CHEAPR pilot program greatly benefited from consistent collaboration between DEEP, CARA, CSE, and the EDCs in designing a program that would optimize how EV incentives were delivered to consumers. The retention of CSE, a contractor with extensive knowledge in administering EV incentive programs, enabled CHEAPR to efficiently and flexibly evolve to meet changing needs. The partnership and participation of CARA and its members helped further efforts to promote EVs in auto dealer showrooms across the state. In addition, auto dealers' willingness to process paperwork for the rebate using an online application at the time of sale has greatly simplified program administration. Recognizing the importance of not only the auto dealers' time and cost of participation in processing rebate applications, but also their enthusiasm for promoting these new vehicles, DEEP designed the CHEAPR program to provide a financial incentive to auto dealers for each CHEAPR rebate processed. Initially, auto dealers received $300 for each rebate, but like the rebate itself, this incentive has since been revised downward to $150 to align limited funding dollars to increased sales.

As the CHEAPR Board considers the future of the program, it will have to decide if continuing the auto dealer purchase incentive will be fruitful. CSE survey data suggests that, while it does help to increase consumer awareness, the majority of auto dealer incentives are not distributed to sales representatives and only result in a moderate change in incentive to sell EVs.[296] The auto dealer incentive may have been necessary during CHEAPR's earliest years, but the availability of greater numbers, models, and types of EVs and the need to maximize available funding for EV deployment may necessitate the discontinuation of the auto dealer incentive.

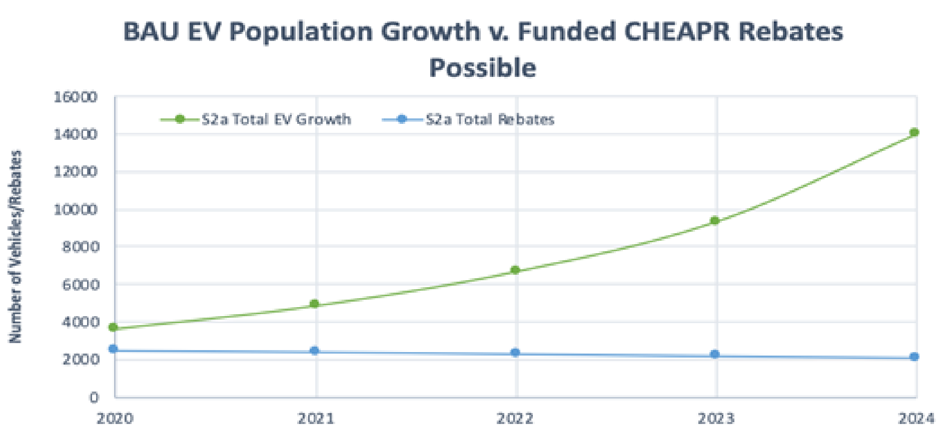
[296] Evaluating the Connecticut Dealer Incentive for Electric Vehicle Sales. Center for Sustainable Energy. June 2017. Retrieved September 10, 2019 from https://energycenter.org/sites/default/files/docs/nav/research/CT-Dealer-IncentiveEvaluation-CSE-2017.pdf.

13.2.3 Adapting CHEAPR incentives to EV market changes

Implementation of CHEAPR beyond the pilot phase should prioritize expanding the program to provide rebates for used EVs and enabling CHEAPR to remain nimble and adaptable to evolving market conditions. As noted above, $18 million is allocated over the next six years to fund the program—including both new and, for the first time, used rebates—at a level of $3 million per year. In advance of this new funding, DEEP modeled EV growth scenarios using Connecticut DMV registration data to determine how many rebates the new funding will support (see Figure 18).

Based on rebate incentive levels effective October 15, 2019, DEEP estimates the $18 million in new funding should support between 13,000 and 16,900 EV rebates. The low end of this range represents modeling done with the existing dealer incentive in place, while the upper limit of the range does not include the dealer incentive. This stable funding, with incentives provided at these levels, will help advance EV deployment in-state, but may require additional support to reach the scale necessary for Connecticut to meet its ZEV MOU commitment. These conclusions will be highly dependent on factors including MSRP trends, availability of federal incentives, and other factors that will affect consumer uptake of EVs. Other factors will include the general economic conditions from the COVID-19 pandemic on vehicle sales generally, and EV sales specifically. DEEP will closely monitor these trends to assess potential funding needs for future years. The new CHEAPR program will need to resolve this challenge to avoid operational and funding gaps in the program, which have negatively impacted other state EV incentive programs as discussed above.

Figure 18: 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 were used to estimate how many funded rebates would be possible using allocated funding.

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.[297] 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 auto manufacturers typically rely

[297] 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.

on a three to five year product planning cycle. Public Act 19-117 requires annual evaluation of the CHEAPR program. It will likely be necessary to recalibrate future CHEAPR incentive levels on at least an annual basis to reflect changing market dynamics.

13.2.4 CHEAPR used vehicle rebates

Public Act 19-117 requires the CHEAPR Board to develop a rebate for used EVs, with an associated income-level cap. This component will serve to expand the program into the secondary EV market and will benefit many Connecticut residents who primarily purchase used vehicles. Across the U.S., consumers purchased 17.3 million new vehicles compared to 40.2 million used vehicles in 2018.[298]

Expanding the EV rebate program to include used vehicles implicates several considerations not addressed in the current program. According to the Connecticut DMV, there are over 1,600 used car dealers in Connecticut.[299] Under the existing CHEAPR program rules, only new car dealers qualify, of which there are approximately 270. Dealer outreach and education will need to increase substantially under the new program. Additionally, the need to demonstrate income eligibility on rebate applications may implicate privacy concerns and could necessitate increased security and administration in verifying applications.

Information on program structure and administration can also be gained from other states that have implemented their own LMI rebate options, such as California and Oregon. California offers up to $5,000 for a used EV eight years old or newer with 75,000 miles or less, and Oregon offers up to $2,500 toward the lease or purchase of used BEVs, pending income verification.[300] The CHEAPR Board should also examine used EV rebates offered by EDCs such as New Hampshire Electric Co-op (NHEC). NHEC provides rebates of $600 and $1,000 toward the purchase or lease of new or used PHEVs and BEVs, respectively.[301] However, NHEC specifies that each EV can only receive the rebate once, verified by the vehicle identification number, which prevents double-counting and providing rebates to vehicles that have already received them.

In implementing the new CHEAPR program, the CHEAPR Board should prioritize contracting with a program administrator that possesses experience in the development and implementation of rebate programs that include used EV rebates and income eligibility requirements.

13.2.5 CHEAPR incentives for FCEVs

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

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[298] 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.

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

[300] Used Electric Vehicle Buyer's Guide. Plug-in America. Retrieved January 10, 2020 from https://pluginamerica.org/wp-content/uploads/2019/11/Used-EV-Buyers-Guide.pdf.

[301] NH Electric Cooperative's (NHEC) 2019 Electric Vehicle Program—Terms and Conditions. New Hampshire Electric Cooperative. Retrieved January 10, 2020 from https://www.nhec.com/wp-content/uploads/2019/01/2019-Electric-Vehicle-Rebate-Terms-and-Conditions.pdf.

Hydrogen Economy Fuel Cell Electric Vehicle Fleet Deployment Plan[302] recommends deployment goals for Connecticut of 591 FCEVs and 6 to 7 hydrogen fueling stations by 2025. To date, there are three 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.

13.2.6 CHEAPR low-income verified rebates

Personal vehicle ownership may not be feasible or preferable for a segment of low-income households and residents living in underserved communities. Making vehicle ownership more accessible for residents with low incomes is but one aspect of an equitable approach to vehicle electrification. Despite the financial hardship of vehicle ownership, many residents with low incomes—particularly in areas where housing, employment, and other frequent 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 low-income residents' opportunities to purchase EVs, the state can equitably broaden access to both new and used EVs through innovative incentive programs. For low-income residents considering the purchase of a personal vehicle, used EVs will likely be more affordable than new EVs. As noted above, the CHEAPR Board will propose parameters for administering used EV rebates, but DEEP is recommending that the Board explore opportunities to offer an additional supplemental rebate for low-income residents purchasing a new or used EV, pending income verification.

Supplemental income-verified rebates have been implemented in other states and the CHEAPR Board should assess the impact of these rebates on EV adoption in low-income communities. California and Oregon offer $2,000[303] and $2,500,[304] 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 an auto dealer are eligible for a $2,500 rebate under Oregon's Charge Ahead Rebate program.[305] In California, 17,126 low-/moderate-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 (CVRP).

13.3 Learning from other states

Beyond Connecticut's own experience with the CHEAPR pilot program, much can be learned from the successes and failures of EV rebate programs implemented in other states. For example, the Oregon and California programs include elements to enhance participation of LMI customers, while the Maryland and Georgia programs provide valuable lessons regarding maintaining momentum and gap funding. A description of these programs follows.

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[302] 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.

[303] 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.

[304] 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.

[305] 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.

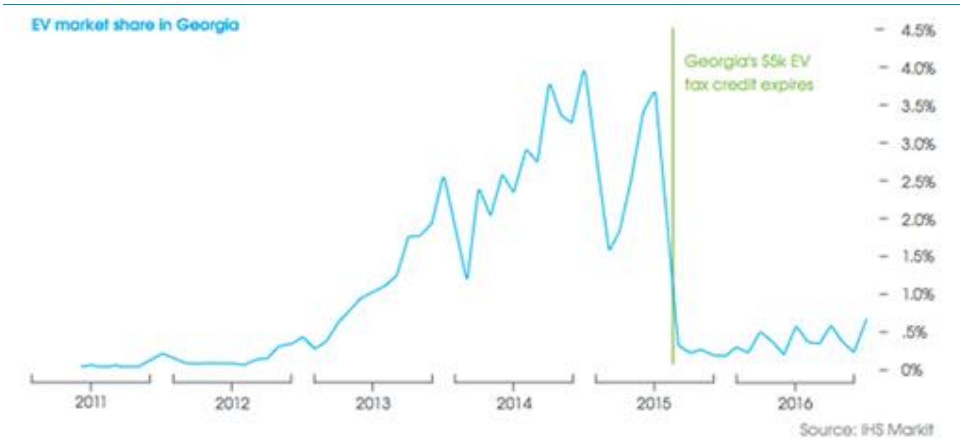
California

The California 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, the CVRP has undergone numerous revisions. For example, rebate levels have been adjusted to maximize existing funding, while additional funding has been added throughout the program. The CVRP introduced an increased rebate amount for low-income consumers in 2014 and established a program-wide income eligibility cap in 2016.[306] As of December 2019, California had provided $823 million dollars for over 359,000 vehicles.[307] The CVRP currently has a waiting list due to funding shortages and large numbers of rebate applicants.

Georgia

In 2001, the state of Georgia introduced a generous $5,000 tax credit for BEVs, which, for reasons including a 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[308] 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 (see Figure 20). Georgia sold a combined 6,004 PHEVs and BEVs in 2018 as available models increased, but without any financial incentives EV market growth in-state has not and likely will 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.

[306] Income Eligibility, California Clean Vehicle Rebate Project. Center for Sustainable Energy. Retrieved January 6, 2020 from https://cleanvehiclerebate.org/eng/income-eligibility.
[307] Center for Sustainable Energy (2019). California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics. Data last updated December 30, 2019. Retrieved January 6, 2020 from cleanvehiclerebate.org/rebate-statistics.
[308] 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/.

Maryland

Maryland's EV rebate credit provides up to $3,000 for the purchase of a new, qualifying EV.[309] Maryland's program is funded at a level of $6 million per year, and upon depletion of the funding the program establishes a waiting list for future rebates.[310] As of July 1, 2019, program funds have been depleted, and the waiting list will currently subsume the $6 million in available funding for next year as well.[311] 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 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. Disruptions in program funding can hamper consumer confidence and affect vehicle purchasing patterns.

Massachusetts

The Massachusetts Offers Rebates for EVs (MOR-EV) program, introduced in 2014, has provided over $31 million for nearly 15,000 EV rebates.[312] 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. At the outset of the program, rebates were capped at $2,500 for both BEVs and PHEVs, but over time adjustments were made to ensure program solvency. At one point, rebates for BEVs were reduced to $1,500 per vehicle and rebates for PHEVs were eliminated entirely. However, the Massachusetts Department of Energy Resources reestablished the MOR-EV program in 2019, making at least $27 million available per year in 2020 and 2021, and restoring rebate amounts to $2,500 per new BEV under $50,000 MSRP and $1,500 per new PHEV with an all-electric range of 25+ miles and MSRP under $50,000.[313]

Annual evaluations of the MOR-EV program can be found on its website.[314] Chief among the recommendations found in the annual reports is the need for more auto dealer outreach, as only one-third of survey respondents in the program reported hearing about the rebate from an auto dealer. Additionally, as mentioned above, program data can be invaluable in planning for charging infrastructure, as only one-third of respondents reported having access to a workplace charging unit.[315]

New Jersey

In 2020, the New Jersey Board of Public Utilities will begin offering state residents a rebate in the amount of $25 per mile of all-electric range, up to $5,000, toward the purchase or lease of a new BEV or PHEV with an MSRP of

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[309] 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.
[310] *Id.*
[311] 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.
[312] Center for Sustainable Energy (2019). Massachusetts Department of Energy Resources Massachusetts Offers Rebates for Electric Vehicles, Rebate Statistics. Data last updated December 23, 2019. Retrieved January 6, 2020 from https://mor-ev.org/program-statistics.
[313] MOR-EV. Massachusetts Offers Rebates for Electric Vehicles. Retrieved January 6, 2020 from https://mor-ev.org/.
[314] MOR-EV. Massachusetts Offers Rebates for Electric Vehicles. Retrieved January 6, 2020 from https://mor-ev.org/resources.
[315] 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.

$55,000 or less. Rebates may be limited to one award per person. Eligible vehicles must be purchased or leased after January 17, 2020. The PHEV rebate expires December 31, 2022, and the BEV rebate expires June 30, 2030. In addition, New Jersey does not charge sales tax for EVs. Moreover, ZEVs sold, rented, or leased in New Jersey are exempt from both the state sales and use tax. This exemption does not apply to partial ZEVs, including hybrid electric vehicles. ZEVs are defined as vehicles that meet CARB zero emission standards for that model year.

New York

In 2017 New York established the Drive Clean Rebate, a $70 million program designed to provide EV rebates. NYSERDA administers the program, which provides rebates of up to $2,000 toward the purchase or lease of an EV, based on electric range. NYSERDA directed $55 million of the funding to rebates, while $15 million is being used for EV awareness and marketing.[316] As of December 2019, nearly $29 million in funding has been spent on over 20,500 vehicle rebates.[317] Given New York's proximity to Connecticut, DEEP will continue to monitor the Drive Clean Rebate program to inform the further development of CHEAPR.

Oregon

In 2018, Oregon introduced the Clean Vehicle Rebate Program, which provides a rebate of up to $2,500, for qualifying EVs with a base price of $50,000 or less.[318] The Oregon Clean Vehicle Rebate Program receives $12 million per year until the program sunsets on January 2, 2024.[319] Unlike most states, zero-emission motorcycles qualify for rebates. 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 also receive the additional $2,500 "Charge Ahead" rebate. Applicants must indicate their intention to apply for the Charge Ahead rebate on the application. The Oregon Department of Environmental Quality contacts the Charge Ahead applicant at a later date to obtain the information necessary to meet those requirements.

The Charge Ahead aspect of the rebate 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 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 could be helpful additional resources to assist LMI applicants.[320] Providing this relief to LMI customers could help to promote the equitable and inclusive expansion of EV ownership.

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[316] 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.

[317] Drive Clean Rebate Primary Statistics. New York State Energy Research and Development Authority. Data last updated December 19, 2019. Retrieved January 6, 2020 from https://www.nyserda.ny.gov/All-Programs/Programs/Drive-Clean-Rebate/Rebate-Data/Rebate-Stats.

[318] Requirements for Standard Rebate Applicants. Oregon Department of Environmental Quality. Retrieved January 6, 2020 from https://www.oregon.gov/deq/aq/programs/Pages/Standard-EV-Rebate.aspx.

[319] Frequently Asked Questions, Oregon Clean Vehicle Rebate Program. Oregon Department of Environmental Quality. Updated September 2019. Retrieved January 6, 2020 from https://www.oregon.gov/deq/FilterDocs/zev-faq.pdf.

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

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 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 adopters wanes. Additional funding sources are necessary to incent the adoption of significant numbers of EVs necessary to meet the state's GHG reduction targets and health-based air quality standards.

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

1. Continue to collect and analyze CHEAPR purchase survey data to implement changes that improve overall program effectiveness.
2. Move expeditiously to implement the revised CHEAPR program per Public Act 19-117, including:
    - Establish rebate parameters, including rebate levels, bins, LMI components, MSRP, eligibility criteria, and strategy to communicate program adjustments.
    - Consider implementation options with and without auto dealer incentive.
    - Maintain and expand education, marketing and outreach.
    - Develop strategies to manage exhaustion of funding each year.
    - Retain a program administrator familiar with used electric vehicle rebates.
    - Establish metrics necessary to maintain program health and funding.
3. Support expansion and extension of the Federal EV Tax Credit.
4. Work to develop market-based incentives to support EV adoption through TCI, the EDCs, and the OEMs.
5. Maintain FCEV rebates at current levels through the next five years of the program along with the development of infrastructure to incent the deployment of FCEVs.

14 Education, Marketing, and Outreach

Public incentives and infrastructure availability can have a positive impact on EV adoption rates, but such policies and tools must be recognized and understood by consumers in order to improve the perception of EVs and increase uptake.[321] Research demonstrates that many consumers are unaware of EVs' operational capabilities and charging needs, and therefore may be unable to truly evaluate the costs and benefits of EV ownership.[322] In addition, consumer awareness of state and federal incentives is critically low. In fact, a 2016 survey by UC Davis indicated that just under 45 percent of consumers in the NESCAUM region were aware of federal EV incentives and just under 15 percent were aware that incentives existed in their respective states.[323, 324] The study further indicated that consumers consistently characterize their knowledge of EVs as being well below that of their knowledge of ICE vehicles, especially when asked if a BEV could meet their transportation needs.[325] These surveys

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[321] 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

[322] 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/.

[323] 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/.

[324] Kurani, Kenneth and Caperello, Nicolette. New Car Buyers' Valuation of Zero-Emission Vehicles: California. Institute of Transportation Studies, University of California, Davis. 2016.

[325] *Id.*

demonstrate that an increased education, marketing, and outreach effort is necessary to expand awareness among the general public and accelerate EV adoption more broadly.

Connecticut, specifically DEEP, along with the other NESCAUM states, understands that the education, marketing, and outreach strategy employed to accelerate EV adoption must be comprehensive and requires regional coordination to identify and implement best practices. An effective education, marketing, and outreach strategy should include the use of visual and informative advertising, positive recognition of leadership in the field, and the availability of experiential opportunities such as ride-and-drive events. A successful strategy will effectively leverage the time, investment, and expertise of parties[326] at the forefront of transportation electrification and lead to heightened consumer awareness and direct EV sales in Connecticut and the region.

14.1 Auto dealers

Until 2018, the ZEV Program operated with a "travel provision" that enabled auto manufacturers to accrue compliance credits in Connecticut for EVs that were sold in California.[327] This provision had previously allowed auto manufacturers to double-count a portion of their EV sales without selling EVs in Connecticut. The expiration of this provision is expected to result in greater numbers of EVs and greater diversity of EV models for direct sale or lease to customers in Connecticut.

Auto dealer 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 auto dealer personnel that possess a strong working knowledge of vehicle capabilities and Connecticut's charging infrastructure. Auto dealers and their sales teams are uniquely positioned to convey information regarding EV attributes, including technology specifications, vehicle availability, affordability, and comfort to prospective EV drivers. Moreover, well-informed sales representatives can increase consumer awareness of federal and state financial incentives. Ultimately, auto dealers that invest time and effort to achieve credible understanding of EV technology and to promote and educate customer awareness will be rewarded with greater EV sales revenue.

According to the Sierra Club's 2016 and 2019 multi-state study of EV shopping at auto dealers, *Rev Up EVs*, there is room for improvement in EV education and promotion.[328] The 2016 study found that almost half of auto dealers failed to display their EVs and many study participants had trouble locating a single EV in sales lots. Other participants reported that dealer representatives failed to mention state and federal EV purchase incentives, and some EVs could not be test-driven due to insufficient charge levels. Connecticut auto dealers visited as part of the 2016 study scored between 3.0 and 3.9 on a 5-point 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. In the 2019 study, participants found that nearly 75 percent of auto dealers nationwide are not selling EVs, many do not

[326] Includes, but is not limited to, applicable state agencies, OEMs, auto dealerships, EDCs, and charging station developers

[327] 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.

[328] REV Up EVs: A Multi-State Study of the Electric Vehicle Shopping Experience. 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.

prominently display EVs, and sales representatives were unfamiliar with state and federal incentives.[329] It bears noting that 14 Connecticut auto dealers received the highest possible score for overall EV shopping experience in 2016, but zero Connecticut dealers achieved that status in 2019.

As EVs continue to grow in popularity, it is likely that consumers interested in buying EVs, but lacking EV experience, will seek out auto dealers that excel in EV sales and technology expertise. An auto dealer recognition program could motivate EV sales, and signal to consumers which auto dealers are leaders in the EV market. DEEP, in partnership with CARA, established the CHEAPR Dealer Award (formerly known as the R*EV*olutionary Dealer Award) to publicly recognize auto dealers with the greatest impact to EV proliferation throughout Connecticut.[330] DEEP will consider expanding future eligibility for the CHEAPR Dealer Award to include used vehicle auto dealers that are accelerating EV adoption in Connecticut. In general, metrics for recognition should include inventory quantity and variety, test-drive availability, use of EV loaners by service departments, EV sales and leases, marketing campaigns, and education and outreach efforts.

14.2 Auto manufacturers/OEMs

Consumer survey data suggest that many rebate applicants thus far are perceived as "early adopters," or people who were already familiar with EVs when they began the purchasing process.[331] Given the ongoing shift in EV purchaser demographics from early adopters to mainstream consumers, greater spending for EV advertising campaigns by OEMs, which have a significant impact on consumer awareness of EVs, will be necessary to reach this broader demographic. A recent analysis of OEM advertising spending[332] found that auto manufacturers as a whole invested less than 10 percent of their total advertising budget on EVs.[333] However, recent spending toward positive EV marketing ads appears to be increasing as more attractive makes and models enter the market. For example, Audi spent more than $5 million for an NFL Super Bowl LII advertising spot to introduce the Audi e-tron GT nationally,[334] and Ford has aired nearly 50 national commercials for its 2021 Mustang Mach-E since late November 2019.[335]

[329] REV Up EVs: A Nationwide Study of the Electric Vehicle Shopping Experience. Sierra Club. November 2019. Retrieved January 2, 2020 from https://www.sierraclub.org/sites/www.sierraclub.org/files/press-room/2153%20Rev%20Up%20Report%202019_3_web.pdf.

[330] EVConnecticut: Dealer Awards. DEEP. Retrieved August 14, 2019 from https://www.ct.gov/deep/cwp/view.asp?A=2684&Q=539780.

[331] 45% of respondents reported that they were "only interested" in purchasing an EV. Center for Sustainable Energy Consumer Survey Report. Retrieve March 9, 2020 from https://energycenter.org/sites/default/files/docs/nav/resources/DAC_Summary-CVRP_Cnsmr_Srvy_2013-15.pdf.

[332] This analysis compares the 2018 advertising expenditures in local markets in California and the Northeast for the best-selling EV model and the selling ICE vehicle model from six of the top EV manufacturers. The data includes estimated expenditures for TV, radio, print, and online advertising and does not include ads run nationwide.

[333] 2018 EV Advertising Spending. NESCAUM. October 2019. Retrieved January 2, 2020 from https://www.atlasevhub.com/wp-content/uploads/2019/11/2018-EV-Marketing-1.pdf.

[334] Halvorson, Bengt. Audi Super Bowl ad: Heavenly electric-car future, hackneyed themes? Green Car Reports. February 3, 2019. Retrieved January 16, 2020 from https://www.greencarreports.com/news/1121293_audi-super-bowl-ad-heavenly-electric-car-future-hackneyed-themes.

[335] 2021 Mustang Mach-E Ford TV Commercial, 'New Breed' Featuring Idris Elba. iSpot.tv. Retrieved January 16, 2020 from https://www.ispot.tv/ad/ZOaz/2021-mustang-mach-e-ford-new-breed-featuring-idris-elba-t1.

14.3 The EDCs

The ability to reach large statewide customer bases puts EDCs in a unique position to advance consumer education and awareness of EVs and associated charging infrastructure, and recruit customers for innovative demand response pilots and programs. However, EDCs generally have not been at the forefront in education, marketing, and outreach efforts for EVs. This is partly attributed to PUCs not requiring that EV-related proposals contain funding for education, marketing, and outreach. EDCs across the country received over $1.18 billion in approved transportation electrification spending as of August 2019, of which less than 2 percent ($20 million) was invested in education, marketing, and outreach.[336]

Despite the overall shortage of engagement with EVs by EDCs, there are individual EDCs that have prioritized education, marketing, and outreach efforts. For example, PG&E, through its website, provides its customers with an EV Savings Calculator to estimate the costs and savings of driving electric as well as information regarding available incentives, rate plans, and charging station locations.[337] Kansas City Light & Power, through the Evergy Connect Center and its Clean Charge Network website, enables customers to sign up for EV test drives on one Saturday per month.[338] And Southern California Edison provides a Plug-in Car Rate Assistant to compare costs and savings of owning a PEV, and recommends a rate plan based on vehicle use.[339]

The two regulated EDCs in Connecticut, Eversource and UI, are already engaged in some forms of outreach and education. Both maintain websites with EV information ranging from the types of EVs, frequently asked questions on charging, and available EDC-offered incentives and programs. Additionally, the EDCs contribute to educational EV resources found on the EnergizeCT website. As discussed in Section 14.5, Connecticut's EDCs have also partnered with state agencies, businesses, and non-profit organizations to sponsor ride-and-drive events across the state. The EDCs in Connecticut have indicated their interest to continue supplementing education, marketing, and outreach campaigns within Connecticut and the NESCAUM region. Supplementary efforts, properly coordinated with other interested parties, should not be duplicative or inconsistent with existing efforts and should maximize the value of the EDCs' input. Their ability to reach large, broad customer bases should be leveraged to bring greater awareness of EVs and the benefits of driving electric for both EV drivers Connecticut ratepayers as a whole. The EDCs can also provide data associated with charging use to help municipalities and private industries deploy infrastructure in priority areas. This information could benefit charging station developers and operators by allowing them to properly anticipate O&M costs and avoid demand charges through services such as TOU rates, smart chargers or other power management options. Innovative resources and customer engagement strategies like those described above should be evaluated by Eversource and UI for inclusion in their EV materials and on the EnergizeCT website. As part of PURA's ZEV Docket, utility investment in marketing and education should be considered to support full utilization of any utility investment in EV charging infrastructure.

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[336] Smith, Conner. Less Than Two Percent of Utility Investment Going Toward EV Awareness. EV Hub, Atlas Policy. August 25, 2019. Retrieved January 2, 2020 from https://www.atlasevhub.com/data_story/less-than-two-percent-of-utility-investment-going-towards-ev-awareness/?utm_source=EV+Hub+Newsletter&utm_campaign=7ec6d61a78-EMAIL_CAMPAIGN_2019_01_07_05_37_COPY_01&utm_medium=email&utm_term=0_173e047b1f-7ec6d61a78-272173933.

[337] EV Savings Calculator. PG&E. Retrieved April 18, 2020 from https://ev.pge.com/.

[338] Electric Car Test Drives. Clean Charge Network. Retrieved January 16, 2020 from https://cleanchargenetwork.com/electric-car-test-drives/.

[339] Plug-In Car Rate Assistant. Southern California Edison. Retrieved April 18, 2020 from http://www.sce.com/evrateplans.

14.4 Collaborative campaigns

To date, immersive education, marketing, and outreach campaigns that have brought together all of the relevant stakeholders have been the most effective in advancing EV awareness and uptake. Launched in 2018, the *Drive Change. Drive Electric.* (DCDE) campaign was formed through a partnership among NESCAUM, NYSERDA, OEMs, and several states to address the need to increase EV awareness and understanding.[340] The northeast states, through NESCAUM, developed a strategy that includes three platforms: social media, news media, and a website that serves as the primary medium for the education campaign.[341] Social and news media, the campaign's secondary platforms, provide efficient and cost-effective opportunities to reach the audience identified by market research as those most likely to embrace electrified transportation. The goal of this multi-pronged approach is to provide informative EV-related highlights that direct the public to the website for the full scope of the education and outreach campaign.

DCDE, in an effort to build consumer knowledge and showcase that EVs can fit into consumers' lifestyles now, engages 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 website and social media platforms are 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 publicly available charging stations. Similarly, the explorer tool on the DCDE website is designed to address concerns regarding affordability and vehicle choice by providing information regarding vehicle options. The explorer tool allows users to compare maintenance and refueling costs, provides current information on financial incentives available in individual partner states, and showcases firsthand driver experiences of current EV drivers. Each of these concepts is fully described on the DCDE website and highlighted through the social media streams (see Figure 20).

Figure 20: *Examples of DCDE social media content*

[340] Drive Change. Drive Electric. Retrieved August 14, 2019 from https://driveelectricus.com/.
[341] Retrieved August 14, 2019 from https://www.facebook.com/DriveElectricUS/ , https://twitter.com/driveelectricUS, https://www.instagram.com/driveelectricUS/.

The Destination Electric Program, a component of the DCDE campaign, is a recognition system for EV-friendly businesses, venues, and attractions. By highlighting the availability of EV charging infrastructure proximate to these destinations, the Destination Electric Program demonstrates to locals and visitors the ease with which EVs can be integrated into the lives of drivers. Launched in the summer of 2019, the Destination Electric Program supplies participating cities and locations with a Destination Electric Toolkit, which includes window decals, postcards, and other promotional signage. These materials promote the destinations' walkability to nearby EV charging stations and highlight Destination Electric's website and social media platforms as sources of additional EV information. The cities and locations participating in the program are among the local leaders for EV infrastructure deployment. The leadership and support of many local businesses, towns, and cities in the Northeast in promoting awareness of the availability of EV charging infrastructure, and by extension the viability of EVs, is key to implementing a successful program and increasing EV adoption. Currently, there are over 140 Destination Electric businesses, venues, and attractions in 14 cities across 7 campaign states.[342] Connecticut's initial destination cities are New Haven and Madison with an intent to expand to other cities and towns across the state.

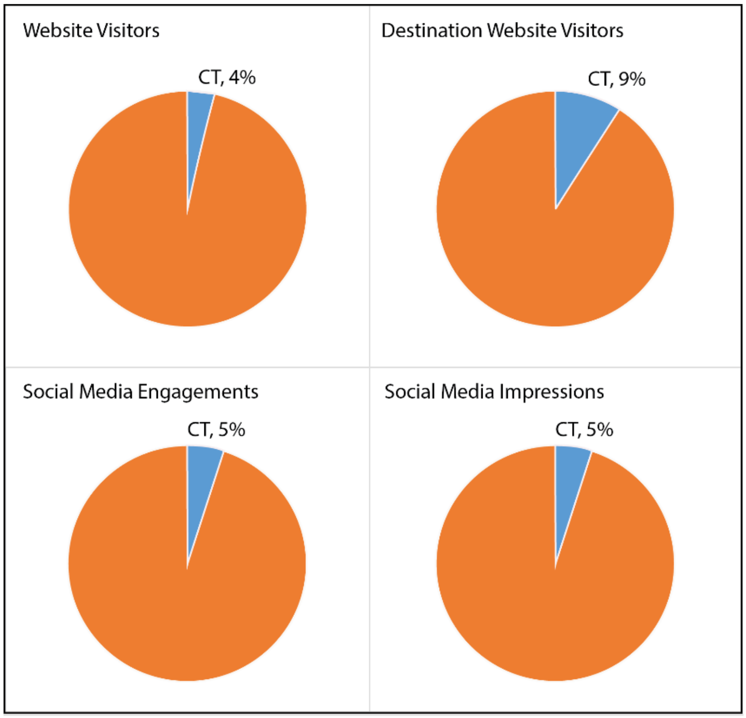
The Destination Electric Program has received additional attention through features in lifestyle media outlets, which has elevated the discussion of EVs as a more sustainable travel option. *Inside Hook* featured the campaign in a July 9, 2019 article that brought additional awareness and excitement to the campaign and the businesses that support it.[343] In fact, during this period (June 13 through July 11, 2019) the DCDC campaign generated over 11,000 website visits and over 1 million impressions and grew its social media following by over 5 percent. As of July 11, 2019, the DCDE campaign had been featured in over 85 local news outlets, including some local Connecticut 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 DCDE 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 Program portion of the website (see Figure 22). As such, Connecticut's priority is to increase consumer engagement with the DCDE campaign to assure the education outreach efforts increasingly impact EV awareness in Connecticut. The apparent focus of Connecticut website visitors on the Destination Electric Program (see Figure 22) may indicate that this program is a valuable tool for continued outreach to Connecticut audiences that should be further utilized.

[342] Destination Electric. Drive Change. Drive Electric. Retrieved August 14, 2019 from https://driveelectricus.com/destination-electric/.

[343] 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.

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



14.5 Experiential opportunities

Experiential events such as ride-and-drives and public exhibitions provide consumers an interactive experience to learn more about EVs and driving electric. Studies show that providing consumers with the opportunity to experience an EV first-hand helps to overcome perceived drawbacks.[344]

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 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 across the country for National Drive Electric Week (NDEW). For a week in September, each year, this grassroots effort recruits volunteers from around the nation to bring together EVs, speakers, and other activities to celebrate and educate the public about EVs.

Opportunities for ride-and-drive events in Connecticut occur throughout the year, but due to limited support, the offerings are not consistent. The annual Connecticut International Auto Show, hosted by CARA, is one such event that has featured ride-and-drives. NDEW provides an ideal opportunity to host a series of coordinated ride-and-drive events across Connecticut. Each year a number of ride-and-drives are planned as part of this week-long event, but due to minimal funding and resources, the events are often limited to a vehicle driver putting their EV on display and offering a question and answer forum around their individual 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 NDEW events across the state demonstrate continued interest in EVs and a

[344] 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

desire to broaden understanding and acceptance of the technology. Stable funding and other resources to support these events would have a visible impact on their scope and reach beyond traditional market channels such as print, radio, and television.

The DCDE campaign has demonstrated the potential that EV ride-and-drive events hold for engaging audiences in meaningful ways. 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 website and social media platforms, and would in turn have the opportunity to participate in and promote Destination Electric at NDEW events. This collaboration would provide both 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 Coalitions, CARA, and local groups to host and participate in NDEW ride-and-drive events throughout Connecticut. The importance of maintaining the momentum of increasing EV awareness and the impact EV ride-and-drive events have on increasing that awareness is evident. Connecticut must continue to build upon established partnerships and its existing education, marketing, and outreach efforts to increase EV uptake at levels needed to reach the state's ZEV deployment and GHG reduction targets.

Policy Recommendations: Education, marketing, and outreach

1. Connecticut should continue to leverage opportunities 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. DEEP will work with OEMs to explore additional marketing opportunities for the EVs available for sale in Connecticut and the region.
3. As part of PURA's ZEV Docket, utility investment in marketing and education should be considered to support full utilization of any utility investment in EV charging infrastructure.
4. The EDCs should provide data associated with charging use to help municipalities and private industries deploy infrastructure in priority areas.

15 Funding Mechanisms to Support Sustainable Incentive and EV Infrastructure Programs

15.1 Transportation and Climate Initiative Regional Policy Design Process

The ongoing TCI Regional Policy Design Process represents one potential source of future incentive funding. Currently, 12 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.[345] If implemented, the resulting policy would generate proceeds that Connecticut and other participating jurisdictions can reinvest in cost-effective low-carbon transportation solutions including, but not limited to, light-, medium-, and heavy-duty vehicle electrification, transit oriented development, travel demand management, traffic flow improvements in urban and suburban

[345] TCI Regional Policy Design Process 2019. Transportation & Climate Initiative. Retrieved January 8, 2020 from https://www.transportationandclimate.org/main-menu/tcis-regional-policy-design-process-2019#Anchor%202.

areas, and complete streets development (pedestrian and bicycle access expansion). As a part of the 2019 TCI Regional Policy Design Process, DEEP and 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.

15.2 Volkswagen Settlement

In late 2015, VW publicly admitted that it had intentionally installed defeat devices—software designed to cheat emissions tests and deceive federal and state regulators—in nearly 500,000 2.0-liter diesel vehicles and nearly 83,000 VW and Audi branded 3.0-liter diesel vehicles sold to American consumers.[346] An estimated 11,911 of these vehicles were sold in Connecticut.[347] The use of the defeat devices has resulted in increased emissions of 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 (collectively known as the VW Settlement), EPA resolved their civil enforcement case against VW. As a result of these settlements, VW agreed to pay $2.7 billion into the VW Mitigation Trust that would be apportioned to the states.[348] Connecticut is expected to receive over $55 million for implementing extensive mitigation projects to reduce NOx emissions from mobile sources. With NOx reduction being its primary focus, the VW Mitigation 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, preserved all replacement options under the VW Mitigation Trust.[349] As a result, diesel-to-diesel replacements are eligible for funding under the Beneficiary Mitigation Plan. While electrification is the long-term goal, these diesel-to-diesel projects provide an opportunity to maximize cost effective, short-term NOx reductions and realize immediate public health benefits in environmental justice communities that have historically borne the brunt of adverse air pollution impacts. In its first cycle of funding, Connecticut allocated more funding to electrification projects than any other project type. Of 10 projects totaling $12.18 million, Connecticut awarded $6.28 million for electrification projects, $4.71 million for diesel projects, and $1.2 million for alternate fuel projects.[350]

15.2.1 Volkswagen EVSE

Under the terms of the VW Mitigation Trust, up to 15 percent of allocated funds—approximately $8.4 million—can fund the acquisition, installation, and O&M of publicly-accessible light-duty zero emission vehicle supply equipment in Connecticut. Specifically, funding can be allocated for Level 1, Level 2, DCFC, and hydrogen refueling stations located in public places and Level 1, Level 2, and DCFC stations located at workplaces and MUDs.

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[346] VW Settlement Information. DEEP. Retrieved January 7, 2020 from https://www.ct.gov/deep/cwp/view.asp?q=587294.
[347] Connecticut VW Mitigation Plan. DEEP. Retrieved August 14, 2019 from https://www.ct.gov/deep/lib/deep/air/mobile/vw/CT_VW_Final_Mitigation_Plan.pdf.
[348] 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.
[349] Connecticut VW Mitigation Plan. DEEP. Retrieved August 14, 2019 from https://www.ct.gov/deep/lib/deep/air/mobile/vw/CT_VW_Final_Mitigation_Plan.pdf.
[350] Administrative Archive, VW Mitigation Plan. DEEP. Retrieved August 14, 2019 from https://www.ct.gov/deep/cwp/view.asp?a=2684&q=602744&deepNav_GID=1619.

DEEP is preparing to make available the $8.4 million in VW EVSE funding for zero-emission vehicle supply equipment. In anticipation of releasing this funding in the near future, Connecticut is monitoring 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 is outlined below in Table 6. Each state's approach to dispersing VW EVSE funding is influenced by a number of internal factors, including but not limited to existing programs, prior investments, and other unique needs. The recommendations below incorporate a mixture of these strategies to optimize EVSE deployment across the state.

Table 7: Summary of planned usage for VW Mitigation 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 Network	MUD / Workplace Housing	Gov. Property Charging	Destination Charging	Environmental Justice Community				
CA				x		x	x	x		x	
CO	x	x		x	x	x				x	x
CT				x	x	x	x	x			
ID	x	x									
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					

DEEP will allocate the maximum allowed by the VW Settlement to light-duty ZEV infrastructure to support the deployment of electrified transportation options and further enhance the state's efforts to improve air quality and reduce GHG emissions from the transportation sector. Under the terms of the VW Settlement, funding for infrastructure is limited to LDVs. 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 ZEV infrastructure plan will also be evaluated to determine the extent to which they leverage additional resources to support transformative technological changes, further the energy and economic benefits of the state, and provide a firm base of support for emerging fuel cell or other alternative fuel transportation technologies.

Policy Recommendations: Volkswagen EVSE

These recommendations are framed based on the ongoing and significant investments by Electrify America and the potential for PURA to develop a regulatory framework that could impact EVSE deployment, and may require adjustment as the regulatory process advances. Connecticut's VW Mitigation Trust EVSE funds ($8.4 million) could be allocated in the following ways to support widespread electrification, including:

1. Direct funding of state and municipal EVSE to support light duty government EV deployment targets specified in Public Act 19-117;
2. Grants for Level 2 workplace charging; next to home charging, which will account for 60-80 percent of all charging, the second most prevalent charging location will be at the work place and will reassure early EV adopters;
3. Grants for publicly-accessible Level 2 charging to provide reasonably cost effective and highly visible charging infrastructure that 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;
4. Grants for MUDs, which could also include innovative solutions for MUDs such as charging hubs, community-based EV sharing, valet or mobile charging. As part of a make ready program, the utilities are well positioned to also offer energy efficiency measures to MUDs that could reduce the cost associated with electric system upgrades necessary to support EVSE;
5. Grants for hydrogen fueling infrastructure and regional corridor development; and
   Reserving a residual amount of funding to address gaps in the EV fast charging network not filled through a utility program, Electrify America build out, or other EVSE provider efforts.

15.3 Electrify America

As part of the VW Settlement, VW established Electrify America as a new entity in 2016 to be "a catalyst for promoting ZEV adoption by offering transformative, customer-centric infrastructure and energy management solutions."[351] Electrify America will oversee the total investment of $2 billion, including $800 million in California and $1.2 billion in the other 49 states, in EV charging infrastructure over a 10-year period.[352] Electrify America intends to manage these investments over four 30-month planning cycles, specifically targeting DCFC deployment, education, and access to support increased ZEV adoption.

Infrastructure investments by Electrify America over the next decade will play a central role in EV market development in the Northeast Corridor, which extends from the Washington, D.C. metro area to Maine. Cycle 1 of Electrify America's investment plan primarily focused on building out its initial nationwide DCFC and Level 2 charging networks along major highway routes and in major metropolitan areas.[353] Cycle 2, which is currently being implemented, will include an investment of $300 million nationally between July 1, 2019 and December 31, 2021.[354] Approximately $250 million of that investment will be directed toward charging infrastructure, especially at retail, transit centers, and MUD locations and the continued build-out of its nationwide DCFC network along

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[351] About Electrify America. Electrify America. Retrieved January 7, 2020 from https://www.electrifyamerica.com/about-us.
[352] Our Investment Plan. Electrify America. Retrieved January 7, 2020 from https://www.electrifyamerica.com/our-plan.
[353] National ZEV Investment Plan: Cycle 1, Public Version. Electrify America. April 9, 2017. Retrieved October 11, 2019 from https://elam-cms-assets.s3.amazonaws.com/inline-files/National%20ZEV%20Investment%20Plan.pdf.
[354] National ZEV Investment Plan: Cycle 2, Public Version. Electrify America. February 4, 2019. Retrieved October 11, 2019 from https://elam-cms-assets.s3.amazonaws.com/inline-files/Cycle%202%20National%20ZEV%20Investment%20Plan%20-%20Public%20Version%20vF.pdf.

highway and regional routes. $35 million will be used for education, awareness, and marketing, with the balance of funds reserved for program overhead. Cycle 2 focuses on 18 metropolitan areas in the U.S., including Bridgeport, Connecticut.[355] Currently, there are two 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 Cycle 2.

Electrify America is at the forefront of national DCFC network buildout and is actively taking steps to future-proof its charging stations. Generally, the standard configuration of each Electrify America station includes 1 MW of total charging equipment.[356] For example, a station may consist of two-350 kW stations and two-150 kW stations. In addition, Electrify America has stated its intention to install stations with a minimum capacity of 150 kW in anticipation of newer vehicles' ability to charge at higher capacity. At 125 sites, the company intends to invest in on-site renewable energy generation and battery storage to help provide cleaner energy sources and to improve the economic sustainability of its infrastructure investments.[357]

While Electrify America will identify regions for EVSE investment, the site selection process is conducted discreetly. As such, site locations are unknown until disclosed by Electrify America. Coordination will be important to ensure that the state can focus its relatively small VW EVSE funding in areas not targeted for investment by Electrify America.

16 Conclusion

Public Acts 08-98 and 18-82 establish 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, respectively. The transportation sector is the largest source of statewide GHG emissions, accounting for 38.1 percent, the majority of which comes from the combustion of fossil fuels in passenger cars and light-duty trucks.[358] As identified in the GC3 GHG pathways reduction analysis, the primary solution for achieving the state's statutorily required reductions is wide-scale EV deployment.

Although EV sales currently account for a relatively small percentage of overall vehicle sales in Connecticut compared to ICE vehicles, the market is growing at a rapid pace. This growth is largely due to advances in battery technology, expanded vehicle range, increased model availability, and state policies and regulations to reduce emissions and incent EV adoption. Competing needs for funding for incentives for vehicle purchases and infrastructure development will require strategic planning to optimize dollars spent and to ensure funding is spent equitably. The transition from ICE vehicles to EVs raises a variety of opportunities and challenges, including developing adequate charging infrastructure to meet consumers' charging needs, addressing increased electricity

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[355] *Id.*

[356] Docket 17-12-03RE04 Correspondence, Infographic—Connecticut PURA Electrify America Presentation vf.pdf. Electrify America. Filed December 19, 2019. Retrieved January 9, 2020 from http://www.dpuc.state.ct.us/dockcurr.nsf/8e6fc37a54110e3e852576190052b64d/9d6f1a347b8d7526852584d5004692d4?OpenDocument.

[357] National ZEV Investment Plan: Cycle 2, Public Version. Electrify America. February 4, 2019. Retrieved October 11, 2019 from https://elam-cms-assets.s3.amazonaws.com/inline-files/Cycle%202%20National%20ZEV%20Investment%20Plan%20-%20Public%20Version%20vF.pdf.

[358] 2016 Connecticut Greenhouse Gas Emissions Inventory. DEEP. Retrieved July 30, 2019 from https://www.ct.gov/deep/lib/deep/climatechange/publications/ct_2016_ghg_inventory.pdf.

demand, maximizing the potential for more efficient use of the electric grid in order to lower electric rates for all ratepayers, and ensuring that low-income residents and underserved communities benefit from transportation electrification.

Appendix

Process to Develop the *EV Roadmap*

DEEP held a scoping meeting and a technical meeting to obtain input during the development of the draft *EV Roadmap*:

- December 14, 2018: DEEP conducted a scoping meeting to brief stakeholders and take oral public comment on the proposed scope of the *EV Roadmap*. DEEP provided for the opportunity to submit written public comment on the proposed scope by December 20, 2018.
- February 8, 2019: DEEP held a technical meeting to inform the recommendations of the draft *EV Roadmap.* The technical meeting consisted of panel discussions with subject matter experts presenting on key topics, followed by a question-and-answer session with the audience.

DEEP issued the draft *EV Roadmap* on October 11, 2019. DEEP provided for the opportunity to submit written public comment on the draft *EV Roadmap* by November 11, 2019.

Toward informing the recommendations of the final *EV Roadmap*, DEEP held a second technical meeting and public comment session and issued a procedural notice:

- November 8, 2019: DEEP held a technical meeting to provide stakeholders an opportunity to pose technical questions to DEEP staff involved in the preparation of the draft *EV Roadmap*, and to take oral comment on the draft *EV Roadmap*.
- December 13, 2019: DEEP issued a procedural notice announcing that it would consider comments and information submitted in connection with PURA Docket No. 17-12-03RE04, *PURA Investigation into Distribution System Planning of the Electric Distribution Companies—Zero Emission Vehicles*, as it prepared the final *EV Roadmap*.

Public Comments on the draft *EV Roadmap*

DEEP received written comment on the draft *EV Roadmap* from over 20 entities and individuals. Some of the most commonly referenced topics included:

- **Equitable access to clean transportation**. Comments spoke to the need to develop integrated approaches to address barriers to beneficial electrification of the transportation sector in communities of low- and moderate-income, rural areas, and other communities or geographic regions where such barriers are particularly acute. Several comments supported increasing access to clean transportation options. More specific comments included: (a) prioritizing electrification of transit buses and school buses, or generally increasing access to clean transportation options; (b) establishing a minimum percentage of such beneficial electrification for environmental justice communities and state-identified economic opportunity zones; (c) enabling EVSE deployment in such communities through incentives or by leveraging the EDCs' competences; and (d) incentivizing or addressing barriers to EV ownership by low-income households.

- **Projected EV deployment needs**. Comments on this topic included: (a) reassurance that targets for vehicle electrification are aligned with Connecticut's climate goals; (b) a suggestion that the *EV Roadmap* include a more assertive target of not less than 1 million ZEVs by 2030; (c) a recommendation that rules for meeting EV goals qualify that vehicles are actually sold rather than simply being delivered; and (d) further consideration of eliminating the state's current prohibition on direct EV sales. Other comments supported the expansion of the CHEAPR incentive to include used EVs; and recommended that the state focus not on rate design as a key barrier to EV deployment, but rather on barriers controlled by the auto industry (e.g., EV costs, model availability, and EV range).

- **Fleet electrification.** Several comments on this topic focused on the current DAS policy goal that 50 percent of new vehicle procurements for Connecticut's state fleet be EVs by 2030, and the feasibility assessment under Public Act 19-117. These comments offered various recommendations including: (a) moving to an earlier 2025 goal; (b) considering setting annual targets for ramping up the procurement levels; (c) considering requiring state agencies to procure ZEVs first, but if not available, opt for PHEVs, then hybrid vehicles; and (d) adopting a policy of procuring 100 percent ZEVs where such vehicles meet the performance needs of their required use; setting a goal that by 2030 at least 50 percent of LDVs and trucks and 30 percent of transit buses in the state fleet are ZEVs. Comments relative to fleet electrification of medium- and heavy-duty vehicles included consideration of a voucher incentive program to catalyze in-state growth of a clean vehicle market in those segments, monitoring, and considering relevant policies, regulations, and initiatives in California.

- **EV infrastructure expansion**. The majority of comments on this subject regarded EV charging site optimization, locational deployment, and building codes and permitting. Commenters highlighted the need for Level 2 EVSE and DCFC expansion, especially along transportation corridors and in MUDs, rural communities, and other underserved areas. ChargePoint's comments emphasized host sites putting "skin in the game" to actively support EV penetration and EVSE deployment, and provided a summary of the comparative technical capabilities of different EVSE types. The Connecticut Center for Advanced Technology supported greater consideration of zero emission transportation and refueling technologies outside of the U.S. market. Others supported recommendations concerning right-to-charge legislation for MUDs, streamlining of permitting processes for EVSE installation, and emphasizing the need to deploy managed charging-capable EVSE. Various submitters supported bold EVSE deployment targets and the use of rate-payer funding to support EV infrastructure expansion.

- **Fuel cell electric vehicles and infrastructure**. Comments from the Fuel Cell & Hydrogen Energy Association and Connecticut Center for Advanced Technology, Inc. sought: (a) greater attention paid to FCEVs and hydrogen fueling infrastructure in the *EV Roadmap*; (b) recognition of how FCEVs could the state achieve ZEV MOU targets and enable deep decarbonization and emissions reduction in the transportation sector; and (c) consideration of California's policies, including regulatory and financial support for FCEV and hydrogen infrastructure deployment.

- **Electric vehicle service equipment (EVSE) public investment models**. Multiple comments on this topic generally support a utility make-ready model for EVSE deployment under public charging and fleet electrification scenarios. Comments also requested that the *EV Roadmap* recognize that utility ownership of EVSE may be appropriate while the market is in a nascent state, and also in areas that may be overlooked by private investment. In addition to support for make ready and utility ownership models, several commenters suggested that multiple investment/ownership models should be used in conjunction to optimize the buildout of EVSE infrastructure.

- **Building codes, pre-wiring requirements, and charging spaces**. Several comments supported the adoption of updated building codes that include provisions for EV-ready standards and requirements, especially for new construction. Other comments included: (a) mandating that 10 percent of parking spaces be pre-wired for EV charging, or encouraging use of 20 percent of parking spaces for Level 2 charging; (b) supporting the recommendation that ratepayer-funded make-ready infrastructure for eventual DCFC installation meet or exceed 150 kW; (c) recommending that permitting for Level 2 EVSE and DCFC be consolidated; and (d) leveraging the Sustainable CT voluntary municipal certification program to develop voluntary municipal building code and zoning ordinance templates with more stringent EV pre-wiring requirements.

- **Consumer charging experience**. Comments included several statements supporting many of the recommendations pertaining to the consumer charging experience, such as the establishment of a fine for ICE-ing, and specific requirements for components such as accessibility, uptime, and payment options. Some comments highlighted the importance of open communication standards and interoperability, but included a preference that the *EV Roadmap* more generally support the principle of open protocols and standards. Other comments noted that advanced planning on this topic would smooth the transition to EVs, and that signage should involve regional collaboration. One comment pointed out that language on ICE-ing should reflect Section 9 of Public Act 19-161, which establishes that only a PHEV or BEV can park at designated spaces, and that a violation is an infraction. One comment remarked that site hosts should retain the flexibility for determining price and access controls for the EV chargers on their premises.

- **Residential and workplace charging**. Comments on residential charging centered on the access to charging stations by residents in MUDs, such as apartments and condominiums. The comments supported policy actions towards adoption of a right-to-charge law, and consideration of financial incentives to support development of charging stations for their use. Relative to workplace charging, comments included: (a) adopting policies to encourage workplace charging in a manner that is technology-neutral and future-proofs such investments; (b) leveraging the Connecticut Green Bank's C-PACE program as a tool to advance EVSE deployment at workplaces and other commercial properties; and (c) identifying certain workplace programs in other state jurisdictions to inform consideration of relevant pilot programs. By its own experience, the Connecticut Green Bank expressed that robust workplace charging promotion can catalyze EV adoption.

- **Grid impact**. Comments from Eversource relating to grid impact sought to place importance on considering the risks of EVSE deployment that may not be used or that potentially gets "leapfrogged" as technology advances; taking a balanced and thoughtful approach with EVSE deployment to ensure the most efficient use of ratepayer funds; and bearing in mind that the electric distribution system is quickly evolving, so a dynamic and flexible approach should be taken when analyzing system impacts. Comments from other stakeholders noted: (a) the value of the EDCs' capacity maps for helping to streamline EV charging development; (b) the need to identify policies and strategies for maximizing the benefits of the new load from electrification; (c) the need to ensure that the new residential EV charging load is shifted to off-peak hours; and (d) that site selection should not be solely determined by the potential to minimize grid impacts, but rather be shaped by demand and transportation needs.

- **Rate design**. Multiple comments favored the development of EV specific TOU rates in order to incent off-peak residential charging. Comments pertaining to EV specific TOU rates recommend that the implementation of EV TOU rates should not require the installation of a separate utility grade meter. Comments also recommended that DEEP not be overly prescriptive about technologies through which EV TOU rates can be implemented. Conversely, UI indicated that the company considers their current TOU rate offerings sufficient for incenting off-peak charging and does not consider rate design a critical element for increased EV deployment. In addition to comments regarding TOU rates, multiple comments were received concerning the impact of demand charges on DCFC stations and fleet electrification. In general, comments supported exploring solutions to demand charges in a predictable, equitable, and transparent manner. Comments suggested that demand charges be addressed in a long-term and sustainable way.

- **Innovation**. Comments included the identification of certain initiatives or programs to deploy on a pilot basis, such as integrating EV charging infrastructure with solar and storage, testing V2G technology, and using light-pole mounted Level 2 chargers. One comment recommended that V2G should not be identified as a high priority in the final *EV Roadmap*. The Connecticut Green Bank expressed that it is in the process of initiating pilot activity under a voluntary market methodology for the measurement of GHG emissions avoidance through EV charging activities.

- **Incentives**. Some comments highlighted how incentives for both EVs and EVSE are essential to the *EV Roadmap's* success, provide the best pathway to achieve significant emissions reductions, and move the market toward cleaner, sustainable fuels. Other comments focused on the CHEAPR program or sought consideration of potential complementary incentives. These comments included: (a) support for the extension of the CHEAPR program to include the purchase of used EVs; (b) consideration of further incentives for dealerships, such as tax credits based on EVs sold; (c) consideration of an incentive for buyers who are low-income, whether as a stand-alone rebate or a low-income adder in the CHEAPR program; and (d) as noted previously, establishment of a clean truck and bus voucher incentive program. Other comments included: (a) dedication of additional funding to support small planning grants for fleets; (b) consideration of incentives and awards for commercial enterprises that advance fleet electrification; and (c) incorporation of managed charging as a key component of incentive programs.

- **Education and outreach**. Comments on this topic included recommendations such as: (a) leveraging established community-based organizations to lead outreach efforts; (b) conducting outreach in communities disproportionately harmed by transportation emissions to better understand their transportation needs; (c) continuing support of and participation in education campaigns in conjunction with efforts to expand EV charging infrastructure; and increasing outreach to auto dealerships concerning the existing dealer incentive under the CHEAPR program.

- **Funding mechanisms to support program sustainability**. Comments on this topic included: (a) support for legislation to provide a permanent funding source for the CHEAPR program; (b) suggestions to explore the possibility of leveraging funds from the VW Settlement, Connecticut's share of RGGI auction proceeds, or any potential initiative arising from TCI's consideration of a regional cap-and-invest framework; (c) suggested use of VW Settlement funds to supporting charging infrastructure or access to electrified transportation for communities that disproportionately bear the burden of transportation-related emissions; and (d) recommendation that EVSE expenditures using VW Settlement funds be coordinated with the EDC programs arising from the ZEV Docket.