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MBTA Bus Electrification Requirements and Procurement Timeline

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ABOUT US



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EXECUTIVE SUMMARY

Recent laws in Massachusetts require the Commonwealth to make progress on transit electrification. On August 11, 2022, Charlie Governor Baker signed An Act Driving Clean Energy and Offshore Wind establishing bus electrification deadlines for the MBTA. This follows other federal and state laws that require Massachusetts to reduce greenhouse gas emissions from the transportation sector. These laws require that the MBTA cease procurement of fossil fuel buses after December 31, 2030, and cease operation of fossil fuel buses after December 31, 2040. In addition to being legally enforceable, this electrification timeline is an essential component to the Commonwealth's climate goals of net-zero carbon emissions by 2050. Another component of the Commonwealth's decarbonization strategy is increased public transit ridership, necessitating expansion of the MBTA's capacity.

This report examines the MBTA's climate and electrification mandates for buses and rails, as well as other relevant laws, regulations, and practical considerations, and the MBTA's current proposal for electrification. It provides a timeline for procurements and bus maintenance facility upgrades and construction to meet the electrification targets. Accomplishing full fleet and facility replacement in less than 20 years, while simultaneously expanding the fleet and service, will be a herculean task for the MBTA. It will require expanded funding and staff capacity, as well as a sea change in how the Authority approaches facility construction project timelines.

The MBTA does not currently have a successful track record of completing major capital investment projects on time. Riders and the climate cannot afford such delays in implementing the current bus electrification strategy. The MBTA must do everything possible to accelerate that strategy, so that it does not find itself either seeking an extension from the legislature or subject to suit leading up to the 2030 or 2040 deadlines.

The bus electrification strategy can be done within the current legislated schedule, and this report includes a proposed plan for MBTA implementation.

ACRONYM GUIDE

- BEB:** Battery Electric Bus
- CECP:** Clean Energy and Climate Plan
- CIP:** Capital Improvement Plan
- CNG:** Compressed Natural Gas
- DEH:** Diesel Electric Hybrid
- DMA:** Dual Mode Articulated
- EOEEA:** Executive Office of Energy and Environmental Affairs
- EMU:** Electric Multiple Units
- ETB:** Electric Trolley Bus
- FTA:** Federal Transit Administration
- GHG:** Greenhouse gas emissions
- GWSA:** Global Warming Solutions Act
- IJJA:** Infrastructure Investment and Jobs Act
- IRA:** Inflation Reduction Act
- MBTA:** Massachusetts Bay Transportation Authority
- RTA:** Regional Transit Authorities

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INTRODUCTION

The Commonwealth of Massachusetts has recognized the significant threat that the climate catastrophe poses to the wellbeing of people and committed to net zero carbon emissions by 2050. Because the transportation sector currently represents the largest share of emissions in the state, successful strategies to decarbonize the sector will be necessary to meet the state's climate goals.

A significant component of the state's transportation decarbonization strategy is electrification of the MBTA's bus fleet, currently comprised of approximately 1,100 buses, almost all of which are fueled by diesel. There are enforceable statutory mandates that require cessation of fossil fuel bus procurement after 2030 and cessation of fossil fuel bus operation after 2040. A central component of bus fleet replacement strategy is to retrofit or reconstruct bus garage and maintenance facilities, and the MBTA has an ambitious plan to renovate or reconstruct the existing nine facilities between now and 2040. The MBTA's current proposal is to reconstruct two facilities, Quincy and Arborway, between now and 2027, and the remainder every two to three years between then and 2040, with very little buffer for delays.

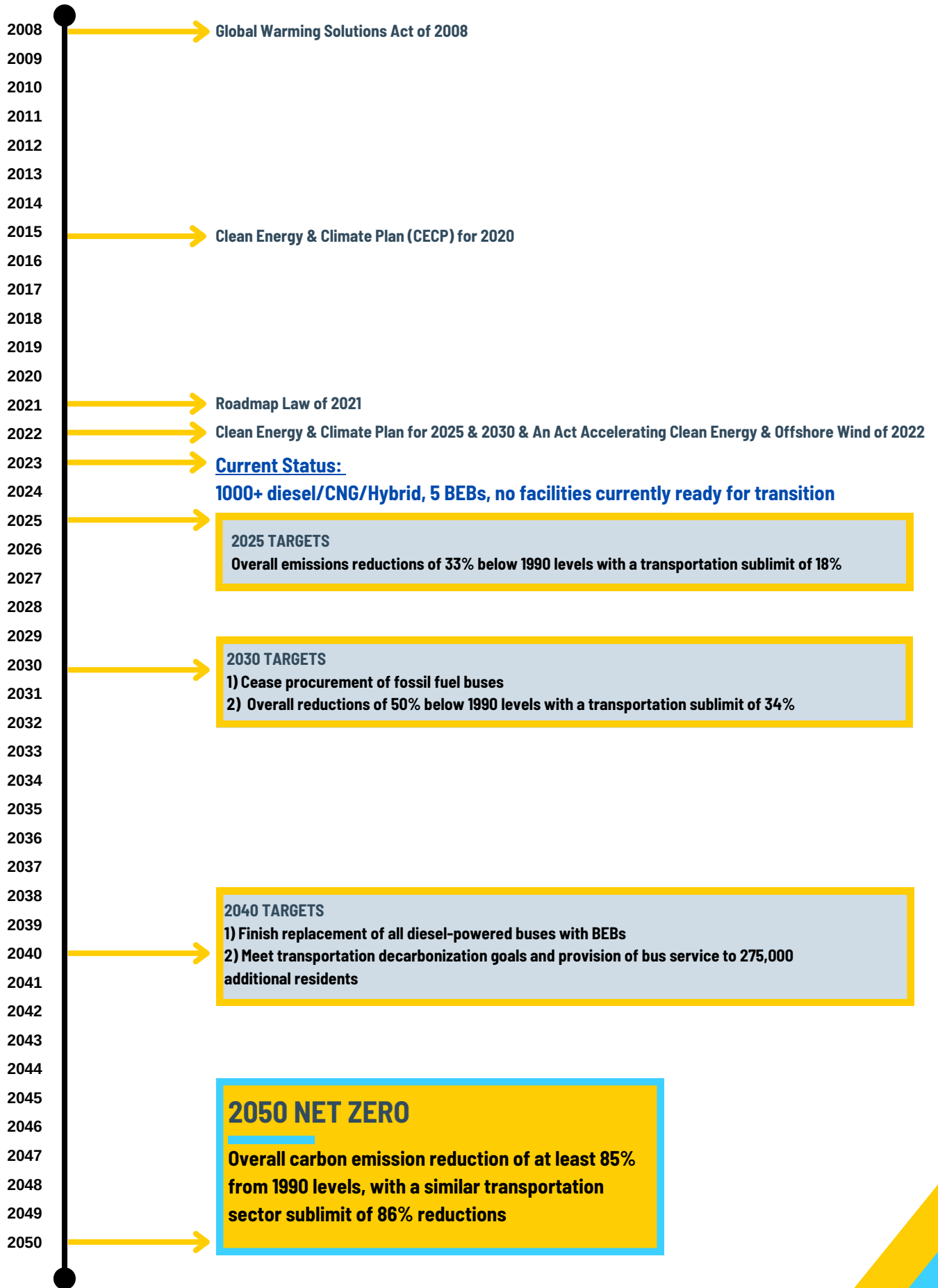
Another aspect of the Commonwealth's transportation sector decarbonization plan is to significantly increase public transit ridership, necessitating expansion of the MBTA's fleet and ridership capacity. Considering that the MBTA's bus fleet has shrunk over the last half century while the population of the service area has grown by approximately 50%, the MBTA faces substantial challenges in meeting both electrification and expansion mandates over the coming decades.

The MBTA, riders, and the climate cannot afford any of the significant delays that are unfortunately too common for MBTA capital investment projects. Therefore, the MBTA must do everything possible to accelerate the current bus electrification strategy so that it does not find itself either seeking an extension from the legislature or subject to suit leading up to the 2030 or 2040 deadlines.

LEGAL & REGULATORY LANDSCAPE

Massachusetts has consistently been at the forefront of creating legal requirements to address climate change, from the comprehensive 2008 Global Warming Solutions Act to two major climate bills passed in the last two legislative sessions. Below is a chronological summary of Massachusetts' major climate laws and policies and their impacts on MBTA.

TIMELINE OF MA CLIMATE LAWS, POLICIES, PLANS AND GOALS





A. GLOBAL WARMING SOLUTIONS ACT OF 2008

One of the most robust state climate change laws in the nation at the time, the Global Warming Solution Act (GWSA) not only created a foundation for climate action by establishing 1990 statewide greenhouse gas (GHG) emissions as the baseline against which progress would be measured, but also established target emission reductions between 10 percent and 25 percent for 2020 and 80 percent by 2050.¹

The 2018 Global Warming Solutions Act 10-Year Progress Report singled out transportation as “the only category of energy use that has not seen significant emissions reductions relative to 1990.”² The progress report identified vehicle electrification as one of the core solutions to decarbonization of the transportation sector to meet GWSA statewide goals.



B. ROADMAP LAW OF 2021

An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy, often referred to as the “Roadmap Law”, is named so because it maps out necessary steps along the path to the clean energy future contemplated in the GWSA.³ Crucially for the MBTA, the Roadmap Law required the Executive Office of Energy and Environmental Affairs (EOEEA) to set 2025 and 2030 greenhouse gas emission limits and sublimits for the transportation sector, described below in the Clean Energy and Climate Plans.

The Roadmap Law also created new definitions for environmental justice populations and codified them in statute for the first time. Environmental justice populations are distributed across the Commonwealth, with many in the MBTA service area.⁴ The law also requires environmental justice analysis for projects that cause damage to the environment in environmental justice populations.

¹ <https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter298>.

² Global Warming Solution Act, 10-Year Progress Report, 2018: <https://www.mass.gov/doc/gwsa-10-year-progress-report/download>.

³ Chapter 8 of the Acts of 2021, <https://malegislature.gov/Laws/SessionLaws/Acts/2021/Chapter8>.

⁴ Updated Massachusetts 2020 Environmental Justice Populations, website last accessed February 6, 2023: <https://mass-eeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212>.



C. CLEAN ENERGY AND CLIMATE PLANS

As required by the GWSA, Massachusetts first released the 2010 Climate Action Plan and updated it in 2015 with the Clean Energy and Climate Plan (CECP) for 2020. The Roadmap Law required EOEEA to further expand and update the state's climate plans in the form of two Clean Energy and Climate Plans, one for 2025 and 2030 released in June of 2022, and one for 2050 released in December of 2022.^{5, 6}

The CECP for 2025 and 2030 mandates specific MBTA actions, including execution of the Bus Modernization Program, as components of a broader transportation sector plan. The CECP for 2025 and 2030 requires overall emissions reductions of 33% below 1990 levels by 2025 with a transportation sublimit of 18%, as well as overall reductions of 50% below 1990 levels by 2030 with a transportation sublimit of 34%.⁷

To meet these rapidly approaching deadlines, the CECP for 2025 and 2030 requires MBTA to execute the Bus Modernization Program, with the goal of full electric transition by 2040.⁸ "The ongoing battery electric bus procurement supports the transition to a full electric fleet by 2040. The MBTA anticipates selecting a bus manufacturer by December 2022, with new battery electric vehicles (BEVs) then placed into service for MBTA-bus passengers in 2023."⁹

The CECP for 2025 and 2030 recognized that the bus electrification plan is ambitious, calling it "one of the most aggressive public bus electrification timelines in the United States."¹⁰ It incorporates several projects currently in progress in the anticipated timeline, including the retrofit of the North Cambridge facility by 2023, construction of the new facility in Quincy by 2024, the new facility at Arborway by 2027. The plan also acknowledges that some of the anticipated progress is based on contingencies. For example, it anticipates that "[b]y 2030, more than half of the fleet will be electric, with the completion of additional facilities at Wellington and in Lynn; again provided that funding and land are available."¹¹

⁵ Exec. Off. Energy and Env't Affs., Massachusetts Clean Energy and Climate Plan for 2025 and 2030 (2022), <https://www.mass.gov/doc/clean-energy-and-climate-plan-for-2025-and-2030/download>.

⁶ Exec. Off. Energy and Env't Affs., Massachusetts Clean Energy and Climate Plan for 2050, (2022), <https://www.mass.gov/doc/2050-clean-energy-and-climate-plan/download>.

⁷ CECP for 2025 and 2030, Table 4.1 Emission from Transportation Sector.

⁸ Note that the CECP refers to the "Bus Modernization Program"; MBTA has a Better Bus Project and a Bus Facility Modernization Project, not a Bus Modernization Program. However, references indicate that these are generally the same set of bus modernization projects.

⁹ CECP for 2025 and 2030 page 37.

¹⁰ *Id.* page 36.

¹¹ *Id.*

In addition to the facility upgrades necessary for electrification of the fleet, the CECP for 2025 and 2030 identifies several other requirements that the MBTA must meet in order for Massachusetts to meet transportation decarbonization goals, including participation in multi-agency partnerships with state and local government, modification of bus routes and schedules to better meet rider needs, and provision of bus service to 275,000 additional residents by 2040.

The CECP for 2050 is much less granular than the shorter-term goals for 2025 and 2030, and requires overall carbon emission reduction of 85% from 1990 levels, with a similar transportation sector sublimit of 86% reductions. These sector and overall emissions reductions are proposed to be supplemented with carbon removal to reach net zero by 2050.¹²



D. AN ACT ACCELERATING CLEAN ENERGY AND OFFSHORE WIND OF 2022

Passed by the Massachusetts Legislature just months after release of the CECP for 2025 and 2030, An Act Accelerating Clean Energy and Offshore Wind in 2022 expands existing state climate laws in several ways, including bus electrification requirements for the MBTA. The 2022 climate law requires that by December 31, 2030, each purchase or lease of MBTA passenger bus be a zero-electric vehicle and that by December 31, 2040, all MBTA passenger buses be a zero-emission vehicle.¹³ These 2030 procurement and 2040 operation deadlines add additional mandates on top of the existing CECP for 2025 and 2030 Bus Modernization Program requirements.

The 2030 and 2040 electrification procurement and operation deadlines are legally enforceable, so the MBTA could be legally liable and subject to lawsuit for purchasing a new fossil fuel bus after 2030 or operating a fossil fuel bus after 2040. As clear statutory mandates intended to protect the environment, noncompliance with the electrification requirements could be pursued by declaratory judgment statute or a ten citizen suit for damage to the environment.¹⁴ The MBTA additionally has an obligation to expand service during this period, so cutting routes or bus frequency are not options available to the agency because that would result in mode shift back to single-occupancy vehicles, in contravention to climate goals.

¹² CECP for 2050, page 49.

¹³ An Act Driving Clean Energy and Offshore Wind, ch. 179, § 65, Mass. Acts (2022), <https://malegislature.gov/Laws/SessionLaws/Acts/2022/Chapter179>.

¹⁴ Mass. Gen. Laws ch. 214, § 7A; See Kain, 49 N.E.3d at 1128; Williams v. Sec'y of Exec. Off. of Hum. Servs., 609 N.E.2d 447, 458 n. 10 (Mass. 1993) ("General Laws c. 231A, § 2, is an appropriate route by which to challenge an administrative agency's noncompliance with its statutory mandate.").

The 2022 clean energy law additionally included numerous related transit and transportation electrification components. The law requires that MassDOT provide assistance to the 15 Regional Transit Authorities (RTAs) to create electric bus rollout plans, which must include: identification of the types of zero-emission bus technologies a regional transit agency may deploy; a schedule for construction of facilities and related infrastructure modifications or upgrades required to deploy and maintain a zero-emission bus fleet including, but not limited to, charging, fueling and maintenance facilities; provided that the schedule shall identify potential sites for each facility; and a schedule for zero-emission and conventional internal combustion engine bus purchases and lease options identifying: (A) the bus and fuel type; (B) the number of zero-emission buses being purchased; and (C) the number of internal combustion engine buses being retired.¹⁵

The 2022 Clean Energy Law includes, among others, the following further provisions related to transportation electrification: (A) creation of an Electric Vehicle Coordinating Council, which includes the MBTA General Manager or designee¹⁶ and (B) requirement for EV charging stations at service plazas and commuter rail, subway parking lots, and installation of EV charging stations at all service plazas, five commuter rail parking lots, five subway stations and one ferry terminal parking lot by July 2024.¹⁷



¹⁵ An Act Driving Clean Energy and Offshore Wind, St. 2022, c. 179, § 78.

¹⁶ *Id.* § 81

¹⁷ *Id.* § 89

Table 1: Timeline of Massachusetts Transportation Climate Requirements & Commitments

Deadline	Agency	Requirement / Commitment	Source
Annually	MBTA	Update its rolling five-year plan with how many zero-emission and non-zero-emission passenger buses it operates	2022 Clean Energy Law
March 1st (annually)	MassDOT	Report on the total number of electric and fossil fuel vehicles it owns or operates	310 Code of Massachusetts Regulations (CMR) 60.06
2023	MBTA	Retrofit the North Cambridge Carhouse; fill with 35 electric buses	2025/2030 CECP
July 1, 2024	MassDOT	Make provision for installing and maintaining public EV charging stations	2022 Clean Energy Law
2024	MBTA	New bus facility in Quincy; fill with 45 electric buses	2025/2030 CECP
2025	Transportation Sector	Greenhouse gas emissions sublimit: 24.9 MMTCO _{2e}	2025/2030 CECP
2025	MassDOT	Carbon dioxide emissions limit for state fleet passenger vehicles: 2,421 metric tons	310 CMR 60.06
2027	MBTA	New bus facility in Boston along the Arborway; fill with 200 electric buses	2025/2030 CECP
2028	MBTA	One-third of MBTA bus fleet to be electric	2025/2030 CECP
2030	Transportation Sector	Greenhouse gas emissions sublimit: 19.8 MMTCO _{2e}	2025/2030 CECP
December 31, 2030	MBTA	All new purchases and leases of passenger buses must be zero-emission	2022 Clean Energy Law
December 31, 2040	MBTA	All operating passenger buses must be zero-emission	2022 Clean Energy Law

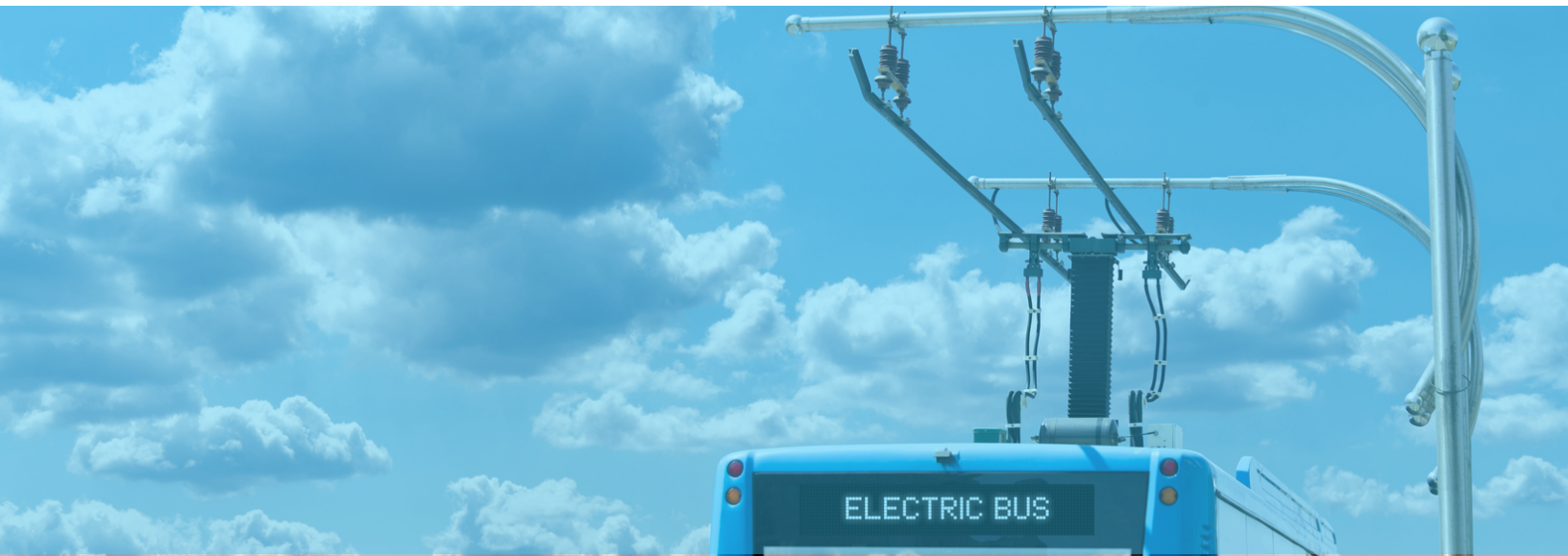


E. FEDERAL LAWS AND POLICIES

In addition to state climate and transportation mandates, federal laws and programs will impact the MBTA electrification timeline and cost. Federal climate action may help to alleviate some of the external pressures by providing incentives for battery availability and federal subsidies for purchase of electric vehicles. Currently the Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) are the two primary pieces of relevant federal legislation.

The IIJA dedicates \$7.5 billion to EV infrastructure, including charging and alternative fuels infrastructure, \$6.7 billion to energy efficient transportation projects generally, which includes public transit, as well as bicycle and pedestrian infrastructure and street lighting.¹⁸ The IRA provides further incentives in the form of tax credits for zero-emission vehicles and fueling infrastructure, including \$1 billion for Clean Heavy Duty vehicles.¹⁹

In addition to national support for the broader electric vehicle and charging industry, the federal government may issue decarbonization mandates; however, these are unlikely to require faster conversion than that which Massachusetts has already imposed upon itself.²⁰



¹⁸ Infrastructure Investment and Jobs Act (2021), H.R. 3684, Pub. L. 117-58

¹⁹ Inflation Reduction Act of 2022, Pub. L. 117-169

²⁰ 87 FR 42401, FHWA & U.S. DOT rulemaking that would require MassDOT and MPOs to establish declining emissions targets.

MBTA PLANS: CAPITAL INVESTMENT AND BUS MODERNIZATION

All MBTA capital expenditures planned for the coming five year period are included in the Capital Investment Plan (CIP). The current CIP for fiscal years 2023 through 2027 went into effect on July 1, 2022. One relevant component of the current CIP is the Better Bus Project, which is comprised of numerous constituent Better Bus Projects, including Bus Network Redesign, Bus Facility Modernization, and Bus Electrification, among others.²¹ Though bus electrification is a core component to making the MBTA's fleet zero-emission, the agency must also electrify the commuter rail and other vehicles.



A. CAPITAL INVESTMENT PLANS

The CIP, also referred to as the capital plan, encompasses 555 unique projects with a total budget of \$9.6 billion, and it is driven by overarching priorities of system reliability improvement, modernization, and expansion of the transportation network.²² A key function of the CIP is the evaluation and prioritization of projects through a scoring process.

On bus electrification, the Quincy Bus Facility project is the only bus project among the top 15 projects by programmed spending, but the CIP also notably includes the Arborway and North Cambridge facility projects, and procurement of BEBs.²³ The 23-37 CIP represents a significant update to the previous 20-24 CIP with respect to bus electrification. Bus fleet electrification is virtually absent from MBTA capital planning in the 20-24 CIP, which was dominated by the Green Line Extension.²⁴

²¹ MBTA Better Bus Project website, accessed Feb. 6, 2023: <https://www.mbta.com/projects/better-bus-project>

²² FY23-27 Capital Investment Plan, page 16

²³ FY23-27 Capital Investment Plan, page 31

²⁴ FY20-24 Capital Investment Plan, <https://massdot.maps.arcgis.com/apps/MapJournal/index.html?appid=33a118c32b3f47b3b90a769498aa68bd#>

²⁵ MBTA Bus Electrification Plan, May 2022, <https://cdn.mbta.com/sites/default/files/2022-10/2022-10-11-mbta-fleet-transition-plan-final.pdf>



B. BUS ELECTRIFICATION PLAN

The Bus Electrification Plan was released by MBTA in May 2022 and updated in October.²⁵ The electrification plan identifies a few key components, including the MBTA's decision to pursue battery electric buses as the vehicle type for all electric bus purchases, as well as the essential nature of facility upgrades, as maintenance and charging facilities are necessary to support bus operation. In the below section regarding bus facility modernization, we examine more closely the timeline, cost, and logistical complexity involved in renovating or reconstructing nearly all of the MBTA's bus maintenance facilities in time to comply with state electrification mandates.

Another factor that further binds the MBTA's timing further is that bus replacement schedules are not just up to the MBTA. First, federal regulations require that buses be replaced on certain schedules and stipulate that transit agencies can be required to repay any federal financial assistance used to purchase a bus if retired too quickly.²⁶ Another element outside of the control of the agency is delivery delays for orders of BEBs, orders of which currently outstrip deliveries as transit agencies nationally expand BEB purchases and manufacturers have supply chain issues of their own.²⁷

Worth pointing out here is the insufficiency of BEB daily charge for heating on the coldest days, and, to a lesser degree, cooling on the hottest. The MBTA identified several options for how to address this concern in a September 2021 assessment, including: reworking the schedule to accommodate the coldest days by supplementing the fleet with additional buses, at significant cost; procuring buses with larger batteries; incorporating in-route charging (IRC); or supplementing heating with auxiliary diesel-fueled heaters.²⁸ Each of these options comes with either considerable cost or added complexity.



C. BUS FACILITY MODERNIZATION

As identified in the Bus Electrification Project, bus facility modernization is an essential and prerequisite condition to electrification of the fleet of buses served by each facility. Below is a timeline showing the MBTA's proposed bus garage renovations.

²⁶ FTA circular 5010.1E (2017)

https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Grant%20Management%20Requirements%20Circular_5010-1E_1.pdf

²⁷ Electric bus orders surge, but deliveries lag, August 11 2022,

<https://www.utilitydive.com/news/orders-surge-electric-buses-deliveries-lag/629451/>.

²⁸ MBTA Approach to Overcoming Winter Range Challenges with Battery Electric Buses (2021)

<https://cdn.mbta.com/sites/default/files/2021-09/2021-09-30-overcoming-winter-range-with-bebs-accessible.pdf>

Table 2: Current MBTA Bus Facility Timeline

Facility	Timeline	Capacity ²⁹	Notes
Quincy	2018 - 2024	Increase from 86 to 120	Construction expected to begin 2023 and complete by 2024
Arborway	Completion 2027	Increase from 118 to 200	Existing fleet of CNG buses retiring starting in 2028 so must be replaced by then. 100% BEB facility
North Cambridge	Completion 2023	Increase from 28 to 35	Conversion of trolley bus facility to BEB. See Albany facility notes regarding consolidation.
Albany	2023* and new facility 2032	Current 116	Current phase retrofit only replacement of overhead doors. Contemplation of future joining of North Cambridge & Albany facilities.
Lynn	Target opening 2030	Currently 116, proposed 65	Current condition is poor. Expected opening 2030
Wellington (Fellsway)	Initial designs 2022, target opening 2029	Fellsway 76, replacement with Wellington 200	Current condition of Fellsway is poor. Proposed replacement of facility with Wellington. Increased capacity to accommodate decrease at Lynn.
Southampton	Target opening 2034	104	Contemplated reconstruction on site, limited details
Cabot	Target opening 2036	180	Contemplated reconstruction on site, limited details
Charlestown	2036-2038, 2039 ³⁰	254	Primary bus maintenance facility, expected to be the final bus facility converted
Everett			*Not a primary bus garage, heavy repair facility that has limited overflow capacity

²⁹ MBTA Bus Electrification Plan, page 17

³⁰ MBTA Charlestown Campus Master Plan (September 2021) <https://cdn.mbta.com/sites/default/files/2021-09/charlestown-yard-executive-summary-accessible.pdf>

However, looking back to the 2017 Integrated Fleet and Facilities Plan conceptual strategy – which proposed to have Quincy finished by 2020, Southamptton expanded, Cabot rehabilitated by 2022, and Arborway completed by 2024 – it is evident that garage replacement could take longer than the MBTA anticipates.³¹ The Boston Globe pointed out in 2022 that cost projections have also not gone to plan, with the 2017 proposal estimating \$808 million for replacement or modernization of all nine garages, but Quincy alone already costing about half of that amount.³²

The significant cost and time associated with bus maintenance facilities isn't surprising when one considers that replacement isn't simply a matter of upgrades to facilities that are currently in good repair; indeed, many of the existing facilities are overdue renovation with significant delayed maintenance issues.³³ Considering the age and state of the current facilities and the fact that the MBTA must expand capacity over the coming decades to accommodate both growing population and increased mode share, the bus facility modernization plans incorporate much broader planning and construction activity than just updates to accommodate electric buses. As we see with both the Quincy and Arborway reconstruction projects, the MBTA is incorporating capacity expansions into these projects, and they take more than a couple years between conception and operation.

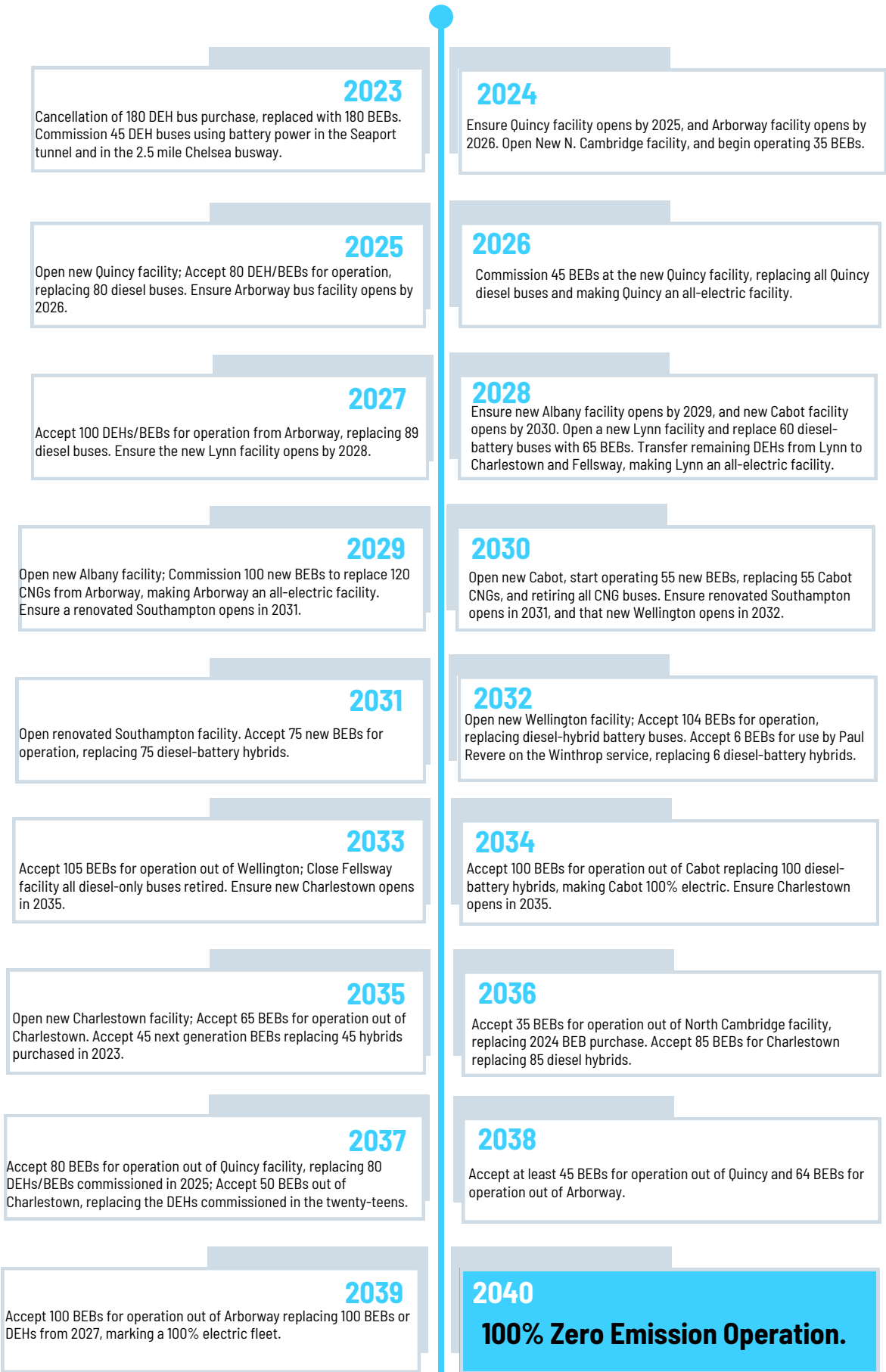


³¹ MBTA Integrated Fleet and Facilities Plan (IFFP), Part Three: Bus, (Dec. 4, 2017) <https://cdn.mbta.com/sites/default/files/fmcb-meeting-docs/2017/december/2017-12-04-fmcb-iffp-part3-bus.pdf>

³² Boston Globe, April 20, 2022 "Eye-popping cost of MBTA's new Quincy bus garage outpaces similar projects in US and Canada" <https://www.bostonglobe.com/2022/04/20/metro/eye-popping-cost-mbtas-new-quincy-bus-garage-outpaces-similar-projects-us-canada/>

³³ StreetBlogMass, Crowded, Obsolete Garages Hamstring T's 'Better Bus' Ambitions (Jan. 7, 2020); <https://mass.streetsblog.org/2020/01/07/crowded-obsolete-garages-hamstring-ts-better-bus-ambitions/>

FEASIBLE REPLACEMENT SCENARIO



The electrification of the MBTA's bus fleet depends not only on the opening of new facilities to support these new fleets, but also on the Authority's ability to deliver on its ambitious fleet-transformation program. There are also other impediments to the successful completion of this initiative. For instance, buses purchased with federal FTA funds must be retained for at least 12 years of service.³⁴ All current MBTA buses were purchased with federal funds. In addition, the lack of modern bus facilities is the principal roadblock to electrification. All buses need a homebase for cleaning, maintenance, operator-training, and as a place for operators to meet with supervisors and each other.

CURRENT MBTA BUS FLEET

The current MBTA bus fleet consists of about 1100 buses housed at 8 different facilities around the region. The Authority operates buses that are both 40-foot in length, and 60-foot in length. 60-foot buses are articulated, and they currently operate on the Silver Line Washington Street, Seaport, Airport, and Chelsea services, as well as on some Route 28 and 39 trips. 40-foot buses operate on all other routes. There are about 104 60-foot and 988 40-foot buses in the fleet. In addition, there are 5 principal propulsion sources in use at the MBTA today: Diesel, Battery-Electric, Diesel-Battery Hybrid, Compressed Natural Gas, and Diesel-Electric Dual-Mode Articulated (DMA). Of the revenue bus fleet, 96% were manufactured by New Flyer of America, Inc. and the remaining 4% by Neoplan USA Corporation. This means the MBTA currently operates 6 types of buses: Diesel 40-Foot, Diesel-Battery Hybrid 40-foot, Compressed Natural Gas (CNG) 40-foot, Diesel-Battery Hybrid 60-foot, Battery-Electric 60-foot, and Diesel-Electric 60-foot.



³⁴ Federal Transit Administration Circular 5010.1

Table 3: 2022 MBTA Bus Totals by Propulsion Type and Depot Organized by Year

MBTA Bus Fleet (2022)			
# Buses	Propulsion	Build Year	Base
35	Electric- Catenary	2004	N. Cambridge
32	Diesel-Electric (DMA)	2004/2005	Southampton 60
23	Diesel	2004/2005	Southampton 40
89	Diesel	2008	Quincy
28	Diesel	2008	Albany
36	Diesel	2008	Lynn
89	Diesel	2008	Albany
60	Diesel-Battery Hybrid	2014/2015	Lynn
120	CNG	2016/2017	Arborway
55	CNG	2016/2017	Cabot
75	Diesel-Battery Hybrid	2010, 2016-2019	Southampton 60
50	Diesel-Battery Hybrid	2016/2017	Cabot
84	Diesel	2016-2020	Fellsway
100	Diesel-Battery Hybrid	2016/2017	Cabot
100	Diesel-Battery Hybrid	2019/2020	Charlestown
100	Diesel-Battery Hybrid	2019/2020	Charlestown
34	Diesel-Battery Hybrid	2019/2020	Charlestown
5	Diesel-Battery Hybrid	2020	Southampton 40
6	Diesel-Battery Hybrid	2020	Paul Revere
15	Diesel-Battery Hybrid	2020	Lynn



A. Diesel 40-Foot Buses

The MBTA operates 349 40-foot diesel buses. 306 of these are New Flyer D40LF models, and the remaining 43 are Neoplan AN440LF models. The New Flyers all have Cummins ISL diesel engines, while the Neoplans all have Caterpillar C9 engines. 117 of these are based at Albany Street, 89 at Quincy, 64 at Fellsway, and 36 at Lynn. The 306 New Flyer buses were built between 2006 and 2008, and all reached retirement age in 2018 and 2020. Of the 43 Neoplan buses, 20 are housed at Fellsway and the remaining 23 at Southampton. These buses were built in 2004 or 2005, overhauled between 2013 and 2015, and have reached minimum retirement age.



B. Diesel-Battery Hybrid 40-foot buses

The MBTA operates 464 diesel-hybrid New Flyer XDE40s with Cummins ISB diesel/BAE hybrid propulsion systems. These buses rely on diesel fuel to power an on-board generator that can propel the transmission, or they can operate directly via diesel fuel. 234 of these buses are housed at Charlestown, 150 at Cabot, 75 at Lynn and 5 at Southampton. The oldest of these buses were built in 2014 and 2015, and the newest in 2020. The oldest of this type of bus reaches minimum retirement age in 2026, with the most recently added bus achieving this milestone in 2032.



C. Compressed Natural Gas (CNG) 40-foot buses

The MBTA operates 175 New Flyer XN40 buses with Cummins ISLG engines fueled by compressed natural gas. 120 of these buses are housed at Arborway and the remaining 55 at Cabot. Each facility contains special fueling and fire-suppression apparatus to support these vehicles. These buses were built in 2016 and 2017, and they will reach minimum retirement age in 2028-2029. The Authority has indicated a preference to replace CNG buses with BEBs once they reach retirement age.³⁵



D. Diesel-Battery Hybrid 60-foot buses

75 New Flyer DE60LFR 60-foot diesel-battery hybrid buses form part of the fleet as well. Like their 40-foot counterparts, these buses use diesel fuel to power an on-board generator, which powers the transmission. They can also operate directly via diesel fuel. Of these 75 buses, 25 utilize Cummins ISL diesel/Allison hybrid engines, were built between 2010 and 2013, and will have reached minimum retirement age between 2022 and 2025. Another 44 are New Flyer XDE60's 60-foot diesel-battery hybrid with Cummins ISB diesel BAE hybrid engines. These buses were manufactured in 2016 and 2017, and they will reach minimum retirement age in 2028 and 2029. In addition to these 44 buses, there is also the so-called 45th bus. This bus is also a New Flyer XDE60, but it has a Cummins ISL (as opposed to ISB) engine with BAE transmission with an extended-range battery. The Authority has used this bus since 2018 to test bus-battery technology.³⁶ This bus proved the efficacy of operating battery buses in the Silver Line and Chelsea busways and was essential in the 2021 order of 45 additional XDE60 hybrids. Like all 60-foot buses, the 45th bus is housed at Southampton. It was built in 2018 and reaches minimum retirement age in 2030.

³⁵ <https://www.mbta.com/projects/bus-facility-modernization>

³⁶ <https://www.masstransitmag.com/home/press-release/12431875/massachusetts-bay-transportation-authority-mbta-first-extendedrange-hybrid-bus-joins-the-mbtas-silver-line-fleet>



E. Battery-Electric 60-foot articulated buses

The Authority operates 5 60-foot, articulated, New Flyer XE60 battery-electric buses with Siemens PEM electric drive propulsion. According to New Flyer, this is the first 60-foot articulated bus available in North America with center-powered axles.³⁷ Such axles are essential to operate 60-foot articulated buses in snow and ice conditions. These 5 buses were purchased in 2019, and are housed at Southampton. The Authority acquired these vehicles to better understand BEB technology and capabilities, and uses them for testing.³⁸ These 5 buses reach minimum retirement age in 2031.



F. Diesel-Electric Dual Mode Articulated 60-foot buses

The Silver Line Seaport, Airport, and Chelsea routes are serviced by a fleet of 32 Neoplan Dual Mode Articulated (DMA) 60-foot buses, with Detroit Diesel Series 60 and Skoda Electric propulsion systems. These vehicles are powered via an overhead catenary wire in the tunnel between South Station and Silver Line way. Since this tunnel lacks exhaust systems, zero-emission vehicles are required. Outside of Silver Line Way, these buses switch from catenary power to diesel propulsion. All 32 vehicles were built in 2004 or 2005 and reached minimum retirement age in 2016 and 2017.



³⁷ <https://www.newflyer.com/site-content/uploads/2018/05/Xcelsior-CHARGE-XE60-Specification-Sheet.pdf>

³⁸ <https://commonwealthmagazine.org/transportation/mbta-goes-out-to-bid-for-battery-electric-buses/#:~:text=The%20MBTA%20obtained%20five%20battery,used%20to%20heat%20the%20vehicles.>

Table 4: Current MBTA Bus Fleet

Home	# Active	Builder-Model	Built	Earliest Retirement
Albany	89	New Flyer D40LF	2006/2007	2018-2019
Albany	28	New Flyer D40LF	2008	2020
Arborway	120	New Flyer-XN40	2016/2017	2028-2029
Cabot	55	New Flyer- XN40	2016/2017	2028-2029
Cabot	150	New Flyer- XDE40	2016/2017	2028-2029
Charlestown	193	New Flyer-XDE40	2019/2020	2031-2032
Charlestown	41	New Flyer-XDE40	2020	2032
Fellsway	20	Neoplan- AN440 LF	2004/2005	2016-2017
Fellsway	62	New Flyer D40LF	2006/2007	2018-2019
Fellsway	2	New Flyer D40LF	2008	2020
Lynn	36	New Flyer D40LF	2008	2020
Lynn	60	New Flyer-XDE40	2014/2015	2026-2027
Lynn	14	New Flyer-XDE40	2020	2032
Lynn	1	New Flyer-XDE40	2019/2020	2031-2032
Quincy	89	New Flyer D40LF	2008	2020
Southampton	23	Neoplan-AN440 LF	2004/2005	2016-2017
Southampton	5	New Flyer-XDE40	2020	2032
Southampton	25	New Flyer-DE60LFR	2010	2022
Southampton	44	New Flyer-XDE60	2016/2017	2028/2029
Southampton	1	New Flyer-XDE60	2018	2030
Southampton	5	New Flyer-XE60	2019	2030
Southampton	19	New Flyer-XDE60	2022/2023	2030-2031
Southampton	11	Neoplan-DMA LF	2004/2005	2016/2017
Southampton	6	Neoplan-DMA LF	2004/2005	2016/2017
Southampton	7	Neoplan-DMA LF	2005	2016/2017
	1106			2016/2017

Source: <http://roster.transithistory.org/> (03/06/2023)

PROPOSED ELECTRIFICATION STRATEGY

The MBTA is required by law to replace its diesel-powered buses with battery electric buses (BEBs) by 2040. Via the combination of new facilities capable of charging, maintaining, cleaning, and housing new buses, and the purchase, building, and commissioning of new vehicles over the next 17 years, the MBTA can and must operate an entirely electrically propelled bus fleet. In early 2022, the Authority began procuring new diesel-electric hybrid buses (DEHs) and battery-electric buses (BEBs). The MBTA plans to alternate between the purchase of DEHs and BEBs annually until 2027.³⁹ The Authority plans to commission 80 new buses annually in 2024 and 2025, ramping up to 100 per year by 2026. As new buses are commissioned, older buses will be retired. The delivery and commissioning of new BEBs is dependent on the construction of new facilities capable of housing, charging, and maintaining them. DEH buses can likely be operated from existing MBTA facilities. BEBs require modernized or new MBTA facilities.



A. 40-foot Battery Electric Buses (BEBs)

In April 2022, the MBTA issued a request for proposals to purchase up to 360 40-foot BEBs, with an initial order for 80 for 2024 delivery.⁴⁰ No manufacturer or propulsion type has been publicly named. These 80 buses will also have supplemental diesel motors to provide customer heating in winter months. If and when these new buses are overhauled in the early 2030s, and if the battery technology exists, these diesel heater motors could be replaced with electric-motors thus allowing for 100% electric service.

Of the initial order of 80 BEBs, 35 are earmarked for the North Cambridge facility.⁴¹ In 2022 the MBTA retired its fleet of 28 Neoplan Electric Trolley Buses (ETBs) that operated from the North Cambridge Carhouse for over a century. These ETBs were propelled by electricity supplied via overhead catenary wires, and they were built in 2004. The remaining 45 BEBs of this order, originally scheduled for a 2024 delivery, will likely be delayed until 2025, when the new Quincy facility opens.⁴² Completion of new North Cambridge and Quincy BEB facilities is required for accepting these new BEBs, as these buses will require charging facilities, as well as a place for maintenance, cleaning, crew training, and more. These new Quincy BEBs will replace 45 2008-model New Flyer 40-foot diesels operating from the current Quincy facility.⁴³

³⁹ <https://www.wbur.org/news/2022/03/25/mbta-diesel-electric-bus>

⁴⁰ <https://commonwealthmagazine.org/transportation/mbta-goes-out-to-bid-for-battery-electric-buses/>

⁴¹ <https://cdn.mbta.com/sites/default/files/2021-04/2021-04-26-fmcb-bus-transformation-update.pdf>

⁴² <https://www.bostonglobe.com/2023/02/14/metro/one-year-after-mbtas-quincy-bus-garage-groundbreaking-no-garage-construction-yet/>

⁴³ <https://cdn.mbta.com/sites/default/files/2021-04/2021-04-26-fmcb-bus-transformation-update.pdf>

If the MBTA follows its plan of alternating between the purchase of DEHs and BEBs, the next BEB purchase would likely be in 2026.⁴⁴ In the past, the Authority has suggested that it plans to rebuild its Arborway bus facility following the new Quincy facility's opening.⁴⁵ Arborway's opening is a critical milestone on the MBTA's path to electrification by 2040, and it is essential for retiring the diesel-only (as compared to diesel hybrid) buses currently in operation as soon as possible. Arborway is designed to host 200 new buses, an increase from the 118 currently housed there. If Arborway opens in 2026, the diesel-only (as compared to diesel hybrid) buses currently in operation can be fully retired by 2027 and current CNG buses retired by 2030. Under these conditions, in 2026, 45 diesels from Quincy, 28 from Albany, and 36 from Lynn can be retired and replaced with BEBs.

Under this scenario, the next BEB purchase would then happen in 2029. In its bus facility plan, the MBTA suggested closing its existing Albany Street facility, which now hosts buses, with a new facility more ideally placed for the bus network of the future. This new facility (New Albany Facility) would house 200 buses. As with Arborway, siting, building and opening this New Albany facility must happen sooner rather than later. If it opens in 2029 in time for the delivery of BEBs, these 100 BEBs can replace 100 of the 120 CNG buses currently operating from Arborway. The remaining 20 CNGs at Arborway can then be replaced by BEBs the following year, along with the 55 other CNGs operating from Cabot. This would mean the retirement of all CNGs by 2030.

The next delivery of 40-foot BEBs is then expected in 2032. As with the Arborway and New Albany facilities, to meet its 2040 legal requirements, the MBTA should open its new Wellington facility by 2032. Wellington is expected to host 200 buses, replacing the Fellsway facility and supporting the downsizing of the Lynn facility. Should Wellington open in 2032, 50 2016/2017-model year diesel-battery hybrids from Cabot can be replaced by 55 BEBs at Wellington. In addition, 15 2020-model year diesel-battery hybrids can be replaced with 49 BEBs at Wellington. In 2032, the 6 2020-model year diesel-battery hybrids currently in use by Paul Revere for Winthrop bus service can be replaced with 6 BEBs for this same service. 2032 is the first year that 2020-model buses are eligible for retirement. The result of this is that 110 BEBs can replace 71 diesel hybrids in 2032.

⁴⁴ <https://www.wbur.org/news/2022/03/25/mbta-diesel-electric-bus>

⁴⁵ https://cdn.mbta.com/sites/default/files/2021-12/2021-12-09-arborway-bus-facility-proj-public-mtg-accessible_0.pdf

In 2033, the new Wellington facility can support additional diesel-hybrid retirements as well as the full retirement of all remaining diesel-only MBTA buses. First, the 5 40-foot, 2020-model year diesel-hybrid buses at Southampton can be replaced by 5 40-foot BEBs at Wellington. This will result in the shift of Southampton to an all-60-foot bus facility. Fellsway can also close once Wellington opens. The remaining 84 diesel-only 2016-2020-model year buses can be retired and be replaced by 100 BEBs at Wellington. Not only will this action result in the retirement of all diesel-only buses, it will also allow the closure of the Fellsway facility. It should be noted that the 2020-model diesels cannot be retired until at least 2032.

In 2034, as with the opening of Quincy, Arborway, Lynn, New Albany, and Wellington, it will become essential to open the new Cabot facility to continue progress towards meeting legal requirements. Should the new Cabot open in 2034, 100 BEBs can replace 100 2016/2017-model year diesel hybrids.

Then, in 2035, the new Charlestown facility should open to continue the electrification progress. Charlestown is the final existing MBTA bus facility requiring renovation to support BEBs. If the renovated Charlestown opens in 2035, the first 65 BEBs housed there will replace 65 2019/2020-model diesel-hybrids. 2036 would mark a major milestone in the MBTA's electrification program, as the first BEBs commissioned in 2024 for North Cambridge reach retirement age and are replaced by the next generation of BEBs, also at the North Cambridge facility. 2037 will see the retirement of the 80 2025-model hybrid buses at Quincy. 2037 will also mark the retirement of the final buses from the twenty-teens and the final diesel-battery hybrid buses, as 34 2019/2020-model such buses are replaced by 50 BEBs. 2038 will see 45 2026-model BEBs from Quincy, and 64 2026-model BEBs from Arborway replaced with the same number of second-generation BEBs. In 2039, the final 100 2027-model hybrids will be replaced with 100 new 2039-model BEBs. This epoch marks the complete electrification of the MBTA's bus fleet, assuming that the plan is adhered to.



B. 40-foot Diesel-Electric Hybrids (DEHs)

In March 2022, the Authority approved the purchase of 160 40-foot diesel-electric hybrid (DEHs) buses from New Flyer Corporation. These buses will be New Flyer XDE40s, which have the option to operate under battery propulsion generated by a diesel engine or via diesel fuel only. These first 80 of these buses are earmarked for Quincy, where they will replace 80 2008-model diesel buses.⁴⁶ The final 80 buses in this order should likely be cancelled in favor of additional BEBs. The final order of 100 DEHs should also be cancelled and replaced by BEBs. However, if the MBTA insists on adhering to its alternating policy of BEBs and DEHs, in 2027 it can replace 100 2008-model diesels at Albany with 100 hybrids at Arborway. As explained above, the 80 2008-hybrids will be replaced with 80 second-generation BEBs in 2037, and the 100 2027-model hybrids replaced with 100 BEBs in 2039.

⁴⁶ <https://mass.streetsblog.org/2022/05/04/mbtas-new-electric-bus-order-could-support-more-center-running-busways-regionwide/>



C. 60-foot Battery Electric Buses (BEBs)

As explained above, the Authority currently operates 5 60-foot, articulated, New Flyer XE60 battery-electric buses with Siemens PEM electric drive. The 5 new buses were purchased in 2019, and they are housed at Southampton. The Authority acquired these vehicles to better understand BEB technology and capabilities and uses them for testing.⁴⁷ These 5 buses reach minimum retirement age in 2031. In 2031, the Authority will likely retire these 5 buses, as well as the 70 remaining 60-foot diesel hybrids. Of these 70 buses, 14 date from 2004/2005 and 25 date from 2010. These buses will be 27/28 and 21 years old, respectively, in 2031. By 2031, these buses will be more than ready for complete replacement by BEBs. In addition, by 2031, 60-foot BEB technology should be more advanced than in the 2020s. With a fleet of low-floor buses, 160 such buses are currently on order, with 80 scheduled to be delivered in 2023 and the remaining 80 in 2024.



D. 60-foot Diesel-Electric Hybrids (DEHs)

In November 2021, the MBTA's governing board approved the purchase of 45 60-foot, articulated, New Flyer XDE60 hybrid buses. These buses began arriving in 2022, and final delivery is projected by the end of 2023. These buses operate via batteries fueled by diesel fuel, or directly via diesel fuel. They must operate with zero-emissions in the Seaport tunnel, as it lacks ventilation. The MBTA has also committed to also operating these vehicles via battery in the 2.5-mile Chelsea busway. They will replace the current fleet of 32 Diesel-Electric Dual Mode Articulated 60-foot buses from 2004 and 2005 currently servicing the Silver Line Seaport, Airport, and Chelsea routes. Currently, all 60-foot articulated buses are stored and maintained at the Southampton bus facility. To support expanded 60-foot articulated bus trips, the MBTA plans to expand Southampton's footprint by 2 acres⁴⁸, as well as outfitting some future, renovated bus facilities and bus stops to accommodate 60-foot buses.⁴⁹ The Authority also plans to accommodate 60-foot articulated buses at renovated future sites, based on service needs.

Please see the below graphic summarizing our proposed timeline to account for replacement of the existing bus fleet.⁵⁰

⁴⁷ <https://commonwealthmagazine.org/transportation/mbta-goes-out-to-bid-for-battery-electric-buses/#:~:text=The%20MBTA%20obtained%20five%20battery,used%20to%20heat%20the%20vehicles.>

⁴⁸ <https://mass.streetsblog.org/2022/07/19/mbta-board-updates-fta-safety-directives-hiring-challenges-and-more-buses/>

⁴⁹ https://cdn.mbta.com/sites/default/files/2021-12/2021-12-09-arborway-bus-facility-proj-public-mtg-accessible_0.pdf

⁵⁰ Please note this timeline does not account for Bus Network Redesign or expanded bus service.

ALL MANDATES COMPARED TO PROPOSED SCENARIO

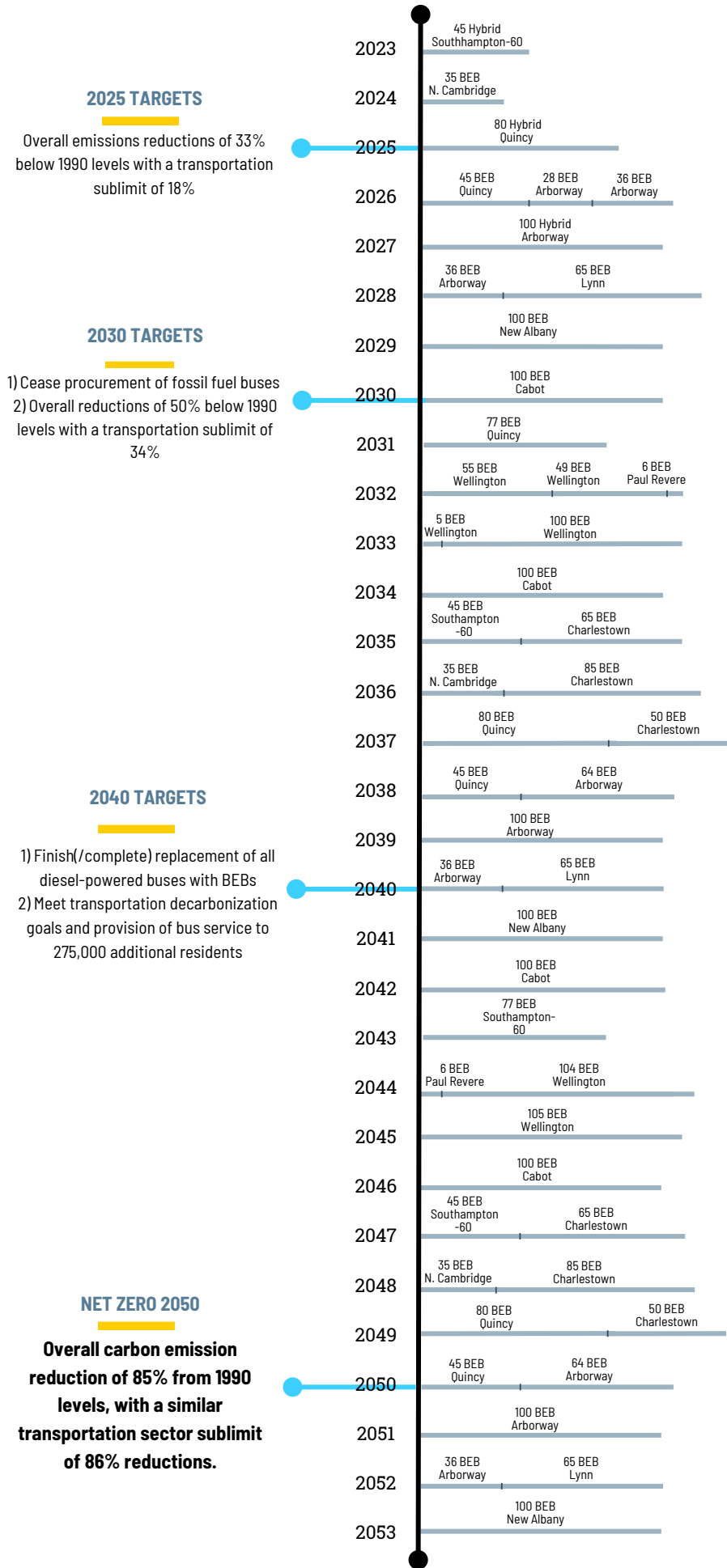


Table 5: Proposed MBTA Bus Replacement Schedule

CURRENT				PROPOSED REPLACEMENT SCHEDULE				
# Buses	Propulsion Type	Build Year	Facility	# of Buses	Propulsion Type	Build Year	Facility	Notes
32	Diesel-Electric	2004/2005	Southampton 60	45	Hybrid	2023	Southampton 60	60 Foot
35	Electric- Catenary	2004	N. Cambridge	35	BEB	2024	N. Cambridge	N. Camb. Open
89	Diesel	2008	Quincy	80	Hybrid	2025	Quincy	New Quincy Open
	Diesel	2008	Quincy	45	BEB	2026	Quincy	
28	Diesel	2008	Albany	28	BEB	2026	Arborway	Arborway Open
36	Diesel	2008	Lynn	36	BEB	2026	Arborway	
89	Diesel	2008	Albany	100	Hybrid	2027	Arborway	
23	Diesel	2004/2005	Southampton 40	36	BEB	2028	Arborway	
60	Diesel-Bat. Hybrid	2014/2015	Lynn	65	BEB	2028	Lynn	Lynn Open
120	CNG	2016/2017	Arborway	100	BEB	2029	New Albany	New Albany Open
55	CNG	2016/2017	Cabot	100	BEB	2030	Cabot	
75	Diesel-Bat. Hybrid	2010, 2016-2019	Southampton 60	77	BEB	2031	Southampton 60	60 Foot
50	Diesel-Bat. Hybrid	2016/2017	Cabot	55	BEB	2032	Wellington	Wellington Open
15	Diesel-Bat. Hybrid	2020	Lynn	49	BEB	2032	Wellington	
6	Diesel-Bat. Hybrid	2020	Paul Revere	6	BEB	2032	Paul Revere	
5	Diesel-Bat. Hybrid	2020	Southampton 40	5	BEB	2033	Wellington	
84	Diesel	2016-2020	Fellsway	100	BEB	2033	Wellington	Diesels Retired
100	Diesel-Bat. Hybrid	2016/2017	Cabot	100	BEB	2034	Cabot	Cabot Opens
45	Hybrid	2023	Southampton 60	45	BEB	2035	Southampton 60	23 Hybrids Retired
65	Diesel-Bat. Hybrid	2019/2020	Charlestown	65	BEB	2035	Charlestown	Charlestown Open
35	BEB	2024	N. Cambridge	35	BEB	2036	N. Cambridge	24 BEBs retired
85	Diesel-Bat. Hybrid	2019/2020	Charlestown	85	BEB	2036	Charlestown	
80	Hybrid	2025	Quincy	80	BEB	2037	Quincy	25 BEBs retired
34	Diesel-Bat. Hybrid	2019/2020	Charlestown	50	BEB	2037	Charlestown	Last "Teens" buses
45	BEB	2026	Quincy	45	BEB	2038	Quincy	
64	BEB	2026	Arborway	64	BEB	2038	Arborway	
100	Hybrid	2027	Arborway	100	BEB	2039	Arborway	100% BEBs
36	BEB	2028	Arborway	36	BEB	2040	Arborway	
65	BEB	2028	Lynn	65	BEB	2040	Lynn	
100	BEB	2029	New Albany	100	BEB	2041	New Albany	
100	BEB	2030	Cabot	100	BEB	2042	Cabot	
77	BEB	2031	Southampton 60	77	BEB	2043	Southampton 60	
55	BEB	2032	Wellington	104	BEB	2044	Wellington	
6	BEB	2032	Paul Revere	6	BEB	2044	Paul Revere	
105	BEB	2033	Wellington	105	BEB	2045	Wellington	
100	BEB	2034	Cabot	100	BEB	2046	Cabot	
45	BEB	2035	Southampton 60	45	BEB	2047	Southampton 60	
65	BEB	2035	Charlestown	65	BEB	2047	Charlestown	
35	BEB	2036	N. Cambridge	35	BEB	2048	N. Cambridge	
85	BEB	2036	Charlestown	85	BEB	2048	Charlestown	
80	BEB	2037	Quincy	80	BEB	2049	Quincy	
50	BEB	2037	Charlestown	50	BEB	2049	Charlestown	
40	BEB	2038	Quincy	45	BEB	2050	Quincy	
64	BEB	2038	Arborway	64	BEB	2050	Arborway	
100	BEB	2039	Arborway	100	BEB	2051	Arborway	
36	BEB	2040	Arborway	36	BEB	2052	Arborway	
65	BEB	2040	Lynn	65	BEB	2052	Lynn	
100	BEB	2041	New Albany	100	BEB	2053	New Albany	

CONCLUSION

Looking at the above timeline table, the plan is pretty tight and does not contain lot of room for slippage. By its own admission, there are significant portions of the bus electrification plan that the MBTA has not figured out, including specific timelines for most of the bus maintenance facilities and whether to incorporate in-route charging or other technologies. With so much uncertainty in the plan and considering the stakes and the MBTA's track record for complying with mandated timelines, the MBTA must take a much more aggressive posture and build in time for new elements of the electrification plan and for unexpected delays.

The MBTA must make contingencies to ensure compliance with the above requirements because delay isn't a viable option. Without other alternatives, if the MBTA falls behind schedule and does not have facilities for sufficient electric buses to cover the system by 2040 it would have to return to the legislature to request an extension. The manifold reasons why the MBTA must meet these electrification goals are spelled out in abundant detail in the Commonwealth's numerous statements on the urgency of combatting climate change in statutes, policies, and they are perhaps best summarized by Executive Order 569 from 2016:

"[C]limate change presents a serious threat to the environment and the Commonwealth's residents, communities, and economy [and] the transportation sector continues to be a significant contributor to greenhouse gas emissions in the Commonwealth, and is the only sector identified through the GWSA with a volumetric increase in greenhouse gas emissions"⁵¹

Massachusetts has set some necessarily ambitious targets for statewide decarbonization, and MBTA bus electrification is an essential component of that. Taken together, the MBTA's current plans, financial status and track record on facility construction timelines, as well as uncertainty about state of the technology, do not bode well for compliance with successful transition to all-electric service by 2040 and compliance with legal mandates.

⁵¹ Massachusetts Executive Order 569 (2016).