Charging Infrastructure Needed to Support Advanced Clean Trucks in Massachusetts

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Massachusetts' medium- and heavy-duty (MHD)[1] trucks provide services that are essential to residents' way of life. They also contribute significantly to the climate crisis: despite making up only seven percent of on-road vehicles in Massachusetts, MHD vehicles emit approximately 20 percent of all greenhouse gases from on-road vehicles.[2] And they cause significant air and health impacts: MHD vehicles are responsible for 46 percent of the nitrogen oxide and 40 percent of the particulate matter emitted by on-road vehicles in the state.[3] These emissions contribute to poor air quality and negative health outcomes across the state, especially for those living near freight corridors and transportation infrastructure.

Recognizing the costs of MHD vehicles, eleven states, including Massachusetts, have adopted the Advanced Clean Trucks (ACT) regulation to set their communities on the path to zero-emission transportation.[4] Additional states are considering adopting the rule. Analysis by ERM estimates that the adoption of ACT in Massachusetts will save $753 million in healthcare costs between 2020 and 2050, including nearly 38,000 cases of acute bronchitis, exacerbated asthma, other respiratory symptoms, and reduced restricted activity days and lost workdays. ERM finds a further $179 million in annual cost savings for Massachusetts' fleets by 2050.[5] In addition, ERM finds that ACT could potentially decrease average residential and commercial electricity rates in Massachusetts thanks to improved utilization of utility assets from EVs, saving the average household $27 per year and the average commercial customer $116 per year on their electricity bills in 2050.[6]

To support planning for the Advanced Clean Trucks regulation in Massachusetts, Atlas Public Policy modeled the charging infrastructure needed at depots and along truck routes to support ACT-

[1] In this analysis, MHD trucks are those with gross vehicle weight ratings in class 2b through 8, i.e. 8,501 pounds+

[2] ERM, 2022, "Southern New England Clean Trucks Program," https://www.erm.com/contentassets/f3d6061dd8a04147a3f38b7db256ae44/sne-clean-trucks-report.pdf

[3] Ibid.

[4] https://afdc.energy.gov/laws/california-standards#/tab-act

[5] In 2020 dollars.

[6] In 2020 dollars. Note that the baseline used in this analysis was developed prior to the U.S. Environmental Protection Agency's Phase 3 Emissions Standards, which were finalized in March 2024. ERM, 2022, "Southern New England Clean Trucks Program," https://www.erm.com/contentassets/f3d6061dd8a04147a3f38b7db256ae44/sne-clean-trucks-report.pdf

consistent adoption in the state through 2032.[7]

Key takeaways from this work:

- ACT requirements ramp over time, enabling fleets and utilities to plan ahead and build charging infrastructure gradually.
- The majority of zero-emission MHD vehicles in Massachusetts under ACT compliance will be class 2b/3 trucks. Electric vehicles of this type are expected to charge with Level 2 charging ports.
- We expect vehicles with access to long-dwell-time parking, such as private or publicly-accessible depots, to electrify first. We therefore model limited need for en-route charging buildout between now and 2032.
- For heavy-duty (class 4 – 8) vehicles, the majority of the charging ports that will be needed at depots are Level 2.[8]

Additional details and findings are provided in the remainder of this document.

EV Adoption Under ACT

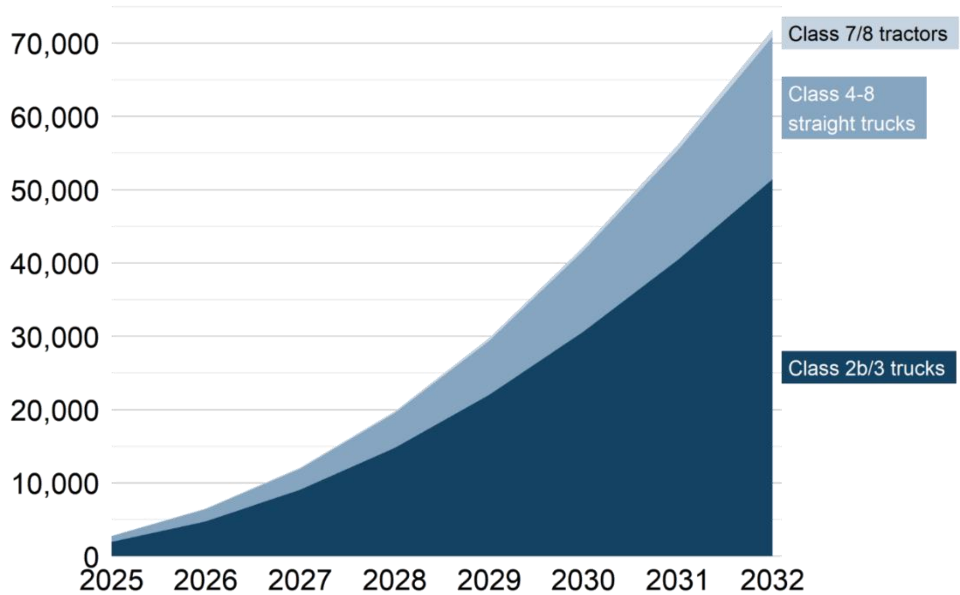
Our projections show that ACT could result in approximately 72,000 electric medium- and heavy-duty vehicles on Massachusetts' roads by 2032.[9] See Figure 1.

[7] Atlas Public Policy thanks Environmental Defense Fund for their support of this work. The conclusions contained herein are Atlas Public Policy's alone. This analysis does not include home charging needed for class 2b/3 vehicles.

[8] Level 2 charging ports modeled in this analysis are 11kW and 19kW.

[9] Assuming the regulation is in place by model year 2025.

Figure 1. Projected ZEVs on the road in Massachusetts under ACT-compliant ZEV adoption, by ACT Category



In 2032, these vehicles would represent:

- 13 percent of registered Class 2b and 3 trucks, vans and other vehicles
- 16 percent of registered Class 4-8 straight trucks and buses
- 9 percent of all registered Class 7 and 8 tractor trucks

Charging Infrastructure Needed Under ACT

Next, we modeled the charging ports that will be needed to charge these vehicles. The ACT rule is technology agnostic and flexible in compliance. However, for the purpose of this analysis, we calculate an upper bound on electric vehicle charging by assuming all ZEVs shown in Figure 1 complete their daily driving with electric miles. For long-haul trucks, we model 100 percent of charging as being done at high-powered, 350kW charging ports either at depots or en-route.[10] For other vehicles, we assume that 10 percent of needed energy is taken from en-route chargers.[11] Their remaining charging is done at 'depots': in these early years of electrification, we assume that electrification of non-long-haul vehicles will mostly occur at locations where vehicles can

[10] It is also possible that Megawatt Charging System technologies will be commercially available in this timeframe and could be used in place of en-route charging ports for long-haul vehicles, especially to enable flexibility in the charging network for long-haul trucks. Given their higher charging power, fewer of these types of chargers would be needed to support the same vehicle fleet.

[11] We expect that early electrification of MDHD vehicles will mostly occur in fleets with operations that allow for in-depot charging, and that on-road charging needs will be minor.

consistently park for extended periods. We assign depot charging ports of different power levels to vehicles based on their energy needs.[12]

Figure 2 and 3 show projected charging port needs for Class 2b/3 and Class 4-8 vehicles, respectively. Importantly, this analysis did not net out expected charging infrastructure build spurred by organic market growth or by the U.S. Environmental Protection Agency's Phase 3 emissions standards, finalized in March 2024.[13]

Under ACT, our analysis suggests that by 2032, Massachusetts will require approximately 23,000 depot Level 2 charging ports for class 2b/3 vehicles, or one for every 12 registered class 2b/3 vehicles in the state. For comparison, the majority of Massachusetts' 99,200 light-duty EVs[14] are likely already charged at a Level 2 charger at home.[15] Massachusetts will also need approximately 510 en-route fast charging ports to serve class 2b and 3 vehicles. To reach that target, an average of 64 en-route ports will need to be added per year from 2025 onward.[16] For comparison, 138 public fast charging ports were deployed in 2023 for light-duty vehicles in the state.[17]

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[12] Level 2 ports are assigned to vehicles on a 1:1 basis but 50 and 150kW depot ports may be shared. We assume that charging from 80 to 100 percent state of charge takes as long as 0 to 80 percent, and that these depot-charging vehicles charge to 100%.

[13] https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-greenhouse-gas-emissions-commercial-trucks

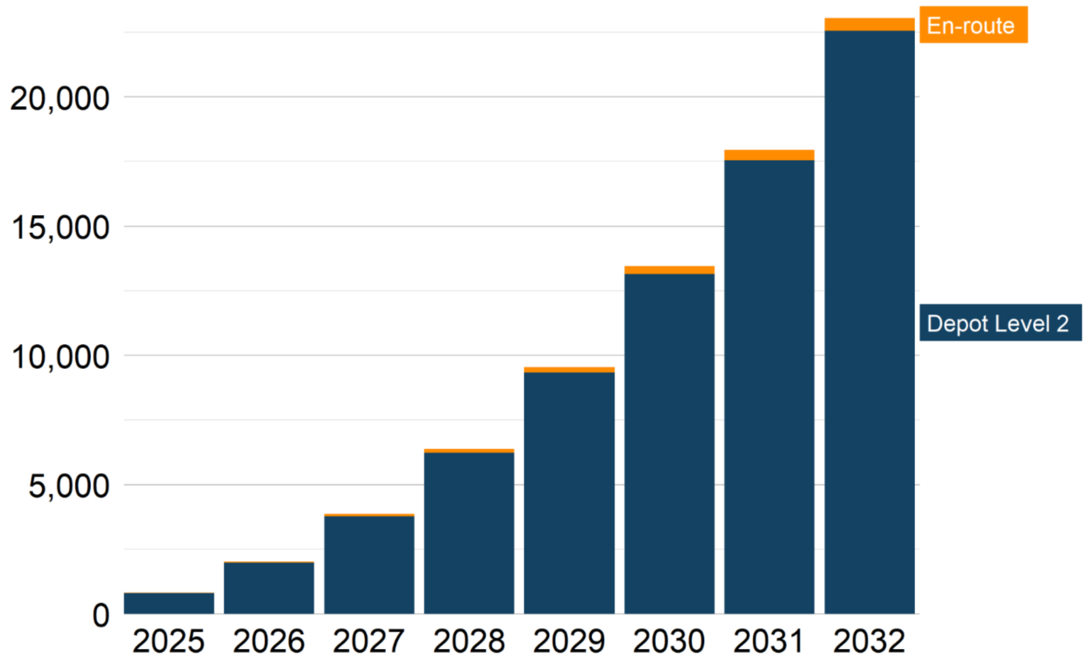
[14] As of June 2024 , https://www.atlasevhub.com/materials/ev-market-dashboard/

[15] A national study by JD Power found that 68% of EV owners in the U.S. use a Level 2 permanently mounted charger at home, with additional drivers using a portable Level 2 charger. In addition, a majority (60%) of current Level 1 users say they are likely to upgrade their home charging station to Level 2. https://www.jdpower.com/business/press-releases/2023-us-electric-vehicle-experience-evx-home-charging-study

[16] We model these as 350kW en-route chargers, but in reality they could be a range of power levels: we model demand for these fast chargers from class 2b/3 vehicles as being incremental additions to light-duty vehicle demand and therefore model a utilization rate of ten class 2b/3 vehicles per day at each en-route fast charging port in 2032.

[17] U.S. Department of Energy, "Alternative Fuels Data Center, https://afdc.energy.gov/stations#/find/nearest

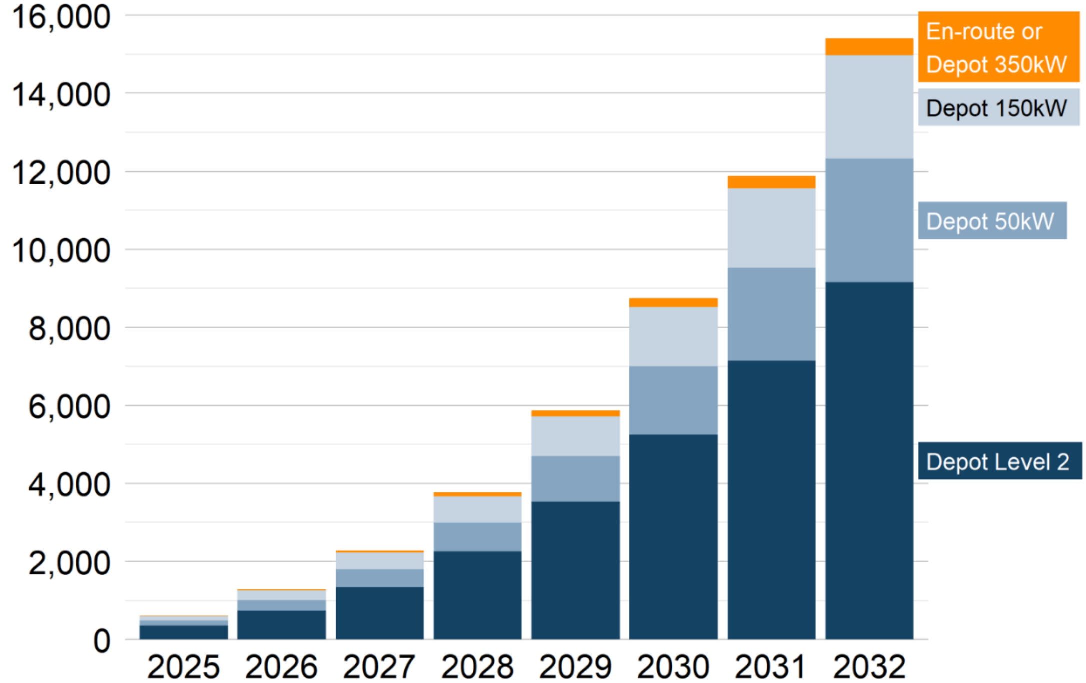
Figure 2. Cumulative projected number of charging ports needed for ACT-compliant adoption of Class 2b and 3 fleet vehicles in Massachusetts, by charger type



To power its Class 4-8 straight trucks and tractor-trailers, we model Massachusetts as needing approximately 15,400 charging ports of varying power levels by 2032 under ACT. Again, most ports are needed at depots. Overall, we model that for class 4-8 vehicles, Massachusetts will need:

- 9,200 Level 2 ports at depots, or one for every 15 Class 4-8 vehicles registered in the state
- 5,800 50kW and 150kW DC fast charging ports at depots, or one for every 24 Class 4-8 vehicles registered
- 440 350 kW DC fast charging ports at depots and en-route, or one for every 310 Class 4-8 vehicles registered.

Figure 3. Cumulative projected number of charging ports needed for ACT-compliant adoption of Class 4-8 vehicles in Massachusetts, by charger type



Electricity Consumption Under ACT

This modeling effort also produced an estimate of the electricity usage associated with this level of EV adoption in Massachusetts. We model that by 2032, these medium- and heavy-duty vehicles will consume 1,545 GWh of electricity per year at depots and en-route chargers.[18] While significant, this represents only 3.0 percent of total annual electricity sales in the state today.[19] Needed distribution system upgrades across the state are more challenging to model and not within the scope of this analysis,[20] but could be significant especially at larger charging sites. In addition to efforts to optimize charging at fleet sites, regulatory and utility efforts to support automated load management in transportation programs and planning can help minimize needed upgrades.[21]

[18] Again, these calculations assume all modeled vehicles are battery electric.
[19] This calculation is performed using 2022 electricity sales, the latest available from the U.S. Energy Information Administration. https://www.eia.gov/electricity/data/state/xls/861/HS861%202010-.xlsx
[20] Simple calculations of total charger nameplate capacity are not appropriate as they don't account for management of charging loads at the site (including against other site loads), existing distribution system capacity, shifts in operations to avoid local peaks, or actions by utilities to account for automated load management in distribution planning decisions.
[21] See, for example, the California Public Utilities Commission Decision in Rulemaking 18-12-006, December 21, 2020, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M355/K794/355794454.PDF