Connecticut Department of Transportation Transit Climate Action Plan

July 2023

Contents

Executive Summary

Connecticut is making significant strides across all sectors to mitigate emissions that contribute to air pollution, including greenhouse gases that contribute to climate change. The transportation sector is the largest contributor to greenhouse gas emissions in Connecticut. Those emissions come from a variety of sources and decisions that individuals and entities who own vehicles make each day.

This CTDOT Transit Climate Action Plan (Plan) covers greenhouse gas emissions from the CTtransit divisions in Hartford, New Haven, and Stamford (HNS), which are the three largest in the CTtransit system. CTDOT owns and operates the bus fleet and the bus garages in these CTtransit divisions, and has prior baseline specific greenhouse gas data for each of them. The key goal outlined in this Plan is to have 30% of the HNS bus fleet electrified by 2029 and 100% by 2035. The Plan lays out high-level strategies and actions to achieve this goal and to reduce bus transit-related greenhouse gas emissions in Connecticut.

1. Introduction

The State of Connecticut has a longstanding commitment to reducing greenhouse gas emissions. In an acknowledgement of the impacts the transportation sector has as the largest contributor of greenhouse gas emissions, the Connecticut Department of Transportation (CTDOT) is in the process of electrifying the State's public transit fleet.

Connecticut has identified electric vehicle (and other non-gasoline, non-diesel fuel) deployment, both in the light-duty and heavy-duty sectors, as among the primary solutions for achieving its statutory required economy-wide greenhouse gas reduction targets of 45 percent and 80 percent below 2001 levels by 2030 and 2050. CTDOT has been actively transitioning transportation in the state towards zero-emission modes. Recent actions include deploying electric trains to replace diesel locomotives on the Shore Line East commuter line, installing electric vehicle charging stations for light duty vehicles (state fleet, visitor, and employee) at our Headquarters and satellite facilities, expanding pedestrian, cyclist, and transit facilities, and advancing the battery electric bus program for its CTtransit operations.

In June of 2021, the Federal Transit Administration (FTA) announced the Sustainable Transit for a Healthy Planet Challenge. The challenge built upon the announcement by President Biden in April 2021 establishing a goal to reduce economy-wide greenhouse gas (GHG) 50-52 percent from 2005 levels by 2030. In April of 2023, CTDOT, with authority over purchase of buses for CTtransit, joined the Sustainable Transit for a Healthy Planet Challenge. In joining, CTDOT re-confirms our commitment to reducing greenhouse gas emissions from the transportation sector.

This Plan focuses on achieving the aggressive goal of zero emissions from the CTtransit bus service, to eliminate greenhouse gas contributing pollutants and other pollutants from the bus fleet. To achieve these goals, CTDOT and this Plan rely on battery electric bus and charging technology and infrastructure. However, as other fuels, technology, and costs change over time, so may CTDOT's planning.

Incorporating battery electric buses (BEBs) into the State's transit bus fleet is a lengthy process that requires substantial capital investments including retrofit or construction of new bus garages, charging equipment and electrical grid connections/upgrades, dedicated planning efforts, workforce training, and the right partners to help ensure the program is a success. CTDOT has previously initiated these efforts, and this Plan sets forth the future course to achieve our CTtransit zero-emission goals.

The Plan will be used as another way to support CTDOT's efforts in reducing greenhouse gas emissions. CTDOT has newly designed branding for electric buses and is also promoting a new grant for bus electrification in New Haven. By publicly demonstrating the progress made and the path ahead, CTDOT commits to making meaningful and measurable change.

2. Agency Overview

The mission of CTDOT is to provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the State and the region. The Bureau of Public Transportation is one of five Bureaus within CTDOT. The mission of the Bureau of Public Transportation is for the development, maintenance, and operation of a safe and efficient system of motor carrier, rail facilities and maritime assets for the movement of people and goods, such as Bus Transit, Rail Operations, Ferries, and Ridesharing programs.

In Connecticut, CTDOT owns and operates a large portion of the public transportation system. CTtransit is the state-owned bus service and has eight divisions serving different areas of the state. These divisions include Hartford, New Haven, Stamford, Waterbury, New Britain, Bristol, Meriden and Wallingford. The state owns and holds title to all the buses that provide CTtransit services and is fully responsible for the costs of operating these local bus systems. The state owns bus storage and maintenance facilities for the CTtransit Hartford Division, the CTtransit New Haven Division, the CTtransit Stamford Division, and the CTtransit Waterbury Division. In addition, the state owns bus storage and maintenance facilities for the Southeast Area Transit District and the Windham Region Transit District. The operators of the New Britain and Bristol Divisions operate out of shared facilities with their private operators.

CTDOT also owns and operates CTfastrak, Connecticut's first Bus Rapid Transit (BRT) system. It is comprised of a system of bus routes that use a bus-only roadway for a portion of the entire trip.

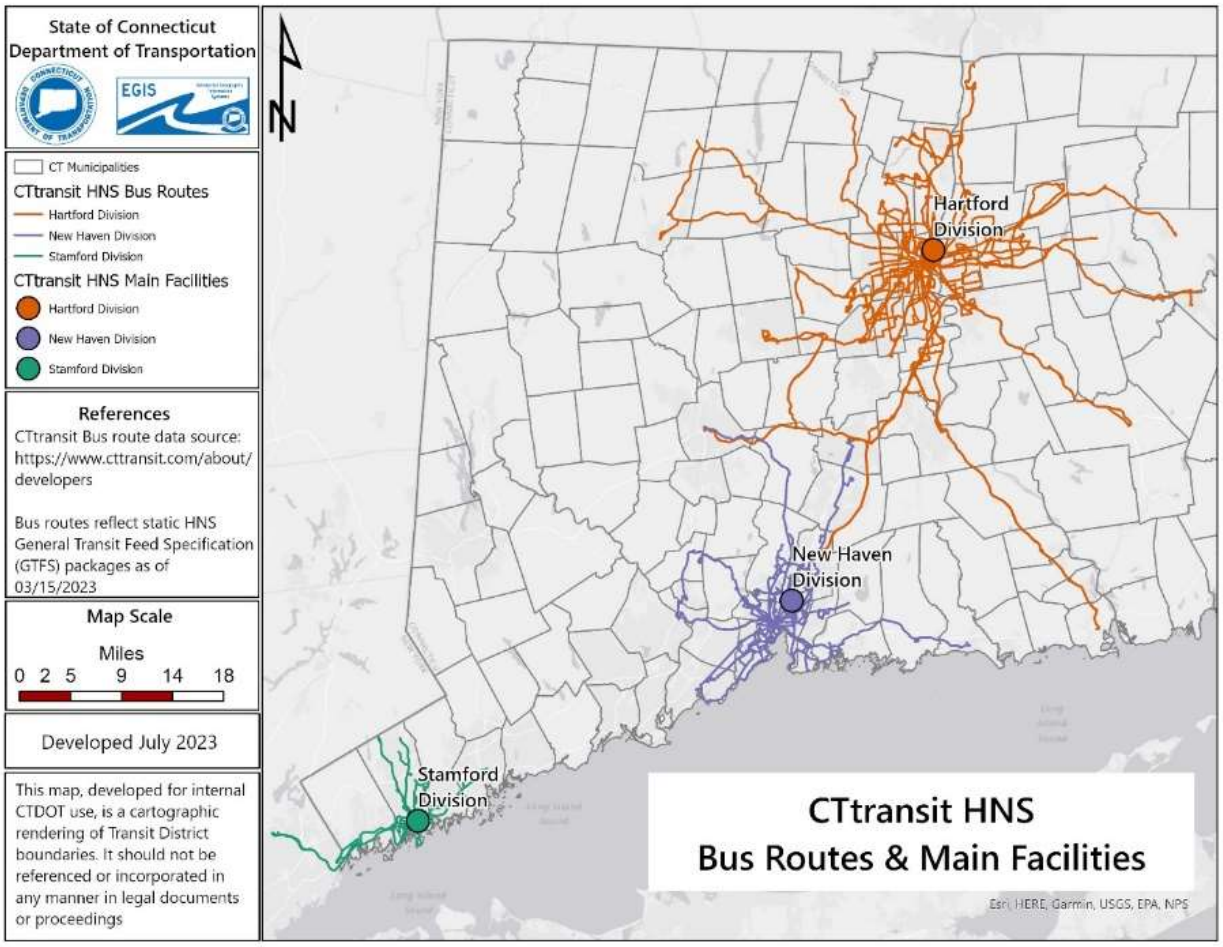
This Plan focuses on the Hartford, New Haven, and Stamford (HNS) Divisions. These divisions are included because they are the largest in the CTtransit system, CTDOT owns their facilities, and baseline division-specific greenhouse gas emissions (GHG) data were available for each of them from a 2018 report (see Chapter 3).

CTtransit Hartford, located at 100 Liebert Road, is the largest fixed-route bus operation in the state, running 273 fixed route buses comprised of 30-, 40- and 60-foot diesel and diesel-hybrid buses.

CTtransit New Haven, located at 2061 State Street in Hamden, CT, serves the greater New Haven area. This operation, CTDOT's second largest, runs 131 buses comprised of 35-, 40-, and 60-foot buses. The fleet is mostly diesel buses, along with 11 battery electric buses.

CTtransit Stamford, located at 26 Elm Court in Stamford, operates 55 diesel buses ranging from 40-foot to 60-foot.

Figure 2.1: CTtransit HNS Bus Routes & Main Facilities



Financial Information

In its FY23 Capital Plan, CTDOT anticipates using approximately $2.2 billion in total Capital Program funding for all transportation modes in FY23. The 2023 Capital Program includes approximately $850 million for bus and rail, $1.3 billion toward the State's highway and bridge infrastructure, and $50 million in support of the Facilities Program. Funding is being provided for rail and bus initiatives, such as TIME For CT (the plan to increase train speeds and improve travel times on the passenger rail system); renovating the Stamford Transportation Center; purchasing new rail cars to operate throughout the State; transitioning the transit fleet from diesel-hybrid buses to battery electric buses; and deploying new bus stops and a state-wide real-time bus information system.

In June of 2023, CTDOT was notified of a $25 million award under the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant Program. The grant will fund a new bus rapid transit system in New Haven including 18 new stops, four mini hubs, and procurement of 15 new battery electric buses.

3. Emissions Inventory

CASE GHG Emissions Inventory

In 2018, a comprehensive greenhouse gas emissions inventory was conducted by the Connecticut Academy of Science and Engineering (CASE) on behalf of CTDOT using 2016 calendar year data. The organizational scope for the CASE inventory was wider than the inventory featured in this Climate Action Plan. The CASE inventory included "Scope 1" (direct emissions[1]) and "Scope 2" (indirect – purchased energy) for all CTDOT-contracted bus operations – systems owned by CTDOT and branded as CTtransit. CTtransit includes fixed route local bus services in eight urban areas: Bristol, Hartford, Meriden, New Britain, New Haven, Stamford, Wallingford, and Waterbury.

The scope of the inventory in this Climate Action Plan is limited to the systems where, in 2018, CTDOT owned both the rolling stock and the facilities associated with bus operations: Hartford, New Haven, and Stamford (HNS)[2]. The data for the other CTtransit divisions were aggregated together in the CASE report as an "Other" category.

The 2016 CASE inventory uses a modified version of the EPA's Simplified GHG Emissions Calculator. Modifications were made to simplify data entry and remove sections not relevant to CTDOT public transportation, including: stationary combustion, waste gases, steam, business travel, and fire suppression. Additional modifications included more specific input parameters from the American Public Transportation Association GHG Calculator for Transit, particularly emission factors tailored to transit buses.

Climate Action Plan GHG Emissions Inventory (2016 baseline)

The following inventory modifies the CASE inventory referenced above and focuses the organizational scope to the HNS bus fleet. The 2016 Inventory will be used as a baseline for future HNS greenhouse gas emissions reporting.

This Climate Action Plan inventory focuses on two items: diesel fuel combustion and electricity usage. Only the major three gases were considered in this analysis, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). For calculating total emissions, multipliers were applied on the total usage for diesel fuel combustion. All emissions factors used are from EPA's Emission Factors Hub, 2015[3].

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[1] https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

[2] A new facility at CTtransit Waterbury is also owned by CTDOT, but that was not the case in 2018 when the report and GHG inventory were produced. Therefore, the emissions data for CTtransit Waterbury are lumped with other smaller CTtransit divisions in the 2018 report and cannot be disaggregated for the purposes of this Plan.

[3] https://www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub, Accessed September 25, 2017.

Scope 1: Diesel Fuel (Mobile Emissions)

Diesel fuel combustion makes up the largest share of GHG emissions for CTDOT public transportation and accounts for all of its mobile emissions. Over 4.1 million gallons of diesel fuel were used by the HNS fleet in Calendar Year 2016 based on the fuel usage records. This results in the emission of 42,100 metric tons of CO2 equivalent (CO2e). This value incorporates the higher global warming potential (GWP) associated with CH4 and N2O. Table 3.1 reports the multipliers used in the calculations featured in Table 3.2.

Table 3.1: Emissions and Global Warming Potential (GWP) Multipliers

Emissions Multipliers			GWP Multipliers	
CO_2 (kg/gal)	CH_4 (g/mile)	N_2O (g/mile)	CH_4	N_2O
10.21	0.0051	0.0048	25	298

Table 3.2: HNS Fleet GHG Contributions from Diesel Fuel Combustion for Calendar Year 2016 (Mobile Sources)

Calendar Year	Diesel Fuel Usage (gal)	Total VMT (miles)	CO_2 emitted (kg)	CH_4 emitted (kg)	N_2O emitted (kg)	CO_{2e} (kg)	CO_{2e} (MT)
Hartford	2,581,485	10,342,365	26,356,962	53	50	26,373,074	26,373
New Haven	1,168,637	4,167,289	11,931,784	21	20	11,938,276	11,938
Stamford	370,797	1,604,373	3,785,837	8	8	3,788,337	3,788
Totals	**4,120,919**	**16,114,027**	**42,074,583**	**82**	**77**	**42,099,687**	**42,100**

Scope 2: Electricity Usage

In calendar year 2016, CTtransit did not have any electric vehicles in revenue service, so this inventory, which is focused on GHG emissions from the HNS fleet, does not report any electricity-based GHG emissions. Going forward, as the agency adds electric vehicles to the fleet, we will record the GHG emissions from electricity used to run those buses.

The total GHG emissions from the CTtransit HNS fleet in calendar year 2016 was 42,100 $MTCO_{2e}$ and represents the baseline for this Plan.

4. Past and Current Initiatives

The following chapter outlines some of the key climate and electrification policies and initiatives that this Plan supports and advances.

Federal Policy

- President Biden's goals:
  - Achieve net-zero emissions by 2050
  - Achieve a 50-52% reduction in GHG emissions from 2005 levels by 2030[4]

- Federal Highway Administration Notice of Proposed Rulemaking on "National Performance Management Measures; Assessing Performance of the National Highway System, Greenhouse Gas Emissions Measure" (2022; pending review by FHWA).

Statewide Initiatives and Plans

- Sustainability Strategies to Minimize the Carbon Footprint for Connecticut Bus Operations[5] (2018)
- Governor's Council on Climate Change[6] (2019)
- State of Connecticut EV Commitment and the Multi-State Medium and Heavy Duty Zero Emission Vehicle MOU[7] (2020)
- CT Electric Vehicle Roadmap[8] (2020)
- CT Public Act 22-25 (2022), requiring actions to reduce transportation air pollution emissions including that the state shall cease to procure, purchase or lease any diesel-fueled transit bus after January 1, 2024.
- CT Comprehensive Energy Strategy[9] (2022)
- In 2023 CTDOT signed onto the Federal Transit Administration's Sustainable Transit for a Healthy Planet Challenge[10]
- CT Public Act 23-135 (2023), requiring establishment of a binding transportation carbon dioxide reduction target and strategic plan

[4] https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/
[5] https://rosap.ntl.bts.gov/view/dot/37300
[6] https://portal.ct.gov/DEEP/Climate-Change/GC3/Governors-Council-on-Climate-Change
[7] https://portal.ct.gov/DEEP/Air/Mobile-Sources/EVConnecticut/EVConnecticut---CTs-EV-Commitment
[8] https://portal.ct.gov/DEEP/Climate-Change/EV-Roadmap
[9] https://portal.ct.gov/DEEP/Energy/Comprehensive-Energy-Plan/Comprehensive-Energy-Strategy
[10] https://www.transit.dot.gov/climate-challenge-participants

Table 4.1: Summary of Emission Reduction Goals and Targets

Jurisdiction	2030	2035	2050
Paris Agreement			Net-zero
United States Federal	50-52% reduction in GHG emissions from 2005 baseline		Net-zero emissions
State of Connecticut - State Legislative Mandates & Executive Orders - CGS §4a-67d(c) - Public Act 08-98 - Public Act 18-82 (CGS §22a-200a(a)) - Executive Order 21-3 - Public Act 23-135	30% of State bus fleet is electric GHG emissions 45% below 2001 levels	100% of State bus fleet is electric	GHG emissions 80% below 2001 levels

Key CTDOT Initiatives

Connected and Automated Vehicle (CAV) CTfastrak Project

CTDOT and its assembled team, including the FTA, Center for Transportation and the Environment (CTE), New Flyer Industries, Robotic Research, Inc., University of Connecticut, and the Capital Region Council of Governments (CRCOG), are working collaboratively to advance a first in the nation, state-of-the-art pilot project that tests the performance and operation of full size, automated, and battery electric buses in revenue service on the CTfastrak BRT. This demonstration project will deploy three 40' New Flyer Excelsior Charge BEBs equipped with increasing levels of driving automation capable of up to high automation (SAE level 4). Automated driving capabilities demonstrated will include steering, braking, lane keeping, pedestrian and object detection, precision docking at CTfastrak station platforms and platooning of buses all aimed to improve service and safety for workforce and riders. CTDOT anticipates operations will begin in 2024.

CTDOT Battery Electric Bus Initiative (Pilot)

CTDOT launched this initiative in 2020, when it awarded a BEB contract to New Flyer through a competitive bid process. As of 2023, CTtransit is in possession of 11 BEBs and is collecting valuable information about their operational performance and efficiency, which will help CTDOT make informed decisions when scaling up their BEB fleet. In 2024, CTDOT will receive 50 additional BEBs from New Flyer. These BEBs will be later deployed at the CTtransit facilities as well as other Transit Agencies across the state.

Figure 4.1: New Flyer BEB at CTtransit New Haven

Bus Service Expansion

As part of the Connecticut Biennial Budget, $9.1 million will be available in FY2024 and $9.4 million in FY2025 to fund increased bus service. The focus of the expansion is on better access to jobs, training, and education by providing service that operates later, seven days a week.

Bus Stop Enhancement Program

Many bus stops in the state do not have shelters, seating, or proper information. CTDOT is committed to creating a better waiting experience for bus customers. It will be investing $17 million over the next 5 years to improve bus stops statewide. The program will help build and install ADA-compliant bus stops and shelters with schedule information. Busier stop locations could include more features, such as real-time signage, solar lighting, and trash receptacles.

SMART Grant / Connecticut Integrated Transit Mobility Project (CT-ITMP)

CTDOT received a federal planning grant through the Strengthening Mobility and Revolutionizing Transportation (SMART) program. This grant will help CTDOT evaluate the best unified mobility app solution for CT and pilot open payments on transit. Open payments allow customers to “tap to pay” for a quick and easy transaction. The planning will include a roadmap for using the same app to provide real-time information on all transit services.

Microtransit

CTDOT will fund up to seven microtransit pilot services in Connecticut, with some service starting as early as fall 2023. Microtransit service offers an on-demand transportation option. People can use technology to book and route their trips. Microtransit service helps expand transit equity to communities that have been historically underserved. It also helps seniors and individuals with disabilities access public transit, and creates first- and last-mile connections to existing public transportation systems.

Safe and Expanded Access to Transit for Vulnerable Users/Pedestrians

CT Public Act 21-28 (2021) established the Vision Zero Council, an interagency work group tasked with developing statewide policy to eliminate transportation-related fatalities and severe injuries. Improved safety for vulnerable users will encourage more transit use. The Vision Zero Council developed legislative proposals that were enacted into state law in 2023 (PA 23-116), making roadways safer for everyone including vulnerable users.

Also, CT DOT's Community Connectivity Program includes a competitive grant program for municipalities to improve and expand non-motorized transportation connections to city, town and neighborhood centers, making them more vibrant and safer and easier to access. Extra points are awarded in the scoring for project proposals that would improve access to transit and for projects in high-transit use areas. Over 100 projects are underway or completed, and a fourth round of projects will be awarded Fall 2023.

5. Emission Reduction Goals and Targets

CTDOT is committed to support the state, and national initiatives to reduce greenhouse gas emissions discussed in the previous chapter. For the CTtransit HNS bus fleet and operations, we have identified one primary goal (with two timepoints) and two secondary goals to support these larger initiatives and move towards a low carbon future for Connecticut.

- **Goal 1: Convert CTtransit Hartford/New Haven/Stamford bus fleet to 30% non-diesel by 2029 and 100% non-diesel by 2035**

The two secondary goals are also important and will help CTDOT achieve greenhouse gas reductions, however, they are not the focus of this Plan and will not be measured and tracked in the same way as the primary goal related to bus fleet conversion.

- **Secondary Goal 1: Install solar photovoltaic (PV) arrays at HNS facilities**
- **Secondary Goal 2: Support EV charging for non-fleet vehicles at HNS facilities**

6. Strategies and Actions

Goal 1: Convert CTtransit Hartford/New Haven/Stamford bus fleet to 30% non-diesel by 2029 and 100% non-diesel by 2035.

Table 6.1 outlines the high-level strategies and actions we plan to take to meet our goals.

Table 6.1: Goal 1 Strategies and Actions

Strategy	Actions	Metric to track progress	Timeframe	Responsible
Develop/convert Stamford facilities to accommodate 100% BEBs	Complete interim facility upgrades	Y/N upgrades completed	Late 2023	CTDOT
	Launch 4-bus pilot	Y/N pilot started	Late 2023	CTDOT
	Complete utility construction & main building full upgrade	Y/N main building upgraded	Fall 2024	Eversource & CTDOT
	Complete construction on additional free-standing bus building	Y/N construction completed	Late 2026	CTDOT
Convert New Haven facility to accommodate 100% BEBs	Complete pilot facility upgrades	Yes – pilot upgrades completed	2022	CTDOT
	Install feeder/duct bank to enable power upgrade	Y/N duct bank completed	Late 2025	United Illuminating
	Complete facility upgrades	Y/N facility completed	Late 2026	CTDOT
Develop/convert Hartford facilities to accommodate 100% BEBs	Complete pilot (six-bus building)	Y/N pilot completed	Spring 2024	CTDOT
	Complete utility upgrades at Liebert Rd facility	Y/N upgrades completed	Late 2028	Eversource
	Complete satellite facility/facilities for 80-100 BEBs	Y/N facility completed	Late 2029	CTDOT
	Complete building upgrades of Liebert Rd facility	Y/N upgrades completed	Late 2031	CTDOT
Procure BEBs to fully replace the HNS diesel bus fleet	Procure pilot BEB fleet	Yes – CTDOT has 11 BEBs	2021	CTDOT
	Replace 30% of diesel buses in HNS fleet with BEBs	Y/N buses replaced	Late 2029	CTDOT
	Replace 100% of diesel buses in HNS fleet with BEBs	Y/N buses replaced	Late 2035	CTDOT

The current strategies set forth in this Plan are focused on BEBs. CTDOT will monitor other options, including hydrogen fuel cell technology, and if warranted may incorporate other fuel and technology into facility and fleet planning in the future.

Facility Assessments

In order to account for the overall facility needs, information was compiled on the upgrades needed for each facility. The following discussion is intended as a high-level overview to identify the types of investments that may be required to reach full electrification of the fleet. More detailed analyses, which are ongoing, will be needed to determine all facility-specific improvements, detailed timelines and associated costs.

CTtransit Hartford Division

Figure 6.1: CTtransit Hartford main facility

Source: Google

Electrification of the entire Hartford facility will be large undertaking considering the age of the facility, the power upgrades needed off-site, and the need to maintain operations during a major construction project. CTDOT is beginning the Hartford electrification program with a pilot that takes advantage of available power on the street and an under-utilized 6-bus free-standing building on the property. CTDOT is installing fire suppression, six chargers, and communication for an autonomous bus program, which will make up three of the six electric vehicles stored in the building. By early 2024, the 6-bus building should be fully energized. Three additional chargers have also been added on site (two 150KW and one 50KW portable charger).

CTDOT is undergoing site selection in the New Britain area for a new facility with capacity for 80-100 BEBs, which would enable the shifting of 1/3 of Hartford's fleet (buses that service the New

Britain area) out of the Liebert Road facility. This would reduce the load requirements in the electrification efforts for Liebert Road, make 30 percent of the fleet more operationally efficient by reducing deadhead, and enable Liebert Road electrification upgrades to co-occur with an active (but smaller) bus operation. CTDOT anticipates the satellite facility will be completed by the end of 2029.

CTDOT plans to upgrade the power at Hartford at one time since there will be significant off-site coordination needed with the power company. Power upgrade completion is anticipated by 2028. Simultaneous to the service upgrade design and construction, CTDOT will be working on the electrification design downstream of the service with the goal of adding charging capacity for 30 percent electrification of the fleet by 2028 and capacity for 100 percent electrification by 2031. The Hartford Division facilities are expected to be fully electrified by 2031 and the entire fleet by 2035.

CTtransit New Haven Division

Figure 6.2: CTtransit New Haven main facility

Source: Google

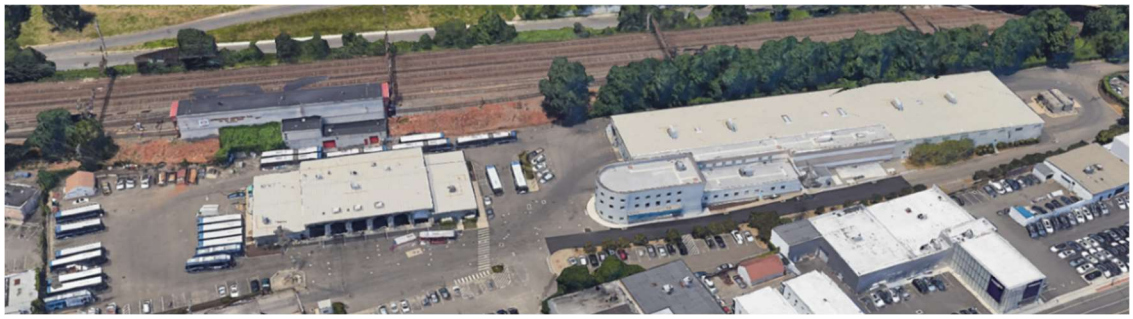
The New Haven Division was one of CTDOT's first facilities to undergo upgrades for electrification due to it being a newer facility (2010), having additional capacity on-site, and having a fleet replacement schedule that aligned with our electric bus procurement. The facility upgrades included the installation of ten 150KW plug-in chargers (see Figure 6.3), fire suppression upgrades, and a fire pump to provide the necessary pressure for the fire suppression system.

Figure 6.3: ABB Level 2 charger and dispenser at CTtransit New Haven

CTDOT is working with the utility company, United Illuminating (UI), to evaluate how many buses can be charged simultaneously on the existing 10 chargers, and also to discuss power upgrade strategies for 100 percent electrification. The necessary power upgrades will require a duct bank to be run to the facility from UI's substation and CTDOT is working with UI to coordinate that work. Service upgrades are anticipated by 2025, while simultaneously designing the downstream charger and charger equipment installation. CTDOT anticipates having capacity for 50 percent electrification of the New Haven fleet by 2026 and capacity for 100 percent electrification by 2027. The New Haven Division facility is expected to be fully electrified by 2026 and the entire fleet by 2028.

CTtransit Stamford Division

Figure 6.4: CTtransit Stamford main facility



Source: Google

As the smallest of the three operations, CTDOT anticipates the Stamford Division will be the first facility ready for an all-electric fleet. A pilot upgrade in 2023 included the installation of five 150KW plug-in chargers in the existing bus storage building, as well as a fire pump with back-up generator, and fire suppression upgrades. In addition, the transformer and feed were sized to support 21 150KW chargers, which will require minimal downstream upgrades of the switchboards as chargers are added on. CTDOT anticipates moving in four BEBs in late 2023 as a pilot. A new service will need to be brought in for additional chargers beyond the first 21, with anticipated completion of installation in fall of 2024.

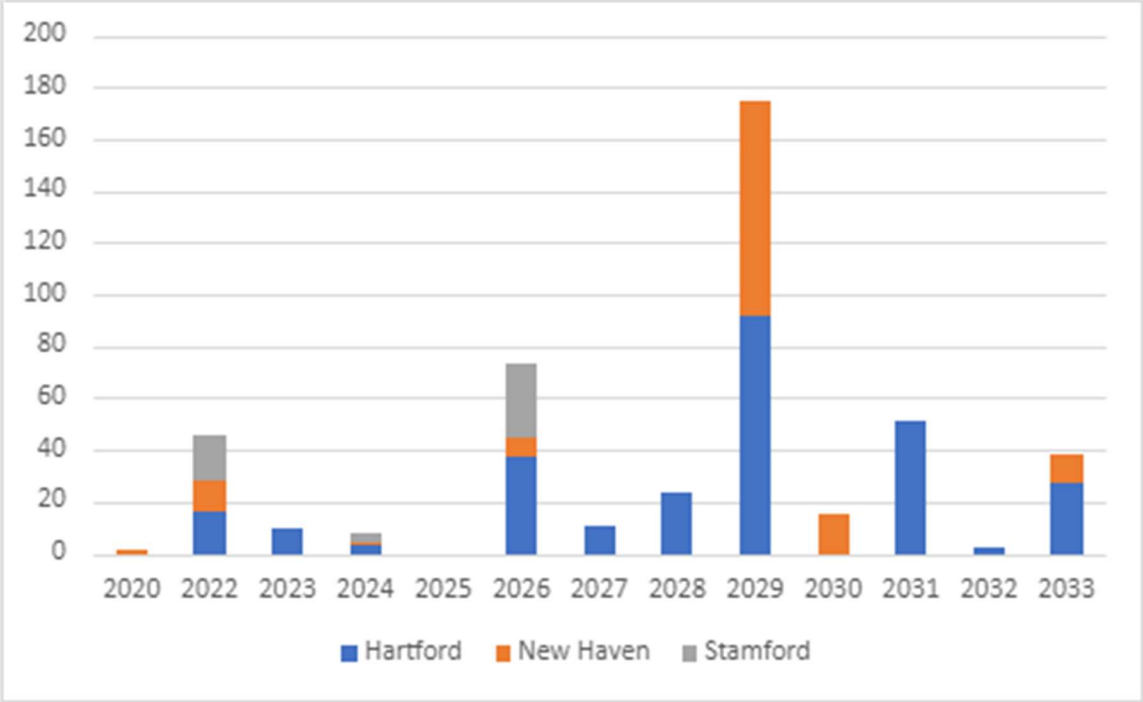
Simultaneous to the electrification of the existing bus storage building, CTDOT is designing a free-standing 11-bus building on-site for additional indoor storage and charging capacity. The addition of this building will allow 100 percent of the fleet to be stored and charged indoors. Design is scheduled to be complete by the end of 2024, with construction complete by the end of 2026. The facility will be outfitted with all necessary fire suppression upgrades, as well as ten 180KW pantograph chargers and one 450KW fast charger. By the end of 2026, both the main building and the 11-bus building will have capacity to support an entirely electric bus fleet. The Stamford Division facility is expected to be fully electrified by 2026 and the entire fleet by 2028.

Bus Purchasing Timeline

The current CTDOT HNS bus fleet is approximately 450 buses, and each bus is anticipated to remain in service for 12 years. Bus procurement plans are aligned with this timeline and assume that a full turnover of the fleet takes approximately 12 years. Figure 6.5 below illustrates the replacement eligibility dates across the existing bus fleet. CTDOT cannot replace a diesel bus with a BEB until the diesel bus has reached the end of its 12-year useful life, and the garage facility has been upgraded to accommodate the necessary BEB charging. So, if replacements happen exactly on schedule and all capacity targets are met, in 2033 there will still be nearly 40 diesel buses in the HNS fleet.

Since the number of buses eligible for replacement is not consistent year over year, the replacement with electric vehicles will also be somewhat variable, with some years (e.g., 2029) needing more new vehicles than others. Bus procurement activities will be dependent on the replacement eligibility of the fleet, available funding, utility rate design, and the charging capacity at each of the facilities.

Figure 6.5: Replacement Eligibility of Current HNS Fleet



Schedule Compatibility Analysis

As part of BEB transition planning, CTDOT is conducting schedule compatibility analyses for each of the three HNS divisions. These involve reviewing existing bus service blocks. A service block is a combination of trips assigned to a single vehicle. CTDOT will determine the extent to which the current system is compatible with the expected operational characteristics of BEBs.

Current BEB technology is expected to achieve a range of approximately 150 miles, though that depends on factors such as vehicle weight; heating, ventilation, and air conditioning (HVAC) use; weather conditions; topography; and driving patterns. As technology advances, ranges will improve, enabling buses to cover longer blocks. Both Hartford and New Haven will have diesel buses in the fleet through the early 2030s and can dispatch those on the more demanding blocks. Upon retirement of the diesel buses, newer BEBs may be able to cover those blocks, or adjustments will need to be made. The compatibility analyses will take these factors into account and will help CTDOT identify potential conflicts, optimize charging infrastructure placement, and make necessary adjustments to ensure that electric buses can operate efficiently and reliably within each division's network.

Workforce Development

Transitioning to zero-emission vehicles is a paradigm shift for all aspects of transit operations including but not limited to scheduling, maintenance, and yard operations. CTDOT has a draft BEB Workforce Development Plan, drafted in 2022, that is guiding this work. CTDOT recognizes that a trained Zero Emission Bus (ZEB) workforce is not readily available, and the transit industry must address the shortage of technicians and mechanics together. CTDOT plans to develop and maintain a qualified ZEB workforce by hiring qualified new staff and retraining existing staff who have previously worked with internal combustion engine (ICE) systems. Meaningful investment is required to upskill maintenance staff and bus operators who were originally trained in diesel vehicle maintenance and fossil fuel fueling infrastructure. CTDOT's workforce development activities will address the identified skills and tools needed for each relevant team.

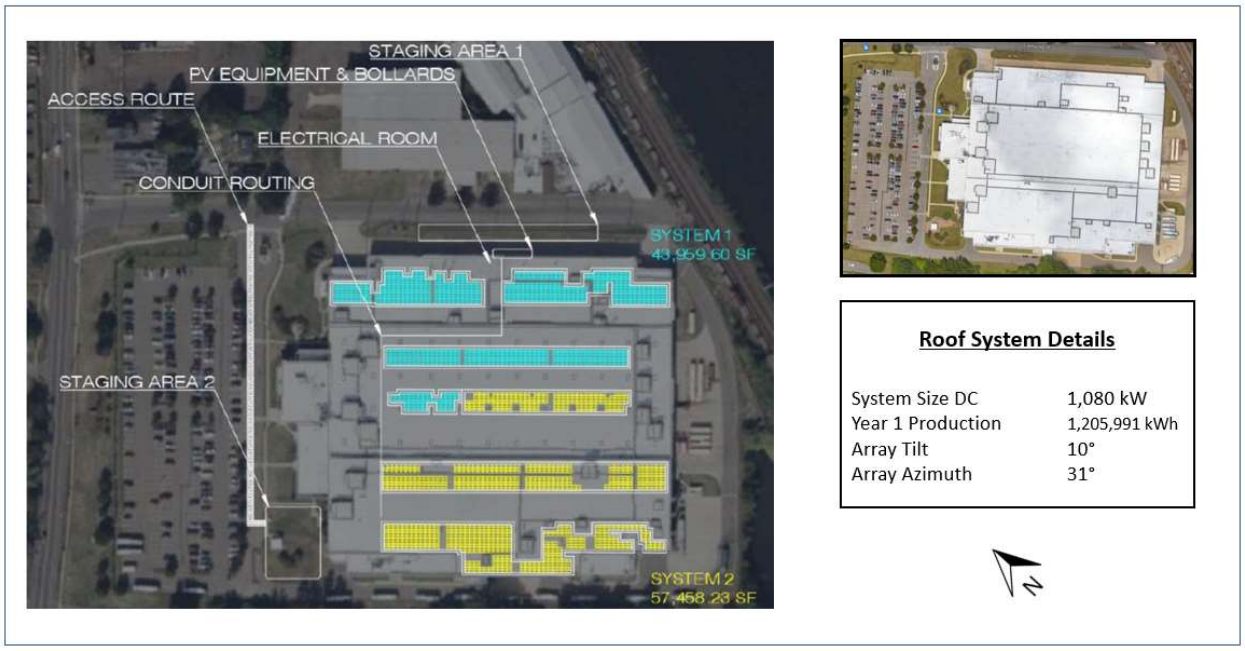
Existing CTDOT/CTtransit initiatives in this area include ZEB Schedule Advisory Committees in each CTtransit division, a Maintenance Apprenticeship Program, and a variety of Employee and First Responder ZEB training classes/events. Looking forward, CTDOT is working closely with the Connecticut State and Colleges & Universities (CSCU) and the CT Office of Workforce Strategy (OWS) to coordinate workforce development programming. CTDOT and the CSCUs have met to discuss the creation of curriculum at the CSCU level. Gateway Community College in North Haven, CT, is centrally located to all transit agencies in the state and CTDOT proposes working closely with Gateway to create an EV lab. CTDOT has engaged OWS to develop programming related to zero-emission transit projects and will collaborate with the Amalgamated Transit Union (ATU) to develop programming in support of the state's ZEB industry. Furthermore, CTDOT and OWS will develop a local apprenticeship program with The Workplace, the workforce development board for Connecticut.

CTDOT is aligning its workforce development activities with its fleet transition goal of having a fully non-diesel fleet by 2035. This alignment will ensure that a qualified workforce is ready and available to support this transition.

Secondary Goal 1: Install solar PV arrays at HNS facilities

As part of their overall strategy to reduce greenhouse gas emissions, CTDOT has a goal of installing solar panels at each of the HNS facilities. This work will be done in collaboration with the Connecticut Green Bank and Solar Marketplace Assistance Program (Solar MAP), who works with government agencies and municipalities to develop solar projects. In line with this commitment, solar panels are scheduled to be installed at the New Haven facility as early as 2024 (see Figure 6.6). Bringing solar to the new and upgraded facilities at Stamford and Hartford will be considered as part of the facility planning process. This initiative will drive a substantial reduction in greenhouse gas emissions from HNS, result in long-term cost savings and serve as another indicator of CTDOT's commitment to mitigating climate change.

Figure 6.6: New Haven Facility Solar Roof System Plan



Secondary Goal 2: Support EV charging for non-fleet vehicles at HNS facilities

CTDOT will identify suitable locations within each HNS facility for EV charging stations for non-fleet vehicles. This will involve factors such as parking capacity, electrical infrastructure, and accessibility. By strategically installing charging stations within HNS facilities, CTDOT aims to enable non-revenue vehicle electrification and promote the adoption of electric vehicles among staff and visitors, which will support statewide efforts to reduce greenhouse gas emissions.

7. Implementation and Monitoring

Ongoing Plan Monitoring

This Plan will serve as a guide to CTDOT and implementing its strategies will be an ongoing effort. We will track key performance indicators, including progress on facilities, utility upgrades, buses deployed, as well as overall emissions from the HNS fleet. We will also consider the differential impacts on vulnerable communities and work to ensure that the benefits of bus electrification are distributed fairly. Using this Plan as a tool will help us evaluate our progress, identify areas for improvement, and make informed decisions to optimize our greenhouse gas reduction efforts.

Funding

BEBs are more expensive to purchase than other types of buses on the market but incentives are attractive and, with the right infrastructure, electric bus fleets can generate substantial cost savings over diesel vehicles in the long run. To achieve all the benefits that electric buses offer, CTDOT maintains awareness of current state and federal grants, bus warranties, and available financing options. The following is not a complete list but represents some potential sources of funding to help electrify the bus fleet:

- Federal Highway Administration Congestion Mitigation and Air Quality (CMAQ) Improvement Program
- Federal Highway Administration Carbon Reduction Program
- Federal Transit Administration Low or No Emission Grant Program (Low-No)
- Diesel Emissions Reduction Act (DERA)
- Connecticut's VW Mitigation Plan/Grant Funding

These programs are important resources to support CTDOT's bus electrification program. The Infrastructure Investment and Jobs Act (IIJA) also provides a significant increase in public transit infrastructure funding compared with previous levels. It includes funding for low and no emissions vehicles and related infrastructure, funding for state of good repair improvements, and greater opportunity for federal highway funds to be transferred to transit projects. CTDOT will work with elected officials, the utility companies, and other partners to pursue funding for bus electrification efforts.

Partnerships

Collaboration with energy providers is critical for establishing a reliable and sustainable power supply to charge electric buses. These partnerships involve working together to identify the energy demands,

determining the charging infrastructure requirements, and developing charging strategies. CTDOT has been holding regular meetings with Eversource and United Illuminating to prepare the long-range strategy. CTDOT also plans to continue partnerships with educational institutions and other state agencies working on these issues. This collaborative work is ongoing and will remain critical as the program to electrify the bus fleet advances.

Emerging Challenges and Looking Ahead

This Plan is based on technology, resources, and information currently available and reasonably foreseeable. The pace of improvements in battery technology and charging infrastructure remain uncertain. It is unclear how much progress will be made in improving battery efficiency, range, and charging speeds between now and 2035. The development of alternative fuel options, such as hydrogen fuel cells, may also impact the transition timeline and technology choices made down the road. Additional factors that may alter the Plan include supply chain, grid limitations, utility rate design, funding, land acquisition and permitting for facilities, and power redundancy and reliability. As new or more reliable information becomes available on challenges and opportunities, CTDOT will review this Plan for any needed updates.