Transportation Sector

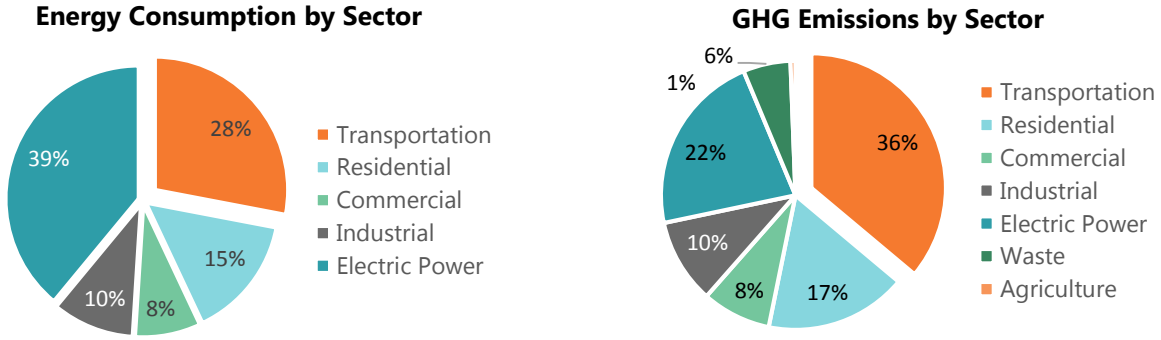
INTRODUCTION

Transportation is an integral part of Connecticut's socioeconomic fabric. Connecticut's transportation system and infrastructure encompass an extensive range of multimodal elements – from roadways and highway facilities, pedestrian and bicycle accommodations, to bus transit systems, passenger and freight railways, airports, deep water ports, and even ferry landings. This infrastructure connects residents and visitors to families, friends, services, jobs and communities. It also enables the movement of retail goods, raw materials, and other commodities in, out, and around the state. The reliability of the state's transportation system and supporting infrastructure, as well as the energy resources necessary to operate that system have a direct impact on Connecticut's economy and quality of life for its 3.5 million residents and their local communities. To effectively enhance quality of life, minimize environmental impacts, and foster continued economic growth, it is critical that the state provides a safe, reliable and efficient transportation system that can accommodate future growth in population, tourism, business, and recreation.

Transportation-related energy use is dependent on the types of fuels used, the vehicles or other modes of transport used, and the number of vehicle miles traveled (VMT). A sustainable and low-carbon transportation energy future will require significant refinements to this system in order to provide increased mobility options to citizens and businesses and ensure that the state achieves its greenhouse gas (GHG) emissions reduction targets. The transportation sector is the state's largest contributor to GHG emissions (Figure T1), requiring steep reductions to ensure Connecticut meets its Global Warming Solutions Act target of reducing emissions 80 percent below 2001 levels by 2050, as well as the 45 percent by 2030 target recommended by the Governor's Council on Climate Change (GC3).[1]

1 The Governor's Council on Climate Change is tasked with recommending an interim statewide GHG reduction target for the years 2020-2050 and identifying short- and long-term strategies to achieve the necessary reductions. The Office of Governor Dannel P. Malloy, "Executive Order No. 46," April 22, 2015, http://portal.ct.gov/en/Office-of-the-Governor/Pages/Press-Room/Executive-Orders?SearchKeyword=&Month=by+Month&Year=2015.

FIGURE T1: Connecticut Energy Consumption and GHG Emissions by Sector



Source: U.S. Energy Information Administration, *Connecticut State Energy Profile*

Connecticut's approach to transportation must embrace solutions that go beyond adding roadway capacity to address population growth and economic expansion. Solutions should involve comprehensive strategies that maximize benefits from limited new construction and improve operational efficiency for public transit and railways while increasing connectivity, user flexibility, and equitable access. Considerable emphasis should be placed on implementing strategies that not only reduce costs and enhance mobility options for people and businesses but also improve local air quality and advance the State's GHG emissions reduction goals.

Connecticut's transportation systems should enhance quality of life for residents, sustain the character of local communities, and enrich the state's economy now and in the future. Linking transportation planning and decision-making to economic growth and sustainable development will not only enhance the well-being of Connecticut residents, but also make the state a more desirable place to live and work.[2] This CES, informed by the prior recommendations of the 2013 CES, reflects DEEP's continuing effort to integrate transportation considerations into the State's overall energy and environmental planning efforts.

It is important to note that the State has limited authority in some of the areas that have the most impact on transportation energy use and emission reductions. For example, historically, federal laws largely determine vehicle efficiency standards, funding for much of the state's infrastructure and transit, and the composition of fuels. Further, municipalities have jurisdiction over land use and development at the local level. Therefore, in this updated CES, DEEP's transportation sector recommendations focus on achieving distinct long-term goals that are expected to support the State's commitment to develop a cheaper, cleaner, more reliable and sustainable transportation system.

2 Let's Go CT!, the Department of Economic and Community Development's 2015 Strategic Plan, and the current draft of Connecticut's Conservation and Development Policies Plan (2018-2023) mutually reinforce these long-term goals for Connecticut's transportation infrastructure.

2013 Comprehensive Energy Strategy: Key Transportation Sector Accomplishments

- Connecticut signed onto the ZEV Memorandum of Understanding (ZEV MOU), a multi-state commitment to collectively deploy 3.3 million EVs by 2025.
- DEEP launched the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) program, which has disbursed over $4.9 million for 2,332 new vehicle leases and purchases.
- EVConnecticut municipal and business charging station grants program deployed a total of 331 Level 2 charging plugs and 4 DC fast chargers at 157 locations.
- Public Act 16-135, An Act Concerning Electric and Fuel Cell Electric Vehicles, was signed into law.
- Release of Let's Go CT!, a 30-year vision for transforming Connecticut's transportation infrastructure.
- CTDOT launched CT*fastrak*, the state's first bus rapid transit.
- CTDOT adopted a Complete Street policy and design approach.
- CTDOT implemented the Community Connectivity Program.
- OPM awarded qualifying 31 projects ~$12.5 million total under the TOD Planning Grant Program and the Responsible Growth and TOD Grant Program.
- The Conservation & Development Policies: The Plan for Connecticut 2013-2018, promotes land use planning, concentrated development and connectivity around transportation nodes and along major corridors to support municipal TOD efforts.
- The State partnered with the Connecticut Housing Finance Authority (CHFA) and the Local Initiatives Support Corporation (LISC) to create the Connecticut TOD Pre-Development and Acquisition Fund (CT TOD Fund). [2014]
- DEEP partnered with the EPA's SmartWay®, which aims to accelerate the availability, adoption and market penetration of advanced fuel efficient technologies and operational practices in the freight supply chain.
- Public Act 14-222 established the Connecticut Port Authority.

Current trends in the Transportation Sector

Energy Consumption and Expenditure

Connecticut uses 28 percent of its total energy to move people and goods (Figure 1).[3] This energy is utilized to power multiple modes of transport, including personal vehicles, large trucks, public transportation, airplanes, freight trains, and boats.

Connecticut's citizens and businesses continue to rely on traditional internal combustion engine (ICE) vehicles — and the use of petroleum-based fossil fuel to power them — as their primary means of mobility. Gasoline, at 77 percent, represents the largest share of energy consumed within the transportation sector, mostly by passenger cars and light trucks (Figure T2). The economic and energy security implications of this dependency on a single fuel source puts the Connecticut economy at risk to market forces largely out of the control of the State.

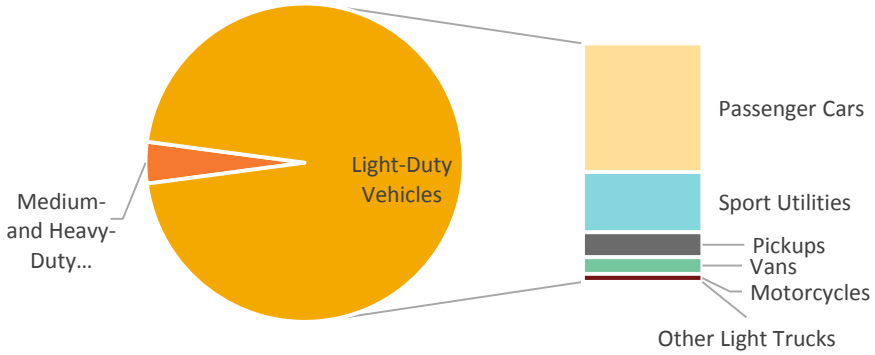
Transportation accounted for 17 percent of U.S. consumer expenditures in 2015, ranking second only to housing.[4] Of that transportation cost, 22 percent was spent on gasoline, diesel fuel, and motor oil for vehicles. (Table T1.) In recent years, low gasoline and diesel prices have helped consumers lower their transportation expenditures. However, dependence on these petroleum-based fossil fuels exposes Connecticut residents and businesses to potential price spikes that could destabilize budgets and bottom lines.

Connecticut Transportation Sector Key Facts

- 91 percent of the state's households have at least one registered vehicle.
- 95 percent of vehicles registered in Connecticut are light-duty vehicles, consisting of passenger vehicles and light-duty trucks (vans, pickups and SUVs).
- 87 percent of the state's residents at or above driving age are licensed drivers.
- Nearly 80 percent of commuters in the state drive to work alone.
- The average commute time in Connecticut is 24.8 minutes.
- Slightly more than half of Connecticut commuters travel less than 10 miles to get to work, while 30 percent travel 10-24 miles.

[3] U.S. Energy Information Administration, State Energy Data System (2013 data).
4 U.S. Department of Labor, Bureau of Labor Statistics, "Consumer Expenditures – 2015," August 30, 2016, 2, https://www.bls.gov/news.release/pdf/cesan.pdf.

FIGURE T2: Vehicle Registrations in CT in 2013



In 2013, Connecticut had about 1.47 million passenger cars and 1.17 million light trucks (vans, pickups and sport utility vehicles) on its roads, and about 120,000 buses, tractor-trailers, and other medium- and heavy-duty vehicles.

Source: Atlas Public Policy and The Cadmus Group, Inc., Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut, p. 16, September 2016.

TABLE T1: U.S. Average Annual Expenditures for Gasoline, Diesel Fuel, Motor Oil, and Vehicle Purchases per Household in 2015

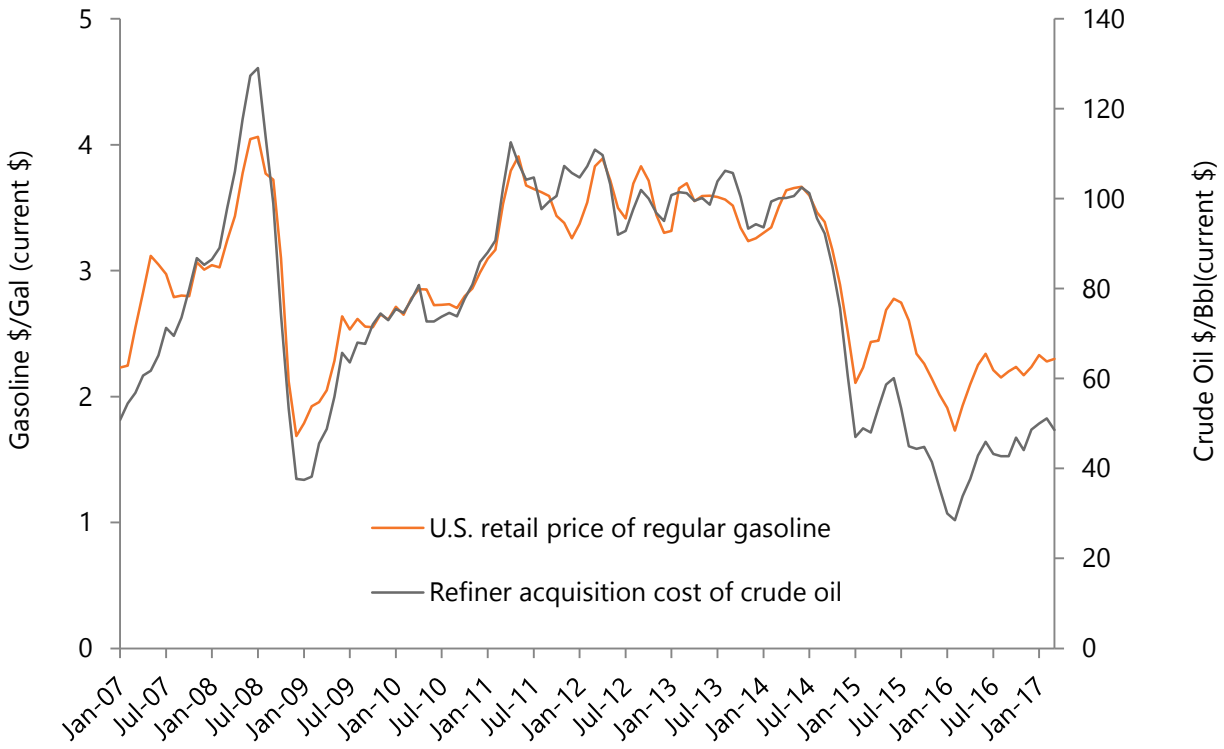
Expenditures	$/Unit	Percent
All transportation expenditures	$9,503	100%
Gasoline, diesel fuel, and motor oil	$2,090	22%
Vehicle Purchases	$3,997	42.1%

Source: Consumer Expenditures – 2015, U.S. Bureau of Labor Statistics ***(8/30/2016).***

Crude oil – which is processed in refineries to make gasoline, diesel, heating oil, jet fuel, lubricants, petrochemical feedstocks and other petroleum products – remains the most economically and politically volatile of all energy resources. Prices for these petroleum products tend to fluctuate in line with crude oil prices, as shown for regular gasoline prices in Figure T3, albeit with some variation due to seasonality, product-specific market factors, or refining outages.[5]

[5] U.S. Energy Information Administration, "What drives crude oil prices: Spot Prices," accessed November 2, 2016, https://www.eia.gov/finance/markets/crudeoil/spot_prices.php.

FIGURE T3: U.S. Regular Retail Gasoline Prices and U.S. Refiner Crude Oil Acquisition Costs



Source: U.S. Energy Information Administration

During 2013, drivers traveled about 31 billion miles on Connecticut's roadways, mostly on interstates, freeways, expressways, and arterial roads.[6] As shown by Figure T4, average daily VMT statewide in Connecticut has largely trended upward since the 1970s, with a period of decline in 2007 due to the recession, higher gasoline prices, and an increase in mass transit ridership. Today the statewide average daily VMT is approximately 85.5 million. Based on Connecticut Department of Transportation's (CTDOT) projections, average daily VMT is expected to increase to 104.1 million miles by 2040.[7]

Despite encouraging signs of increased public transit use, Connecticut anticipates that the populace will likely continue to rely largely on personal motorized vehicles to meet its transportation needs. One possible contributing factor to this is low gasoline prices, which is correlated with a recent uptick in VMT in Connecticut for travel needs.

[6] Atlas Public Policy and The Cadmus Group Inc., *Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut*, September 2016, 18, http://atlaspolicy.com/wp-content/uploads/2016/11/2016-09-01_Moving_Forward_with_Green_Energy.pdf.

[7] Connecticut Department of Transportation response to DEEP data request.

The Hartford, Bridgeport/Stamford, and New Haven urban areas accounted for the largest average daily VMT during 2015, at 23.5 million miles per day, 20.6 million miles per day, and 13.9 million miles per day, respectively.[8] Combined, passenger vehicles and light-duty trucks make up nearly 90 percent of all VMT statewide, while motorcycles, buses, single-unit trucks and combination trucks contribute the remaining 10 percent. (Figure T5.) Increased VMT on Connecticut's roadways contributes to congestion, causing delays, added costs, increased emissions, and frustration for residents, businesses, and visitors. Nearly 50 percent of all travel occurs along 652 miles of interstate and limited-access highways, a mere 3 percent of Connecticut's roadways.[9] In its May 2017 report, TRIP estimated that congested roads and bridges cost Connecticut's drivers $6.1 billion — $2.2 billion in additional vehicle operating costs, $2.4 billion in congestion-related delays (i.e., lost time and wasted fuel), and $1.5 billion in costs from traffic crashes in which roadway design was likely a contributing factor.[10,11] The average driver in Connecticut sits in traffic approximately 45 hours per year, at a cost of approximately $1,000 annually.[12] (Figure T6.) Table T2 outlines the average cost per driver for congestion-related delays and hours wasted in traffic in Connecticut's three largest urban areas. Notably, 45 percent of businesses surveyed by the Connecticut Business & Industry Association believe that road congestion in the state restricts or limits the territory of their market.[13]

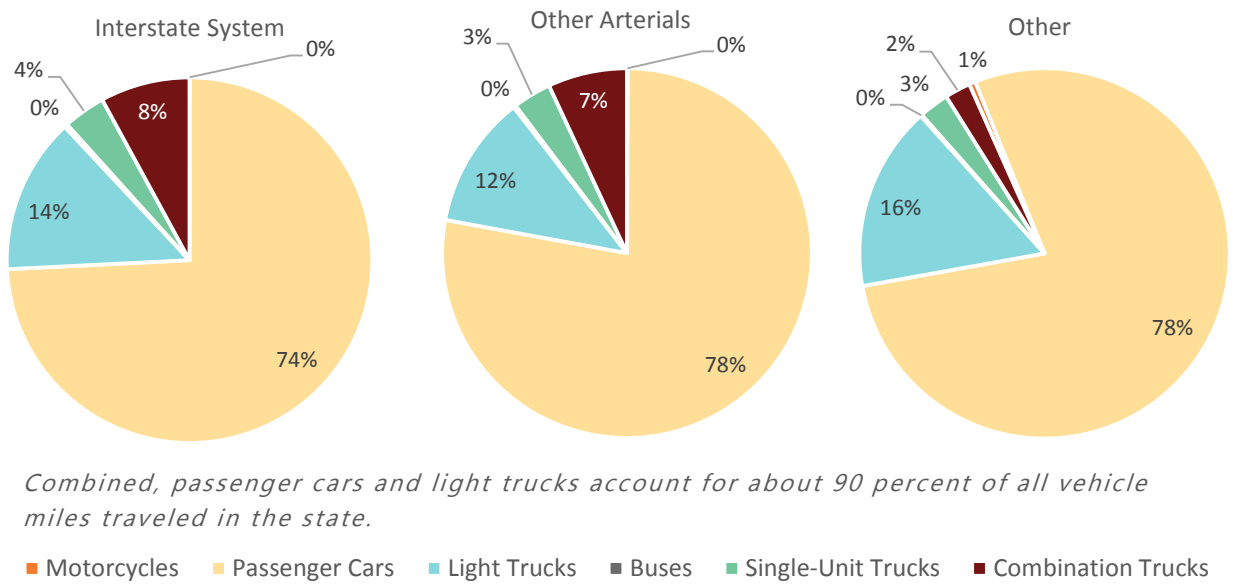
TABLE T2: Congestion-related Costs and Hours Wasted

Urban Area	Average Cost of Congested-related Delays per Driver	Average Number of Hours Wasted in Traffic
Bridgeport/Stamford	$1,174/year	49 hours/year
Hartford	$1,038/year	45 hours/year
New Haven	$932/year	40 hours/year

Source: Texas A&M Transportation Institute, 2015 Urban Mobility Scorecard, p. 20, August 2015.

[8] Connecticut Department of Transportation response to DEEP data request (May 8, 2017).
[9] Connecticut Department of Transportation, "Let's GO CT! Fact Sheets: Connecticut's Traffic Bottlenecks," March 2015, http://www.transformct.info/img/documents/Lets%20Go%20CT-%20Fact%20Sheets%2020150313.pdf.
[10] Founded in 1971, TRIP is a private nonprofit organization that researches, evaluates and distributes economic and technical data on surface transportation issues.
[11] TRIP, *Connecticut Transportation by the Numbers: Meeting the State's Need for Safe and Efficient Mobility*, May 2017, 2, http://www.tripnet.org/docs/CT_Transportation_by_the_Numbers_TRIP_Report_May_2017.pdf.
[12] Texas A&M Transportation Institute, "2015 Urban Mobility Scorecard," August 2015, 20, https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-scorecard-2015-wappx.pdf.
[13] Connecticut Business & Industry Association, "2013 Connecticut Transportation Survey," https://www.cbia.com/resources/economy/reports-surveys/2013-connecticut-transportation-survey/.

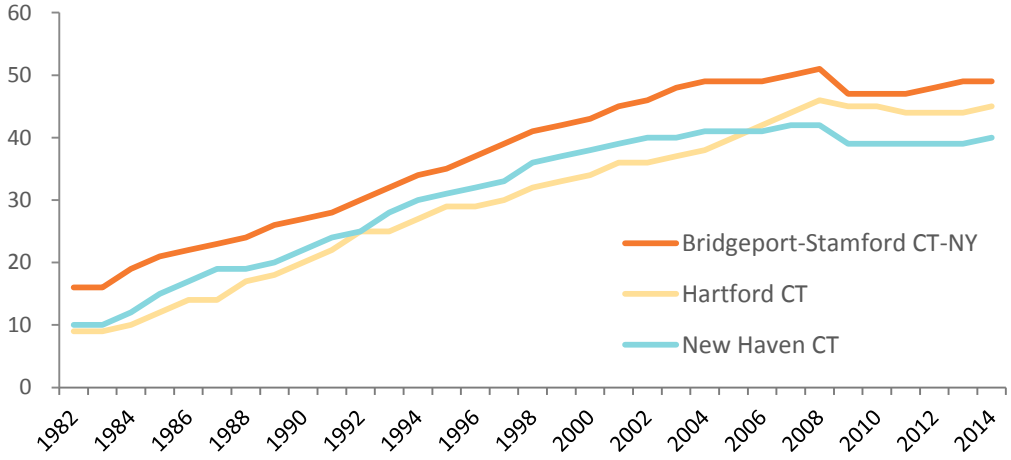
FIGURE T5: Percent of Daily Miles Traveled by Vehicle in 2013



Combined, passenger cars and light trucks account for about 90 percent of all vehicle miles traveled in the state.

Source: Atlas Public Policy and The Cadmus Group, Inc., *Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut*, p. 18, September 2016.

FIGURE T6: Hours of Delay Per Commuter in Connecticut (1982 to 2014)



Source: Texas A&M Transportation Institute

Air Pollution and Climate Change

Petroleum-based fossil fuels for transportation are a significant contributor to air pollution and GHG emissions in Connecticut. Poor air quality exacerbates respiratory and cardiovascular health conditions, heightens the risk of cancer, and burdens our health care system with considerable

medical costs. For example, the state's asthma rate — driven by elevated levels of air pollutants — has been higher than the national rate since 2000.[14] Connecticut has two nonattainment areas that have failed to meet the U.S. Environmental Protection Agency (EPA) 2008 national ambient air quality standards for ozone. Both areas have now been reclassified from "marginal" to "moderate" nonattainment status and face a new compliance deadline of July 2018.[15] This reclassification requires Connecticut to revise its state implementation plan (SIP) under the Clean Air Act, in order to describe the control measures that will be implemented to achieve compliance. Moreover, EPA adopted a more stringent ozone standard in 2015, and as a result, Connecticut will be designated as "nonattainment" under the revised standard.[16] DEEP will have to adopt even more stringent emission control programs to achieve timely compliance with the new standard.

Passenger vehicles and heavy-duty trucks account for the majority of air pollutants ozone, particulate matter, and other smog-forming emissions. Transportation contributes 75 percent of emissions of oxides of nitrogen (NO_x) and 40 percent of volatile organic compound (VOC) emissions, the precursors of ground-level ozone.[17] In 2011, heavy duty vehicles accounted for about 24 percent of all transportation-related emissions of NO_x.[18]

While the transportation sector continues to be the single largest source of GHG emissions in the state, improvements in vehicle efficiency have led to a 13 percent reduction in the sector since 2001. However, recent trends show transportation sector emissions leveling off, along with VMT.[19] Significantly reducing emissions in this sector in the coming decades will require improvements in vehicle fuel economy for all class sizes, deployment of low- and zero-emission vehicles, increased car and ride sharing, and expanded use of public transit.

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[14] Connecticut Department of Public Health, *The Burden of Asthma in Connecticut: 2012 Surveillance Report*, 3, http://www.ct.gov/dph/lib/dph/hems/asthma/pdf/full_report_with_cover.pdf.

[15] Environmental Protection Agency, Rules and Regulations, "Determinations of Attainment by the Attainment Date, Extensions of the Attainment Date, and Reclassification of Several Areas for the 2008 Ozone National Ambient Air Quality Standards," *Federal Register* 81, no. 86, (May 4, 2016): 2669, http://www.ct.gov/deep/lib/deep/air/ozone/ozoneplanningefforts/2016-reclassifications_for_2008_ozone_naaqs.pdf.

[16] U.S. Environmental Protection Agency, Rules and Regulations, "National Ambient Air Quality Standards for Ozone," *Federal Register* 80, no. 206, (October 26, 2015): 65292, https://www.gpo.gov/fdsys/pkg/FR-2015-10-26/pdf/2015-26594.pdf.

[17] U.S. Environmental Protection Agency, 2011 National Emissions Inventory, version 2, Technical Support Document, August 2015.

[18] de la Torre Klausmeier Consulting, Inc., Cambridge Systematics, and Eastern Research Group, *Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut*, March 28, 2013, 7; http://www.ct.gov/deep/lib/deep/air/diesel/freightreport_03_28_2013.pdf.

[19] Connecticut Department of Energy and Environmental Protection, *2013 Connecticut Greenhouse Gas Emissions Inventory*, 2016, http://www.ct.gov/deep/lib/deep/climatechange/2012_ghg_inventory_2015/ct_2013_ghg_inventory.pdf.

Transportation Infrastructure

As a small, densely populated state with considerable through traffic from neighboring states, Connecticut requires a safe and reliable network of roads, rail lines, shipping ports, and airports. The state's road system consists of 21,508 miles of public roadways, including 1,392 miles of interstate and other National Highway System roadways, along with numerous state highways, bypasses and service ramps.[20] Connecticut's three major highways — I-95, I-91, I-84 — which are among the most heavily used highways in the nation — serve 100,000 to 170,000 vehicles per day, and heavy-trucks comprise 10-15 percent of that traffic.[21] Maintaining this infrastructure in a good state of repair makes travel more efficient for users by reducing congestion and fuel consumption. Unfortunately, 47 percent of the state's roadways are rated in poor or fair condition.[22] Deficient roadways result in $2.6 billion in spending on higher operating costs, fuel consumption, and traffic accidents each year.

The rail system in Connecticut consists of 628.5 miles of active rail segments. Three passenger rail lines operate in the state – CTDOT's Shore Line East, Metro-North Railroad's New Haven Line, and Amtrak. Several freight railroads, ranging from a large Class 1 railroad to shorter regional and local railroads, provide for the shipment of goods. Safe, reliable, and efficient passenger and freight rail infrastructure provides opportunities to divert the movement of people and goods from cars and trucks to rail, saving fuel and reducing emissions.

Two commercial airports operate in the state – Bradley International Airport in Windsor Locks (the second-largest airport in New England) and Tweed New Haven Airport. Three "reliever" airports, eight general aviation airports, and seven other public-use airports provide additional aviation services in the state.

Connecticut's three deep-water ports are located in Bridgeport, New Haven and New London. Ships utilizing the state's deep-water ports help reduce fuel consumption and emissions by lessening the need for tractor-trailers in the transport of goods in and out of the state. The energy-saving impacts of these ports can be further realized when infrastructure is in place to connect each port to a freight rail line.

[20] Connecticut Department of Transportation, "Connecticut… on the move! Transportation Fast Facts 2015," 18, http://www.ct.gov/dot/lib/dot/documents/dcommunications/2015_ct_fastfacts_final.pdf.
[21] Connecticut Department of Transportation, "Connecticut… on the move! Transportation Fast Facts 2015," 18, http://www.ct.gov/dot/lib/dot/documents/dcommunications/2015_ct_fastfacts_final.pdf.
[22] Connecticut Department of Transportation, "Connecticut… on the move! Transportation Fast Facts 2015," 21, http://www.ct.gov/dot/lib/dot/documents/dcommunications/2015_ct_fastfacts_final.pdf.

Transportation Infrastructure Funding

Connecticut's ability to finance necessary infrastructure repair and future build-out depends on the availability of federal and state funds. Support from the U.S. Department of Transportation and revenues from the State gasoline tax, which have funded the construction and maintenance of roads, bridges, and railroad systems, has declined sharply in recent years and is expected to continue to decrease. For the United States as a whole, the Congressional Budget Office forecasts that, in the absence of reforms, gasoline tax revenues will drop about 21 percent by 2040 as vehicle fuel economy improves.[23] Within the State transportation budget, annual fuel tax revenue will be reduced by an estimated $357 million by 2040 due to increased fuel efficiency, when compared to current fuel tax revenues.[24]

The need to reduce energy consumption and GHG emissions creates a transportation policy challenge. The more Connecticut vehicle owners increase their fuel efficiency, reduce VMT, and transition to alternative fuels, the larger the transportation revenue gap will become. Alternative options for funding necessary transportation infrastructure projects and enhancing public transit present a critical challenge that must be addressed to achieve the State's energy and climate policy goals while also ensuring a safe and reliable transportation system.

Let's Go CT! Plan

Released during February 2015, Let's Go CT! is Governor Malloy's transportation "Call to Action." The Let's Go CT! Plan represents a 30-year vision for Connecticut's best-in-class transportation system.

The Let's Go CT! Plan was drafted with extensive public outreach, under a strategic planning process called TransformCT. This 18-month process identified basic needs and defined a vision for the state's transportation system. The result of this effort was a bold strategy to achieve the State's transportation vision.

The goals of the Let's Go CT! Plan are realized through a combination of ambitious statewide, corridor, and local projects across all transportation modes. Achievement of these goals will be executed in two stages — a 5-Year Ramp-Up Plan and a 30-Year Vision.

[23] Ed Regan, "The Motor Fuel Tax: A Critical System at Risk, Framing the Problem for Connecticut" (white paper), February 13, 2017, https://www.cga.ct.gov/2017/tradata/od/2-24-17%20The%20Motor%20Fuel%20Tax%20Ed%20Regan.pdf.

[24] The estimated fuels tax revenue assumes no change in the effective gas tax rate. Fuel efficiency is based on the EIA "Reference Case" MPG forecast.

CT*fastrak*

Launched by CTDOT on March 28 2015, CT*fastrak* is Connecticut's first Bus Rapid Transit system. Featuring a regional network of service utilizing a 9.4 mile dedicated bus only roadway, distinctive stations, branded buses, new technologies, and most of all, a significant improvement in frequent, reliable bus service, CT*fastrak* is changing the landscape of public transportation in Connecticut.

The routes are integrated with the CT*transit* system making it easier for riders to connect, transfer, and pay for fares. The system provides direct service to and from Waterbury, Cheshire, Southington, Bristol, Plainville, New Britain, Newington, West Hartford, Hartford, East Hartford and Manchester with routes that take advantage of the bus-only CT*fastrak* roadway.

In its first year of operation CT*fastrak* surpassed its first year ridership goal of 11,180 daily passenger trips and has doubled the daily ridership in the corridor.

In February 2015, Governor Malloy released the Let's Go CT! Plan, a 30-year vision for the state's transportation system. The Plan, which aimed to make Connecticut's transportation system best-in-class, called for developing a transportation "Lock Box" that would help to ensure all funding designated for transportation projects can be spent only on transportation projects. While this recommendation is a step in the right direction, there is also a need for alternative funding mechanisms to support a clean, efficient, safe, and well-maintained transportation infrastructure.

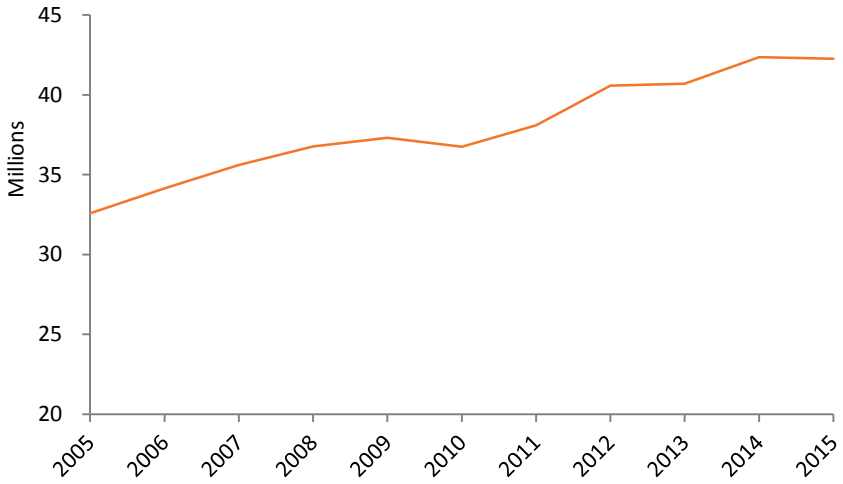
Mass Transit Services

Mass transit – buses and rail services – provides important alternate modes of travel for the state's commuters that can ease road congestion, reduce vehicle-related accidents, decrease GHG emissions, and improve air quality. Bus transit service is the foundation of Connecticut's transit system and is the primary commuting method for urban, transit-dependent workers while also serving as the mode of choice for many suburban commuters who use express buses. Bus services also play an important role in the transportation of the elderly, those with disabilities, the young, and those who prefer to use public transportation rather than personal vehicles. In urban areas with rail service, buses play a critical role in connecting rail passengers to their final destination, which is often located beyond walking distance from the train station.

Connecticut's bus system serves multiple functions and geographic areas. Its ridership has increased from 40 million passengers a year in 2013 to over 42 million passengers a year in 2015.[25] (Figure T7.)

[25] Connecticut Department of Transportation, "Let's GO CT! Fact Sheets: Connecticut's Bus System," March 2015, http://www.transformct.info/img/documents/Lets%20Go%20CT-%20Fact%20Sheets%2020150313.pdf.

FIGURE T7: Statewide Total Bus Transit Ridership



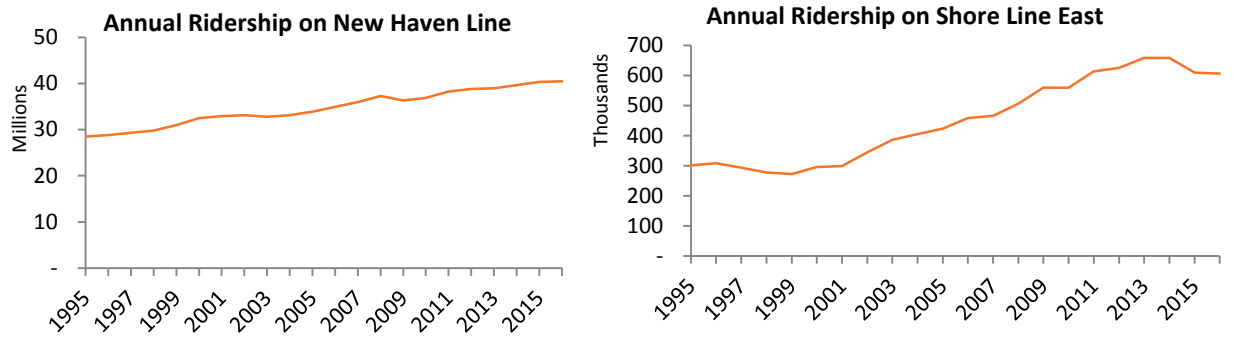
Source: Connecticut Department of Transportation

In March 2015, CT*transit* expanded its bus transit with the launch of the CT*fastrak* bus rapid transit (BRT) service. This is a system of bus routes utilizing a bus-only roadway for all or a portion of trips and making it easier for riders to connect, transfer, and pay. Ridership in the corridor before CT*fastrak* opened was approximately 8,000 weekday passenger trips. Subsequently, weekdays averaged 12,000-16,000 trips.[26]

Connecticut is served by three primary rail services: Shore Line East (SLE), the New Haven Line (NHL), and Amtrak. With over 40 million trips per year, the NHL is the busiest commuter rail corridor in the country.[27] Each weekday, the NHL serves approximately 115,000 commuters, 80,000 of whom originate in Connecticut.[28] Ridership for both the NHL and the SLE increased by approximately 10 percent between 2009 and 2016. (Figure T8.)

[26] Connecticut Department of Transportation, *CTfastrak Year One Report*, March 26, 2016, 4, http://www.ct.gov/dot/lib/dot/documents/dcommunications/press_release/ctfastrak_year_one_report.pdf.
[27] Connecticut Department of Transportation, "Let's GO CT! Fact Sheets: Rail Bridge Conditions and Needs on New Haven Line," March 2015, http://www.transformct.info/img/documents/Lets%20Go%20CT-%20Fact%20Sheets%2020150313.pdf.
[28] "New Haven Line," Connecticut Department of Transportation, accessed June 28, 2017, http://www.ct.gov/dot/cwp/view.asp?a=1390&q=316752.

FIGURE T8: Annual Ridership on Connecticut Rail Services



Source: Connecticut Department of Transportation

Over the past three years, transit service improvements have made public transit more accessible, which will ultimately lead to economic development within the state's transit corridors. By building on the foundation of these improvements, the State will continue to make it possible for thousands more Connecticut residents to travel by rail or bus, cutting VMT and reducing emissions.

Transit-Oriented Development and Connectivity

Compact, mixed-use, pedestrian-oriented development around existing and planned public transportation hubs is critical to enhancing connectivity between communities. Transit-oriented development (TOD), a combination of land use and transportation planning, makes all modes of transportation more accessible, reducing individual car travel and traffic congestion, both of which contribute to local air quality issues and GHG emissions. This type of development can provide residents with easier access to jobs, education, recreational opportunities, and other day-to-day activities. Developing vibrant communities around transit hubs revitalizes neighborhoods and areas designated as brownfields and can have positive impacts on property values. Businesses benefit from TOD through increased foot traffic around their establishments. Residents living in TOD communities may also have more discretionary income to spend at local businesses, because the percentage of income spent on transportation is typically lower for residents who are not heavily reliant on a personal vehicle.

Implementing a principal recommendation in the 2013 CES, the State developed and supported a variety of initiatives to facilitate TOD to increase mobility, reduce emissions, and create more livable communities in Connecticut. For example, the Office of Policy and Management selected a total of 31 projects to receive funding under the TOD Planning Grant Program as well as the

Responsible Growth and TOD Grant Program.[29] In addition, the Let's Go CT! Plan articulates and recognizes the role of TOD along the New Haven Line, the Hartford Line, and the CT*fastrak* corridors. Continued support for TOD will create more livable communities and provide residents with greater opportunities to use alternative forms of transportation.

Infrastructure that supports non-motorized travel is essential to enhancing connectivity and is a key component of TOD. Walking and cycling are zero-emission alternatives to motor vehicle use, especially for short distance trips, and provide a health benefit for people who chose to utilize them.

CTDOT's adoption of a "Complete Streets" policy in 2014 has furthered the integration of safe on-road access for all users – pedestrians, bicyclists, motor vehicle operators, and transit users.[30, 31] The policy requires that cyclists, pedestrians, and transit users are considered in the design and planning of all roads. Typical characteristics of a complete street include bike and walking paths, highly visible crosswalks, curb extensions, and streetlights. Eight municipalities have also adopted Complete Streets plans, ordinances and/or policies formalizing their intent to plan, design, and maintain streets so they are safer for all users regardless of the mode of transportation.[32] Used in conjunction with land use planning, smart growth, and transit-oriented development ideals, the Complete Streets approach has helped create dynamic communities and urban areas with improved connectivity across the state.

Communities that are designed to rely primarily on people's use of cars to get to work, home, places of worship, and recreational and healthcare facilities tend to drive more annual miles, consume more fuel, and produce more pollution. Connecticut should continue to incentivize, support, and promote TOD and smart-growth strategies that create more accessible, multi-modal communities. Improving regional accessibility, density, mixed-use development, street connectivity, walkability, and public transit proximity will increase economic, social, and environmental benefits across the state.

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29 Transit-Oriented Development (TOD) Planning Grant Program, Office of Policy and Management, accessed June 28, 2017, http://www.ct.gov/opm/cwp/view.asp?a=2985&q=567428; and The Office of Governor Dannel P. Malloy, "Gov. Malloy Announces State Grants to Encourage Transit-Oriented Development and Responsible Growth Across Connecticut," June 8, 2016, http://portal.ct.gov/office-of-the-governor/press-room/press-releases/2016/06-2016/gov-malloy-announces-state-grants-to-encourage-transit-oriented-dev-and-responsible-growth-across-cy.

30 "Complete Streets" is a transportation policy and design approach to roadways that enables safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation.

31 Connecticut Department of Transportation, "Policy Statement, Policy No. EX.O. – 31," October 23, 2014, http://www.ct.gov/dot/lib/dot/plng_plans/bikepedplan/cs-exo31-signed.pdf.

32 Enfield, Hartford, Middletown, New Haven, Portland, Stamford, South Windsor, and West Hartford have passed Complete Street policies and/or ordinances.

Fuel and Vehicle Standards

Fuel and vehicle standards adopted by the U.S. Environmental Protection Agency (EPA), the National Highway Traffic Safety Administration (NHTSA), and the California Air Resources Board (CARB) advance our nation's goals to address climate change and reduce our dependence on petroleum-based fossil fuels for transportation. These standards lead to reductions in fuel use from on-road transportation sources, which improve energy security, increase fuel savings, conserve billions of barrels of oil, reduce GHG and other air emissions, and provide regulatory certainty for automakers.

When CARB adopted the Advanced Clean Cars (ACC) program in 2012, the agency committed to conducting a comprehensive midterm review of three elements of the program — the zero-emission vehicle (ZEV) regulation, the 1 milligram per mile (mg/mi) particulate matter (PM) standard, and the light-duty vehicle GHG standards for 2022 and later model years. CARB also worked with EPA and NHTSA on the national midterm review, as the California program closely mirrors the national program for these model years. In March of 2017, CARB made a determination, set out in Resolution 17-3, that the technical and economic evidence supporting the 2022-2025 model year LEV III GHG standards is definitive and conclusive. As a result, CARB made no

ZEV Regulation

Connecticut's adoption of the California ZEV rule in 2013 has the potential to boost deployment of ZEVs in the state. The rule requires automakers to attain an increasing number of zero-emission vehicle credits based on the number of vehicles produced and delivered for sale in participating states. However, due to a clause in the regulation, called the "travel provision," vehicle manufacturers can earn credits in every state for ZEVs that are sold in any ZEV-program state. As a result, manufacturers have focused on selling ZEVs primarily in California, due to the size and strength of its market.

Despite the travel provision, according to NESCAUM, EV sales in ZEV states other than California increased 60 percent in 2016 over the previous year. This shows that state and federal incentives, education and awareness about environmental and financial benefits, and expanding availability of reliable infrastructure is starting to pay off. The travel provision expired at the end of 2017. This expiration will likely lead to an increase in ZEV sales in Connecticut and participating New England states. It is anticipated that this will support increased market penetration of ZEVs in the years ahead.

adjustments to the stringency of these rules, which Connecticut had adopted in 2013.[33]

While the CARB program (along with the Section 177 States) covers almost 35 percent of the nation's light-duty fleet, EPA and the NHTSA jointly developed a National Program for GHG emissions and fuel economy standards applicable to the remaining light-duty cars and trucks in model years 2012-2016 (first phase) and 2017-2025 (second phase).[34] The EPA has projected that the final standards will achieve an average industry fleet-wide emission level of 163 grams/mile of carbon dioxide (CO2) in model year 2025, which is equivalent to 54.5 miles per gallon (mpg) if achieved exclusively through fuel economy improvements.[35] As part of the 2017-2025 standards rulemaking, the EPA made a regulatory commitment to conduct, in coordination with NHTSA and CARB, a midterm evaluation of the longer-term standards for model years 2022-2025. EPA made a final determination in December 2016, declaring the GHG emissions standards remain feasible, practical, and appropriate under the federal Clean Air Act and were achievable at lower costs than previously estimated using widely available technology. Based on an extensive technical record, EPA determined the standards should remain unchanged.[36] However, on March 15, 2017 EPA and NHTSA announced that EPA intends to reconsider this final determination.[37]

To ensure Connecticut meets its climate and clean air goals, the State will continue to advocate for aggressive national vehicle efficiency standards while maintaining its commitment to implementing the California LEV, ZEV and GHG programs that will result in cleaner, more efficient vehicles being deployed in the state. Connecticut will continue to advocate for robust federal fuel efficiency standards as well as diversification of, and funding for, alternative fueling infrastructure. Specific interests include, but are not limited to, more stringent emission standards, more robust efficiency requirements, support for electrification, and investment in hydrogen and other alternative fueling infrastructure.

Of particular challenge are recent efforts by the federal government to roll back the energy and environmental standards that underpin the technology-forcing nature of the national regulatory

33 California Air Resources Board, "Advance Clean Cars Midterm Review, Resolution 17-3," March 24, 2017, https://www.arb.ca.gov/msprog/acc/mtr/res17-3.pdf.
34 Section 177 of the Clean Air Act authorizes other states to choose to adopt California's standards in lieu of federal requirements. Currently, 15 states have done so: Connecticut, Delaware, Georgia, Maine, Maryland, Massachusetts, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington.
35 U.S. Environmental Protection Agency, "Regulations for Greenhouse Gas Emissions from Passenger Cars and Trucks," accessed July 12, 2017, https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-greenhouse-gas-emissions-passenger-cars-and.
36 EPA Final Determination on the Appropriateness of Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, January 2017, https://www.epa.gov/nscep.
37 U.S. Department of Transportation, National Highway Traffic Safety Administration, and Environmental Protection Agency, "Notice of Intention to Reconsider the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light Duty Vehicles," *Federal Register* 82, no. 54, (March 22, 2017): 14671, https://www.gpo.gov/fdsys/pkg/FR-2017-03-22/pdf/2017-05316.pdf.

framework for vehicle emission standards and fuel-economy standards. The State must closely monitor such counterproductive developments and, in cooperation with the Connecticut Attorney General's office and our state partners, continue to support ongoing legal challenges and actively confront federal actions that harm Connecticut's public health, environment, or economy.

Heavy Duty Vehicle Regulations

Emissions from heavy-duty vehicles also impact energy use and air quality and are regulated primarily by EPA. EPA took a significant step in 2001 by deciding to regulate heavy-duty vehicles and their fuel as a single system, beginning with the 2007 model year. This effort lead to the use of ultra-low sulfur diesel (ULSD) and accounts for significant reduction in both sulfur dioxide (SO_2) and particulate emissions from all sources that use ULSD. In 2007, EPA began to phase in the 2001 standards, which, in combination with ULSD, reduced harmful air pollution from heavy duty vehicles more than 90 percent.[38] In June 2016 several states (and cities), including Connecticut, petitioned EPA to adopt these standards nationally. In 2011, EPA and NHTSA adopted the first phase of a comprehensive program to reduce GHG emissions and fuel consumption from heavy-duty highway vehicles, including combination tractors as well as heavy-duty pickup trucks and vans for model years 2014-2018. In 2016, EPA and NHTSA adopted the second phase of GHG standards for model years 2018-2027 for certain trailers and model years 2021-2027 for semi-trucks, large pickup trucks, vans, and all types and sizes of buses and work trucks. The second phase of this program will significantly reduce carbon emissions and improve the fuel efficiency of heavy-duty vehicles, helping to address the challenges of global climate change and energy security.

For light-duty vehicles, Connecticut has adopted three California regulatory programs that empower the State's clean vehicle platform. The Low Emission Vehicle (LEV) II program adopted in 2004 requires manufacturers to meet fleet average emissions requirements for light-duty and medium-duty vehicles. LEV III, adopted in 2013 for model years 2015-2025, is expected to reduce emissions for smog-forming pollutants 75 percent (compared to 2015 levels) and GHG emissions 34 percent.[39] And the Zero Emission Vehicle (ZEV) program adopted in 2013 requires automakers to deliver a certain portion of their fleet as ZEV vehicles in order to facilitate commercialization of advanced technology vehicles, which are typically lower emitting than comparable conventional vehicles. As part of the midterm review under the ACC, CARB made a determination on April 14,

[38] U.S. Environmental Protection Agency, "EPA Final Rule for Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements," https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-control-air-pollution-new-motor-vehicles-heavy.

[39] California Air Resources Board, "The California Low-Emission Vehicle Regulations," https://www.arb.ca.gov/msprog/levprog/cleandoc/cleancomplete%20lev-ghg%20regs%204-13.pdf.

2017 to maintain current ZEV volumes through 2025 and re-committed to ending the "travel provision" for all battery electric ZEVs in the California rule, resulting in the delivery of greater numbers of ZEVs to the Section 177 states beginning in 2018.[40]

Volkswagen Settlement

In 2015, a federal multi-state investigation revealed that Volkswagen AG, Audi AG, and Porsche (collectively, VW) installed emissions-control "defeat" devices in approximately 600,000 of their 2.0L and 3.0L diesel vehicles, starting with model year 2009 through model year 2015. The investigation, which Connecticut helped lead, ultimately revealed a deliberate strategy by VW to circumvent the U.S. emissions standards for diesels, resulting in emissions of up to 40 times the legal limit.

The parties reached a series of settlement agreements totaling over $20 billion.[41] These settlement agreements include various funds and programs benefitting Connecticut and its citizens. In particular, VW established a $2.7 billion Environmental Mitigation Trust to fund replacement of diesel engines with cleaner technology and to mitigate the continuing NO_x emissions from the VW's violating 2.0L vehicles. VW added an additional $225 million to the trust when it settled the claims regarding its 3.0L vehicles.

Of the $2.7 billion, Connecticut will be allocated almost $56 million. Connecticut's use of this allocation is controlled by the Consent Decree (Appendix D), which specifies that up to 15 percent of these funds may be used for electric vehicle infrastructure, while the remainder of the funds must be used for the replacement or repowering of a wide array of on-road vehicles — for example, class 4-8 freight trucks (model years 1992-2009), school buses (2009 and older), transit buses (2009 and older), and non-road diesel-powered vehicles and other sources (for example, commercial marine engines, locomotive engines, airport ground-service equipment, forklifts, port handling equipment). The federal court overseeing the VW litigation issued an order approving the VW Trust on October 3, 2017, which is now known as the VW Trust effective date. Shortly thereafter, Connecticut filed a certification to become a beneficiary under the trust on October 18, 2017. On January 29, 2018 in a notice to the federal court overseeing the VW litigation,

[40] A clause in the California Zero Emission Vehicle regulation, called the "travel provision," allows vehicle manufacturers to earn credits in every state for ZEVs that are sold in any ZEV-program state. As a result, manufacturers have focused on selling ZEVs primarily in California, due to the size and strength of its market. The provision expired at the end of 2017.

[41] "Volkswagen Clean Air Act Civil Settlement," U.S. Environmental Protection Agency, accessed June 30, 2017, https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement.

Connecticut became a designated beneficiary under the VW trust when the Trustee notified the court that Connecticut's certification for beneficiary status was both timely made and complete.

Connecticut is now working to finalize the draft beneficiary mitigation plan based on stakeholder comments. The plan, proposed for public comment in January 2017, describes actions or projects eligible for funding, along with a description of the expected ranges of emission benefits.[42] Concurrent with this effort, Connecticut will finalize its internal fiscal controls consistent with the Trustee's requirements and then begin soliciting mitigation project proposals in the spring of 2018. All proposals will be subject to an open, transparent and competitive process consistent with similar grant reimbursement programs.

In addition to establishing the trust, through its Electrify America LLC a subsidiary, VW over the next 10 years is investing $2 billion in ZEV infrastructure and education to support the adoption of ZEV technology. Of the $2 billion, $800 million will be invested in California and $1.2 billion in other states.[43] The $1.2 billion will be invested in $300 million increments over four 30-month cycles.

In the recently announced first investment cycle, Electrify America committed to three primary initiatives: 1) installing charging infrastructure, 2) public education initiatives, and 3) ZEV access initiatives. The installation of charging infrastructure will consist primarily of community charging and a long-distance highway network. In the first investment cycle, selected investments include establishing a network of 2,500 non-proprietary EV chargers along high-traffic corridors between major metropolitan areas and community charging infrastructure in 11 metropolitan areas, including New York City and Boston.[44]

On a rolling basis, Electrify America is accepting comments, recommendations, and proposals on development and implementation of the ZEV Investment Plans. Future investment cycles may include hydrogen fueling stations, national ZEV car-sharing, or ride-sharing services. In the future,

[42] "VW Settlement Information," Department of Energy and Environmental Protection, http://www.ct.gov/deep/cwp/view.asp?a=2684&q=587294&deepNav_GID=1619.
[43] Volkswagen Group of America, "National ZEV Investment Plan: Cycle 1," April 9, 2017, 1, https://www.epa.gov/sites/production/files/2017-04/documents/nationalzevinvestmentplan.pdf.
[44] Volkswagen Group of America, "National ZEV Investment Plan: Cycle 1," April 9, 2017, 17, https://www.epa.gov/sites/production/files/2017-04/documents/nationalzevinvestmentplan.pdf.

the State should work to evaluate opportunities to submit a state and/or regional proposal to advance its efforts to advance EV infrastructure.

Alternative Fuel Vehicles and Infrastructure

Connecticut has a long history of implementing policies and programs that support the deployment of alternative fuel vehicles and associated infrastructure. This history includes: utilizing a 5 percent biofuel additive and piloting fuel cell buses in the statewide bus fleet; promoting the use of clean diesel; funding initiatives that support deployment of compressed natural gas (CNG) and LNG vehicles and fueling stations; converting school buses to cleaner burning propane; and providing financial incentives for the purchase of hybrids, electric vehicles, and charging stations.

In October 2013, Connecticut signed the Zero Emissions Vehicle Memorandum of Understanding (ZEV MOU). This multi-state initiative commits the seven participating states to collectively deploy 3.3 million EVs by 2025 and take coordinated action to ensure successful deployment of these vehicles.[45]

CHEAPR

The Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) provides a cash rebate for residents, businesses, and municipalities that purchase or lease a battery electric, fuel cell, or plug-in hybrid vehicle. Fuel cell powered EVs receive the largest rebate of $5,000, while plug-in hybrid and full battery electric EVs receive incentives ranging from $750 to $3,000, based on battery size. The rebate amount can be credited at the point of sale or lease, lowering the cost of the car immediately.

More than 30 vehicles are eligible, and the list continues to grow as manufacturers release new models.

Since the launch of CHEAPR in May 2015, $4.9 million have been issued for 2,332 EVs in Connecticut. Consistent utilization of the rebates and acceleration of EV purchases demonstrate the ongoing success of CHEAPR.

[45] On October 24, 2013 Governor Malloy signed the State Zero-Emission Vehicle Program Memorandum of Understanding with seven other states (California, Maryland, Massachusetts, New York, Oregon, Rhode Island and Vermont). "State Zero-Emission Vehicle Program Memorandum of Understanding," October 23, 2013, http://www.ct.gov/deep/lib/deep/air/zeromeissionvehicle_mou.pdf.

Environmental Impact of EV Batteries

DEEP recognizes and acknowledges the potential lifecycle impacts of lithium-ion (li-ion) batteries that power electric drive vehicles, from the mining of raw materials, the use of the electric grid for charging purposes, to the eventual disposal of spent batteries. Mining companies are positioning themselves to meet rising demand for lithium, nickel, cobalt and other raw materials that constitute these batteries, which provokes unease about mining's environmental footprint.

As exponentially more batteries enter the environment, it will be crucial for industry to improve the efficacy of recycling li-ion batteries to help offset the increased need for raw materials and to mitigate environmental impacts. In a 2013 Report, the EPA's Design for the Environment program concluded that batteries using nickel and cobalt, such as li-ion batteries, have the "highest potential for environmental impacts." DEEP stands ready to provide assistance to producers, suppliers, and recyclers in the supply chain to identify and consider opportunities for reducing environmental impacts associated with the lifecycles of li-ion batteries.

To ensure compliance to achieve this multi-state commitment, automakers within each state are required to maintain ZEV credits equal to a set percentage of non-electric sales. Each car sold earns a number of credits based on the type of ZEV and its battery range.[46] Connecticut's portion of this commitment is approximately 150,000 ZEVs. The MOU identifies joint cooperative action which spurred the development of the Multi-state ZEV Action Plan, released in May 2014. Connecticut continues to implement the 11 key actions outlined in the plan to further accelerate adoption of EVs in the state.[47]

As part of the 2013 CES recommendations to support the deployment of clean fuel/vehicles and to meet its ZEV MOU commitment, DEEP launched the EVConnecticut Program. The program was established to promote environmental and economic opportunities presented by increased ownership of electric vehicles.

To increase awareness and educate consumers, the EVConnecticut website was developed as a clearinghouse for information on incentives, charging infrastructure, program statistics, regional and national EV commitments, and news and events. The

[46] Union of Concerned Scientists. "What is ZEV?" October 31,2016. https://www.ucsusa.org/clean-vehicles/california-and-western-states/what-is-zev#.WmdxTq6nHDB

[47] The Multi-state ZEV Action Plan assists in developing consistent and complementary measures within and across all ZEV MOU states to foster efficient market development and maximize the ownership experience for consumers. ZEV Program Implementation Task Force, "Multi-state ZEV Action Plan," May 2014, http://www.ct.gov/deep/lib/deep/air/electric_vehicle/path/multi-state_zev_action_plan_may2014.pdf.

website has garnered 70,000 page views and serves as a one-stop-shop portal for residents to gather information about electric vehicles.

In May 2015, DEEP launched the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) program. CHEAPR provides residents with a point-of-sale rebate on the purchase or lease of new ZEVs, up to $5,000. Rebates are offered on a sliding scale based on battery capacity and vehicle technology. CHEAPR has disbursed over $4.9 million for 2,332 new vehicle leases and purchases.[48] DEEP also partnered with the Connecticut Automotive Retailers Association to establish a dealer recognition and cash bonus award, both of which incentivize dealers to actively sell EVs. This public-private partnership also has encouraged auto dealers to install free public EV charging on their premises.

CHEAPR Participant Survey

Fifty-five percent of CHEAPR participating consumers (655 responses) have completed a brief survey about EV adoption motivators and adopter demographics. More than 87 percent of drivers said that the CHEAPR rebate was an "extremely" or "very" important factor in the decision making process, with over two-thirds of participants responding that they would not have purchased or leased their EV without the CHEAPR rebate. Other responses of note indicate the median anticipated utilization of BEVs is 10,000 miles/year and 12,000 miles/year for PHEVs.

For 76 percent of participating consumers, CHEAPR is supporting the replacement of a primary household vehicle. In other words, CHEAPR vehicles are not third cars or "commuter cars"; they will be utilized as primary vehicles.

The CHEAPR program is continually evaluated to ensure that it responds to developments in battery technology and changing consumer market demands. For example, rebate levels were adjusted after the first year of operation to ensure the best performing models in each respective technology category (Plug-in Hybrid Electric Vehicles, Battery Electric Vehicles, Fuel Cell Electric Vehicles) are eligible for the highest rebate amounts while optimizing current and future program funding. Rebate recipients are also asked to complete a follow up survey that investigates the purchaser's primary purchase motivation and the importance of the CHEAPR rebate. These survey results help inform future program modifications.

To further educate consumers about the costs and benefits of EVs, DEEP collaborated with Plug-In America to host four "ride and drive" events at large workplaces throughout Connecticut. At

[48] Administered by the Center for Sustainable Energy, the CHEAPR program is funded through a commitment by Eversource as part of a broader funding commitment to energy efficiency and related initiatives set forth in a settlement agreement related to the NU/NSTAR merger.

these four events over 500 surveys were collected; and the results showed that more than 85 percent of participants who rode in or drove a plug-in vehicle walked away with a better opinion of EVs.

Utilizing a more traditional marketing approach, DEEP developed a Public Service Announcement (Honey, We Should Get an Electric Car) to address the top concerns potential buyers have expressed about purchasing EVs. The PSA has been distributed by several municipalities for local broadcast and used by a variety of outreach groups to educate the public about misconceptions surrounding EVs. In addition to traditional marketing techniques, social media has become a primary means for people — especially young adults — to gather information.[49] The State continues to utilize social media platforms, such as Facebook and Twitter, as an additional way to reach the public.

In 1993, the U.S. Department of Energy launched the Clean Cities program to provide technical expertise, information, and funding assistance to regulated fleets and voluntary adopters of alternative fuels. Its mission is to reduce petroleum dependence and to strengthen economic, environmental, and energy security through public and private stakeholder engagement.

Starting in 1994, U.S. DOE officially started the designation of four Clean Cities coalitions in Connecticut: Greater New Haven Clean Cities Coalition, Capitol Clean Cities of Connecticut, Connecticut Southwestern Area Clean Cities, and Norwich Clean Cities.[50] Through their partnerships with business owners, alternative fuel providers, fleet managers, local and state government agencies, and vehicle manufacturers, these non-profit coalitions have helped

TABLE T3: Clean Cities Coalition 2015 Program Statistics

	Annual Petroleum Savings (gallons of gasoline equivalent)	Annual GHG Emission Avoided (tons of CO_2)
Capitol CC	2,598,320	9,786
Greater New Haven CC	4,245,844	34,376
Norwich CC	208,184	806
SW CT CC	609,063	1,624
Totals	7,661,411	46,592

Source: Department of Energy, Clean Cities

[49] Shannon Greenwood, Andrew Perrin and Maeve Duggan, "Social Media Update 2016," Pew Research Center, http://www.pewinternet.org/2016/11/11/social-media-update-2016/.

[50] "Clean Cities Coalitions," U.S. Department of Energy, Energy Efficiency & Renewable Energy, accessed on June 30, 2017, https://cleancities.energy.gov/coalitions/designation.

advanced deployment of alternative and renewable fuels, emerging transportation technologies, fuel-economy improvements, and idle-reduction measures. The coalitions have been instrumental in adoption of propane buses by a growing number of school districts as well as promotion and demonstration of plug-in electric vehicle use through local showcases.

Medium and Heavy Duty Trucks

There are limited opportunities to cost-effectively reduce emissions in the medium- and heavy-duty truck classes.[51] Diesel substitutes like biodiesel and renewable diesel can be used in any diesel vehicle type, although some engine manufacturers may void warranties in biodiesel blends over 20 percent.[52] However, most categories of trucks have CNG and propane versions, or versions that can run on renewable natural gas (RNG). Retrofit companies can also install CNG or propane tanks and engines on most truck types. For example, Connecticut AAA is converting its 28-truck fleet to run on both propane and gasoline, a setup known as "bi-fuel." With a payback period of 9-11 months, the switch to propane will save the company money and reduce emissions.[53]

While several demonstration or prototype vehicles have been built for electric and hydrogen fuel cell medium- and heavy-duty vehicles, these offerings are much more limited.[54] Emerging applications for medium- and heavy-duty vehicle electrification include waste trucks and transit buses. Cities and companies across the U.S. have implemented pilot programs to identify and demonstrate cost savings and emissions reductions associated with both applications.

In a pilot program to test electric garbage trucks, Chicago replaced 20 of its conventional diesel trucks with electric powered truck technology developed by Motiv. This has saved the city 2,668 gallons of fuel a year and reduced GHG emissions by 68 tons per truck.[55] In 2017 Mack Trucks unveiled its version of an electric garbage truck, which included a powertrain developed by Tesla Motors.[56] As additional models come into the marketplace and the prices drop, garbage truck

[51] Atlas Public Policy and The Cadmus Group Inc., *Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut*, September 2016, 49, http://atlaspolicy.com/wp-content/uploads/2016/11/2016-09-01_Moving_Forward_with_Green_Energy.pdf.
[52] National Biodiesel Board, "Biodiesel standard (ASTM D 6751)," accessed May 4, 2016, http://biodiesel.org/using-biodiesel/oem-information.
[53] Matt Pilon, "CT AAA club converting truck fleet to propane," *Hartford Business Journal*, April 21, 2016, accessed June 30, 2017, http://www.hartfordbusiness.com/article/20160421/NEWS01/160429982/ct-aaa-club-converting-truck-fleet-to-propane.
[54] Atlas Public Policy and The Cadmus Group Inc., *Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut*, September 2016, 27, http://atlaspolicy.com/wp-content/uploads/2016/11/2016-09-01_Moving_Forward_with_Green_Energy.pdf.
[55] Emily MacRae, "What Toronto can learn from Chicago's electric garbage truck," *Torontoist*, August 20, 2016, accessed June 30, 2017, http://torontoist.com/2016/08/what-toronto-can-learn-from-chicago/.
[56] Carina Ockedahl, "Tesla veteran helps Mack create an electric garbage truck," *Trucks.com*, June 7, 2016, accessed June 30, 2017, https://www.trucks.com/2016/06/07/mack-trucks-shows-electric-garbage-truck/.

electrification may make a lot of sense for waste management companies. The stop-and-go movements of trash pick-up allows the braking system in an electric drivetrain to recapture energy; the quiet nature of the drivetrain also makes early-morning trash pick-up less disruptive; and reduction in tailpipe emissions improves local air quality. While capital costs for these trucks are currently high, fuel and maintenance savings make this technology a viable option for waste truck fleet conversions.

Several companies are manufacturing and deploying Battery Electric Buses (BEBs) in the United States. Successful demonstrations of BEBs in cities, towns, and college campuses around the country are proving that the cost savings and technology are beneficial. BEBs are able to charge quickly at fixed stops along routes and are able to operate almost continuously. In an analysis conducted by Columbia University for New York City Transit, the purchase, maintenance, and fuel costs of an electric bus was compared to that of a diesel powered bus. The analysis found that BEBs generally cost about $300K more than a diesel bus; however, fuel and maintenance savings over the lifetime of the vehicle could more than offset the difference in purchase prices. The analysis also found that if the city converted its full bus fleet to BEBs, it would result in a savings of nearly 500,000 metric tons of GHG emissions.[57] As current bus fleets age and retire, and BEB technologies improve, BEBs are poised to become a viable option for transit fleets due to their fuel and maintenance savings and their GHG reduction potential.

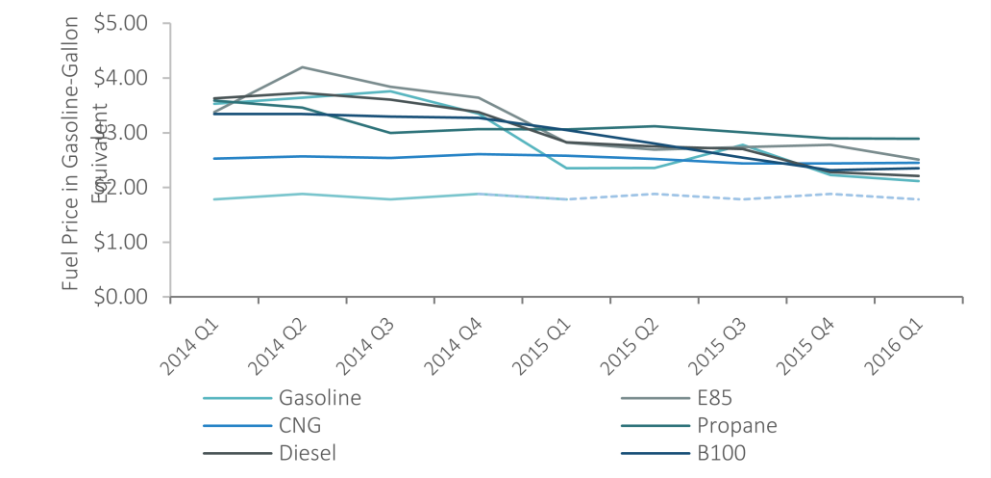
[57] Judah Aber; Columbia University, *Electric Bus Analysis for New York City Transit*, May 2016, 27, http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf.

Fuel Price Considerations

Price volatility in the alternative fuel market can vary greatly by region and fuel type, with the exception of electricity, whose price is often regulated. Prices for E85 and biodiesel tend to follow swings of petroleum prices, in part because these fuels often compete directly with gasoline and diesel, respectively. The price of CNG can vary greatly by region, but volatility tends to be low. For example, average CNG prices ranged between $2.09 and $2.17 per gallon of gasoline equivalent (gge) nationally in 2014-2016. During this period prices were as low as $1.79 per gge in the Rocky Mountain States and as high as $2.61 per gge in New England.

In Connecticut and the rest of New England, fuel prices have generally followed the national trend since the first quarter of 2014. While electricity remains the least expensive transportation fuel, its lead over other fuels has decreased. Other alternative fuels, including E85, CNG, propane, and B100, are more expensive than gasoline and diesel on an equivalent basis as of the first quarter of 2016. Propane has consistently been the most expensive transportation fuel since the first quarter of 2014. (Supply chains for renewable diesel and hydrogen have not been established in Connecticut. In early 2016 the California prices for these fuels were $2.39/gallon and $13.59/kilogram, respectively.) Alternative fuel prices that are cheaper than those reported in the Alternative Fuel Price Reports can result when fleet managers enter into contracts directly with local suppliers. Contract prices will differ depending on several factors, including fleet size, amount of fuel to be obtained, distance from the supplier, and regional location. Also, propane prices reflect both primary and secondary stations. Primary propane stations have dedicated vehicle services and secondary stations mostly serve the tank and bottle market. Propane prices at primary stations tend to be cheaper than secondary stations.

2014 electricity prices are for Connecticut only and 2015 electricity prices were estimated based on historical prices.



Source: Atlas Public Policy and The Cadmus Group Inc., Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut, pp. 18-19, September 2016.

Source: *U.S. DOE "Fuel Prices." Available at:* http://www.afdc.energy.gov/fuels/prices.html.

EV and Alternate Fueling Infrastructure

As the makeup of the state's vehicle fleet shifts toward cleaner alternative-fuel vehicles, the necessity to expand alternative-fueling infrastructure increases. There are now 395 public and private alternate fueling stations in operation throughout the state (Table T4).[58] Fuel options offered include biodiesel (B20 and above), compressed natural gas, Electric (Electric Vehicles Supply Equipment or EVSE), E85 (ethanol flex fuel), hydrogen, liquefied natural gas, and liquefied petroleum gas (propane). The vast majority of stations are electric charging stations – 298 public and 46 private stations, offering a total of 653 public and 96 private charging outlets.[59]

TABLE T4: Alternative Fueling Stations in Connecticut

Fuel Type	Public	Private
Biodiesel	1	1
Compressed natural gas	9	12
EVSE	298	46
E85 (Ethanol)	3	1
Hydrogen	1	1
Liquefied natural gas	1	0
Propane	20	1

Source: DOE, Alternative Fuels Data Center

Connecticut has been pursuing the development of electric vehicle charging infrastructure through the EVConnecticut municipal and business charging station grant programs.[60] Grant programs cover varying costs of installing charging stations in public locations, making them accessible to all Connecticut residents at no cost. Momentum for the build out of EV chargers caught on quickly, with initial demand for EV charging centered on Level 1 and Level 2 charging.[61] To help develop a more robust EV charging network, DEEP also worked with CTDOT to initiate a project that placed DC fast chargers at several Connecticut travel plazas along main transportation

[58] U.S. Department of Energy, "Alternative Fuels Data Center: Alternative Fueling Station Counts by State," accessed May 5, 2017, https://www.afdc.energy.gov/fuels/stations_counts.html.
[59] Totals indicate the total number of stations for all fuel types combined. Individual stations are counted multiple times if the station offers multiple types of fuel. The total numbers for electric charging stations include legacy chargers, but do not include residential electric charging stations.
[60] Under the EVConnecticut municipal and business charging station grants program, a total of 331 Level 2 charging plugs and 4 DC fast chargers have been deployed at 157 locations.
[61] Level 1 charging uses an ordinary 120V outlet. Level 2 supplies 240V, like the current supplied to a household electric clothes dryer. DC Fast Charging is the fastest type of charging available, providing up to 40 miles of range for every 10 minutes of charging.

As a result of these efforts, EV infrastructure installations have far outpaced the 2013 Comprehensive Energy Strategy goal of 50 new publically available, Level 2 EV chargers. Public and private demand along with increased funding support from other sources has prompted installation of 200 additional public chargers since 2013, which has greatly expanded the infrastructure and helped reduce EV drivers' "range anxiety."

In 2015 in partnership with the Connecticut Center for Advanced Technology, Inc., EVConnecticut issued a request for proposals seeking to award up to $400,000 to establish two hydrogen fueling stations in the greater Hartford area to support the first commercially available model year of light duty Fuel Cell Electric Vehicles (FCEVs) in Connecticut. During the RFP process, it became known that a hydrogen fueling station was already planned for the Hartford area and is anticipated to commence operation in mid-2017. This station will be operated by Air Liquide, which, in collaboration with Toyota Motor Sales USA, plans to build the first of twelve hydrogen fueling stations in the Northeast.

To further support the development of hydrogen fueling infrastructure, EVConnecticut recently announced a new request for Hydrogen Refueling Infrastructure Development proposals. The H2Fuels Grant Program will award up to $840,000 to a qualified vendor to establish, operate and maintain a retail hydrogen fueling station preferably within 5 miles, but no more than 8 miles, of Interstates 91/95 interchange in New Haven, Connecticut.[62]

Emerging Mobility Services

Over the past few years, several new mobility services have been established in Connecticut, changing the transportation marketplace for consumers. Ease of use and flexibility for consumers to choose how they move from place to place have made these mobility options popular. These services include new ways of planning trips, shared cars and bikes, and ride-hailing.

Shared mobility involves service categories beyond traditional transit services and carpooling programs. Enabled through technological advances in smartphones, GPS navigation, and social networking, car-sharing services (e.g., ZipCar and Streetcar) and ride-hailing services (e.g., Uber and Lyft) have established themselves in several urban locations throughout the state. These services provide Connecticut citizens with fresh and innovative mobility options. These services' ease-of-use is shifting consumer dependence on single-occupancy driving, especially among consumers under the age of 30. Car-sharing services are ideal for individuals who may need a vehicle only for a few days or even a few hours, and can be significantly less expensive than owning, operating, and maintaining a vehicle. Typically, car-sharing services charge a fee to use a

[62] EVConnecticut Public Notice, Hydrogen Refueling Infrastructure Development Program. http://www.ct.gov/deep/lib/deep/air/electric_vehicle/evct/2018-02-01_-_Hydrogen_Grant_Solicitation_Notice.pdf

vehicle for a designated period of time, and include insurance coverage and fuel in their membership costs.

CTDOT's CTrides has partnered with NuRide, a national program that utilizes a web-based platform to seamlessly connect members to facilitate shared trips and reduced VMT. NuRide also rewards members for selecting alternative modes of transportation such as walking, biking, telecommuting, carpooling or using public transportation. To encourage alternatives to single-occupancy driving, CTrides has also begun facilitating partnerships between employers and private providers of commuter vanpooling services operating in Connecticut, such as vRide, Inc. and The Rideshare Company.

These new mobility services provide consumers with a variety of choices to move from place to place without using single-occupancy vehicles. A hybrid approach utilizing shared mobility, alternative fuels, and transit-oriented development may reduce consumer spending on transportation needs and lead to significant VMT and GHG emissions reductions. The State should continue to explore how these dynamic services can help decarbonize the transportation sector.

Freight

Movement of goods by truck, train, ship, and aircraft is essential to Connecticut's economy. Freight mobility allows delivery of goods to end users in the state and enables Connecticut businesses to ship their goods out of state. The movement of these goods consumes large amounts of energy, predominantly from fossil fuels, and makes a major contribution to transportation-related emissions.

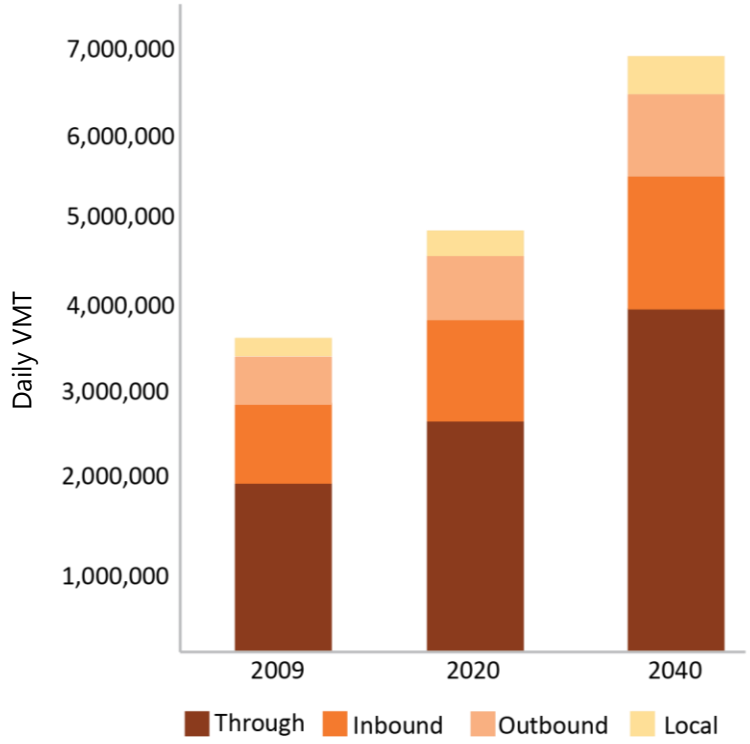
According to a 2013 study prepared for DEEP entitled "Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut," on-road trucks move more than 90 percent of freight in Connecticut, while rail and water move 2 and 6 percent respectively. As a result of this dependence, on on-road trucks, and the diesel fuel that powers them, are responsible for almost all Connecticut emissions associated with freight movement.[63]

Of the 3.7 million VMT per day attributed to freight movement in Connecticut in 2009, 53 percent consisted of through-freight. Inbound and outbound freight comprised 25 percent and 15 percent, respectively. Local transport made up the smallest share, at 6 percent of statewide VMT. Total freight VMT is expected to grow 88 percent from 2009 to 2040. Through-freight, predicted

[63] de la Torre Klausmeier Consulting, Inc., Cambridge Systematics, and Eastern Research Group, *Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut*, March 28, 2013, 7; http://www.ct.gov/deep/lib/deep/air/diesel/freightreport_03_28_2013.pdf.

to grow 103 percent by 2040, is expected to represent the majority of this increase (Figure 9).[64] Air-quality issues stemming from this growth will necessitate significant changes in Connecticut's freight management.

FIGURE T9: Truck VMT Projections 2009-2040



Source: Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut

In 2015, DEEP became a SmartWay® Affiliate. SmartWay® is an innovative partnership of the U.S. Environmental Protection Agency that reduces greenhouse gases and other air pollutants and improves fuel efficiency using market-driven partnerships to help businesses move goods in the cleanest, most efficient way possible. By providing a consistent set of tools and the information needed to make informed transportation choices, the program enables companies across the supply chain to exchange performance data in ways that protect the environment, enhance energy security and foster economic vitality. To encourage continued improvement, SmartWay® provides incentives and recognition for top performers. Twelve businesses in Connecticut are currently registered as SmartWay® partners. As an Affiliate of the program DEEP actively promotes the program and educates stakeholders about the benefits of becoming a SmartWay® partner.

[64] de la Torre Klausmeier Consulting, Inc., Cambridge Systematics, and Eastern Research Group, *Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut*, March 28, 2013, 8; http://www.ct.gov/deep/lib/deep/air/diesel/freightreport_03_28_2013.pdf.

To further reduce emissions associated with movement of freight, the State should continue to analyze and identify opportunities to pursue the four emissions-reduction strategies outlined in "Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut," which include: technological improvements that reduce emissions per ton-mile, reducing freight-miles traveled, mode shifting, and system efficiency improvements.[65]

[65] de la Torre Klausmeier Consulting, Inc., Cambridge Systematics, and Eastern Research Group, *Development of a Strategic Plan for Reducing Emissions Associated with Freight Movement in Connecticut*, March 28, 2013; http://www.ct.gov/deep/lib/deep/air/diesel/freightreport_03_28_2013.pdf.