

July
2017

Electric Vehicles: Impacts on Transportation Revenue



Charles D. Baker, Governor

Karyn E. Polito, Lieutenant Governor

Stephanie Pollack, MassDOT Secretary & CEO



Technical Memo Document Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Zero Emission Vehicles: Impacts on Transportation Revenue		5. Report Date July 7, 2017	
		6. Performing Organization Code	
7. Author(s) Song Gao, Michael Plotnikov		8. Performing Organization Report No.	
9. Performing Organization Name and Address University of Massachusetts, Amherst 130 Natural Resources Road, Amherst, MA 01003		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No.	
12. Sponsoring Agency Name and Address Massachusetts Department of Transportation Office of Transportation Planning Ten Park Plaza, Suite 4150, Boston, MA 02116		13. Type of Report and Period Covered Final Report April 2017 – July 2017	
		14. Sponsoring Agency Code n/a	
15. Supplementary Notes			
16. Abstract <p>The maintenance of transportation infrastructures has traditionally been funded from federal and state taxes collected by the state from fossil fuel distributors, included into fuel price at the pump and ultimately paid by all internal combustion engine (ICE) vehicle road users. Zero emission vehicles (ZEVs), use alternative energy sources completely or partially, and do not refuel (or as much) at pumps that collect state and federal fuel taxes. As a result, they do not contribute as much as ICE vehicles do to the upkeep of transportation infrastructures they use.</p> <p>At the request of the Massachusetts State legislature, the Massachusetts Department of Transportation (MassDOT) will conduct a study on the feasibility and advisability of assessing surcharges, levies, or other assessments to offset the projected gas tax revenue loss from the purchase or operation of ZEVs. The objective of this study was to provide MassDOT with an evidence base of the existing research on this topic and efforts elsewhere to implement such assessments.</p>			
17. Key Word Zero-Emission Vehicle, ZEV, Battery Electric Vehicle, BEV, Plug-in Hybrid Electric Vehicle, PHEV, Fuel Cell Electrical Vehicle, FCEV, road user fee, fuel tax		18. Distribution Statement	
19. Security Classification (of this report) unclassified	20. Security Classification (of this page) unclassified	21. No. of Pages 15	22. Price n/a

Massachusetts Department of Transportation (MassDOT)

**Zero Emission Vehicles: Impacts on Transportation Revenue
Technical Memo**

Principal Investigator

Song Gao, Associate Professor
214C Marston Hall, University of Massachusetts, Amherst
Tel: 413-545-2688
Email: sgao@umass.edu

Project Champion/Technical Representative

Jules Williams, Manager of Sustainable Transportation
Office of Transportation Planning
Tel: 857-368-9024
E-mail: Jules.Williams@state.ma.us

Date: August 24, 2017

Acknowledgements

Prepared in cooperation with the Massachusetts Department of Transportation, Office of Transportation Planning, and the United States Department of Transportation, Federal Highway Administration.

The research team would like to acknowledge the efforts of Mr. Jules Williams, Manager of Sustainable Transportation, Office of Transportation Planning for his support and guidance. In addition, the research team would like to acknowledge the contribution of Nicholas Zavalas from the Office of Transportation Planning for providing the research team with valuable feedback from MassDOT; Melissa Paciulli from the UMass Transportation Center for her contribution to interagency coordination; and Frances Fahey for her help with proofing of the final draft of this Memo.

Disclaimer

The contents of this report reflect the views of the author, who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Massachusetts Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

1. Background

The maintenance of transportation infrastructures has traditionally been funded from federal and state taxes on fossil fuels. Zero emission vehicles (ZEVs) use alternative energy sources completely or partially, and do not use (or as much) fuels as traditional internal combustion engine (ICE) vehicles. As a result, they may not contribute as much funding to the upkeep of transportation infrastructures they use as compared to ICE vehicles.¹

There are three types of ZEVs:

- Battery electric vehicles (BEVs) run entirely on electricity provided by an internal battery that is recharged from the electrical grid.
- Plug-in hybrid electric vehicles (PHEV) combine a conventional gasoline-powered engine with a secondary electric motor and a battery that can also be recharged from the electrical grid.
- Fuel cell electrical vehicles (FCEV) run on electricity produced from a fuel cell using hydrogen gas.

2. Objectives

At the request of the Massachusetts Legislature, the Massachusetts Department of Transportation (MassDOT) will be undertaking a study on the feasibility and advisability of assessing surcharges, levies, or other assessments to offset the projected gas tax revenue loss from the purchase or operation of ZEVs. The objective of this study is to provide MassDOT with an evidence base of the existing research on this topic and efforts elsewhere to implement such assessments.

Specifically, a literature synthesis is provided to help answer the following questions:

- Which states have implemented or are considering assessments on ZEVs to offset their projected fuel tax revenue loss? Are these assessments established by vehicle type? Do the assessments include a fixed annual payment or a mileage-based fee?
- What has been the experience of states that have implemented ZEV assessments?
- What have been the major findings and recommendations of studies on ZEV assessments, in particular of studies commissioned by other states?

3. Literature Synthesis

The literature synthesis consists of three parts. The first part provides a brief review of the states that have imposed ZEV assessments or are actively considering the implementation of such assessments. The second part describes the experience of states that have implemented assessments on ZEVs. The third part discusses the findings of studies on ZEV assessments, with an emphasis on studies commissioned by state DOTs or other public agencies.

There have been a number of approaches taken to establish ZEV assessments. The most commonly discussed approaches include the following (1, 2):

- Electric Vehicle Registration Fee (charged annually upon renewal)
- Electric Vehicle License Plate Fee (charged once per ownership)

¹ The appendix contains background on sources of transportation revenue in Massachusetts and illustrative differences in gas tax revenue paid by vehicle type.

- Volumetric Electricity Charge Fee (charged per kW·h)
- Alternative Fuels Matrix Conversion Fee (charged per converted BTU equivalent)
- Vehicle-Miles Traveled Fee (charged per mile)

The first two approaches are not related to the level of road use by individual vehicle, but have a low implementation cost and are less prone to tax evasion. As ZEVs are still at the early stage of adoption, and their presence on the roads is almost negligible, registration and licensing fees are currently viewed as the preferred approaches for implementation. The last three approaches are either directly or indirectly tied to road usage and are more expensive to collect, with potentially additional investments in equipment and infrastructure (3).

3.1. States That Have Implemented or Are Considering Implementing Assessments on ZEVs

Currently, 16 states have levied fees for ZEVs: Colorado, Georgia, Idaho, Indiana, Michigan, Missouri, Nebraska, North Carolina, South Carolina, Oklahoma, Tennessee, Virginia, West Virginia, Washington, and Wyoming. In addition, California has enacted legislation to impose a fee on ZEVs that will start in 2020 (4). Fees ranging from \$50 to \$300 are charged annually. No state has implemented a distance-based fee to date. A summary of fees that states have levied on ZEVs is presented in Table 1.

Table 1. States with Fees Assessed on ZEVs

State	Year Introduced	BEV Fee, \$/year	PHEV Fee, \$/year	Notes
California	2017	100	100	The bill will be enacted in 2020.
Colorado	2013	50	50	Any plug-in vehicles.
Georgia	2015	200/300 ¹	200 ²	¹ Non-commercial/commercial EVs. ² The fee is optional for PHEVs.
Idaho	2015	140	75	
Indiana	2017	150	50	
Michigan	2015	135/235	47.50/117.50	Under 8,000 lbs./over 8,000 lbs.
Missouri	2014	75	75	Non-passenger ZEVs extra.
Nebraska	2011	75	75	
North Carolina	2015 (2013)	130 (100)	130 (100)	
South Carolina	2017	120	60	Effective July 1, 2017. The fee is biennial.
Oklahoma	2017	100	30	Effective January 1, 2018.
Tennessee	2017	100	-	Effective July 1, 2017.
Virginia	2014	64 (50) ³	-	³ If revenue is not used for roads.
West Virginia	2017	200 ⁴	100	⁴ Including hydrogen-propelled vehicles.
Washington	2016 (2012)	100+50 ⁵ (100)	-	⁵ Additional charge on EVs with range in excess of 30 miles.
Wyoming	2016 (2014)	50 (50) ⁶	-	⁶ Payment frequency not specified.

Of all states listed in Table 1, only California has explicitly identified and imposed a fee on FCEVs together with other ZEVs. While fuel cell is indeed a very promising technology to propel vehicles in the future, FCEVs are still extremely rare, few such vehicles can be found anywhere in the United States in private ownership except California. The vast majority of them are leased vehicles, and there are only about two dozen charging stations in the entire state. Another state, West Virginia, imposed an annual registration fee of \$200 for a vehicle fueled with hydrogen or natural gas. This fee may also be applicable to FCEVs. Additional details on those states' legislative acts that have imposed additional fees on ZEVs are presented as follows.

California

State Bill 1, Chapter 5 (2017)

Effective January 1, 2020, a fee of \$100 over and above standard vehicle registration fees is imposed on all ZEVs, including Electric Vehicles (EV), PHEVs, and FCVs. The fee is going to be collected annually (5).

Colorado

House Bill 1110, Section (25) (a) (2013)

Effective January 1, 2014, a fee of \$50 over and above standard vehicle registration fees is imposed on all plug-in electric vehicles. Out of this amount, \$30 is credited to a road fund, and \$20 is credited to an EV fund. The fee is collected annually (6).

Georgia

House Bill 170, Section 3.2 (2015)

The bill imposes a fee of \$200 in addition to standard vehicle registration fees, non-commercial alternative fuel vehicles, including ZEVs. Currently, Georgia charges the highest registration fee for non-commercial electric vehicles at \$200, which is an optional fee for plug-in-hybrid electric vehicles. The owner of the plug-in-hybrid may choose to pay a fee in order to enjoy benefits that include access to high-occupancy vehicle (HOV) lanes and high-occupancy toll lanes, regardless of the number of passengers. Also, a fee of \$300 on top of standard vehicle registration fees has been levied on commercial alternative fuel vehicles, including ZEVs. The fee is collected annually (7).

Idaho

House Bill 312 (2015)

The bill institutes a fee of \$140 in addition to standard vehicle registration fees on all electric vehicles. Also, a fee of \$75 in addition to standard vehicle registration fees has been levied on plug-in hybrids. The fee is collected annually (8).

Indiana

House Bill 1002 (2017)

The bill requires an owner of an electric vehicle (powered by battery or other electrical device where electricity is not generated by ICE) to pay a supplemental registration fee of \$150, with an increase every five years based on a combination of consumer price index and mean Indiana personal income factor. The bill also requires a person who registers a hybrid vehicle (including plug-in hybrid) to pay a supplemental registration fee of \$50, with an increase every five years

based on a combination of consumer price index and mean Indiana personal income factor. The fee is collected annually (9).

Michigan

House Bill 4736 (2015)

The bill imposes a fee of \$135 for electric vehicles under 8,000 pounds and \$235 for vehicles propelled solely by electricity over 8,000 pounds, in addition to standard vehicle registration fees. A fee of \$47.50 on hybrid electric vehicles up to 8,000 pounds and \$117.50 for hybrid electric vehicles weighing over 8,000 pounds in addition to standard vehicle registration fees. “Hybrid electric vehicle” means a vehicle that can be propelled at least in part by electrical energy and uses a battery storage system of at least 4 kilowatt-hours, but is also capable of using gasoline, diesel fuel, or alternative fuel to propel the vehicle. The fee is collected annually (10).

Missouri

Revised Statutes 142.803 and 142.869 (2014)

The bill imposes a fee of \$75 for passenger alternative fuel vehicles, including ZEVs, on top of standard vehicle registration fees. The fee for commercial alternative fuel vehicles ranges from \$75 to \$1,000, depending on weight. The fee for buses is \$75 or \$150, depending on the use of the bus. The fee is collected annually (11).

Nebraska

Legislative Bill 289 (2011)

Effective January 1, 2014, a fee of \$75 in addition to standard vehicle registration fees is imposed on all alternative fuel vehicles, including ZEVs. The fee is collected annually (12).

North Carolina

State Bill 402 (2013)

The bill institutes a fee of \$100 in addition to standard vehicle registration fees on all electric vehicles. Also, a fee of \$50 on top of standard vehicle registration fee has been levied on plug-in hybrids. The fee is collected annually.

House Bill 97 (2015)

The bill institutes a fee of \$120 in addition to standard vehicle registration fees on all plug-in electric vehicles. The fee is collected annually (13).

Oklahoma

State Bill 402 (2017)

The bill institutes a fee of \$100 upon every electric-drive motor vehicle to be registered and a fee of \$30 upon every hybrid-drive motor vehicle to be registered. The fee is collected annually (14).

South Carolina

State Bill 3516 (2017)

An additional \$120 biennial fee for electric vehicles and \$60 biennial fee on hybrid vehicles will go to the Trust Fund, to make up for the lost motor fuel user fees from these more efficient vehicles. (15).

Tennessee

Governor's IMPROVE Act, amendment House Bill 234 and State Bill 1221 (2017)

A fee of \$100 over and above standard vehicle registration fees is imposed on all vehicles propelled solely by electricity (EV). Hybrid vehicles are excluded. The fee is collected annually (16).

Virginia

State Bill 127 (2014)

A fee of \$64 over and above standard vehicle registration fees is imposed on all alternative fuel vehicles, including ZEVs. If the jurisdictions receiving the revenues from this fee do not use the funds for transportation purposes, the fee within that jurisdiction will fall to \$50 in subsequent years. Hybrid vehicles are excluded. The fee is collected annually (17).

West Virginia

State Bill 1006 (2017)

The annual registration fee for a vehicle fueled with hydrogen or natural gas is \$200, which may be also applicable to FCEV. (There is no specific mention of FCEV in SB 1006, and hydrogen vehicles are listed in the same category as compressed gas vehicles. The legislation's primary target may be alternative fuels used by modified ICE vehicles, not ZEVs.) The annual registration fee for a vehicle operating on a combination of electricity and petrochemical fuels is \$100. The annual registration fee for a vehicle operating exclusively on electricity is \$200. The fees imposed in addition to any other vehicle registration fees and are collected annually (18).

Washington

House Bill 2660 (2012)

The bill institutes a fee of \$100 in addition to standard vehicle registration fees on all electric vehicles. An additional fee of \$50 will be imposed on vehicles that have a range in excess of 30 miles in purely electric mode. The fee will expire if the legislature imposes a vehicle miles traveled fee or tax in the state. The fee is collected annually (19).

Wyoming

House Bill 9 (2016)

The bill institutes a one-time fee of \$50 in addition to standard vehicle registration fees for plug-in EVs. Hybrid vehicles are excluded from this fee.

House Bill 2 (2016)

The bill provides a clarification that the fee of \$50 in addition to standard vehicle registration fees for EVs should be paid annually. (This was not clear from H.B. 9 enacted in 2015.) (20)

In addition, nine states are considering fees for ZEVs, including Arizona (21), Illinois (22), Kansas (23), Kentucky (24), Maine (25), Minnesota (26), Montana (27), New Hampshire (28), and Wisconsin (29). The fees being considered range from \$30 to \$150 and are expected to be charged annually on top of standard registration fees. All states are still actively debating the proposals in either their Houses of Representatives or in their Senates. In Montana, the bill passed the legislature but has recently been vetoed by the governor (30). A summary of these ZEV fee proposals is presented in Table 2.

Table 2. States Debating Assessments on ZEVs

State	BEV Fee, \$/year	PHEV Fee, \$/year	Notes
Arizona			Currently, the registration fee for ZEV is less than the registration fee for similar ICE vehicles.
Illinois			Currently, the registration fee for ZEV is less than the registration fee for similar ICE vehicles.
Kansas	115	40	House Bill 2060 currently in State Senate
Kentucky	100	-	
Maine	350/200	250/200	Two proposals are considered
Minnesota	125/85	85/75	Two proposals are considered
Montana	85 (300) ²	30 (150) ²	Currently in Senate ¹ ² Initially proposed fee
New Hampshire	123	77	
Wisconsin	125	30	Currently in State Assembly

¹On May 4, 2017, H.B. 205 was vetoed by Governor Steve Bullock.

Similar to states that have already enacted fees on ZEVs, no references to FCEVs are made in Table 2 due to the almost nonexistent market at the present time. Also, there are no current proposals for the distance-based fee on such vehicles in states where ZEV legislation is still being debated. Arizona is the only state to attempt to introduce such a fee. Arizona House Bill 2257, introduced by Rep. Steve Farley (D-AZ), was based on the Oregon Vehicle-Miles Traveled (VMT) fee study and proposed charging electric car owners up to 1.43 cents per mile traveled. The bill failed at the committee level, before even being considered by the House. The major reason why distance-based fees are not currently under consideration is because of the relatively low number of ZEVs to justify implementation of any but the most basic fee system.

Finally, on several occasions, the state of Vermont, has considered the implementation of ZEV fees and has conducted three studies to evaluate options. However, to date, no further proposals for new ZEV fee legislation have followed the aforementioned studies (1, 2, 3).

3.2. The Experience of States That Have Implemented Assessments for ZEVs

As most of the states implemented additional fees on ZEVs quite recently, the experience from imposing new fees is limited and primarily related to changes in consumer demand for this category of vehicles.

Prior to its implementation of ZEV fees, Georgia was one of the United States' most dynamically growing ZEV markets. When the state legislature repealed its generous \$5,000 tax credit on ZEVs in July 2015 and imposed a \$200 registration fee, which is the largest fee levied to ZEVs to date in the entire United States, sales of ZEVs tumbled by almost 90% (31).

In contrast, states that introduced new road use fees but still continue offering tax credits to new buyers of ZEVs, as well as other incentives for ZEV owners, experienced only a minor drop in sales (3, 4).

3.3. Major Findings and Recommendations from Studies of Assessments for ZEVs

Currently, three states have published their research on ZEV fees: California, Tennessee, and Vermont.

California

A study conducted in California indicated that the market penetration of ZEVs in the state is the highest in the country; that ZEV share continues to grow dynamically; and that the state budget will experience a noticeable revenue loss if fees are not imposed on ZEVs. The study recommends imposing such a fee when the share of ZEVs reaches 10% and the market of such vehicles can be considered mature and hence does not need any special protection, which is expected to occur around the year 2020 (5, 32).

Tennessee

A study conducted in Tennessee found that new fees for ZEVs were less than what typical drivers of ICE vehicles pay in gas taxes in almost all states that implemented such fees, with the exception of Georgia, where ZEV owners would pay more than owners of ICE vehicles. The study concluded that missing revenues from ZEVs are not the leading issue among state transportation funding challenges, as the share of hybrid and electric vehicles on the road is insignificant in most states. However, it also suggested that collecting such fees strives to establish a more fair and equitable approach to collecting revenues for roadway users (4).

Vermont

Vermont conducted three studies that have focused on user fees for alternative fuel vehicles. Two studies have focused on ZEVs (2, 3), and the third includes ZEVs along with other alternative fuel vehicles (1). None of the reports recommends any additional fees on ZEVs at this stage, citing both their insignificant number and current policy to promote their faster adoption. Another argument against such fees specifically mentioned that owners of such vehicles in fact already contribute more than enough to the state budget through sales tax than the proposed fee, due to the large difference in sales price of ZEVs versus comparable gasoline-driven vehicles. Authors of the research (2) recommend, if such a fee is in fact imposed, it should be paired with additional incentives for the ZEV buyers that should be funded outside of the state transportation program. The latest study (3) suggested that additional fees on ZEVs should be imposed when their share in new car sales or state vehicle fleets exceeds 15%, at which time the announced state clean energy target is reached and ZEV technology is considered mature, which is expected to happen around the year 2025. At that point, EVs would be considered mainstreamed and will not need additional effort to be promoted. According to the report, the fee amounts should be reasonable and reflect factors such as estimated lost gas tax revenues due to factors such as battery technology and estimated average vehicle use at the time the fee is put in place.

The California and Vermont studies (1, 2, 3, 32) address the timing of ZEV fee implementation. These studies suggest implementation of road use fees for ZEVs must provide adequate revenue while not discouraging early adoption of alternative vehicle technologies that many states try to promote. Proposed milestones to introduce fees include:

- ZEVs comprise a given percentage of new and used vehicle purchases.

- Smart grid is available statewide, and the energy use of EVs and the amount of electricity powering transportation can be tracked.
- Transportation accounts for a given percentage of electricity demand.
- Goals to reach a specific percentage of ZEVs in state's fleet are met.
- Fuel tax revenues fall by a given percentage or amount.

Independent Studies Not Commissioned by States

In addition, a number of independent studies should be mentioned. While many of these studies support special government-sponsored incentives to promote ZEVs among other “environmentally friendly” technologies and argue that no additional fees should be imposed due to their overall benefits to society (33, 34), others argue that in fact all the environmental benefits of ZEVs are questionable, as the majority of electricity used in such vehicles is generated using traditional fossil fuel-burning electric plants, and the process of manufacturing such vehicles requires more energy than that of comparable gasoline-driven vehicles. Proponents with such a point of view not only demand additional ZEV fees but also support the removal of all government-sponsored incentives to promote such technologies (35).

On the other hand, ZEV proponents argue that owners of ZEVs vehicles are paying enough tax. Some studies shows that EV owners pay more in state taxes than do owners of conventional gasoline vehicles, over the typical lifespan of a vehicle. For example, a study done in Minnesota (36) pointed out that because electric cars are priced higher , the state receives more in taxes from their drivers than it does from ICE vehicle drivers, a difference large enough that it takes about a decade to make up.

Finally, some studies argue that levying assessments on electric and hybrid vehicles is not sufficient to raise a significant amount of revenue to cover the costs of transportation infrastructure expansion and maintenance (34). For example, California has accounted for almost half of all ZEVs sold in the United States in 2016. Out of all vehicles sold in the state in 2016, about 4.7% were PHEVs and 1.9% were BEVs. However, even in California, the new fee assessed on alternative fuel vehicles is expected to generate only about \$200 million over the next decade. By comparison, an increase of gasoline tax by 12 cents per gallon should generate approximately \$24.4 billion, and a proposed “transportation improvement fee,” which is going to be assessed on a sliding scale on all vehicles based on their cost, should generate approximately \$16.3 billion. As a result, it has been suggested that states consider pairing new fees on ZEVs with increases in fuel tax.

References

1. Vermont Agency of Transportation. *Act 153: Section 39 Report: Alternative Fuel Vehicle User Fee Options*. Montpelier, VT, 2012.
2. Vermont Department of Public Service. *Section 28 Report: A Study on Replacing Motor Fuel Tax Revenues Not Collected from Plug-In Electric Vehicles*. Montpelier, VT, 2013.
3. Vermont Agency of Transportation. *Sec. 15. 2016 Plug-In Hybrid and Electric Vehicle Registration Fees: Legislative Report*. Montpelier, VT, 2016.
4. Davis, R., M. N. Murray, and J. G. Welch. *How Much Should Hybrids and Electric Vehicles Contribute to Roadway Funding?* The Howard J. Baker Jr. Center for Public Policy, University of Tennessee, Knoxville, TN. 2017.
5. California State Bill 1, Chapter 5. SB-1 Transportation Funding. 2017. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1 Accessed May 5, 2017.
6. Colorado House Bill 1110, Section (25) (a). Concerning Charges Related to Motor Vehicles That Travel on the Public Highways of the State, and, in Connection Therewith, Making an Appropriation. 2013. [http://www.leg.state.co.us/clics/clics2013a/csl.nsf/fsbillcont3/0602C7EBF986A79387257AEE00574BCD/\\$FILE/1110_enr.pdf](http://www.leg.state.co.us/clics/clics2013a/csl.nsf/fsbillcont3/0602C7EBF986A79387257AEE00574BCD/$FILE/1110_enr.pdf). Accessed May 25, 2017.
7. Georgia House Bill 170, Section 3.2 (2015). <http://www.legis.ga.gov/Legislation/20152016/153458.pdf>. Accessed May 12, 2017.
8. Idaho House Bill 312.2015. <https://legislature.idaho.gov/sessioninfo/billbookmark/?yr=2015&bn=H0312>. Accessed May 12, 2017.
9. An Act to Amend the Indiana Code Concerning Transportation and to Make an Appropriation. Public Law Number 218. 2017. <https://iga.in.gov/legislative/2017/bills/house/1002#document-e6c910ce>. Accessed July 7, 2017.
10. Michigan House Bill 4736. 2015. <http://www.legislature.mi.gov/documents/2015-2016/publicact/pdf/2015-PA-0174.pdf>. Accessed May 25, 2017.
11. Missouri Revised Statutes 142.803 and 142.869. 2014. <http://revisor.mo.gov/main/OneSection.aspx?section=142.869&bid=7150&hl=142.803%u2044142.869>. Accessed May 15, 2017.
12. Nebraska Legislative Bill 289. 2011. <http://www.revenue.nebraska.gov/info/legislation/2011/LB289.pdf>. Accessed May 5, 2017.
13. North Carolina State Bill 402. 2013. <http://www.ncleg.net/Sessions/2013/Bills/Senate/PDF/S402v3.pdf>. Accessed May 10, 2017.
14. Oklahoma House Bill 1449. 2017. http://webserver1.lsb.state.ok.us/cf_pdf/2017-18%20ENR/hB/HB1449%20ENR.PDF. Accessed July 7, 2017.
15. South Carolina Infrastructure and Economic Development Reform Act of 2017 (H. 3516). 2017. http://www.scstatehouse.gov/sess122_2017-2018/bills/3516.htm. Accessed July 7, 2017.
16. Tennessee Governor's IMPROVE Act, amendment House Bill 234 and State Bill 1221. 2017. <https://www.tn.gov/nexttennessee/section/the-improve-act-main-section>. Accessed June 1, 2017.

17. Virginia State Bill 127. 2014. <https://lis.virginia.gov/cgi-bin/legp604.exe?141+ful+CHAP0014+pdf>. Accessed June 1, 2017.
18. West Virginia State Bill 1006. 2017. http://www.wvlegislature.gov/Bill_Text_HTML/2017_SESSIONS/1X/bills/sb1006%20enr.pdf. Accessed July 5, 2017.
19. Washington House Bill 2660. 2012. <http://lawfilesexternal.wa.gov/biennium/2011-12/Pdf/Bills/Session%20Laws/House/2660.SL.pdf>. Accessed May 5, 2017.
20. Wyoming House Bill 2. 2016. <https://legiscan.com/WY/text/HB0002/id/1351762/Wyoming-2016-HB0002-Enrolled.pdf>. Accessed May 5, 2017.
21. Latzman, P. Fees Proposed for Electric Car Owners in Arizona. KJZZ.org, Dec. 28, 2016. <http://kjzz.org/content/406208/fees-proposed-electric-car-owners-arizona>. Accessed May 25, 2017.
22. Tabuchi, H. Behind the Quiet State-by-State Fight Over Electric Vehicles. *New York Times*, March 11, 2017.
23. Carpenter, T. Kansas House Bill Calls for Special Registration Fees for Electric, Hybrid Vehicles. *The Topeka Capital-Journal*, Jan. 28, 2017. <http://cjonline.com/news/local/2017-01-28/kansas-house-bill-calls-special-registration-fees-electric-hybrid-vehicles>. Accessed May 13, 2017.
24. Barton, R. Bill Would Place Fee on Kentucky Electric Car Owners. WFPL 89.3, Dec. 15, 2015. <http://wfpl.org/bill-fees-kentucky-electric-cars-gas-tax/>. Accessed May 14, 2017.
25. McGuire, P. Maine Lawmakers Consider Raising Fuel Tax to Boost Road, Bridge Repairs. *Portland Press Herald*, Apr. 11, 2017. <http://www.pressherald.com/2017/04/11/lawmakers-consider-7-cent-increase-on-gas-tax-and-surcharges-on-hybrid-vehicles-to-sustain-highway-fund/>. Accessed May 14, 2017.
26. Hughlett, M. Electric Vehicle Fee Proposed for Minnesota. *Star Tribune*, Mar. 21, 2017.
27. Carter, T. Bipartisan Support Emerges for Electric Car Fee That Would Affect Thousands in Montana. *Bozeman Daily Chronicle*, Feb. 6, 2017. http://www.bozemandailychronicle.com/news/mtleg/bipartisan-support-emerges-for-electric-car-fee-that-would-affect/article_e2efa572-72ca-57eb-8ff2-3bae4036844d.html. Accessed May 2, 2017.
28. Morris, A. Fee on Fuel-efficient Vehicles Back on the Table. *Concord Monitor*, Feb. 14, 2017.
29. Bence, S. Wisconsin Is Latest State to Consider Fees on Electric, Hybrid Vehicles. WBUR 90.9, Jan. 5, 2015. <http://www.wbur.org/hereandnow/2015/01/05/wisconsin-hybrid-fee>. Accessed May 5, 2017.
30. Montana Office of the Governor. House Bill 205 Governor Veto. 2017. <http://leg.mt.gov/bills/2017/AmdHtmH/HB0205GovVeto.pdf>. Accessed June 9, 2017.
31. Badertscher, N. Electric Car Sales Hit the Brakes as Tax Credit Axed and Fee Added. PolitiFact Georgia, Nov. 2, 2015. <http://www.politifact.com/georgia/statements/2015/nov/02/don-francis/electric-car-sales-hit-brakes-tax-credit-axed-and/>. Accessed May 2, 2017.
32. Governor's Interagency Working Group on Zero-Emission Vehicles. *2016 ZEV Action Plan. An updated roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025*. Office of Governor Edmund G. Brown Jr., Sacramento, CA, 2016.

33. Fulton, L., J. Schiffman, and G. Tal. *Can California Sustain Its Commitment to Providing Zero-Emission Vehicle Rebates?* Policy Brief. Institute of Transportation Studies, University of California, Davis, 2016.
34. Beyond the Gas Tax: Funding California transportation in the 21st century. The Next10.org. <http://next10.org/sites/next10.org/files/transportation-funding-brief-final.pdf>. Accessed May 5, 2017.
35. Gruenspecht, H. Zero Emission Vehicles: A dirty little secret. *Resources for the Future*, No. 142, 2001. <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-Resources-142-zeroemmis.pdf>. Accessed May 5, 2017.
36. McFarlane, D. Electric Vehicles Pay Their Fair Share. Great Plains Institute for Drive Electric Minnesota, 2017. <http://driveelectricmn.org/electric-vehicles-pay-their-fair-share/>. Accessed May 20, 2015.

Appendix

Massachusetts Road User Contributions to Transportation Infrastructure Funding

Massachusetts' funding for transportation infrastructure construction and maintenance is supported, in part, by several different taxes and fees collected from transportation system users. The primary taxes and fees include the following:

- Fuel Taxes – Gasoline and diesel fuel is taxed on a combination of per gallon excise taxes. The current MA gasoline tax rate is \$0.24/gallon for both gasoline and diesel fuels. Federal excise tax on gasoline is 18.4 cents per gallon and 24.4 cents per gallon for diesel fuel. It is important to note, though, that revenues from collected federal fuel tax are only partially (about 60%) used for highway and bridge construction. The remaining portion of collected revenues (about 40%) goes to earmarked programs. Also, the actual federal aid to state transportation infrastructure investments and special programs may or may not match the state contribution to the Federal Highway Trust Fund.
- Vehicle Registration Fees – the Massachusetts Registry of Motor Vehicles (RMV) levies registration fees which go into the transportation fund. Standard registration fee for passenger vehicle is \$60 and require biennial renewal.
- Purchase and Use Taxes – The 6.25% state purchase and use tax is levied on vehicle purchases.

In order to assess an average loss of potential revenues from fuel tax, Table 3 provides a comparison of different types of vehicles and their annual contributions to transportation funding in fuel taxes.

Table 3. Typical Annual Revenue Contribution to Transportation Infrastructure Maintenance from State and Federal Gas Tax by Vehicle Type.

Type of Vehicle	Average Miles per Gallon ¹	Travel on Gasoline ¹ , %	Average Annual Miles Traveled on Gasoline	Gasoline Consumption, gallons	MA fuel Tax Contribution, at \$0.24/gallon	Federal ² fuel Tax Contribution, at \$0.184/gallon
ICE	25	100	12,000	480	115	88
HEV ³	50	100	12,000	240	58	44
PHEV	42	50	6,000	143	34	26
BEV	n/a	0	0	0	0	0

Notes: ¹ U.S. EPA estimate. ² Almost all ZEVs are light vehicles. Currently, the vast majority of light vehicles are gasoline-driven. ³ Hybrid Electric Vehicles.

It should be noted, however, that ZEVs in general and BEVs in particular may travel fewer miles annually due to limited electric charging station networks and their purchase may generate greater transportation revenues than traditional vehicles from sales taxes as has been suggested by studies completed elsewhere (3,36).